

FAA TECHNICAL CENTER LETTER REPORT

PROGRAM TO COMPUTE THE
USER ERRORS OF THE
GLOBAL POSITIONING SYSTEM (GPS)

by

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INTRODUCTION

Background

C.S. Wong at Texas A&M University developed a program on a Texas Instruments 990/4 minicomputer, which computes the following parameters from the GPS satellite almanac: the satellite rise and fall times, the satellite azimuth and elevation, and the geometric dilution of precision (Reference 1). This program was modified by M. Magrogan for execution on a Digital Equipment Corporation PDP-11/34 minicomputer to analyze FAA test results (Reference 2). Additional changes and refinements to these routines allowed computation of the dilution of precision parameters on a Hewlett Packard (HP) 1000 minicomputer not only for the case of four satellites, but also for three satellites plus altitude aiding (Reference 3). The derivation of the GPS dilution of precision parameters assume that the standard deviations of the pseudorange measurement errors are equal and independent. R.J. Esposito at the FAA Technical Center has recently discussed the user error behavior for the more general case when the measurement errors are independent but not necessarily equal (Reference 4).

Scope

This report documents the programs which compute and plot the GPS user errors from pseudorange errors (biases and standard deviations which are independent but not necessarily equal) on the HP 1000 for different satellite/configurations with and without an altimeter input.

DISCUSSION

The main program EB00 and its associated routines described in this report stem from the program HD00 and routines contained in reference 3. In order to be executed, the programs require inputs which are requested with explaining comments. The algorithms and equations used in these programs are given in references 4 through 9.

Table 1 displays the input time parameters. Special attention must be given to the fact that different units (day and second) and different origins are used.

The Keplerian parameters, which are included in the almanac message and used to compute satellite trajectories, are listed in table 2. Note that parameters 9 through 14 are computed in the program EB00, with μ as the earth's universal gravitational constant.

USER MANUAL

Appendix A contains the transfer files for programs EB00, PLCOR, PLSIG, PLAEL, and PL5FI. Appendix B gives the flowcharts on programs EB00 (pages B-1 through B-10), FILE (page B-11), PLCOR/PLSIG (pages B-12 and B-13), PLAEL (pages B-14 through B-16), PL5FI (pages B-17 through B-19), and subroutines EBO6 (pages B-20 through B-23), PSUB1/PLSUB (pages B-24 and B-25), INPUT (page B-26). Appendix C provides listings of these programs and all subroutines. Each program is called on the HP computer with its name, and user prompting explicitly asks for the required inputs. Appendix D gives examples of the program outputs.

Program EB00 (Pages C-1 through C-10)

This program computes and prints out the position of three or four satellites in earth-centered earth-fixed (ECEF) coordinates and in azimuth and elevation relative

to the user, the user-satellite direction cosine matrix including time (G-matrix), the covariance matrix of the user error (sigma matrix), the square root of the diagonal elements of the sigma matrix (standard deviations), the multiple standard deviations in two, three, and four dimensions, the correlation coefficients (related to the off diagonal elements of the sigma matrix), and the user bias errors. The multiple dimensional user standard deviations are proportional to the dilution of precision parameters when the standard deviation of the pseudorange measurement errors are equal and independent.

All input data and relevant information are printed out. The data output for every point in time, for which computations are made, consists of one page. Since the program is frequently run just to generate plot files, the data printout is often not needed and may be suppressed by setting the sense switch number ϕ (ISSW(ϕ)) to the "ON" position. In this configuration, only one page with the input data is printed. The start sequence and parts of the input data of the program EBG ϕ are the same as for the program HD ϕ , and portions of the later user manual are repeated here for completeness.

The user position must be entered in geographical coordinates (latitude (LAT) and longitude (LON)) and altitude (ALT) in feet. If the location is the FAA Technical Center, this information is already stored in the program. After the program has received user position, the geographical coordinates are converted into ECEF and printed out. The next data requested are the start (TSTART) and stop (TFIN) times, the time increment (TDEL), the time of collection (TC) of the almanac, and the date of use (DTU) (see table 1).

The choice must be then be made whether the computations should be made with four satellites or three satellites. When the navigation mode utilizes three satellites plus altitude aiding, the altimeter is modeled as the fourth space vehicle located in the center of the earth. The elements in the fourth row of the G-matrix are given by 0, 0, -1, 0. If an altimeter input is not available, the program assumes that the receiver clock bias is extrapolated and the fourth row of the G-matrix is given by 0, 0, 0, 1.

The next decision concerns the input of the almanac for the satellites:

- (1) If the almanac is on a magnetic tape, it must be stated so and the entire almanac file is read from the tape. Then, the PRN numbers of the satellites are requested, and the program checks whether the data is on the tape.
- (2) The other choice is either to provide the program with the names of the data files containing an almanac for each space vehicle, or to enter the data by the keyboard.

If the pseudorange variance matrix V is identical to the unit matrix, the values are provided by the program, otherwise, the diagonal elements must be entered via the keyboard. Since each pseudorange variance may have unique value, it must be associated with the proper satellite PRN number. The time tagged pseudorange bias errors are then read from the appropriate file and stored in a array (see program FILE). Finally, the names of the three plot files are entered, and the program prints the relevant data and generates the data files for the plot programs.

PROGRAM FILE (Page C-11)

This program was developed to generate files with time tagged psuedorange bias errors (URE) for the program EB~~pp~~. The program FILE requests the number of files to be produced, the number of records for each file, the file name, and the data to be stored. Finally, it generates a URE file in the correct format to be compatible with the URE input in EB~~pp~~.

Program PLSIG/PLCOR (Pages C-12 through C-19)

Each program plots data stored in the sigma-matrix files which are described under the section entitled Data Files. Each program makes five subplots on one figure.

PLCOR plots the user error parameter versus Greenwich mean time (GMT): the four single dimensional standard deviations, the six correlation coefficients in two subplots, and the four user bias errors.

PLSIG plots the user error parameters versus GMT in a slightly different form: the upper triangular elements of the sigma matrix in three subplots, the single dimensional user standard deviations, and the user bias errors.

Both programs need the same input data: the name of the plot file, the logical unit of the output device, and the ID of the device-subroutine (Monitor: 1, 1; Printer/Plotter: 20,5). In order to scale the time axis and to select a time slot from the data file, the user enters the start and stop times and, as a way of distinguishing several plots, the date. The last entry may have any six alphanumeric characters. The plot is then generated and displayed on the selected output device.

Program PLAEL (Pages C-20 through C-22)

The program PLAEL requires the following input information: the logical unit of the output device, the ID of the device subroutine, the start and stop times, the name of the file containing the satellite azimuth and elevation angles relative to the user, and the number of satellites whose data are stored in the file. The program generates a figure with subplots of the satellite elevation and azimuth angles versus GMT. A dotted line is drawn at an elevation angle of 10 degrees above the horizon.

Program PL5FI (Pages C-23 and C-24)

This program is designed to plot the two dimensional user standard deviations versus GMT for up to five data files and in the same figure. However, any file may be plotted which contains a record of the y-value, a time in hours and minutes as the x-value. The only thing which should be changed are the titles of the axes.

PL5FI requires the same type of input information as the other plot routines: the logical unit, ID, start and stop times, and names of the files. The program generates plots with a legend for each curve since each data file is plotted in a different line style.

Subroutine Description

EB02: computes the rotation matrix, given on page C-25.
EB03: converts user geographical coordinates into the ECEF system, given on page 26.
EB05: calls EB06 and EB07 and computes satellite azimuth and elevation given, on page C-27.
EB06: computes satellite position in ECEF, given on page C-28.
EB07: computes user to satellite distance, given on page C-29.
EB08: computes the G-matrix and its transpose, and calls EB09B and MINVD, given on pages C-30 through C-32.
EB09B: multiplies two matrices, given on page C-33.
MINVD: inverts the matrices from the "Scientific Subroutine" package from DEC (Reference 6), given on pages C-34 through C-36.
EB11: multiplies a matrix and a vector, given on page C-37.
EB12: converts seconds into hours, minutes and seconds, given on page C-38.
EB14: unpacks the almanac data (with assembly language subroutine DINTF), given on pages C-39 through C-41.
DINTF: assembly language subroutine, unpacks the almanac data (with subrouinte EB14), given on page C-42.
PLSUB: plots user sigma matrix elements, single dimensional standard deviations, correlation coefficients, and bias errors, given on page C-43.
PSUB1: plots user multi dimensional standard deviations, given on page C-44.
INPUT: reads data files in plot programs, given on page C-45.

Data Files

Five types of data files are utilized, two as input for EB00, and three with data points for the plot programs. The files are:

1. Almanac Files: Each contains the date of collection of the almanac, the satellite PRN number (first record), and, in the next two lines, the eight almanac parameters in the order described in table 2.
2. URE Files: These files are generated by the program FILE for each satellite, and include the number of records and the pseudorange bias errors as a function of time per record.
3. Sigma Files: These are the files for the programs PLCOR and PLSIG. The order of the record values stored in a data block is the following:
 - a. time in hours and minutes,
 - b. upper triangular sigma matrix (10 values),
 - c. square root of the diagonal elements of the sigma matrix (4 values),
 - d. correlation coefficients (6 values),
 - e. user bias errors (4 values).This data block is then repeated for each time increment.
4. HDOP Files: Each record contains the time versus the two dimensional standard deviation in meters for the plot program PL5FI. The standard deviation and time are set equal to zero in the last record.

5. Angle Files: These are generated for the plot program PLAEL, and include the time in hours and minutes and the satellite records per data block. Each record contains the program internal satellite number and the elevation and azimuth for this satellite.

<u>Parameter</u>	<u>Start of Count</u>	<u>Unit</u>
DTU - Date of use	Beginning of Year	Day
DTC - Date of collection of Almanac	Beginning of Year	Day
T - GPS - Time	Beginning of Day	Second
TC - Collection Time of Almanac	Beginning of week (0000 hours Sunday)	Second

The used time zone is Greenwich Mean Time (GMT)

Table 1: TIME PARAMETERS USED IN PROGRAMS

<u>No. in Almanac</u>	<u>Keplerian Parameter</u>	<u>Name in Program and (GPS) - Name</u>
1	Eccentricity of ellipsoid	E (e)
2	Reference time for almanac	TOA (toa)
3	Orbit inclination	Di (i)
4	Drift rate of right ascension	OMD ($\dot{\Omega}$)
5	Square root of semi-major axis	RA (\sqrt{A})
6	Right ascension of the orbit	OMO (Ω_o)
7	Argument of perigee	W (ω)
8	Mean anomaly	MO (Mo)
9	Semi-major axis	A
10	Cosine of orbit inclination angle	cos(i)
11	Sine of orbit inclination angle	sin(i)
12	Cosine of argument of perigee	cos(ω)
13	Sine of argument of perigee	sin(ω)
14	Mean motion	$\sqrt{\mu/A^3}$

Table 2: ORDER OF KEPLERIAN PARAMETERS

REFERENCES

1. A GPS Almanac, Wong, C.S., Texas A&M University.
2. Global Positioning System (GPS) Satellite Elevation and Azimuth Angles, Magrogan, M., FAA Technical Center Report Number CT-82-100-41LR.
3. A Program to Compute the Dilution of Precision Parameters for the GPS System, Buchberger, E., FAA Technical Center Report Number CT-82-100-106LR.
4. Derivation of Global Positioning System (GPS) User Errors with Representative Examples, Esposito, R.J., FAA Technical Center Report Number CT-82-100-113LR.
5. Computer Program Development Specification for the Z-User-Set, Specification No. GP-US-305.
6. The Scientific Subroutine Package, Digital Equipment Corporation.
7. Principle of Operation of NAVSTAR and System Characteristics, Milliken, R.J., and Zoller, C.J., Navigation, Vol. 25, pages 95-106, 1978.
8. Using the Global Positioning Satellite System for Positioning and Navigation, Rhyne, T., Noe, P., and Painter, J., Altair Corporation.

APPENDIX A

Transfer Files - These files are used to load programs which consist of several subroutines.

TEB00 T=00004 IS ON CR00002 USING 00002 BLKS R=0000

0001 REL, %TEB00
0002 SEA, %TEB02
0003 SEA, %TEB03
0004 SEA, %TEB05
0005 SEA, %TEB06
0006 SEA, %TEB07
0007 SEA, %TEB08
0008 SEA, %TEB08B
0009 SEA, %TEB09B
0010 SEA, %MINYD
0011 SEA, %TEB11
0012 SEA, %TEB12
0013 SEA, %TEB14
0014 SEA, %DINTF

TPLCOR T=00004 IS ON CR00002 USING 00002 BLKS R=0000

0001 REL, %PLCOR
0002 SEA, %PLSUB
0003 SEA, %PSUB1
0004 RE, %DLTBL
0005 SEA, %INPUT
0006 SEA, %GPS

TPLSIG T=00004 IS ON CR00011 USING 00002 BLKS R=0000

0001 REL, %PLSIG
0002 SEA, %PLSUB
0003 RE, %DLTBL
0004 SEA, %INPUT
0005 SEA, %GPS

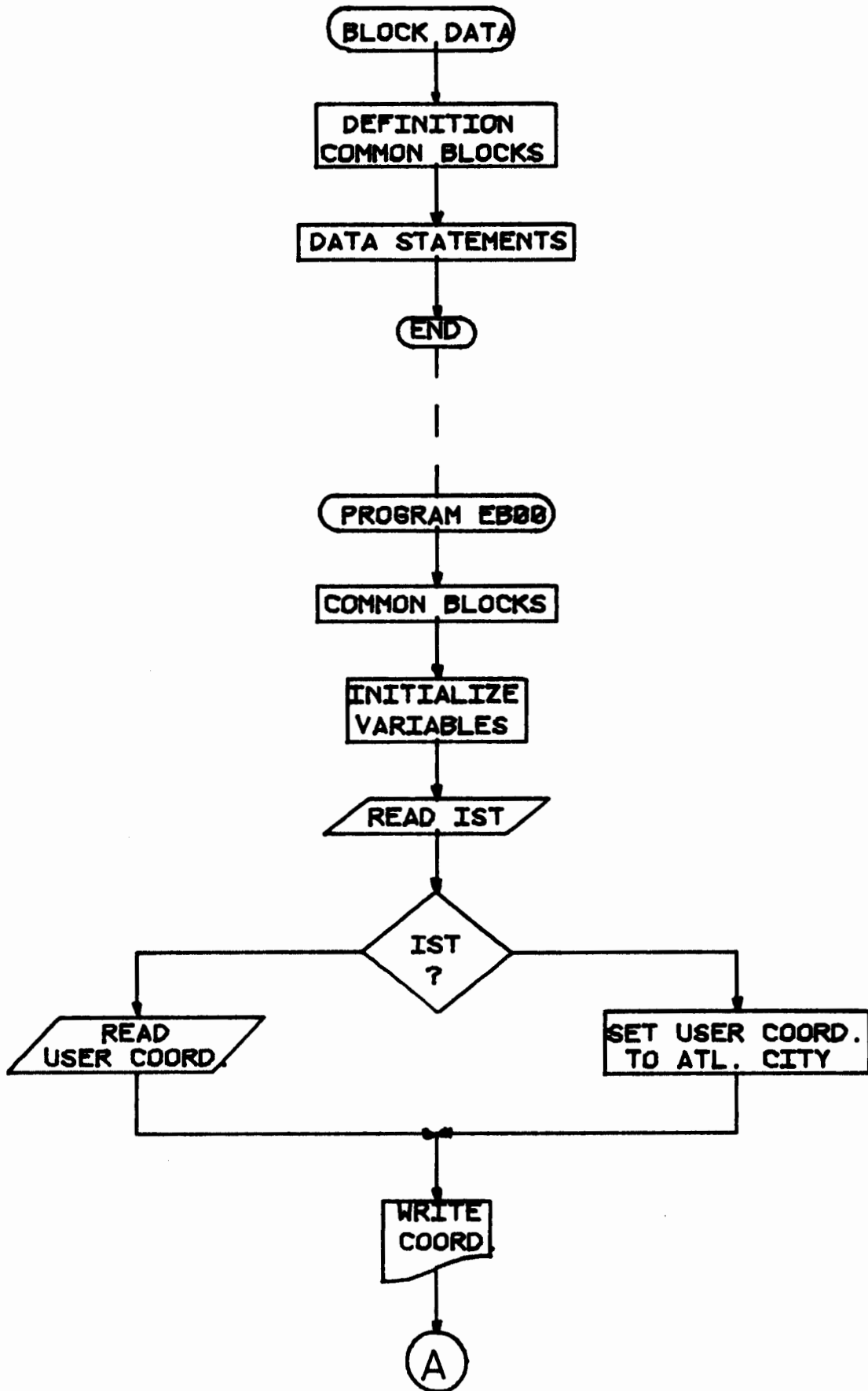
TPLAEL T=00004 IS ON CR00011 USING 00002 BLKS R=0000

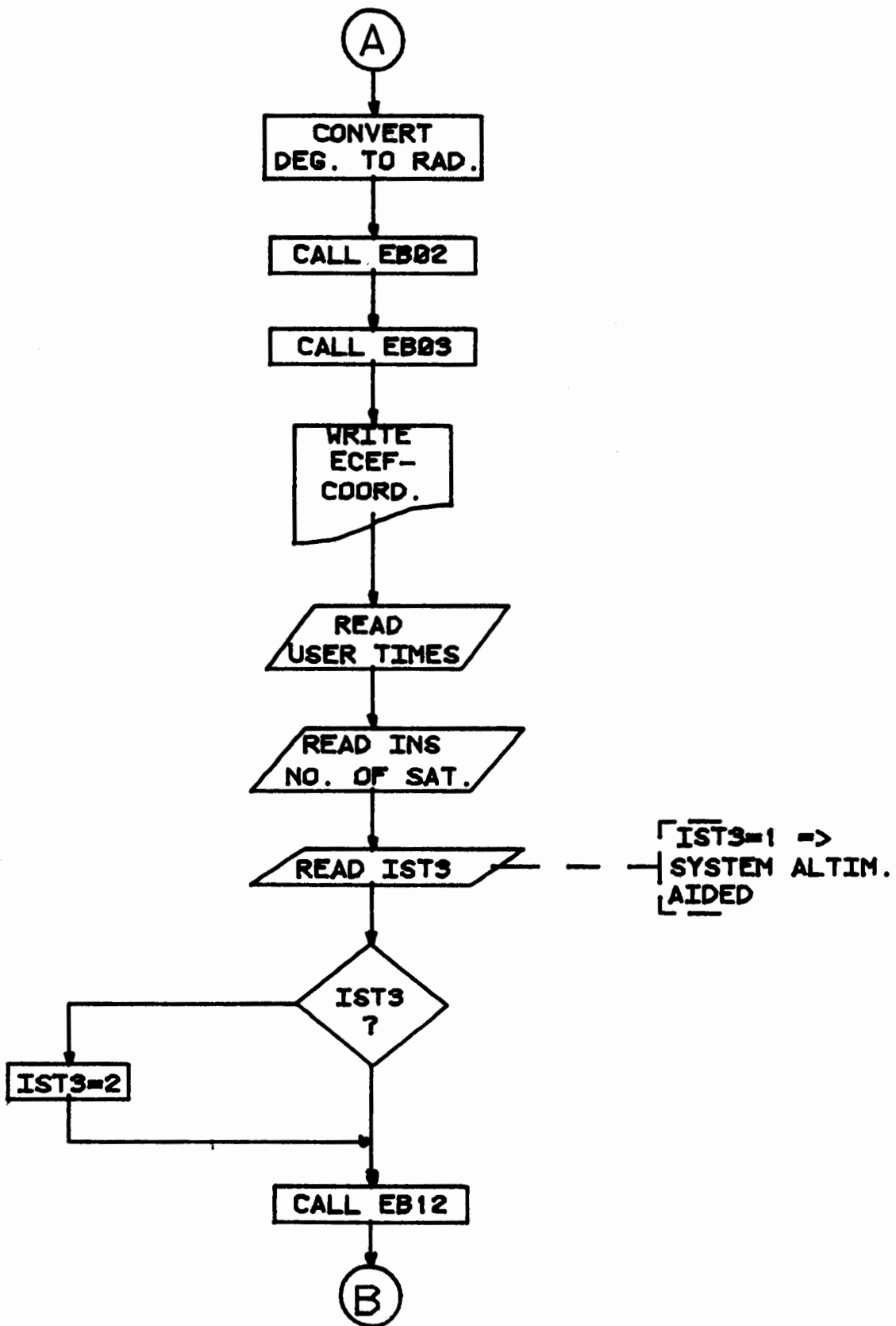
0001 RE, %PLAEL
0002 RE, %DLTBL
0003 SEA, %GPS

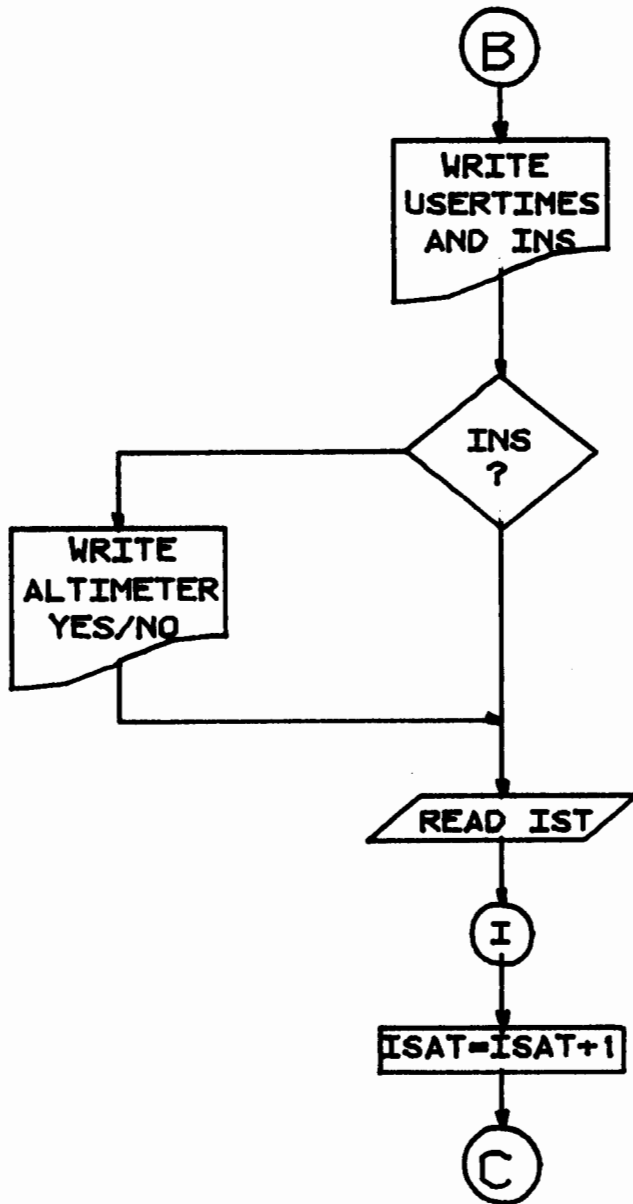
TPL5FI T=00004 IS ON CR00011 USING 00002 BLKS R=0000

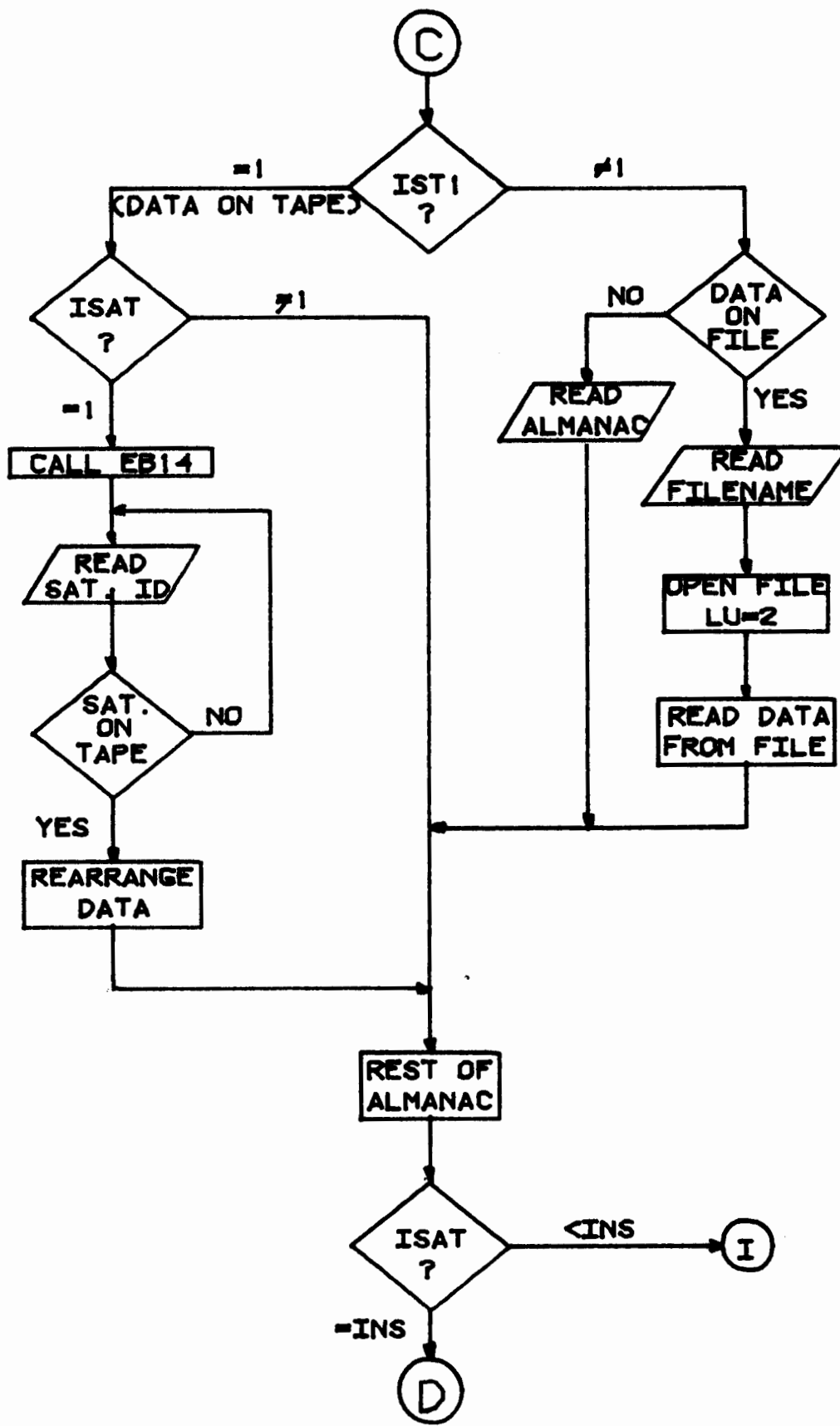
0001 RE, %PL5FI
0002 RE, %DLTBL
0003 SEA, %GPS

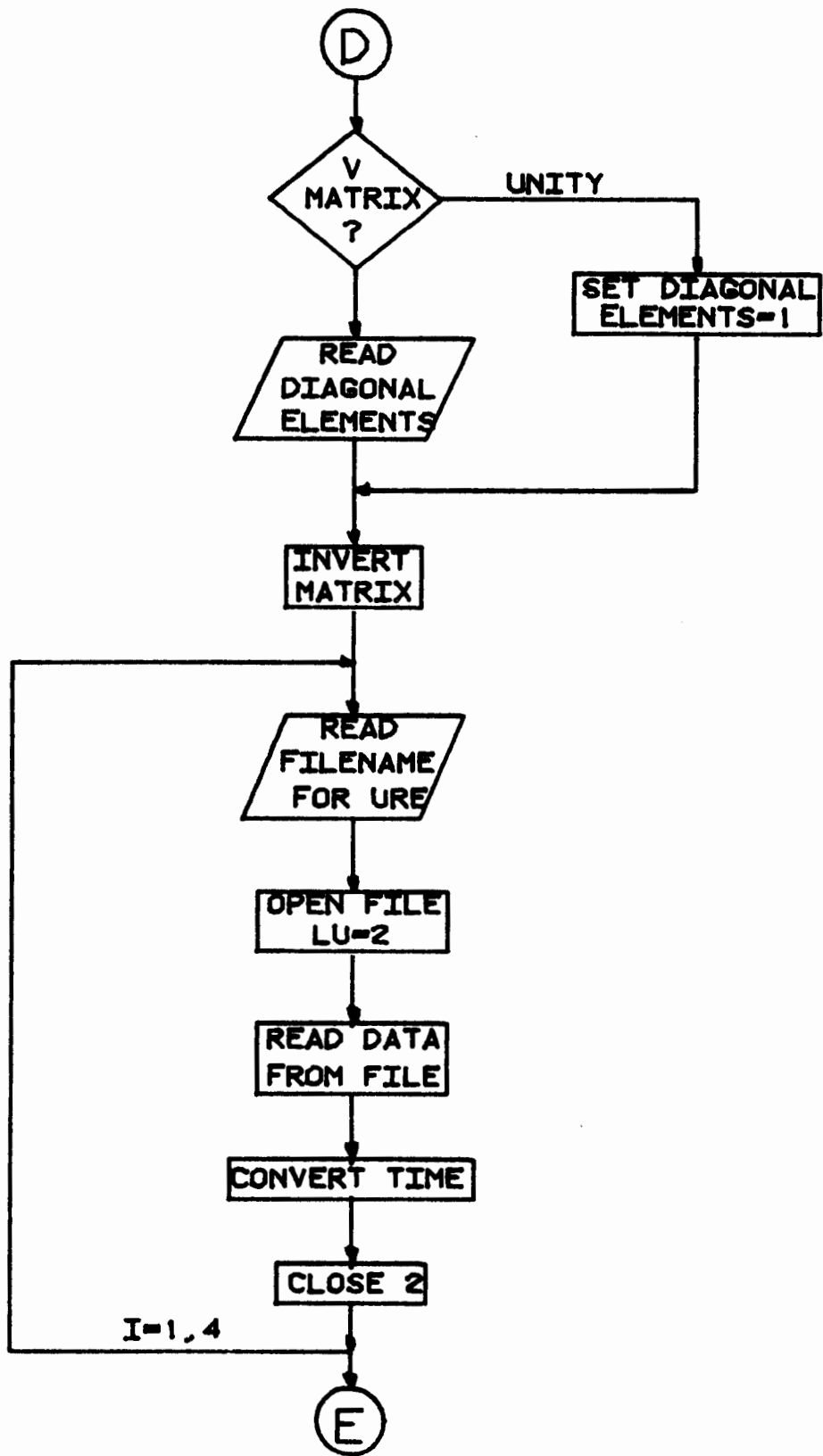
APPENDIX B
FLOWCHART

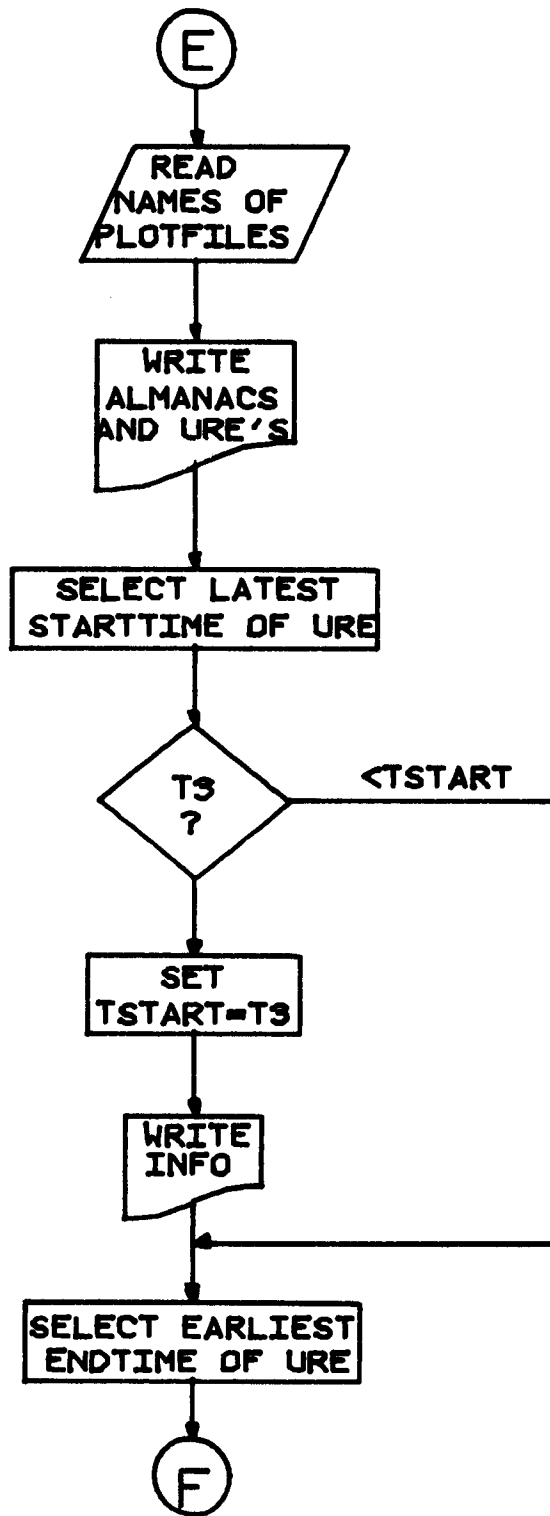


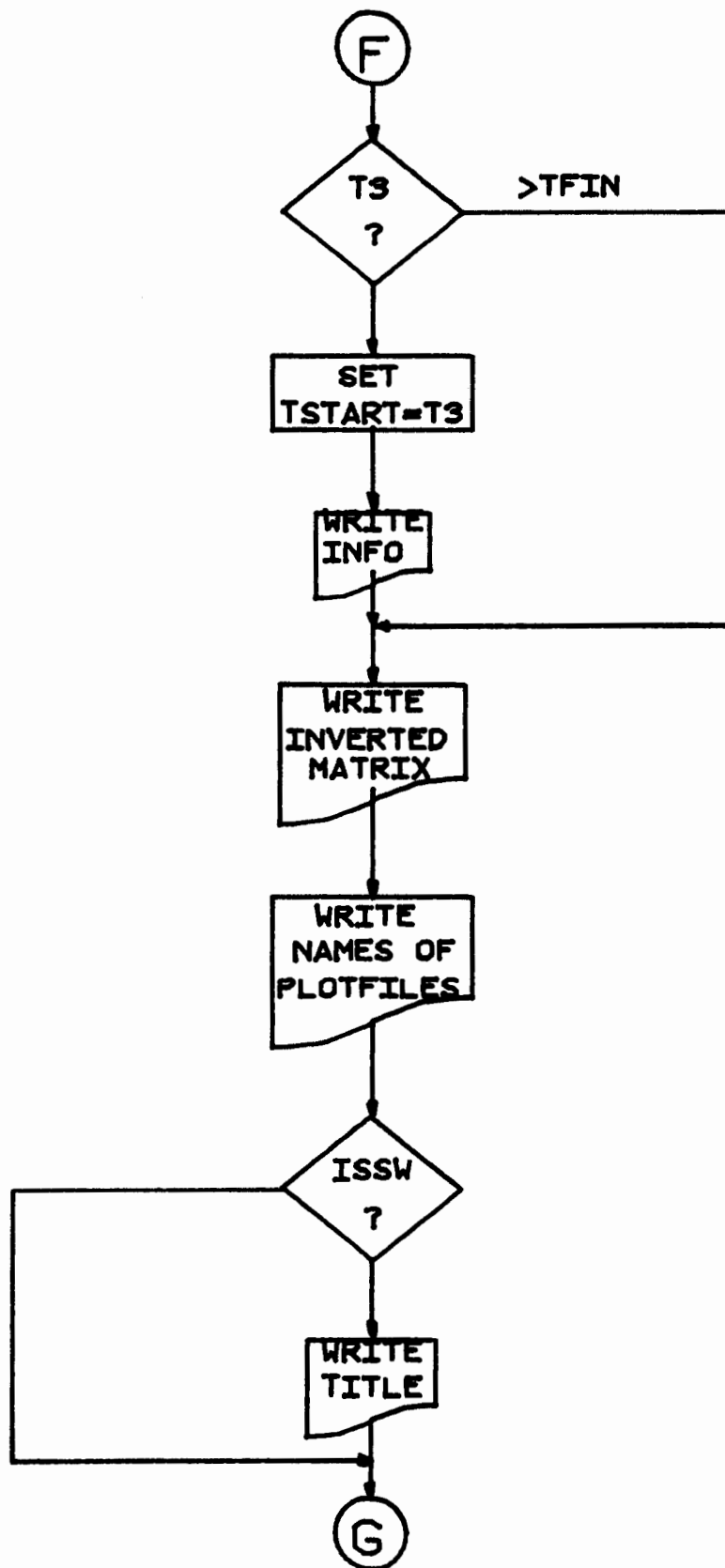


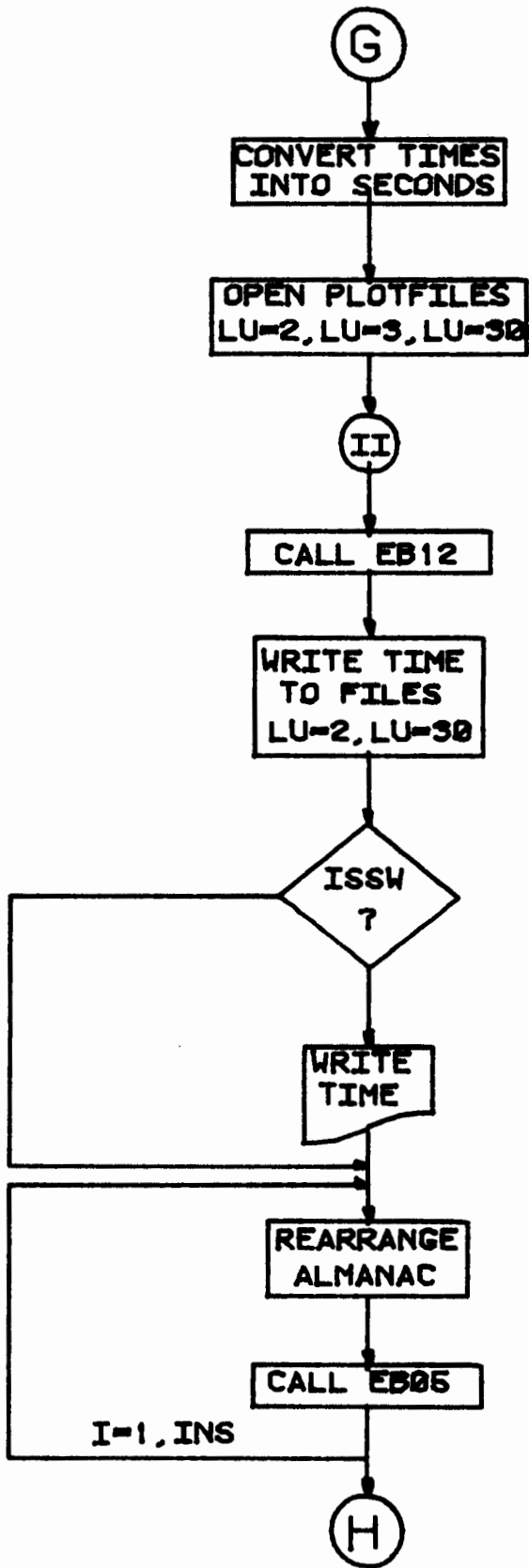


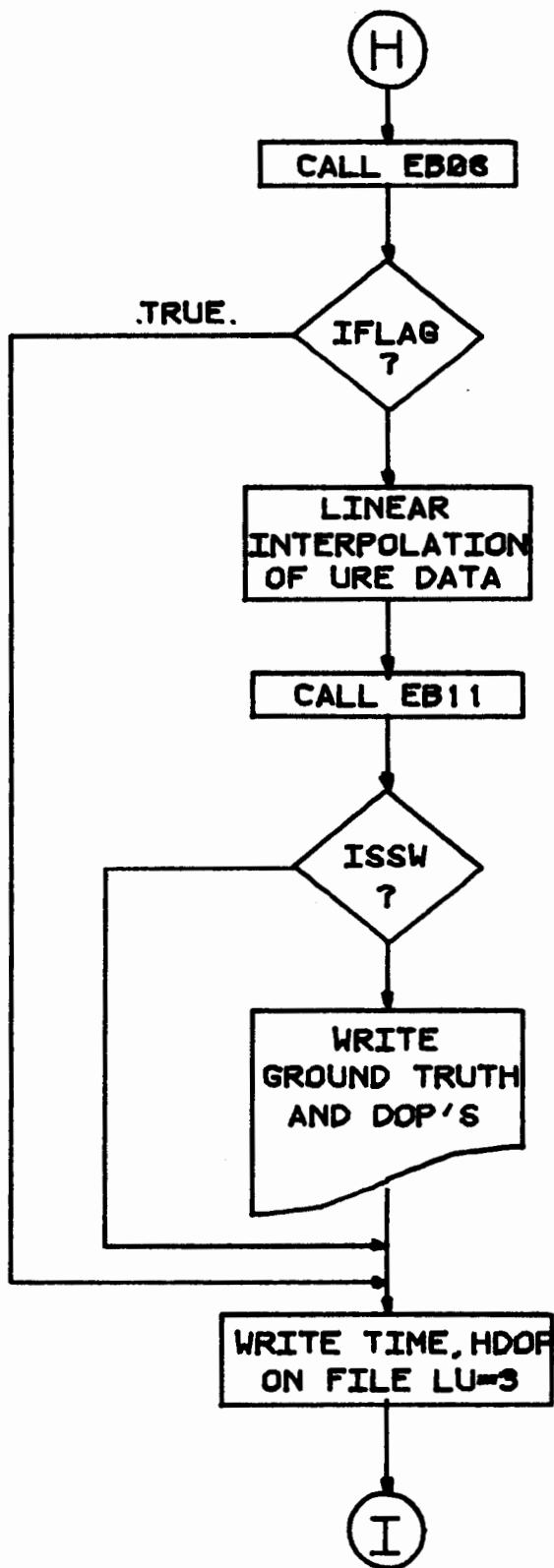


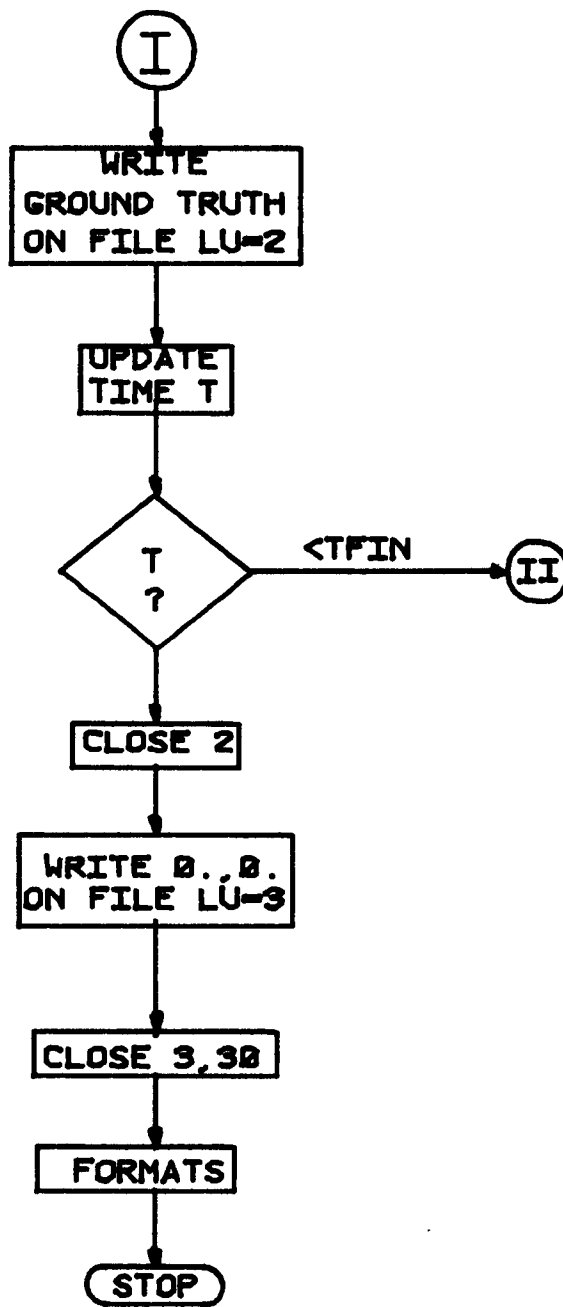


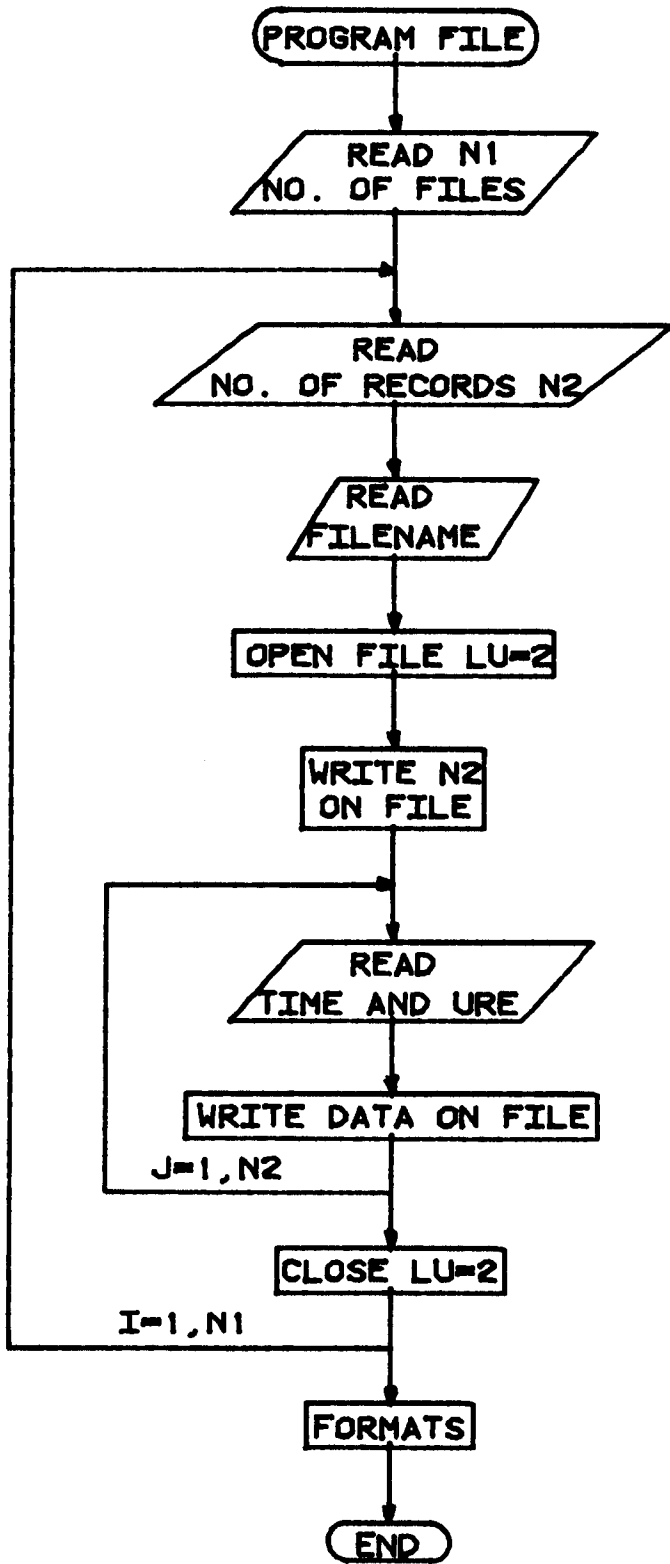


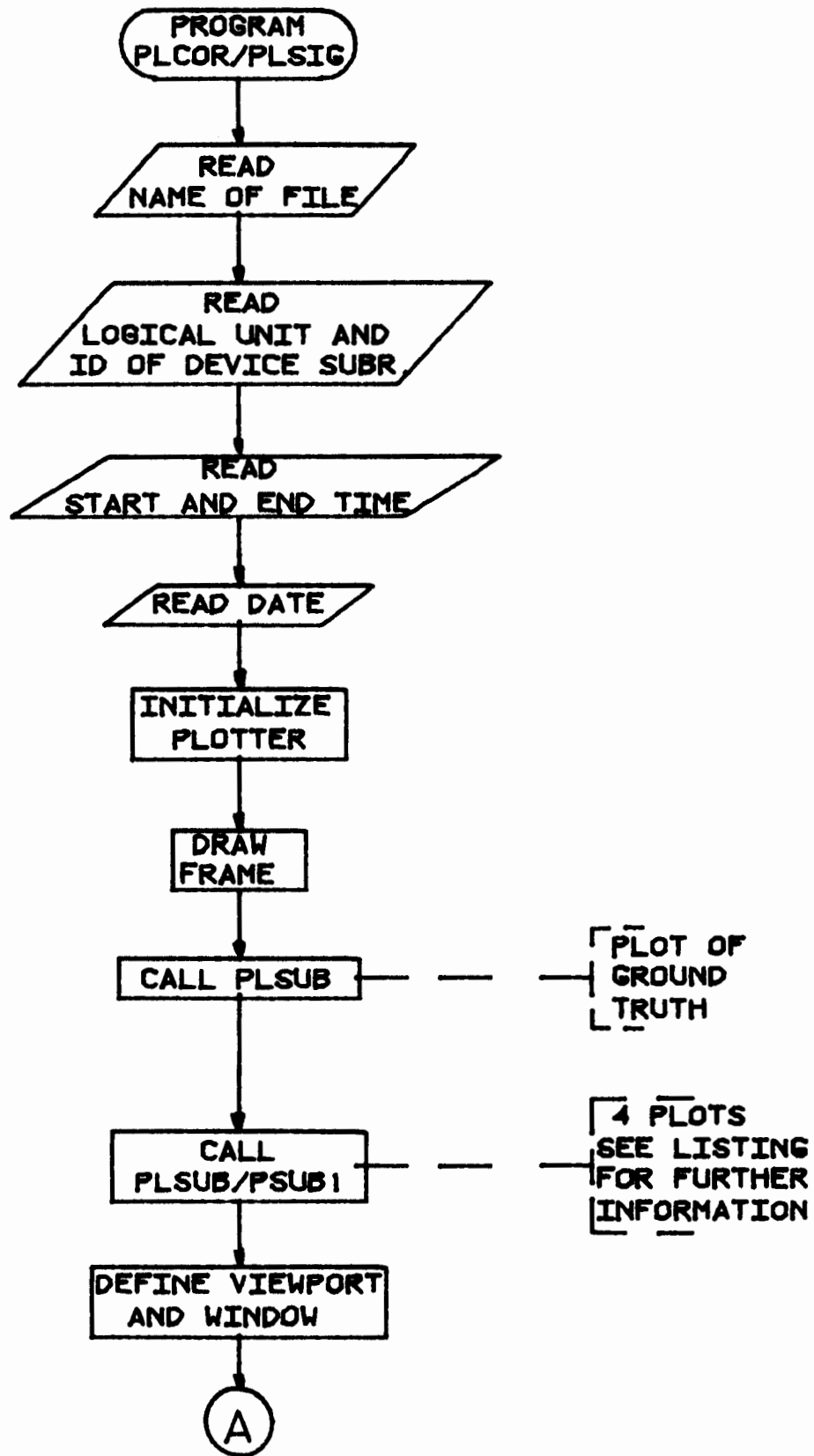


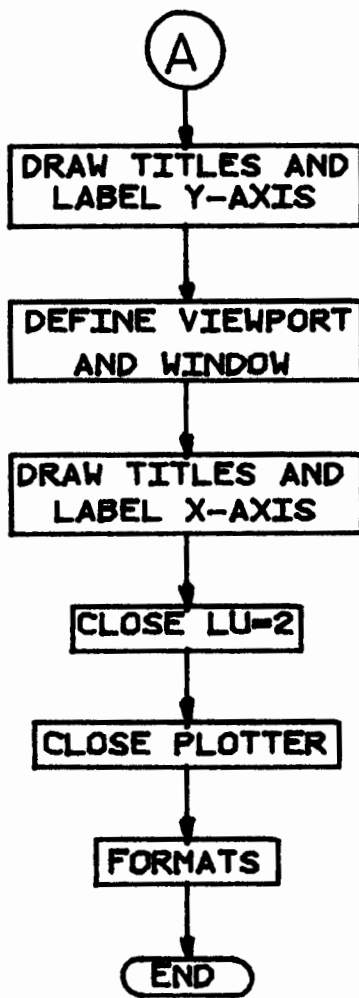


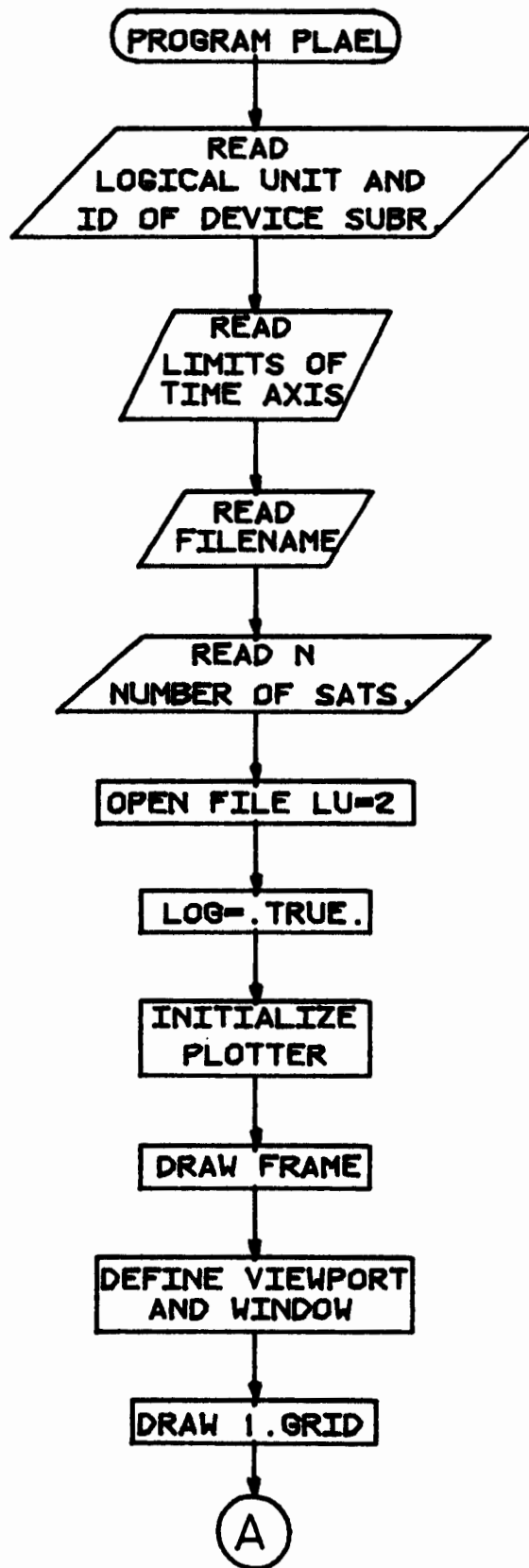


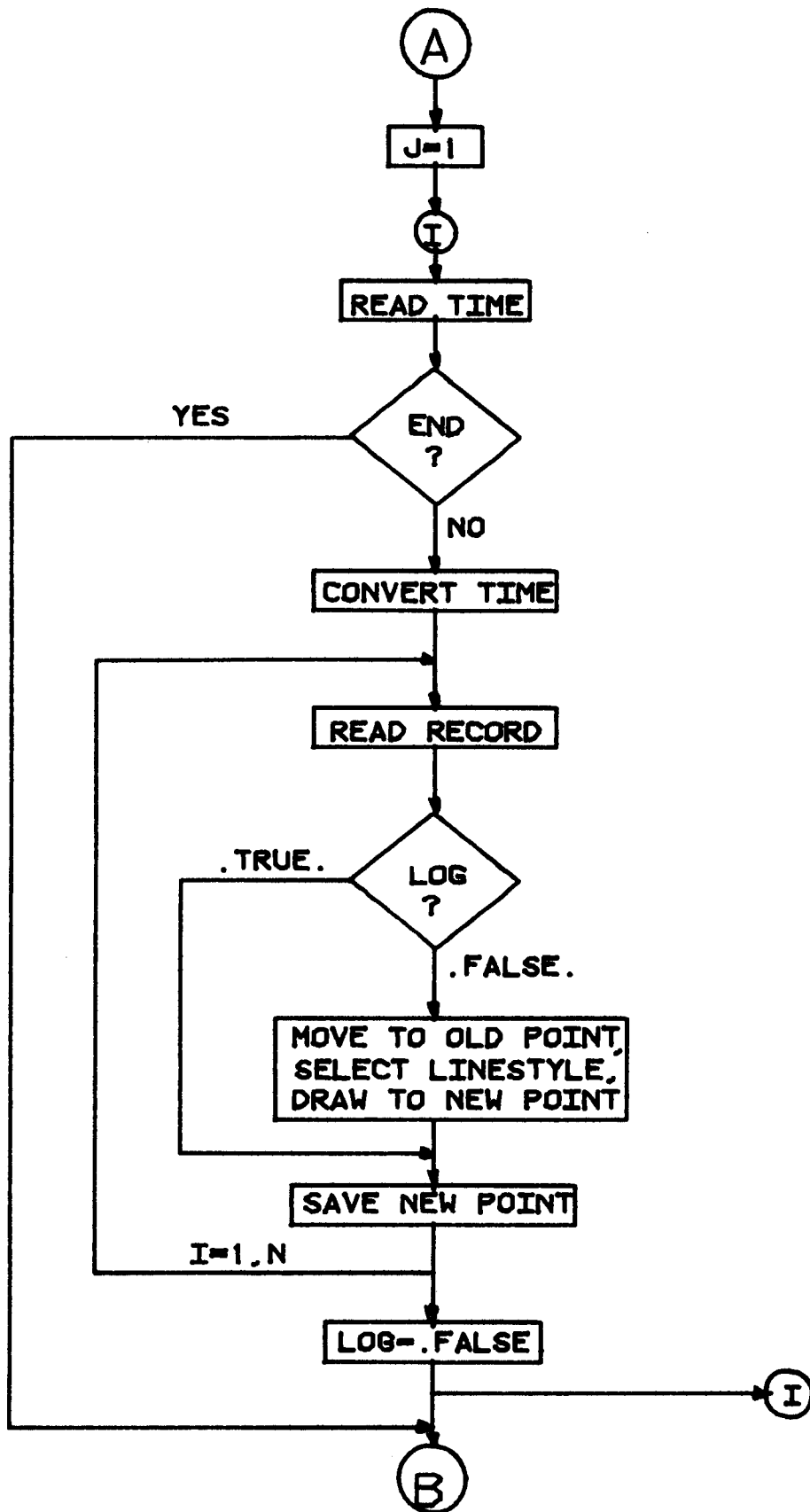


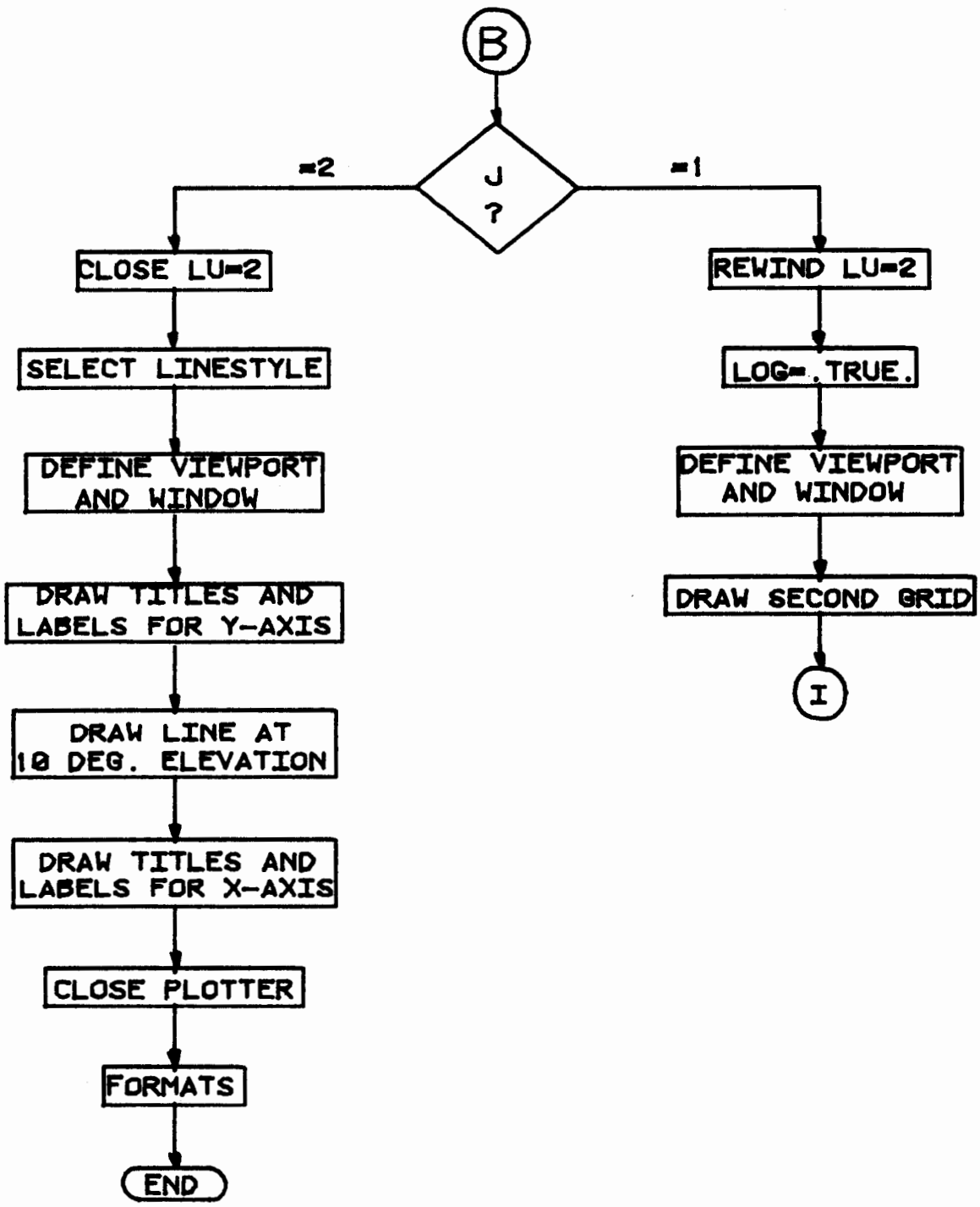


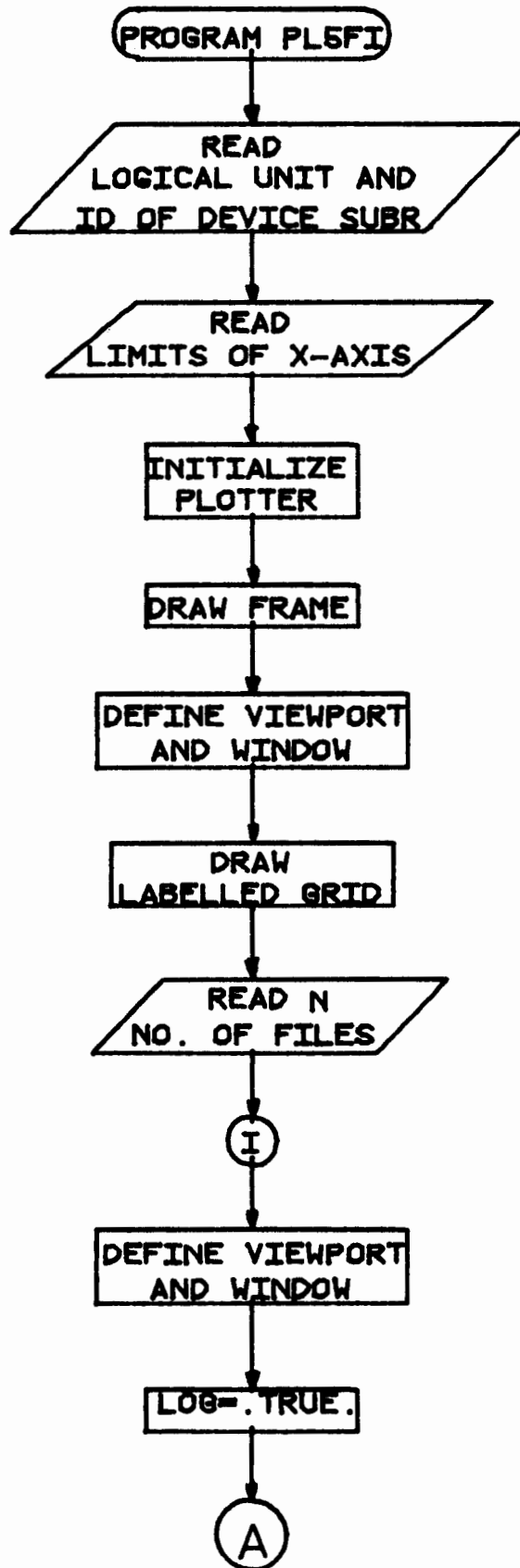


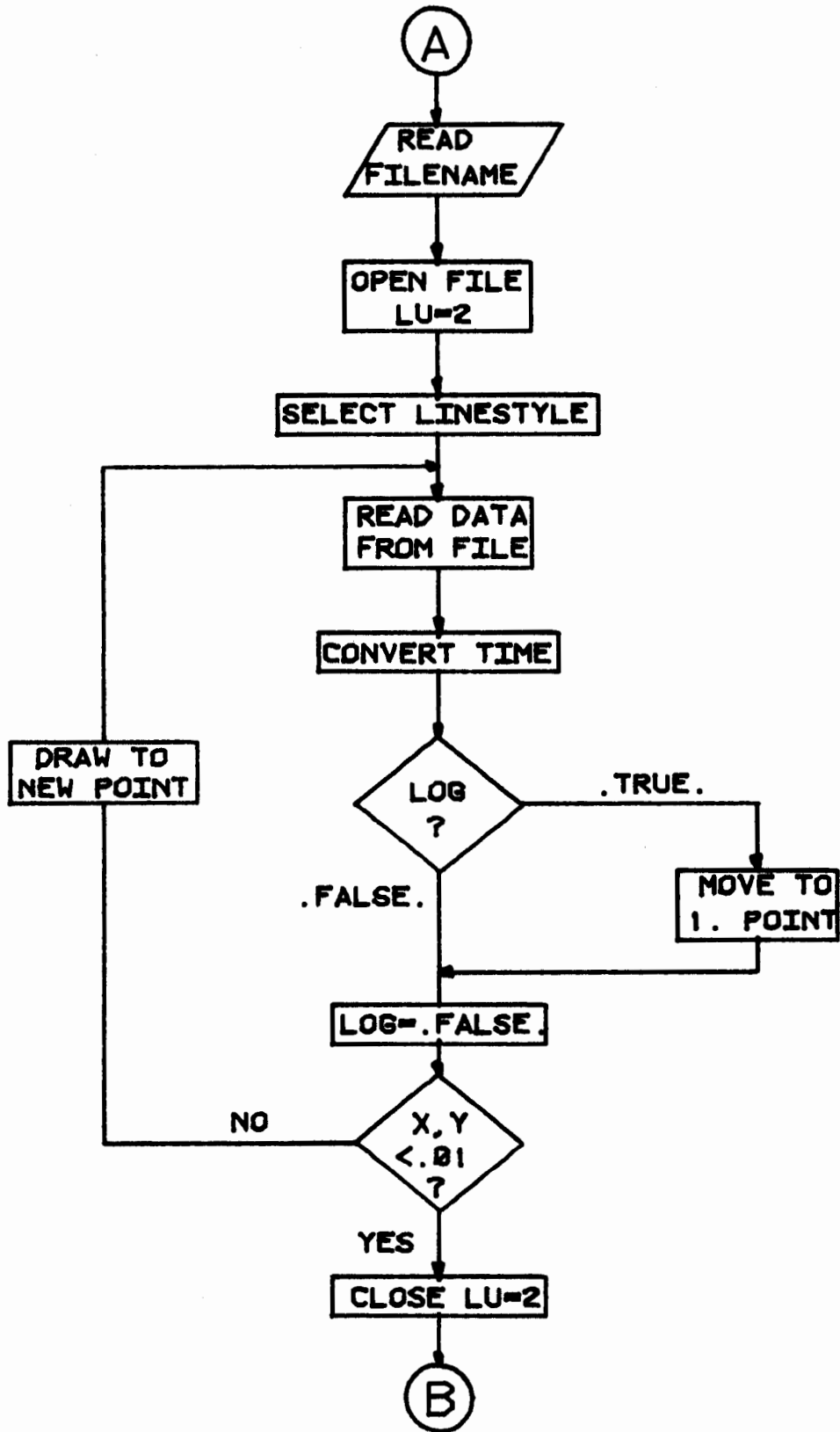


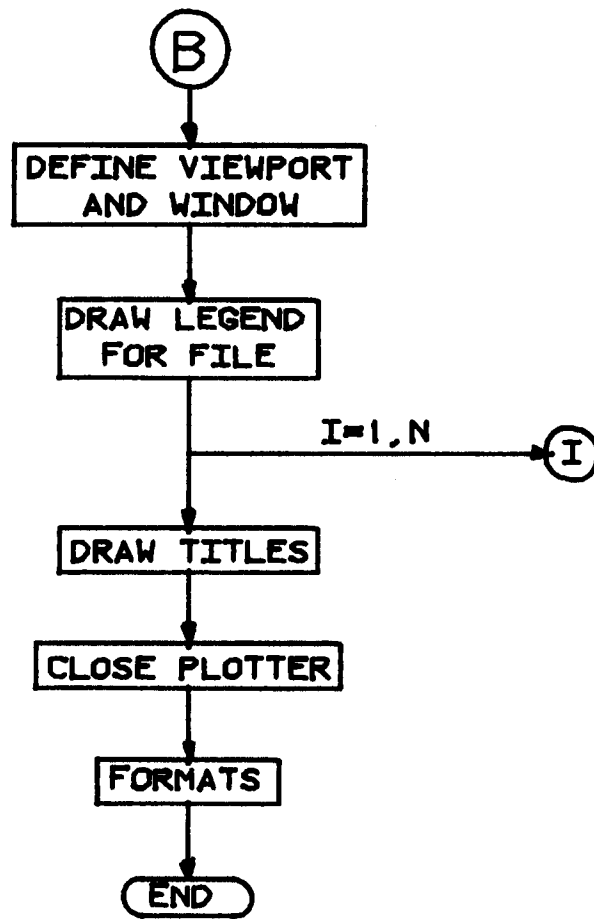


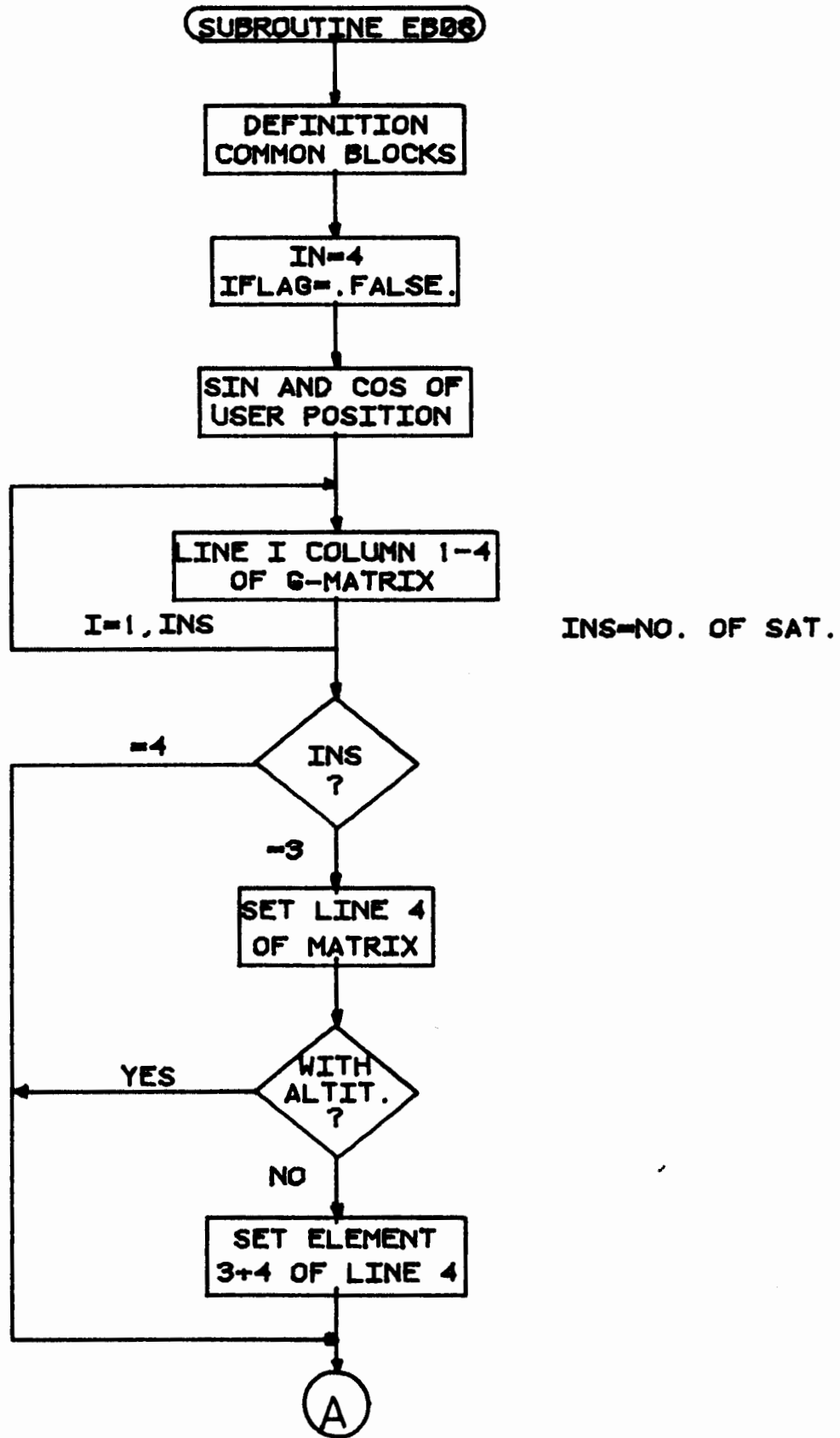


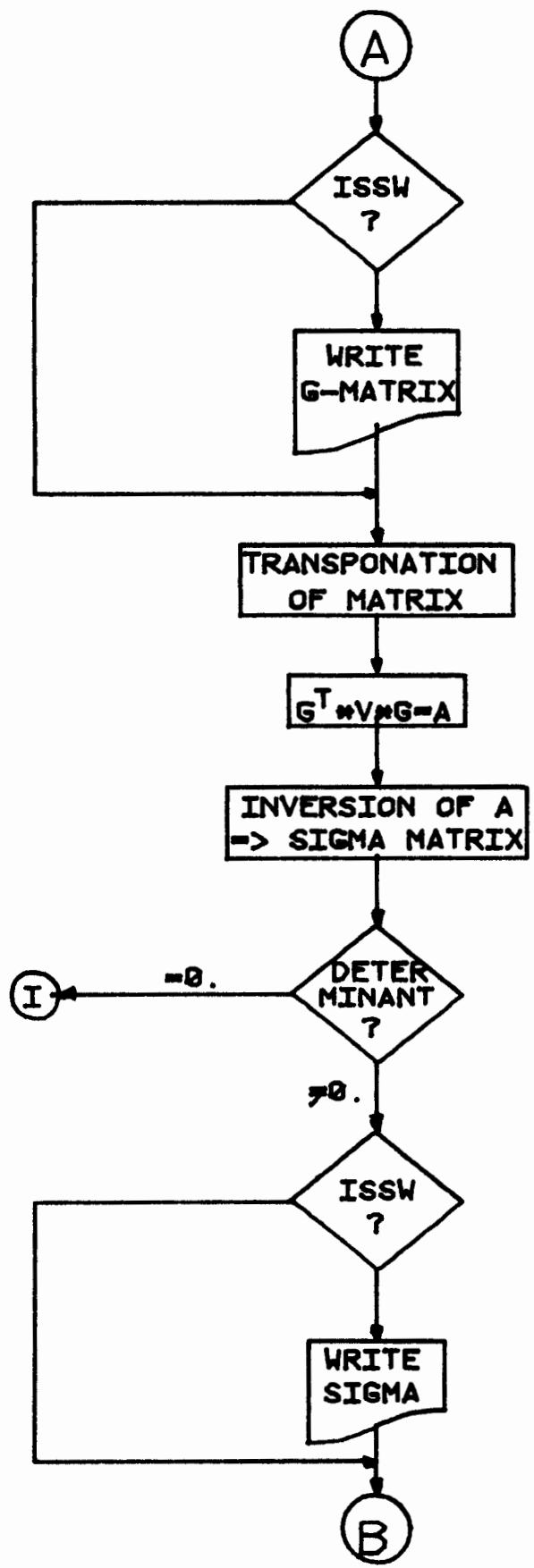


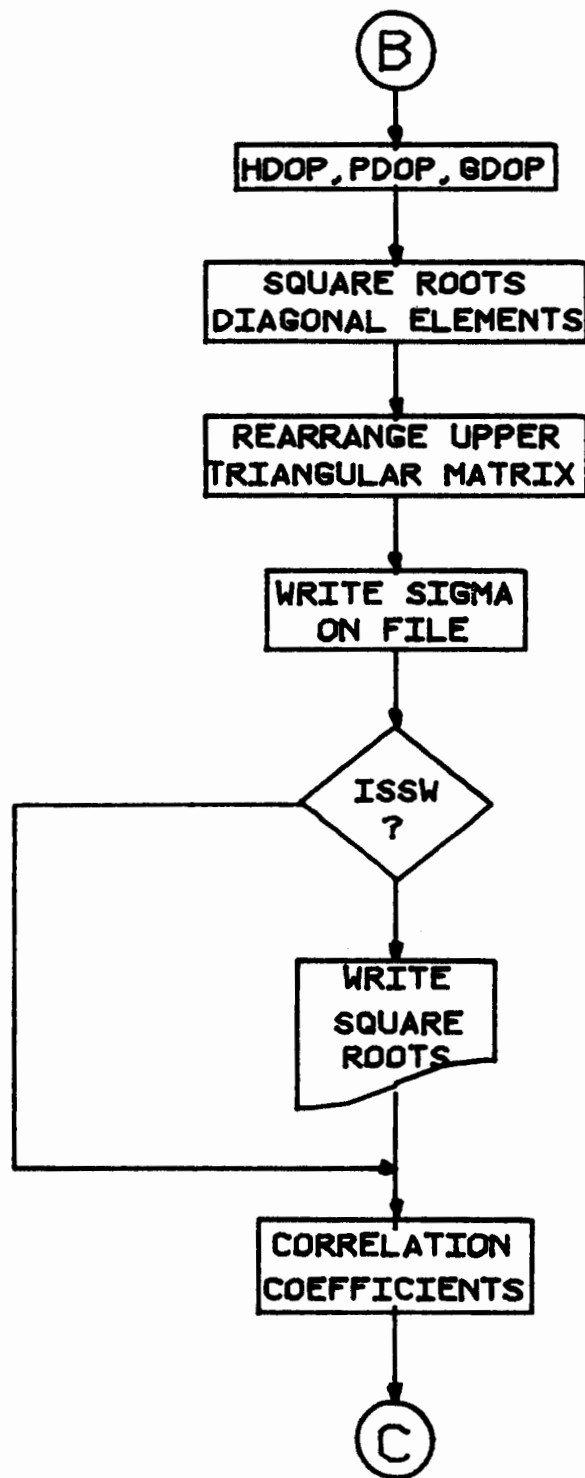


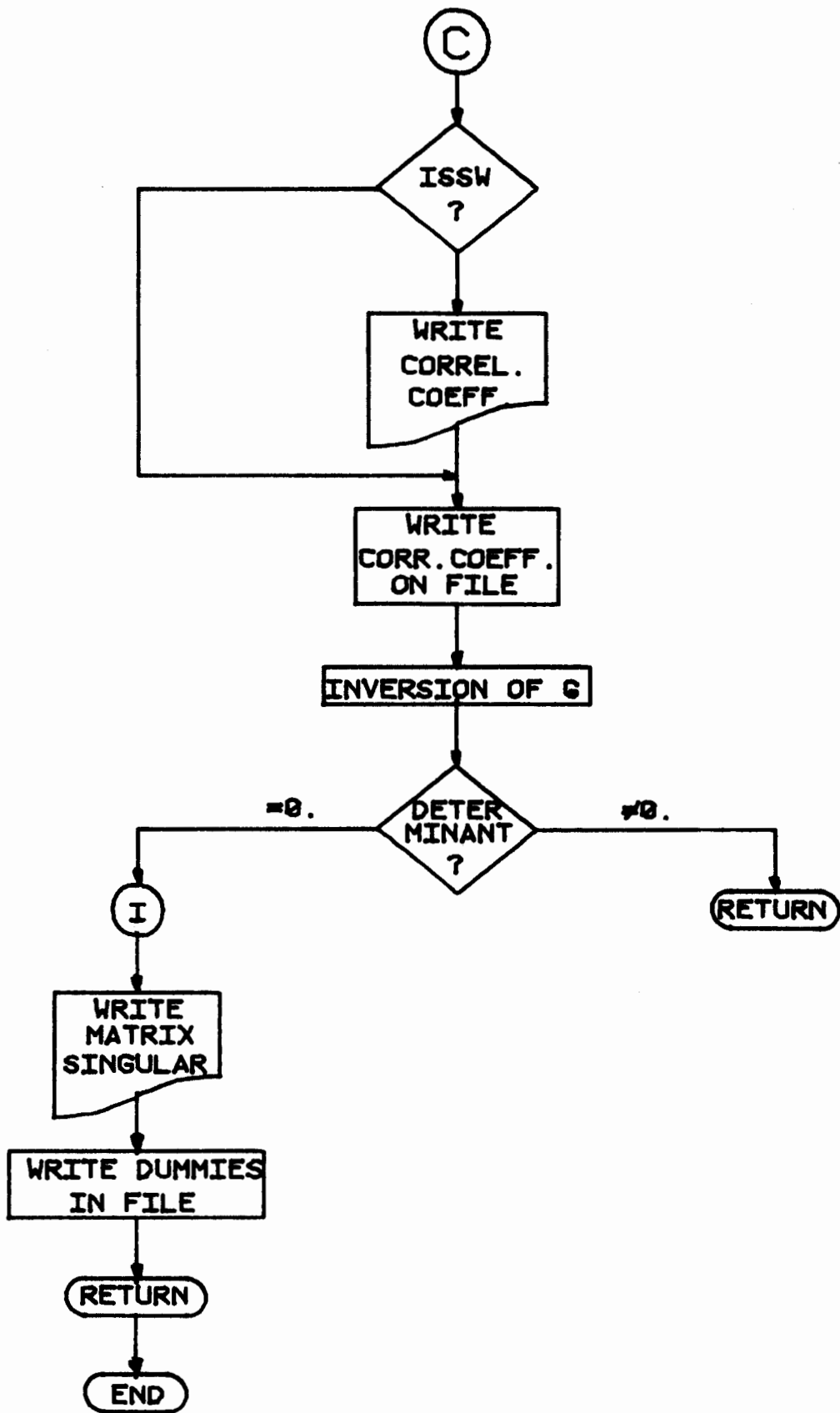


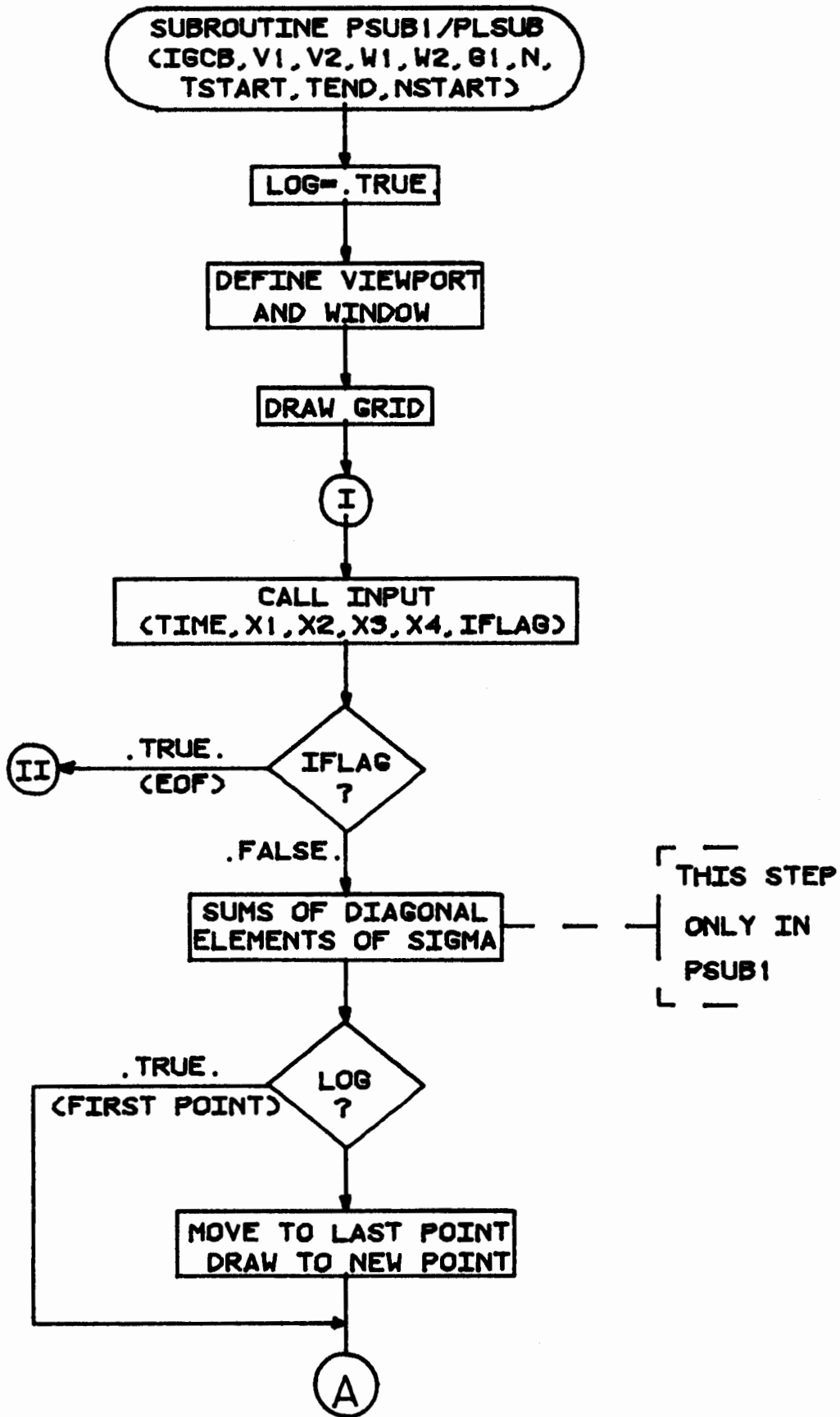


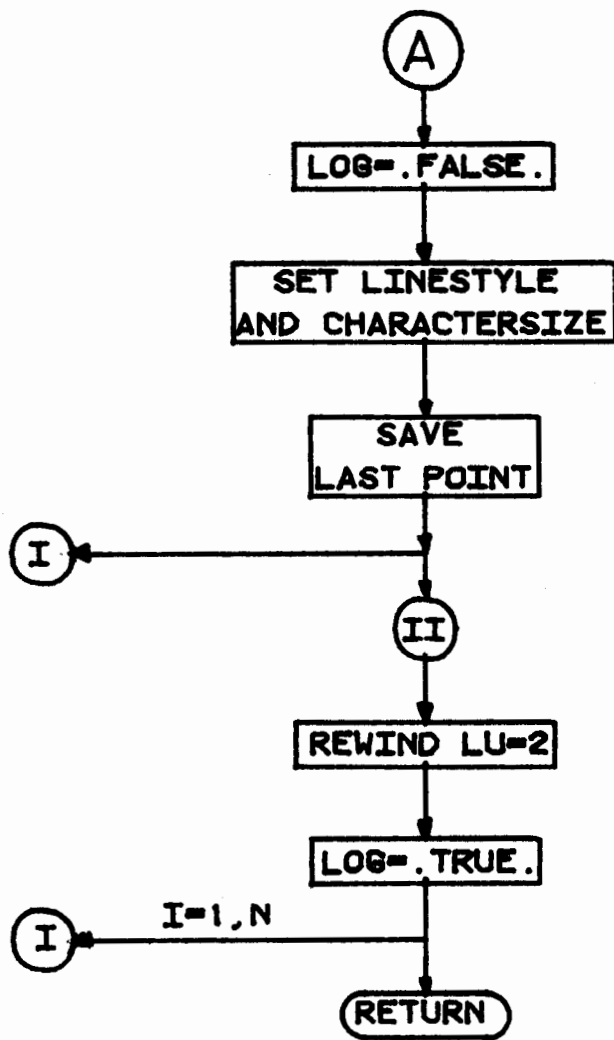


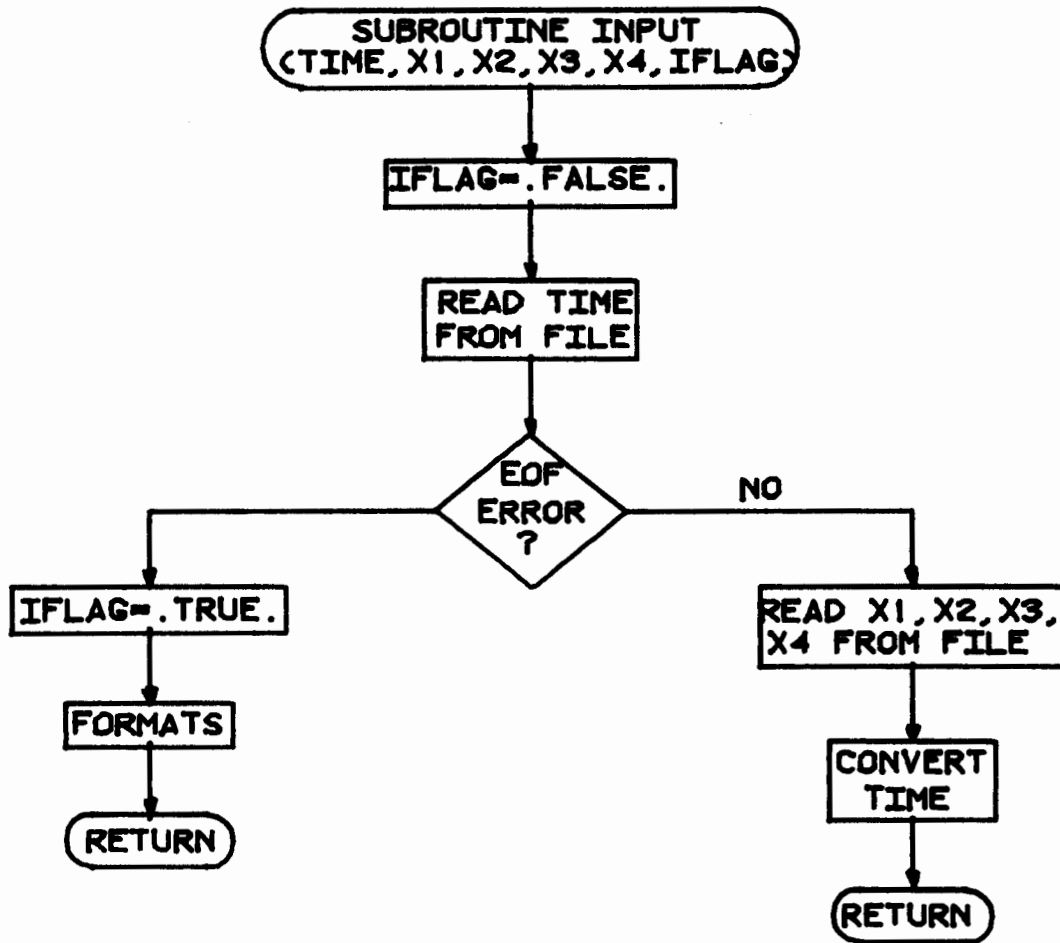












%EB00 T=00004 IS ON CR00011 USING 00114 BLKS R=0000

```

0001 FTN4X,L,Y
0002 C *****
0003 C *   FILENAME : %EB00   *
0004 C *****
0005     BLOCK DATA
0006     IMPLICIT DOUBLE PRECISION (A-H,K-Z)
0007     INTEGER N
0008     LOGICAL IFLAG
0009     COMMON /CONST/PI1,RTD,DMF,AE,E2,DMF2,SGC,ERATE,PI2
0010     COMMON/TIME/TDEL,TFIN
0011     COMMON/AZM/ELV(4),AZM(4)
0012     COMMON/POS/LAT,LOH,ALT,R
0013     COMMON/HAC/TUY,TCY,TKC,DTCC(4),DTU,TC,T
0014     COMMON/DB2/AD1(14)
0015     COMMON/DTX/U(4),D(4,4),RBAR(4)
0016     COMMON/SAT/S(4)
0017     COMMON/URE/URE1(4),DX(4)
0018     COMMON/GDOP/GDOP,PDOP,HDOP,INS,IFLAG,V(4,4),IST3,AP,AB
0019     COMMON/ELEV/E(3,3)
0020     COMMON/BLG/G(4,4),N
0021     COMMON/ALN/AD2(14,24),ID1(24)
0022     DATA PI/3.14159265D0/,RTD/57.2957795D0/,PI2/6.2831853D0/
0023     DATA DMF/1.99664722D0/,AE/6.378135D6/
0024     DATA E2/6.694317778D-3/,DMF2/1.993305683D0/
0025     DATA SGC/1.996499D7/,ERATE/7.292115147D-5/
0026     END
0027 $FILES (3,3)
0028     PROGRAM EB00
0029 C *****
0030 C *   ROUTINE COMPUTES FOR A GIVEN DAY AND 3 OR 4 GIVEN SATELLITES *
0031 C * FROM THE ALMANAC-DATA THE POSITION OF THE SATELLITES,THE *
0032 C * DISTANCES TO THE USER,THE DILUTION-OF-PRECISION-PARAMETERS AND *
0033 C * WITH THE PSEUDO-RANGE-ERRORS (URE) THE GROUND-TRUTH, *
0034 C * THE SATELLITE-POSITIONS ARE COMPUTED BY A MODIFIED PROGRAM OF *
0035 C * THE TEXAS A&M-UNIVERSITY. *
0036 C * PLOTFILES WITH A TIME-TAGGED HDOP ON LU=3 WITH THE SIGMA - *
0037 C * MATRIX,SQUARE-ROOT OF DIAGONAL ELEMENTS AND THE GROUND-TRUTH *
0038 C * ON LU=2 AND WITH THE ELEVATION AND AZIMUTH ON LU=30 ARE CREATED*
0039 C * *
0040 C * - - - - - *
0041 C * *
0042 C *   USED SUBROUTINES:      EB02 *
0043 C *                          EB03 *
0044 C *                          EB05 *
0045 C *                          EB06 *
0046 C *                          EB07 *
0047 C *                          EB08 *
0048 C *                          EB09B *
0049 C *                          MINVD *
0050 C *                          EB11 *
0051 C *                          EB12 *
0052 C *                          EB14 *
0053 C *                          DINTF *
0054 C * *
0055 C * - - - - - *
0056 C * *
0057 C *   USED EARTH-REFERENCE-ELLIPSOID : WGS-72 *
0058 C * *

```

```

0059 C *   IMPORTANT VARIABLES AND CONSTANTS : *
0060 C *   INTEGER : IST,IST1,IST2,IST3 --> CONTROL-PARAMETERS *
0061 C *           I,II,J,II,I2,I3 --> INDEX FOR DO-LOOPS *
0062 C *           ICOUNT --> COUNTER FOR OUTPUT *
0063 C *           N --> SIZE OF MATRIX (USED IN *
0064 C *             INVERSION-SUBROUTINE) *
0065 C *           INS --> NUMBER OF SATELLITES FOR *
0066 C *             HDOP COMPUTATION *
0067 C *           ISAT --> INDEX OF SATELLITES *
0068 C *           ID (4) --> PRN-NO. OF USED SATELLITES *
0069 C *           ID1 (24) --> PRN-NO. OF ALL SATELLITES *
0070 C *           INAM (3) --> NAME OF INPUT- AND PLOTFILE *
0071 C *           INUM --> NUMBER OF POINTS IN URE-FILE *
0072 C * LOGICAL : IFLAG --> INDICATES SUCCESS OF MATRIX- *
0073 C *             INVERSION *
0074 C * *
0075 C * REAL : A1,A2,T1,T2,TOUT, --> ONLY FOR OUTPUT,THESE REAL- *
0076 C *           TMAX,TMIN --> VARIABLES ARE NOT INVOLVED *
0077 C *             IN ANY SIGNIFICANT COMPUTAT. *
0078 C *           ARR (15,4) --> TIME OF DATA-POINT *
0079 C *           URE (15,4) --> URE-VALUE AT POINT OF TIME *
0080 C * *
0081 C * DOUBLE PRECISION : *
0082 C *           AD (14,4) --> ALMANAC FOR 4 SATELLITES *
0083 C *           AD1 (14) --> ALMANAC JUST USED *
0084 C *           AD2 (14,24) --> ALMANAC FOR 24 SATELLITES *
0085 C *           ALT --> ALTITUDE *
0086 C *           AE --> RADIUS OF EARTH *
0087 C *           AZM (4) --> AZIMUTH ANGLE OF SATELLITE *
0088 C *           AP,AB --> VARIANCE OF SATELLITES URE- *
0089 C *             AND CLOCK-BIAS (3 SAT.,WITH- *
0090 C *             OUT ALTIMETER-AIDING) *
0091 C *           A(4,4),AT(4,4), --> MATRIX,INVERTED MATRIX AND *
0092 C *           AAT(4,4) --> MULTIPLICATED MATRIX. *
0093 C *             A CONTAINS THE DIRECTION- *
0094 C *             COSINES IN ENU-COORDINATES *
0095 C *           D(4,4) --> DISTANCES FROM USER TO 4 *
0096 C *             SATELLITES IN ECEF-COORD. *
0097 C *           DTC(4) --> DATE OF COLLECTION IN DAYS *
0098 C *             FROM BEGINNING OF THE YEAR *
0099 C *           DTU --> DATE OF USE IN DAYS (CONVER- *
0100 C *             TED INTO SECONDS) FROM *
0101 C *             BEGINNING OF THE YEAR *
0102 C *           DX(4) --> USER-ERRORS DUE TO SPACE- *
0103 C *             SEGMENT OF GPS *
0104 C *           E (3,3) --> MATRIX CONTAINING SINES AND *
0105 C *             COSINES OF USER POSITION *
0106 C *           E2 --> SQUARE-ROOT OF THE EXCENTRI- *
0107 C *             CITY OF THE EARTH-ELLIPSOID *
0108 C *           ELV (4) --> ELEVATION ANGLE OF SATELLITES *
0109 C *           ERATE --> EARTH-ROTATION-RATE *
0110 C *           G (4,4) --> MATRIX FOR INVERSION-SUBROU. *
0111 C *           GDOP --> GEOMETRIC DILUTION OF PRECI- *
0112 C *             SION *
0113 C *           HDOP --> HORIZONTAL DILUTION OF *
0114 C *             PRECISION *
0115 C *           LAT --> LATITUDE *
0116 C *           LON --> LONGITUDE *
0117 C *           PI,PI2 --> PI(3.1415...) AND 2*PI *
0118 C *           PDOP --> POSITION,DILUTION OF *

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0119 C *                                PRECISION                                *
0120 C *                                RTD                                --> RADIAN TO DEGREE CONVERSION *
0121 C *                                FACTOR (180/PI)                                *
0122 C *                                RBAR                                --> LENGTH OF VECTOR USER-SATEL,*
0123 C *                                S (4)                                --> SATELLITE-POSITION IN ECEF *
0124 C *                                SGC                                --> SQUARE ROOT OF GRAVITATIONAL*
0125 C *                                CONSTANT OF THE EARTH                                *
0126 C *                                ALL TIMES IN GMT AND IN SECONDS                                *
0127 C *                                T                                --> GPS-TIME                                *
0128 C *                                TC                                --> COLLECTION TIME,START OF *
0129 C *                                COUNT AT BEGINNING OF EPOCH *
0130 C *                                TCY                                --> TIME OF COLLECTIONS STARTING*
0131 C *                                AT BEGINNING OF YEAR                                *
0132 C *                                TDEL                                --> TIMEINCREMENT                                *
0133 C *                                TFIN                                --> ENDTIME                                *
0134 C *                                TKC                                --> DIFFERENCE BETWEEN COLLEC- *
0135 C *                                TIONTIME AND REFERENCETIME, *
0136 C *                                WRAPAROUNDS CONSIDERED                                *
0137 C *                                TUY                                --> TIME OF USE                                *
0138 C *                                U (4)                                --> USER POSITION IN ECEF-COORD,*
0139 C *                                URE1(4)                                --> PSEUDO-RANGE-ERRORS *
0140 C *                                V(4,4)                                --> KOVARIANCE-MATRIX *
0141 C *                                *
0142 C *****
0143 C
0144 C
0145 C     IMPLICIT DOUBLE PRECISION(A-H,K-Z)
0146 C     REAL A1,A2,URE(15,4),ARR(15,4),T2,T1,TMAX,TMIN,TOUT,TEXT(2)
0147 C     LOGICAL IFLAG
0148 C     DIMENSION AD(14,4),ID(4),INAM(3),INAM1(3),INAM2(3)
0149 C     COMMON/TIME/TDEL,TFIN
0150 C     COMMON/AZM/ELV(4),AZM(4)
0151 C     COMMON/POS/LAT,LON,ALT,R
0152 C     COMMON/NAC/TUY,TCY,TKC,DTC(4),DTU,TC,T
0153 C     COMMON/CNST/PI,RTD,OMF,AE,E2,OMF2,SGC,ERATE,PI2
0154 C     COMMON/DB2/AD1(14)
0155 C     COMMON/DTX/U(4),D(4,4)
0156 C     COMMON/SAT/S(4)
0157 C     COMMON/URE/URE1(4),DX(4)
0158 C     COMMON/ALM/AD2(14,24),ID1(24)
0159 C     COMMON/GDOP/GDOP,PDOP,HDOP,INS,IFLAG,V(4,4),IST3,AP,AB
0160 C     DATA TEXT/'YES ','NO'/
0161 C     ISAT=0
0162 C!! AB=0.0
0163 C!! AP=0.0
0164 C     TC=0.
0165 C     ICOUNT=0
0166 C     WRITE (6,90)
0167 C .....
0168 C
0169 C                                INPUT
0170 C
0171 C ***** INPUT THE LATITUDE, LONGITUDE AND THE ALTITUDE *****
0172 C                                LON WEST AND LAT SOUTH ARE DENOTED BY A NEGATIVE VALUE
0173 C
0174 C     WRITE (16,1)
0175 C     FORMAT (/' ' INPUT USER POSITION"
0176 C     1/ " ATLANTIC CITY (=1) OTHER POSITION (=2)"
0177 C     2/ " ANSWER :_")
0178 C     READ (16,98) IST

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```

0179         IF(IST.EQ.2) GOTO 1001
0180 C -----
0181         LAT=0.39449555D2
0182         LON=-0.74566777D2
0183         ALT=0.4626D2
0184         GOTO 1002
0185 C -----
0186 1001 CONTINUE
0187         WRITE (16,2)
0188 2         FORMAT (/ " USER POSITION IN DEGREES (FORMAT :G15.8)"
0189         1/ " " LATITUDE " :_")
0190         READ (16,97) LAT
0191         WRITE (16,3)
0192 3         FORMAT (" LONGITUDE " :_)
0193         READ (16,97) LON
0194         WRITE (16,4)
0195 4         FORMAT (" ALTITUDE IN FEET :_")
0196         READ (16,97) ALT
0197 1002 CONTINUE
0198 C -----
0199         WRITE (6,50) LAT,LON,ALT
0200 50        FORMAT (" PROGRAM * E B 0 0 *")
0201         1/ " -----"
0202         2// " USER-POSITION : "
0203         3/ " LATITUDE :",G15.8," DEGREE"
0204         4/ " LONGITUDE:",G15.8," DEGREE"
0205         5/ " ALTITUDE :",G15.8," FEET")
0206         LAT=LAT/RTD
0207         LON=LON/RTD
0208         ALT=ALT/0.32809D1
0209 C
0210 C ***** EB02 COMPUTES E-MATRIX *****
0211 C
0212         CALL EB02
0213 C
0214 C ***** EB03 TAKES LAT, LON, AND ALT; *****
0215 C         IT RETURNS X,Y,Z IN U-VECTOR
0216 C
0217         CALL EB03
0218         WRITE (6,51) (U(I),I=1,3)
0219 51        FORMAT (" ECEF-COORDINATES : X = ",G16.8," Y = ",G16.8," Z =
0220         1 ",G16.8)
0221         U(4)=0.
0222 C
0223 C ***** READ USER TIME *****
0224 C
0225         WRITE (16,5)
0226 5         FORMAT (/ " USER TIME (FORMAT : G15.8)"
0227         1/ " STARTTIME(TSTART),ENDTIME(TFIN),TIME INCREMENT(TDEL)"
0228         2/ " AND ALMANAC-COLLECTION-TIME (TC) IN SECONDS."
0229         3/ " START OF COUNT:TSTART,TFIN,TDEL-->EVERY DAY AT 00:00"
0230         4/ " " TC " -->BEGINNING OF EPOCH"
0231         5/ " TSTART=_")
0232         READ (16,97) T
0233         WRITE (16,6)
0234 6         FORMAT (" TFIN =_")
0235         READ (16,97) TFIN
0236         WRITE (16,7)
0237 7         FORMAT (" TDEL =_")
0238         READ (16,97) TDEL

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```

0239      WRITE (16,8)
0240  8      FORMAT ( " TC      =_" )
0241      READ (16,97) TC
0242      WRITE (16,10)
0243  10     FORMAT ( " DATE OF USE IN DAYS FROM JANUARY,FIRST :_" )
0244      READ (16,97) DTU
0245      WRITE (16,9)
0246  9      FORMAT ( " NUMBER OF SATELLITES (3 OR 4) =_" )
0247      READ (16,98) INS
0248      IF(INS.EQ.4) GOTO 1016
0249      WRITE (16,34)
0250  34     FORMAT ( " SYSTEM ALTIMETER AIDED (=1) ;_" )
0251      READ (16,98) IST3
0252      IF(IST3.NE.1) IST3=2
0253  C11    IF(IST3.EQ.1) GOTO 1016
0254  C11    IST3=2
0255  C11    WRITE (16,35)
0256  C1135  FORMAT ( " SATELLITE URE- (AP) AND CLOCK-VARIANCE (AB)"
0257  C11    1/      " AP (SQUARED) ;_" )
0258  C11    READ (16,97) AP
0259  C11    WRITE (16,36)
0260  C1136  FORMAT ( " AB (SQUARED) ;_" )
0261  C11    READ (16,97) AB
0262  C -----
0263  1016   CONTINUE
0264      CALL EB12(T,T1)
0265      CALL EB12(TFIN,T2)
0266      WRITE (6,52) T,T1,TFIN,T2,TDEL,DTU,INS
0267  52     FORMAT (/ " USERTIMES : "
0268          1/      "   START (TSTART) : ",G15.8," SEC. = ",F5.2," HOURS"
0269          2/      "   END (TFIN)      : ",G15.8," SEC. = ",F5.2," HOURS"
0270          3/      "   INCR. (TDEL)   : ",G15.8," SEC"
0271          4/      "   DATE (DTU)     : ",G15.8," DAYS"
0272          5//     " THE COMPUTATIONS ARE MADE WITH",I2," SATELLITES")
0273      IF(INS.EQ.3) WRITE (6,66) TEXT(IST3)  !!,AP,AB
0274  66     FORMAT (/ " SYSTEM ALTIMETER-AIDED : ",A4)
0275  C11    1/      " AP-SQUARED : ",G8.4," AB-SQUARED : ",G8.4,
0276  C11    2"     (APPLICABLE ; 3 SATELLITES WITHOUT ALTIMETER)" )
0277  C
0278  C ***** READ ALMANAC - DATA *****
0279  C
0280      WRITE (16,12)
0281  12     FORMAT ( " ALMANAC-DATA FROM TAPE (=1) ? _" )
0282      READ (16,98) IST1
0283  1000   CONTINUE
0284      ISAT=ISAT+1
0285      IF(IST1.EQ.1) GOTO 1009
0286      WRITE (16,13) ISAT
0287  13     FORMAT (/ " SUN ALMANAC =1 OR DATA FROM FILE =2 FOR SV NO.",I2,"?"
0288          1/      " ANSWER ;_" )
0289      READ (16,98) IST
0290      IF(IST.EQ.1) GOTO 1005
0291  C -----
0292      WRITE (16,14)
0293  14     FORMAT (/ " FILENAME ;_" )
0294      READ(16,92) INAM
0295      OPEN (2,FILE=INAM,FORM='FORMATTED')
0296      READ (2,96) DTG(ISAT),ID(ISAT)
0297      READ (2,91) (AD(I,ISAT),I=1,4)
0298      READ (2,91) (AD(I,ISAT),I=5,8)

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0299      CLOSE(2)
0300      WRITE (16,15) ID(ISAT)
0301  15    FORMAT ( " SATELLITE ID = ",I2)
0302      GOTO 1010
0303  C -----
0304  1005  CONTINUE
0305      WRITE (16,16) ISAT
0306  16    FORMAT ( " ##### ALMANAC-DATA FOR SATELLITE ",I2,"#####"
0307      1/      " FORMAT :D12.4"
0308      2//      " DATE OF COLLECTION           :_" )
0309      READ (16,99) DTG(ISAT)
0310      WRITE (16,17)
0311  17    FORMAT ( " EXCENTRICITY           :_" )
0312      READ (16,99) AD(1,ISAT)
0313      WRITE (16,18)
0314  18    FORMAT ( " REFERENCE TIME         :_" )
0315      READ (16,99) AD(2,ISAT)
0316      WRITE (16,19)
0317  19    FORMAT ( " ORBIT INCLINATION (10)  :_" )
0318      READ (16,99) AD(3,ISAT)
0319      WRITE (16,20)
0320  20    FORMAT ( " DRIFT RATE OF (10)      :_" )
0321      READ (16,99) AD(4,ISAT)
0322      WRITE (16,21)
0323  21    FORMAT ( " SQUARE ROOT OF GREAT HALF-AXIS :_" )
0324      READ (16,99) AD(5,ISAT)
0325      WRITE (16,22)
0326  22    FORMAT ( " RIGHT ASCENSION OF ORBIT :_" )
0327      READ (16,99) AD(6,ISAT)
0328      WRITE (16,23)
0329  23    FORMAT ( " ARGUMENT OF PERIGEE     :_" )
0330      READ (16,99) AD(7,ISAT)
0331      WRITE (16,24)
0332  24    FORMAT ( " MEAN ANOMALY           :_" )
0333      READ (16,99) AD(8,ISAT)
0334      WRITE (16,25)
0335  25    FORMAT ( " SATELLITE ID           :_" )
0336      READ (16,98) ID(ISAT)
0337      GOTO 1010
0338  C -----
0339  1009  CONTINUE
0340      IF(ISAT.NE.1) GOTO 1010
0341      CALL EB14
0342      DO 107 I1=1,INS
0343  1011  CONTINUE
0344      WRITE (16,26) I1
0345  26    FORMAT ( " ID OF SATELLITE (",I2,") :_" )
0346      READ (16,98) ID(I1)
0347      DO 108 I2=1,24
0348      IF(ID(I1).NE.ID1(I2).AND.I2.LT.24) GOTO 108
0349      IF(ID(I1).EQ.ID1(I2)) GOTO 1012
0350      WRITE (16,27) ID(I1)
0351  27    FORMAT ( " ===== SATELLITE-ALMANAC OF SAT.(",I2,") NOT ON"
0352      1" TAPE 11 (=====)"
0353      GOTO 1011
0354  108  CONTINUE
0355  1012  CONTINUE
0356      DO 107 I3=1,8
0357      AD(I3,I1)=AD3(I3,I2)
0358      ID(I1)=ID1(I2)

```

```

0359 107 CONTINUE
0360 C -----
0361 1010 CONTINUE
0362 AD(9,ISAT)=AD(5,ISAT)**2
0363 AD(10,ISAT)=COS(AD(3,ISAT))
0364 AD(11,ISAT)=SIN(AD(3,ISAT))
0365 AD(12,ISAT)=COS(AD(7,ISAT))
0366 AD(13,ISAT)=SIN(AD(7,ISAT))
0367 AD(14,ISAT)=SGC/(AD(5,ISAT)*AD(9,ISAT))
0368 IF(ISAT.LT.INS) GOTO 1000
0369 C
0370 C ***** INPUT V-MATRIX AND INVERSION *****
0371 C
0372 WRITE (16,28)
0373 28 FORMAT (/ " V-MATRIX =UNITY-MATRIX (=1) ? "
0374 1/ " ANSWER :_" )
0375 READ (16,98) IST
0376 IF(IST.EQ.1) GOTO 1014
0377 WRITE (16,29)
0378 29 FORMAT ( " INPUT DIAGONAL-ELEMENTS OF MATRIX "
0379 1/ " !! PARAMETERS HAVE TO CORRESPOND TO SATELLITES !!" )
0380 DO 110 I=1,4
0381 WRITE (16,30) I,I
0382 30 FORMAT ( " ELEMENT (",I2," ",I2,") :_" )
0383 READ (16,97) V(I,I)
0384 V(I,I)=1./V(I,I)
0385 110 CONTINUE
0386 GOTO 1015
0387 1014 CONTINUE
0388 DO 111 I=1,4
0389 V(I,I)=1.
0390 111 CONTINUE
0391 1015 CONTINUE
0392 DO 112 I=1,4
0393 DO 112 J=1,4
0394 IF(I.EQ.J) GOTO 112
0395 V(I,J)=0.
0396 112 CONTINUE
0397 C
0398 C ***** INPUT USER- -ERROR *****
0399 C
0400 DO 109 II=1,4
0401 WRITE (16,31) ID(II)
0402 31 FORMAT ( " FILENAME FOR URE OF SAT.(ID=",I2,") :_" )
0403 READ (16,92) INAM
0404 OPEN(2,FILE=INAM,FORM='FORMATTED')
0405 READ(2,98) INUM
0406 DO 103 I=1,INUM
0407 READ (2,*) ARR(I,II),URE(I,II)
0408 ARR(I,II)=ARR(I,II)*3600.
0409 103 CONTINUE
0410 CLOSE (2)
0411 109 CONTINUE
0412 C
0413 C ***** INPUT NAME OF PLOTFILE *****
0414 C
0415 WRITE (16,32)
0416 32 FORMAT (/ " NAME OF PLOTFILE FOR SIGMA-MATRIX :_" )
0417 READ (16,92) INAM
0418 WRITE (16,33)

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0419 33   FORMAT ( " NAME OF PLOTFILE FOR HDOP :_" )
0420     READ (16,92) INAM1
0421     WRITE (16,37)
0422 37   FORMAT ( " NAME OF PLOTFILE FOR AZIMUTH AND ELEVATION :_" )
0423     READ (16,92) INAM2
0424 C .....
0425 C
0426 C ***** OUTPUT ALMANAC AND URE *****
0427 C
0428     A1=SNGL(DTC(1))
0429     A2=SNGL(TC)
0430     WRITE (6,53) A1,A2,(ID(I),I=1,4)
0431 53   FORMAT (/ "      USED ALMANACS          DTC= ",F5.0,"      TC= ",F6.0,
0432     1/      "      -----"
0433     2/      " SAT. ID : ",I3,I9X,I3,I9X,I3,I9X,I3)
0434     WRITE (6,54) ((AD(I,J),J=1,4),I=1,14)
0435 54   FORMAT (4(I0X,D12.4,))
0436     WRITE (6,55) (ID(I),I=1,4)
0437 55   FORMAT (/ "      USED URES"
0438     1/      "      -----"
0439     2/      " SAT. ID : ",I3,I25X,I3,I25X,I3,I25X,I3)
0440     WRITE (6,56) ((ARR(I,J),URE(I,J)),J=1,4),I=1,INUM)
0441 56   FORMAT (4(2E12.4,4X))
0442 C
0443 C ***** START- AND ENDTIMECONTROL *****
0444 C
0445     T3=DBLE(AMAX1(ARR(1,1),ARR(1,2),ARR(1,3),ARR(1,4)))
0446     IF(T3.LE.T) GOTO 1003
0447     T=T3
0448     CALL EB12(T,TMAX)
0449     WRITE (6,57) TMAX,T
0450 57   FORMAT (/ " ---> URE-DATA STARTS AT ",F7.4," HOURS."
0451     1/      " ==> NEW TSTART = ",D12.4," SEC.")
0452 1003 CONTINUE
0453     T3=DBLE(AMIN1(ARR(INUM,1),ARR(INUM,2),ARR(INUM,3),ARR(INUM,4)))
0454     IF(T3.GE.TFIN) GOTO 1007
0455     TFIN=T3
0456     CALL EB12(TFIN,TMIN)
0457     WRITE (6,58) TMIN,TFIN
0458 58   FORMAT (/ " ---> URE-DATA ENDS AT ",F7.4," HOURS."
0459     1/      " ==> NEW TFIN   = ",D12.4," SEC.")
0460 1007 CONTINUE
0461     WRITE (6,59)
0462 59   FORMAT (/ " INVERTED V-MATRIX ")
0463     WRITE (6,91) ((V(I,J),J=1,4),I=1,4)
0464 C .....
0465 C
0466 C ***** WRITE TITLE *****
0467 C
0468     WRITE (6,60) INAM,INAM1,INAM2
0469 60   FORMAT (/ " NAME OF PLOTFILE FOR SIGMA-MATRIX          : ",3A2,
0470     1/      " NAME OF PLOTFILE FOR HDOP                    : ",3A2,
0471     2/      " NAME OF PLOTFILE FOR AZIMUTH AND ELEVATION : ",3A2)
0472     IF(ISSW(0).GE.0) WRITE (6,61)
0473 61   FORMAT ( "OUTPUT OF COMPUTATIONS "
0474     1/      " ----- ")
0475     DTU=(DTU-1.0)*0.864005
0476     TCY=(DTC(1)-1.0)*0.864005+DMQD(TC,0.864005)
0477     OPEN (2,FILE=INAM,FORM='FORMATTED')
0478     OPEN (3,FILE=INAM1,FORM='FORMATTED')

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0479      OPEN (30,FILE=INAM2,FORM='FORMATTED')
0480 1004  CONTINUE
0481      ICOUNT=ICOUNT+1
0482      CALL EB12 (T,TOUT)
0483      WRITE (2,97) TOUT
0484      WRITE (30,97) TOUT
0485      IF(ISSW(0).GE.0) WRITE (6,62) TOUT
0486 62    FORMAT (/ " TIME : ",F12.4," HOURS "
0487      1/,15X," SATELLITE POSITIONS"
0488      2/,11X,"X",17X,"Y",17X,"Z",16X,"ELV",15X,"AZM")
0489      DO 102 I=1,INS
0490      DO 101 J=1,14
0491      AD1(J)=AD(J,I)
0492 101  CONTINUE
0493  C
0494  C ***** COMPUTATION OF POSITION,DISTANCE TO USER *****
0495  C           AND AZINUTH AND ELEVATION OF SATELLITE (I)
0496  C
0497      II=I
0498      CALL EB05(I1)
0499 102  CONTINUE
0500  C
0501  C ***** COMPUTATION OF G-MATRIX,HDOP AND GDOP *****
0502  C
0503  C!!   IF((INS.EQ.4).OR.(INS.EQ.3.AND.IST3.EQ.1)) CALL EB08
0504  C!!   IF(INS.EQ.3.AND.IST3.EQ.2) CALL EB08B
0505      CALL EB06
0506      IF(IFLAG) GOTO 1013
0507  C
0508  C ***** INTERPOLATION OF URE-DATA *****
0509  C
0510      DO 104 I=1,4
0511      DO 105 J=1,INUM-1
0512      IF(T-ARR(J,I).GE.0.AND.ARR(J+1,I)-T.GT.0) GOTO 1008
0513 105  CONTINUE
0514 1008  CONTINUE
0515      B=DBLE((URE(J+1,I)-URE(J,I))/(ARR(J+1,I)-ARR(J,I)))
0516      A=DBLE(URE(J,I))-DBLE(ARR(J,I))*B
0517      URE1(I)=A+B*T
0518 104  CONTINUE
0519  C
0520  C ***** COMPUTATION OF GROUND-TRUTH *****
0521  C
0522      CALL EB11
0523      IF(ISSW(0).GE.0) WRITE (6,63)
0524 63    FORMAT (/ " GROUND-TRUTH AND FIGURES OF MERIT " )
0525      IF(ISSW(0).GE.0) WRITE (6,64)
0526 64    FORMAT (10X,"DX",16X,"DY",16X,"DZ",15X,"-DB",13X,"HDOP",8X,
0527      1"PDOP",8X,"GDOP")
0528      IF(ISSW(0).GE.0) WRITE (6,65) (DX(I),I=1,4),HDOP,PDOP,GDOP
0529 65    FORMAT (4D18.8,4X,3(2X,G10.4))
0530      A1=SNGL(HDOP)
0531      WRITE (3,89) TOUT,HDOP
0532 1013  CONTINUE
0533      WRITE (2,94) DX
0534      IF(ISSW(0).GE.0) WRITE (6,90)
0535      T=T+TDEL
0536      IF(T.LE.TFIN) GOTO 1004
0537      CLOSE (2)
0538      WRITE (3,89) 0.,0.

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```
0539          CLOSE (3)
0540          CLOSE (30)
0541          STOP
0542 C
0543 C ***** FORMATS *****
0544 C
0545 89          FORMAT (2F12.6)
0546 90          FORMAT (1H1)
0547 91          FORMAT (4D18.8)
0548 92          FORMAT (3A2)
0549 93          FORMAT (I4)
0550 94          FORMAT (4E12.4)
0551 95          FORMAT (A4)
0552 96          FORMAT (G15.8,I3)
0553 97          FORMAT(G15.8)
0554 98          FORMAT(I2)
0555 99          FORMAT(D12.4)
0556          END
0557
```

&FILE T=00004 IS ON CR00011 USING 00006 BLKS R=0000

```
0001 FTN4X,L,Y
0002 #FILES (1,1)
0003 PROGRAM FILE
0004 C *****
0005 C * FILENAME : &FILE *
0006 C * PROGRAM TO READ URE-DATA AND CREATE FILES. *
0007 C *****
0008 C
0009 DIMENSION URE(15),TIME(15),INAME(3)
0010 WRITE (16,1)
0011 1 FORMAT (" NUMBER OF FILES :_")
0012 READ (16,99) N1
0013 DO 100 I=1,N1
0014 WRITE (16,2) I
0015 2 FORMAT ("NUMBER OF RECORDS IN FILE ",I2," ;_")
0016 READ (16,99) N2
0017 WRITE (16,3) I
0018 3 FORMAT ("NAME OF FILE ",I2," ;_")
0019 READ (16,98) INAME
0020 OPEN (2,FILE=INAME,FORM='FORMATTED')
0021 WRITE (2,99) N2
0022 C -----
0023 DO 101 J=1,N2
0024 WRITE (16,4) J
0025 4 FORMAT (" TIME(",I2," ) =_")
0026 READ (16,97) TIME (J)
0027 WRITE (16,5) J
0028 5 FORMAT (" URE(",I2," ) ;_")
0029 READ (16,97) URE(J)
0030 WRITE (2,96) TIME(J),URE(J)
0031 101 CONTINUE
0032 CLOSE(2)
0033 100 CONTINUE
0034 C -----
0035 96 FORMAT (2E12.4)
0036 97 FORMAT (E12.4)
0037 98 FORMAT (3A2)
0038 99 FORMAT (I2)
0039 STOP
0040 END
```

&PLCOR T=00004 IS ON CR00002 USING 00030 BLKS R=0000

```
0001 FTN4K,L,Y
0002 #FILES (1,1)
0003 PROGRAM PLCOR
0004 C *****
0005 C * FILENAME : &PLCOR *
0006 C * ***** *
0007 C * PROGRAM PLOTS DATA FILES GENERATED BY THE PROGRAM "EB00" *
0008 C * THE FILES CONTAIN VALUES IN THE FOLLOWING ORDER : *
0009 C * TIME IN HOURS AND MINUTES *
0010 C * UPPER-TRIANGULAR SIGMA-MATRIX (X1) *
0011 C * SQUARE-ROOTS OF DIAGONAL ELEMENTS (X2) *
0012 C * CORRELATION-COEFFICIENT (X3) *
0013 C * GROUND-TRUTH (X4) *
0014 C * *
0015 C * ----- *
0016 C * PLOTTED VALUES ARE : *
0017 C * SQUARE-ROOT OF DIAGONAL ELEMENTS *
0018 C * SQUARE-ROOT OF THE SUM OF THE DIAGONAL ELEMENTS *
0019 C * GROUND-TRUTH *
0020 C * CORRELATION-COEFFICIENT *
0021 C * *
0022 C * ----- *
0023 C * USED SUBROUTINES : DLTBL,GPS --> PLOTLIBRARY *
0024 C * INPUT,PLSUB *
0025 C * *
0026 C *****
0027 C
0028 DIMENSION IGCB(192),INAM(3),IDATE(3)
0029 C
0030 C ***** READ NAME OF FILE,LOGICAL UNIT AND ID OF *****
0031 C DEVICE SUB *****
0032 C
0033 WRITE (16,1)
0034 1 FORMAT (" NAME OF PLOTFILE :_")
0035 READ (16,92) INAM
0036 OPEN (2,FILE=INAM,FORM='FORMATTED')
0037 WRITE (16,3)
0038 3 FORMAT (" LOGICAL UNIT (LU) AND ID OF DEVICE-SUBROUTINE"
0039 1/ " LU =_")
0040 READ (16,93) LU
0041 WRITE (16,4)
0042 4 FORMAT (" ID =_")
0043 READ (16,93) ID
0044 C
0045 C ***** INITIALIZE PLOTTER, GET LIMITS OF X-AXIS *****
0046 C AND LABELS AND DRAW VERTICAL GRID *****
0047 C
0048 WRITE (16,5)
0049 5 FORMAT (" START-AND ENDTIME IN HOURS."
0050 1/ " TSTART :_")
0051 READ (16,94) TSTART
0052 WRITE (16,6)
0053 6 FORMAT (" TEND :_")
0054 READ (16,94) TEND
0055 WRITE (16,19)
0056 19 FORMAT (" DATE (MMDDYY) :_")
0057 READ (16,92) IDATE
0058 CALL PLOTR (IGCB,ID,1,LU)
```

```

0059      CALL SETAR (IGCB,1,1)
0060      CALL FRAME (IGCB)
0061 C .....
0062 C          PLOTTING OF DATA
0063 C
0064 C ***** GROUND TRUTH *****
0065 C
0066      CALL PLSUB (IGCB,10.,28.,-20.,20.,4,TSTART,TEND,21)
0067 C
0068 C ***** CORRELATION-COEFFICIENTS *****
0069 C
0070      CALL PLSUB (IGCB,28.,46.,-1.,1.,1.,3,TSTART,TEND,15)
0071      CALL PLSUB (IGCB,46.,64.,-1.,1.,1.,3,TSTART,TEND,18)
0072 C
0073 C ***** SQUARE-ROOTS OF THE SUM OF THE DIAGONAL ELEMENTS *****
0074 C
0075      CALL PSUB1 (IGCB,64.,82.,0.,40.,20.,3,TSTART,TEND,11)
0076 C
0077 C ***** SQUARE-ROOT OF DIAGONAL ELEMENTS *****
0078 C
0079      CALL PLSUB (IGCB,82.,100.,0.,20.,10.,4,TSTART,TEND,11)
0080 C
0081 C ***** LABELS *****
0082 C
0083      CALL VIEWP (IGCB,0.,100.,0.,100.)
0084      CALL WINDOW (IGCB,0.,100.,0.,100.)
0085      CALL CSIZE (IGCB,1.,1.,0.)
0086 C -----
0087      CALL MOVE (IGCB,5.,98.)
0088      CALL LABEL (IGCB)
0089      WRITE (LU,91) 20.
0090      CALL MOVE (IGCB,5.,83.)
0091      CALL LABEL (IGCB)
0092      WRITE (LU,91) 0.
0093      CALL MOVE (IGCB,1.,91.)
0094      CALL LABEL (IGCB)
0095      WRITE (LU,7)
0096 7      FORMAT ( "SQUARE" )
0097      CALL MOVE (IGCB,1.,89.)
0098      CALL LABEL (IGCB)
0099      WRITE (LU,8)
0100 8      FORMAT ( "ROOTS" )
0101      CALL MOVE (IGCB,10.,82.)
0102      CALL LINE (IGCB,0)
0103      CALL DRAW (IGCB,0.,82.)
0104 C -----
0105      CALL MOVE (IGCB,5.,80.)
0106      CALL LABEL (IGCB)
0107      WRITE (LU,91) 40.
0108      CALL MOVE (IGCB,1.,73.)
0109      CALL LABEL (IGCB)
0110      WRITE (LU,21)
0111 21      FORMAT ( "SQUARE-ROOTS" )
0112      CALL MOVE (IGCB,1.,71.)
0113      CALL LABEL (IGCB)
0114      WRITE (LU,9)
0115 9      FORMAT ( "OF SUMS" )
0116      CALL MOVE (IGCB,5.,65.)
0117      CALL LABEL (IGCB)
0118      WRITE (LU,91) 0.

```

```

0119      CALL MOVE (IGCB,10.,64.)
0120      CALL DRAW (IGCB,0.,64.)
0121  C -----
0122      CALL MOVE (IGCB,5.,62.)
0123      CALL LABEL (IGCB)
0124      WRITE (LU,91) 1.
0125      CALL MOVE (IGCB,1.,55.)
0126      CALL LABEL (IGCB)
0127      WRITE (LU,20)
0128  20    FORMAT ( "CORRELATION" )
0129      CALL MOVE (IGCB,1.,53.)
0130      CALL LABEL (IGCB)
0131      WRITE (LU,10)
0132  10    FORMAT ( "COEFFICIENTS" )
0133      CALL MOVE (IGCB,5.,47.)
0134      CALL LABEL (IGCB)
0135      WRITE (LU,91) -1.
0136      CALL MOVE (IGCB,10.,46.)
0137      CALL DRAW (IGCB,0.,46.)
0138  C -----
0139      CALL MOVE (IGCB,5.,44.)
0140      CALL LABEL (IGCB)
0141      WRITE (LU,91) 1.
0142      CALL MOVE (IGCB,1.,37.)
0143      CALL LABEL (IGCB)
0144      WRITE (LU,20)
0145      CALL MOVE (IGCB,1.,35.)
0146      CALL LABEL (IGCB)
0147      WRITE (LU,10)
0148      CALL MOVE (IGCB,5.,29.)
0149      CALL LABEL (IGCB)
0150      WRITE (LU,91) -1.
0151      CALL MOVE (IGCB,10.,28.)
0152      CALL DRAW (IGCB,0.,28.)
0153  C -----
0154      CALL MOVE (IGCB,5.,26.)
0155      CALL LABEL (IGCB)
0156      WRITE (LU,91) 20.
0157      CALL MOVE (IGCB,1.,19.)
0158      CALL LABEL (IGCB)
0159      WRITE (LU,12)
0160  12    FORMAT ( "GROUND-" )
0161      CALL MOVE (IGCB,1.,17.)
0162      CALL LABEL (IGCB)
0163      WRITE (LU,13)
0164  13    FORMAT ( "TRUTH" )
0165      CALL MOVE (IGCB,5.,11.)
0166      CALL LABEL (IGCB)
0167      WRITE (LU,91) -20.
0168      CALL MOVE (IGCB,0.,10.)
0169      CALL DRAW (IGCB,10.,10.)
0170  C
0171  C ***** TITLES *****
0172  C
0173      CALL VIEWP (IGCB,0.,110.,0.,100.)
0174      CALL WINDOW (IGCB,0.,110.,0.,100.)
0175      CALL CSIZE (IGCB,2.,1.,0.)
0176      CALL MOVE (IGCB,1.,7.)
0177      CALL LABEL (IGCB)
0178      WRITE (LU,14) TSTART

```

```

0179 14   FORMAT ( " TSTART = ",F5.2)
0180     CALL MOVE (IGCB,90.,7.)
0181     CALL LABEL (IGCB)
0182     WRITE (LU,15) TEND
0183 15   FORMAT ( " TEND = ",F5.2)
0184 C -----
0185     CALL MOVE (IGCB,30.,4.)
0186     CALL LABEL (IGCB)
0187     WRITE (LU,16)
0188 16   FORMAT ( "GROUND TRUTH COMPUTATIONS")
0189     CALL MOVE (IGCB,40.,7.5)
0190     CALL LABEL (IGCB)
0191     WRITE (LU,17)
0192 17   FORMAT ( "TIME IN HOURS")
0193     CALL CSIZE (IGCB,1.,1.,0.)
0194     CALL MOVE (IGCB,80.,1.)
0195     CALL LABEL (IGCB)
0196     WRITE (LU,18) IDATE
0197 18   FORMAT ( "PROGRAM FLOOR --> DATE : ",A2,"-",A2,"-",A2)
0198     CALL MOVE (IGCB,100.,10.)
0199     CALL DRAW (IGCB,110.,10.)
0200 C .....
0201     CLOSE (2)
0202     CALL PLOTR (IGCB,ID,0)
0203 C
0204 C ***** FORMATS *****
0205 C
0206 91   FORMAT (F5.0)
0207 92   FORMAT (3A2)
0208 93   FORMAT (I2)
0209 94   FORMAT (F8.6)
0210 95   FORMAT (1X,3F12.6)
0211     STOP
0212     END

```

&PLSIG T=00004 IS ON CR00011 USING 00018 BLKS R=0000

```
0001 FTN4X,L,Y
0002 #FILES (1,1)
0003 PROGRAM PLSIG
0004 C *****
0005 C * FILENAME : &PLSIG *
0006 C * ***** *
0007 C * PROGRAM PLOTS DATA FILES GENERATED BY THE PROGRAM "EB00" *
0008 C * THE FILES CONTAIN VALUES IN THE FOLLOWING ORDER : *
0009 C * TIME IN HOURS AND MINUTES *
0010 C * UPPER-TRIANGULAR SIGMA-MATRIX (X1) *
0011 C * SQUARE-ROOTS OF DIAGONAL ELEMENTS (X2) *
0012 C * CORRELATION-COEFFICIENT (X3) *
0013 C * GROUND-TRUTH (X4) *
0014 C * *
0015 C * - - - - - *
0016 C * PLOTTED VALUES ARE : *
0017 C * ELEMENTS OF SIGMA-MATRIX *
0018 C * SQUARE-ROOTS *
0019 C * GROUND TRUTH *
0020 C * *
0021 C * - - - - - *
0022 C * USED SUBROUTINES : DLTLB,GPS --> PLOTLIBRARY *
0023 C * INPUT.PLSUB *
0024 C * *
0025 C *****
0026 C
0027 DIMENSION IGCB(192),INAM(3),IDATE(3)
0028 C
0029 C ***** READ NAME OF FILE,LOGICAL UNIT AND ID OF *****
0030 C DEVICE SUB
0031 C
0032 WRITE (16,1)
0033 1 FORMAT (" NAME OF PLOTFILE :_")
0034 READ (16,92) INAM
0035 OPEN (2,FILE=INAM,FORM='FORMATTED')
0036 WRITE (16,3)
0037 3 FORMAT (" LOGICAL UNIT (LU) AND ID OF DEVICE-SUBROUTINE"
0038 1/ " LU =_")
0039 READ (16,93) LU
0040 WRITE (16,4)
0041 4 FORMAT (" ID =_")
0042 READ (16,93) ID
0043 C
0044 C ***** INITIALIZE PLOTTER, GET LIMITS OF X-AXIS *****
0045 C AND LABELS AND DRAW VERTICAL GRID
0046 C
0047 WRITE (16,5)
0048 5 FORMAT (" START-AND ENDTIME IN HOURS."
0049 1/ " TSTART :_")
0050 READ (16,94) TSTART
0051 WRITE (16,6)
0052 6 FORMAT (" TEND :_")
0053 READ (16,94) TEND
0054 WRITE (16,19)
0055 19 FORMAT (" DATE (MMDDYY) :_")
0056 READ (16,92) IDATE
0057 CALL PLOTR (IGCB,ID,1,LU)
0058 CALL SETAR (IGCB)
```

```

0059      CALL FRAME (IGCB)
0060 C .....
0061 C          PLOTTING OF DATA
0062 C
0063 C ***** GROUND TRUTH *****
0064 C
0065      CALL PLSUB (IGCB,10.,28.,-10.,10.,10.,4,TSTART,TEND,21)
0066 C
0067 C ***** SQUARE-ROOT OF DIAGONAL ELEMENTS *****
0068 C
0069      CALL PLSUB (IGCB,28.,46.,0.,20.,10.,4,TSTART,TEND,11)
0070 C
0071 C ***** SIGMA MATRIX --> 3 PLOTS *****
0072 C
0073      CALL PLSUB (IGCB,46.,64.,-100.,100.,100.,4,TSTART,TEND,1)
0074      CALL PLSUB (IGCB,64.,82.,-100.,100.,100.,3,TSTART,TEND,5)
0075      CALL PLSUB (IGCB,82.,100.,-100.,100.,100.,3,TSTART,TEND,8)
0076 C
0077 C ***** LABELS *****
0078 C
0079      CALL VIEWP (IGCB,0.,100.,0.,100.)
0080      CALL WINDW (IGCB,0.,100.,0.,100.)
0081      CALL CSIZE (IGCB,1.,1.,0.)
0082 C -----
0083      CALL MOVE (IGCB,5.,98.)
0084      CALL LABEL (IGCB)
0085      WRITE (LU,91) 100.
0086      CALL MOVE (IGCB,5.,83.)
0087      CALL LABEL (IGCB)
0088      WRITE (LU,91) -100.
0089      CALL MOVE (IGCB,1.,91.)
0090      CALL LABEL (IGCB)
0091      WRITE (LU,7)
0092 7      FORMAT ( "SIGMA" )
0093      CALL MOVE (IGCB,1.,89.)
0094      CALL LABEL (IGCB)
0095      WRITE (LU,8)
0096 8      FORMAT ( "LINE 3+4" )
0097      CALL MOVE (IGCB,10.,82.)
0098      CALL LINE (IGCB,0)
0099      CALL DRAW (IGCB,0.,82.)
0100 C -----
0101      CALL MOVE (IGCB,5.,80.)
0102      CALL LABEL (IGCB)
0103      WRITE (LU,91) 100.
0104      CALL MOVE (IGCB,1.,73.)
0105      CALL LABEL (IGCB)
0106      WRITE (LU,7)
0107      CALL MOVE (IGCB,1.,71.)
0108      CALL LABEL (IGCB)
0109      WRITE (LU,9)
0110 9      FORMAT ( "LINE 2" )
0111      CALL MOVE (IGCB,5.,65.)
0112      CALL LABEL (IGCB)
0113      WRITE (LU,91) -100.
0114      CALL MOVE (IGCB,10.,64.)
0115      CALL DRAW (IGCB,0.,64.)
0116 C -----
0117      CALL MOVE (IGCB,5.,62.)
0118      CALL LABEL (IGCB)

```

```

0119      WRITE (LU,91) 100.
0120      CALL MOVE (IGCB,1.,55.)
0121      CALL LABEL (IGCB)
0122      WRITE (LU,7)
0123      CALL MOVE (IGCB,1.,53.)
0124      CALL LABEL (IGCB)
0125      WRITE (LU,10)
0126 10    FORMAT ( "LINE 1" )
0127      CALL MOVE (IGCB,5.,47.)
0128      CALL LABEL (IGCB)
0129      WRITE (LU,91) -100.
0130      CALL MOVE (IGCB,10.,46.)
0131      CALL DRAW (IGCB,0.,46.)
0132 C -----
0133      CALL MOVE (IGCB,5.,44.)
0134      CALL LABEL (IGCB)
0135      WRITE (LU,91) 20.
0136      CALL MOVE (IGCB,1.,37.)
0137      CALL LABEL (IGCB)
0138      WRITE (LU,11)
0139 11    FORMAT ( "SQUARE" )
0140      CALL MOVE (IGCB,1.,35.,)
0141      CALL LABEL (IGCB)
0142      WRITE (LU,20)
0143 20    FORMAT ( "ROOTS" )
0144      CALL MOVE (IGCB,5.,29.)
0145      CALL LABEL (IGCB)
0146      WRITE (LU,91) 0.
0147      CALL MOVE (IGCB,10.,28.)
0148      CALL DRAW (IGCB,0.,28.)
0149 C -----
0150      CALL MOVE (IGCB,5.,26.)
0151      CALL LABEL (IGCB)
0152      WRITE (LU,91) 10.
0153      CALL MOVE (IGCB,1.,19.)
0154      CALL LABEL (IGCB)
0155      WRITE (LU,12)
0156 12    FORMAT ( "GROUND-" )
0157      CALL MOVE (IGCB,1.,17.)
0158      CALL LABEL (IGCB)
0159      WRITE (LU,13)
0160 13    FORMAT ( "TRUTH" )
0161      CALL MOVE (IGCB,5.,11.)
0162      CALL LABEL (IGCB)
0163      WRITE (LU,91) -10.
0164      CALL MOVE (IGCB,10.,10.)
0165      CALL DRAW (IGCB,0.,10.)
0166 C -----
0167      CALL CSIZE (IGCB,2.,1.,0.)
0168      CALL MOVE (IGCB,1.,7.)
0169      CALL LABEL (IGCB)
0170      WRITE (LU,14) TSTART
0171 14    FORMAT ( " TSTART = ",F5.2)
0172      CALL MOVE (IGCB,1.,2.)
0173      CALL LABEL (IGCB)
0174      WRITE (LU,15) TEND
0175 15    FORMAT ( " TEND   = ",F5.2)
0176 C -----
0177      CALL MOVE (IGCB,30.,4.)
0178      CALL LABEL (IGCB)

```

```

0179      WRITE (LU,16)
0180 16    FORMAT ( "GROUND TRUTH COMPUTATIONS --> PLOT-VERSION 1")
0181      CALL MOVE (IGCB,40.,7.5)
0182      CALL LABEL (IGCB)
0183      WRITE (LU,17)
0184 17    FORMAT ( "TIME IN HOURS")
0185      CALL MOVE (IGCB,75.,1.)
0186      CALL LABEL (IGCB)
0187      WRITE (LU,18) IDATE
0188 18    FORMAT ( " DATE : ",A2,"-",A2,"-",A2)
0189 C .....
0190      CLOSE (2)
0191      CALL PLOTR (IGCB,ID,0)
0192 C
0193 C ***** FORMATS *****
0194 C
0195 91    FORMAT (F5.0)
0196 92    FORMAT (3A2)
0197 93    FORMAT (I2)
0198 94    FORMAT (F8.6)
0199 95    FORMAT (1X,3F12.6)
0200      STOP
0201      END

```

&PLAEL T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTN4X,L,Y
0002 $FILES (1,1)
0003     PROGRAM PLAEL
0004 C *****
0005 C *           FILENAME : &PLAEL *
0006 C *           ***** *
0007 C * PROGRAM TO PLOT AZIMUTH AND ELEVATION FROM *
0008 C * A DATAFILE GENERATED BY THE PROGRAM EB00. *
0009 C *****
0010 C
0011     DIMENSION IGCB(192),INAM(3),X(2),X0(4)
0012     DOUBLE PRECISION DX(2)
0013     LOGICAL LOG
0014 C
0015 C ***** GET INFORMATION TO INITIALIZE PLOTTER *****
0016 C           AND LIMITS OF TIME-AXIS AND DRAW GRID
0017 C
0018     WRITE (16,1)
0019 1     FORMAT ( " LOGICAL UNIT OF PLOT AND ID OF DEVICE-SUBROUTINE"
0020 1/      " LU,ID ;_" )
0021     READ (16,*) LU,ID
0022     WRITE (16,2)
0023 2     FORMAT ( " LIMITS OF TIME-AXIS "
0024 1/      " TSTART,TEND ;_" )
0025     READ (16,*) TSTART,TEND
0026     WRITE (16,3)
0027 3     FORMAT ( " FILENAME ;_" )
0028     READ (16,90) INAM
0029     OPEN (2,FILE=INAM,FORM='FORMATTED')
0030     WRITE (16,4)
0031 4     FORMAT ( " NUMBER OF SATELLITES IN FILE ;_" )
0032     READ (16,*) N
0033     LOG=.TRUE.
0034     CALL PLOTR (IGCB,ID,1,LU)
0035     CALL SETAR (IGCB,1,3)
0036     CALL FRAME (IGCB)
0037     CALL VIEWP (IGCB,20.,130.,20.,60.)
0038     CALL WINDW (IGCB,TSTART,TEND,0.,90.)
0039     CALL GRID (IGCB,0.25,30.,TSTART,0.,2.,1.)
0040 C
0041 C ***** PLOT DATA *****
0042 C
0043     J=1
0044 1000 CONTINUE
0045     READ (2,*,END=2000) T
0046     IT=IFIX(T)
0047     T1=T-IT
0048     T=IT+T1/0.6
0049     DO 100 I=1,N
0050     READ (2,*) M,DX
0051     X(1)=SNGL(DX(1))
0052     X(2)=SNGL(DX(2))
0053     IF(LOG) GOTO 1001
0054     CALL MOVE (IGCB,T0,X0(I))
0055     CALL LINE (IGCB,I-1)
0056     CALL DRAW (IGCB,T,X(J))
0057 1001 CONTINUE
0058     X0(I)=X(J)
```

```

0059 100  CONTINUE
0060      LOG=.FALSE.
0061      TO=T
0062      GOTO 1000
0063 2000  CONTINUE
0064      IF(J.EQ.2) GOTO 2001
0065      REWIND (2)
0066      LOG=.TRUE.
0067      CALL VIEWP (IGCB,20.,130.,60.,100.)
0068      CALL WINDW (IGCB,TSTART,TEND,0.,360.)
0069      CALL GRID (IGCB,0.25,30.,TSTART,0.,2.,2.)
0070      J=2
0071      GOTO 1000
0072 2001  CONTINUE
0073      CLOSE (2)
0074  C
0075  C ***** PLOT TITLES AND LABELS *****
0076  C
0077      CALL LINE (IGCB,0)
0078      CALL VIEWP (IGCB,0.,130.,0.,100.)
0079      CALL WINDW (IGCB,0.,130.,0.,100.)
0080      CALL MOVE (IGCB,13.,97.)
0081      CALL CSIZE (IGCB,2.,1.,0.)
0082      CALL LABEL (IGCB)
0083      WRITE (LU,91) 360.
0084      CALL MOVE (IGCB,1.,81.)
0085      CALL LABEL (IGCB)
0086      WRITE (LU,5)
0087 5     FORMAT ("AZIMUTH")
0088      CALL MOVE (IGCB,1.,78.)
0089      CALL LABEL (IGCB)
0090      WRITE (LU,6)
0091 6     FORMAT ("IN DEGREES")
0092      CALL MOVE (IGCB,13.,61.)
0093      CALL LABEL (IGCB)
0094      WRITE (LU,91) 0.
0095      CALL MOVE (IGCB,0.,60.)
0096      CALL DRAW (IGCB,20.,60.)
0097      CALL MOVE (IGCB,13.,57.)
0098      CALL LABEL (IGCB)
0099      WRITE (LU,91) 90.
0100      CALL MOVE (IGCB,1.,41.)
0101      CALL LABEL (IGCB)
0102      WRITE (LU,7)
0103 7     FORMAT ("ELEVATION")
0104      CALL MOVE (IGCB,1.,38.)
0105      CALL LABEL (IGCB)
0106      WRITE (LU,6)
0107      CALL MOVE (IGCB,13.,21.)
0108      CALL LABEL (IGCB)
0109      WRITE (LU,91) 0.
0110  C -----
0111      CALL MOVE (IGCB,0.,20.)
0112      CALL DRAW (IGCB,20.,20.)
0113      CALL LINE (IGCB,1)
0114      CALL MOVE (IGCB,20.,24.444)
0115      CALL DRAW (IGCB,130.,24.444)
0116      CALL MOVE (IGCB,16.,17.)
0117      CALL LABEL (IGCB)
0118      WRITE (LU,92) TSTART

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```

0119      CALL MOVE (IGCB,54.,12.)
0120      CALL LABEL (IGCB)
0121      WRITE (LU,8)
0122  8    FORMAT ( "GMT-TIME IN HOURS" )
0123      CALL MOVE (IGCB,54.,5.)
0124      CALL LABEL (IGCB)
0125      WRITE (LU,9)
0126  9    FORMAT ( "PLOTPROGRAM PLAEI" )
0127      CALL MOVE (IGCB,120.,17.)
0128      CALL LABEL (IGCB)
0129      WRITE (LU,92) TEND
0130      CALL MOVE (IGCB,0.,0.)
0131      CALL PLOTR (IGCB,10,0)
0132  C    -----
0133  90    FORMAT (3A2)
0134  91    FORMAT (F4.0)
0135  92    FORMAT (F5.2)
0136      STOP
0137      END

```

PL5FI T=00004 IS ON CR0011 USING 00018 BLKS R=0000

```
0001 FTN4X,L,Y
0002 $FILES (1,1)
0003 PROGRAM PL5FI
0004 C *****
0005 C * FILENAME : &PL5FI *
0006 C * ***** *
0007 C * PROGRAM TO PLOT UP TO 5 FILES CONTAINING *
0008 C * TIME-TAGGED TWO-DIMENSIONAL ACCURACIES. *
0009 C * FILES ARE GENERATED BY THE PROGRAM EB00 AND *
0010 C * TERMINATED BY AN END-CRITERIA ; X=Y=0. *
0011 C *****
0012 C
0013 DIMENSION IGCB(192),INAM(3)
0014 LOGICAL LOG
0015 C
0016 C ***** GET INFORMATION TO INITIALIZE PLOTTER *****
0017 C AND LIMITS OF TIME-AXIS AND DRAW GRID
0018 C
0019 WRITE (16,1)
0020 1 FORMAT ( " LOGICAL UNIT OF PLOT AND ID OF DEVICE-SUBROUTINE"
0021 1/ " LU,ID ;_" )
0022 READ (16,*) LU,ID
0023 WRITE (16,2)
0024 2 FORMAT ( " LIMITS OF TIME-AXIS "
0025 1/ " TSTART,TEND ;_" )
0026 READ (16,*) TSTART,TEND
0027 CALL PLOTR (IGCB,ID,1,LU)
0028 CALL SETAR (IGCB,1,3)
0029 CALL FRAME (IGCB)
0030 CALL VIEWP (IGCB,20,112,20,80)
0031 CALL WINDW (IGCB,TSTART,TEND,0,100)
0032 CALL FXD (IGCB,2)
0033 CALL LGRID (IGCB,-0.25,-20,TSTART,0,2,2)
0034 C
0035 C ***** PLOT DATA *****
0036 C
0037 CALL CSIZE (IGCB,2,1,0)
0038 WRITE (16,3)
0039 3 FORMAT ( " NUMBER OF FILES ;_" )
0040 READ (16,*) N
0041 DO 100 I=1,N
0042 CALL VIEWP (IGCB,20,112,20,80)
0043 CALL WINDW (IGCB,TSTART,TEND,0,100)
0044 LOG=.TRUE.
0045 WRITE (16,4) I
0046 4 FORMAT ( " FILENAME ",I2," ;_" )
0047 READ (16,90) INAM
0048 OPEN (2,FILE=INAM,FORM='FORMATTED')
0049 CALL LINE (IGCB,I-1)
0050 1000 CONTINUE
0051 READ (2,*) X,Y
0052 IT=IFIX(X)
0053 T1=X-IT
0054 X=IT+T1/0.6
0055 IF(LOG) CALL MOVE (IGCB,X,Y)
0056 LOG=.FALSE.
0057 IF(X.LT.0.01.AND.Y.LT.0.01) GOTO 1001
0058 CALL DRAW (IGCB,X,Y)
```

```

0059      GOTO 1000
0060 1001  CONTINUE
0061      CLOSE (2)
0062      CALL VIEWP (IGCB,0.,130.,0.,100.)
0063      CALL WINDW (IGCB,0.,130.,0.,100.)
0064      CALL MOVE (IGCB,I*20.,90.)
0065      CALL DRAW (IGCB,I*20.+10.,90.)
0066      CALL MOVE (IGCB,I*20.+12.,89.)
0067      CALL LABEL (IGCB)
0068      WRITE (LU,90) INAM
0069 100   CONTINUE
0070 C
0071 C ***** PLOT TITLES *****
0072 C
0073      CALL MOVE (IGCB,10.,25.)
0074      CALL LDIR (IGCB,1.57)
0075      CALL LABEL (IGCB)
0076      WRITE (LU,5)
0077 5     FORMAT ( "TWO-DIMENSIONAL ACCURACIES" )
0078      CALL LDIR (IGCB,0.)
0079      CALL MOVE (IGCB,54.,12.)
0080      CALL LABEL (IGCB)
0081      WRITE (LU,6)
0082 6     FORMAT ( "GMT-TIME IN HOURS" )
0083      CALL MOVE (IGCB,54.,5.)
0084      CALL LABEL (IGCB)
0085      WRITE (LU,9)
0086 9     FORMAT ( "PLOTPROGRAM PLSFI" )
0087      CALL MOVE (IGCB,0.,0.)
0088      CALL PLOTR (IGCB,ID,0)
0089 C -----
0090 90    FORMAT (3A2)
0091      STOP
0092      END

```

&EB02 T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTH4X,L,Y
0002 C *****
0003 C *          FILENAME ; &EB02          *
0004 C *                                          *
0005 C *          PROGRAM COMPUTES THE E-MATRIX          *
0006 C *****
0007 C
0008          SUBROUTINE EB02
0009          IMPLICIT DOUBLE PRECISION (A-H,K-Z)
0010          COMMON/ELEV/E(3,3)
0011          COMMON/POS/LAT,LON,ALT,R
0012 C -----
0013          SN=DSIN(LON)
0014          CN=DCOS(LON)
0015          ST=DSIN(LAT)
0016          CT=DCOS(LAT)
0017          E(1,1)=-SN
0018          E(1,2)=CN
0019          E(1,3)=0.0
0020          E(2,1)=-CN*ST
0021          E(2,2)=-SN*ST
0022          E(2,3)=CT
0023          E(3,1)=CN*CT
0024          E(3,2)=SN*CT
0025          E(3,3)=ST
0026          RETURN
0027          END
```

&EB03 T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTH4X,L,Y
0002 C *****
0003 C *          FILENAME :  &EB03          *
0004 C *          *          *
0005 C * COMPUTES THE USER-POSITION IN ECEF-COORDINATES *
0006 C * (TU-VECTOR=U-VECTOR (IN MAINPROGRAM) ) *
0007 C *          *          *
0008 C *****
0009 C
0010     SUBROUTINE EB03
0011     IMPLICIT DOUBLE PRECISION(A-Z)
0012     COMMON/CNST/PI,RTD,OMF,AE,E2,OMF2,SGC,ERATE
0013     COMMON/DTX/TU(4)
0014     COMMON/POS/LAT,LON,ALT,XY
0015 C -----
0016     SLAT=DSIN(LAT)
0017     XY=AE/DSQRT(1.E0-E2*SLAT*SLAT)
0018     TU(3)=(XY*OMF2+ALT)*SLAT
0019     XY=(XY+ALT)*DCOS(LAT)
0020     TU(1)=XY*DCOS(LON)
0021     TU(2)=XY*DSIN(LON)
0022     RETURN
0023     END
```

&EB05 T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTR4X,L,Y
0002 C *****
0003 C * FILENAME : &EB05 *
0004 C * *
0005 C * COMPUTES ELEVATION AND AZIMUTH OF SATELLITES AND IN *
0006 C * SUB. "EB06" THE POSITION AND IN SUB. "EB07" THE DISTANCE *
0007 C * USER-SATELLITE. *
0008 C * *
0009 C *****
0010 C
0011 SUBROUTINE EB05 (I)
0012 IMPLICIT DOUBLE PRECISION (A-H,K-Z)
0013 DIMENSION Y(4,3)
0014 COMMON/ELEV/E(3,3)
0015 COMMON/SAT/S(4)
0016 COMMON/AZM/ELV(4),AZM(4)
0017 COMMON/CONST/PI,RTD,DMF,AE,E2,DMF2,SGC,ERATE
0018 COMMON/DTX/U(4),D(4,4),RBAR(4)
0019 C -----
0020 CALL EB06
0021 CALL EB07(I)
0022 DO 100 II=1,3
0023 Y(I,II)=0.D0
0024 DO 100 III=1,3
0025 Y(I,II)=Y(I,II)+S(III)*E(II,III)
0026 100 CONTINUE
0027 C
0028 C ***** COMPUTATION OF ELEVATION AND AZIMUTH OF *****
0029 C SATELLITES AND OUTPUT
0030 C
0031 Y(I,3)=Y(I,3)-AE
0032 SY=DSQRT(Y(I,1)*Y(I,1)+Y(I,2)*Y(I,2))
0033 ELV(I)=DATAN2(Y(I,3),SY)*RTD
0034 AZM(I)=DATAN2(Y(I,1),Y(I,2))*RTD
0035 IF(AZM(I).LT.0.) AZM(I)=AZM(I)+360.0
0036 IF(ISSW(0).GE.0) WRITE (6,1) (S(J),J=1,3),ELV(I),AZM(I)
0037 WRITE (30,2) I,ELV(I),AZM(I)
0038 2 FORMAT (I2,2D18.8)
0039 1 FORMAT (5D18.8)
0040 RETURN
0041 END
```

&EB06 T=00004 IS ON CR00011 USING 00018 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C *          FILENAME :  &EB06          *
0004 C *          *          *
0005 C * COMPUTES THE ACTUAL POSITION OF THE SATELLITE *
0006 C * IN ECEF-COORDINATES ( S-VECTOR = X,Y,Z )   *
0007 C *          *          *
0008 C *****
0009 C
0010     SUBROUTINE EB06
0011     IMPLICIT DOUBLE PRECISION (A-Z)
0012     INTEGER I
0013     COMMON/NAC/TUY,TCY,TKC,DTC(4),DTU,TC,T
0014     COMMON/CNST/PI,RTD,OMF,AE,E2,OMF2,SGC,ERATE,PI2
0015     COMMON/SAT/X,Y,Z,MK
0016     COMMON/DB2/ECC,TOE,INOT,NRATE,SRAD,OME0,OME,MNOT,R,CINO,
0017     *SINO,COME,SOME,C
0018 C -----
0019     A=TC-TOE
0020     TUY=DTU+T
0021     IF(A.GT.-0.3024D6.AND.A.LT.3024D6) TKC=A
0022     IF(A.LT.-0.3024D6) TKC=A+0.6048D6
0023     IF(A.GT.0.3024D6) TKC=A-0.6048D6
0024     TK=TUY-TCY+TKC
0025     OGA=OME0+(NRATE-ERATE)*TK-ERATE*TOE
0026     MK=MNOT+C*TK
0027     6 IF(MK.GE.-PI2)GO TO 7
0028     MK=MK+PI2
0029     GO TO 6
0030     7 IF(MK.LE.PI2)GO TO 8
0031     MK=MK-PI2
0032     GO TO 7
0033     8 EK=MK+ECC*DSIN(MK)
0034     DO 100 I=1,4
0035     COSE=DCOS(EK)
0036     SINE=DSIN(EK)
0037     TK=1.-ECC*COSE
0038     100 EK=EK-(EK-MK-ECC*SINE)/TK
0039     COSE=(COSE-ECC)/TK
0040     SINE=DSQRT(1.-ECC*ECC)*SINE/TK
0041     EK=COSE*COME-SINE*SOME
0042     MK=SINE*COME+COSE*SOME
0043     SINE=2.*MK*EK
0044     COSE=2.*EK*EK-1.
0045     RK=TK*R
0046     X=RK*EK
0047     Y=RK*MK
0048     Z=Y*SINO
0049     EK=CINO*Y
0050     SINE=DSIN(OGA)
0051     COSE=DCOS(OGA)
0052     Y=X*SINE+EK*COSE
0053     X=X*COSE-EK*SINE
0054     RETURN
0055     END
```

\&EB07 T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C *          FILENAME : &EB07          *
0004 C *                                          *
0005 C *    COMPUTES DISTANCES TO SATTELLITE    *
0006 C *                                          *
0007 C *****
0008 C
0009     SUBROUTINE EB07(I)
0010     IMPLICIT DOUBLE PRECISION (A-H,K-Z)
0011     COMMON/SAT/S(4)
0012     COMMON/DTX/U(4),D(4,4),R(4)
0013 C -----
0014     R(I)=0.
0015     DO 100 J=1,3
0016     D(I,J)=S(J)-U(J)
0017     R(I)=D(I,J)*D(I,J)+R(I)
0018 100 CONTINUE
0019     R(I)=DSQRT(R(I))
0020     D(I,4)=1.0
0021     RETURN
0022     END
```

&EB08 T=00004 IS ON CR00011 USING 00018 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C *          FILENAME :  &EB08          *
0004 C *                                          *
0005 C * COMPUTES THE G-MATRIX AND DOES THE MATRIX- *
0006 C * TRANSFORMATION TO DELIVER AS A RESULT THE *
0007 C * DILUTION-OF-PRECISION-PARAMETERS FOR A CONFI- *
0008 C * GURATION WITH 4 SATELLITES OR WITH 3 SATEL- *
0009 C * LITES WITH ALTITUDE-AIDING.          *
0010 C *                                          *
0011 C *****
0012 C
0013 C          SUBROUTINE EB08
0014 C          IMPLICIT DOUBLE PRECISION (A-H,K-M,O-Z)
0015 C          DIMENSION A(4,4),AT(4,4),AAT(4,4),SSIG(4),K(4,3)
0016 C          LOGICAL IFLAG
0017 C          REAL X1(10),X3(4)
0018 C          DIMENSION IL(4),IM(4)
0019 C          COMMON/POS/LAT,LON,ALT
0020 C          COMMON/DTX/U(4),D(4,4)
0021 C          COMMON/CNST/PI,RTD
0022 C          COMMON/BLG/G(4,4)
0023 C          COMMON/GDOP/GDOP,PDOP,HDOP,INS,IFLAG,V(4,4),ISTJ3
0024 C          IN=4
0025 C          IFLAG=.FALSE.
0026 C
0027 C ***** COMPUTATION OF A(=G) *****
0028 C
0029 C          A1=DSIN(LON)
0030 C          A2=DCOS(LON)
0031 C          A3=DSIN(LAT)
0032 C          A4=DCOS(LAT)
0033 C          DO 100 I=1,INS
0034 C          A5=1./DSQRT(D(I,1)*D(I,1)+D(I,2)*D(I,2)+D(I,3)*D(I,3))
0035 C          A(I,1)=(-D(I,1)*A1+D(I,2)*A2)*A5
0036 C          A(I,2)=(-D(I,1)*A3*A2-D(I,2)*A3*A1+D(I,3)*A4)*A5
0037 C          A(I,3)=(D(I,1)*A4*A2+D(I,2)*A4*A1+D(I,3)*A3)*A5
0038 C          A(I,4)=1.
0039 C          100 CONTINUE
0040 C          IF(INS.EQ.4) GOTO 1000
0041 C          A(4,1)=0.
0042 C          A(4,2)=0.
0043 C          A(4,3)=-1.
0044 C          A(4,4)=0.
0045 C          IF(ISTJ3.EQ.1) GOTO 1000
0046 C          A(4,3)=0.
0047 C          A(4,4)=1.
0048 C          1000 CONTINUE
0049 C          IF(ISSW(0).GE.0) WRITE (6,8)
0050 C          8 FORMAT (/" G-MATRIX ")
0051 C          IF(ISSW(0).GE.0) WRITE (6,2) ((A(I,J),J=1,4),I=1,4)
0052 C
0053 C ***** MATRIX-TRANSPONATION *****
0054 C
0055 C          DO 101 I=1,4
0056 C          DO 101 J=1,4
0057 C          AT(I,J)=A(J,I)
0058 C          101 CONTINUE
```

```

0059 C
0060 C ***** MULTIPLICATION OF MATRIZES (AT*A)=AAT *****
0061 C
0062     CALL EB09B (AT,V,AAT,IN)
0063     CALL EB09B (AAT,A,G,IN)
0064 C
0065 C ***** INVERSION OF AT (=SIGMA-MATRIX) *****
0066 C     AND COMPUTATION OF HDOP AND GDOP
0067 C
0068     CALL MINVD (G,IN,DET,IL,IM)
0069     ICOUNT=1
0070     IF(DET.EQ.0.0D0) GOTO 1010
0071     IF(ISSW(0).GE.0) WRITE (6,1)
0072 1     FORMAT (/ " SIGMA-MATRIX ")
0073     IF(ISSW(0).GE.0) WRITE (6,2) ((G(I,J)),J=1,4),I=1,4)
0074 2     FORMAT (4D18.8)
0075     GDOP=DSQRT(G(1,1)+G(2,2)+G(3,3)+G(4,4))
0076     HDOP=DSQRT(G(1,1)+G(2,2))
0077     PDOP=DSQRT(G(1,1)+G(2,2)+G(3,3))
0078 C
0079 C ***** COMPUTATION OF SQUARE-ROOTS OF DIAGONAL *****
0080 C     ELEMENTS AND CORRELATION COEFFICIENT
0081 C
0082     II=0
0083     DO 105 I=1,4
0084     SSIG(I)=DSQRT(G(I,I))
0085     X3(I)=SNGL(SSIG(I))
0086     DO 105 J=1,4
0087     IF(I.GT.J) GOTO 105
0088     II=II+1
0089     X1(II)=SNGL(G(I,J))
0090 105    CONTINUE
0091     WRITE (2,9) X1
0092 9     FORMAT (10E12.4)
0093     WRITE (2,10) X3
0094 10    FORMAT (4E12.4)
0095     IF(ISSW(0).GE.0) WRITE (6,3) SSIG
0096 3     FORMAT (/ " SQUARE-ROOTS OF DIAGONAL ELEMENTS "
0097 1/,4D18.8)
0098     DO 106 I=1,4
0099     JJ=0
0100     DO 106 J=1,4
0101     IF(I.EQ.J) GOTO 106
0102     AT(I,J)=0.
0103     IF(DABS(G(I,I)).LT.0.D-10.OR.DABS(G(J,J)).LT.0.D-10) GOTO 1001
0104     AT(I,J)=G(I,J)/DSQRT(G(I,I)*G(J,J))
0105 1001  CONTINUE
0106     JJ=JJ+1
0107     K(I,JJ)=AT(I,J)
0108 106   CONTINUE
0109     IF(ISSW(0).GE.0) WRITE (6,4)
0110 4     FORMAT (/ " CORRELATION COEFFICIENTS "
0111 1/,4X,"12",8X,"13",8X,"14",8X,"21",8X,"23",8X,"24",8X,"31",8X,
0112 2"32",8X,"34",8X,"41",8X,"42",8X,"43")
0113     IF(ISSW(0).GE.0) WRITE (6,11) ((K(I,J),J=1,3),I=1,4)
0114 11    FORMAT (1H ,12G10.5)
0115     WRITE (2,5) K(1,1),K(1,2),K(1,3),K(2,2),K(2,3),K(3,3)
0116 5     FORMAT (1H ,6G10.5)
0117 C
0118 C ***** INVERSION OF A (=G) *****

```

```

0119  C
0120      DO 102 I=1,4
0121      DO 102 J=1,4
0122      G(I,J)=A(I,J)
0123 102  CONTINUE
0124      CALL MINVD (G,IN,DET,IL,IM)
0125      ICOUNT=2
0126      IF(DET.EQ.0.0D0) GOTO 1010
0127      RETURN
0128 1010 CONTINUE
0129      IFLAG=.TRUE.
0130      IF(ICOUNT.EQ.2) GOTO 1011
0131      WRITE (2,9) X1
0132      WRITE (2,10) X3
0133      WRITE (2,5) K(1,1),K(1,2),K(1,3),K(2,2),K(2,3),K(3,3)
0134      RETURN
0135 1011 CONTINUE
0136      WRITE (6,7)
0137 6     FORMAT ( " ***** "
0138      1/      " *PRODUCT-MATRIX SINGULAR* "
0139      2/      " ***** ")
0140 7     FORMAT ( " ***** "
0141      1/      " *G-MATRIX SINGULAR* "
0142      2/      " ***** ")
0143      RETURN
0144      END

```

&EB09B T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C *          FILENAME  : &EB09B          *
0004 C *          MULTIPLICATES TWO MATRICES : H*G=A          *
0005 C *****
0006 C
0007          SUBROUTINE EB09B (H,G,A,N)
0008          IMPLICIT DOUBLE PRECISION (A-H,O-Z)
0009          DIMENSION H(N,N),G(N,N),A(N,N)
0010 C -----
0011          DO 100 I=1,N
0012          DO 100 J=1,N
0013          TEMP=0.000
0014          DO 101 K=1,N
0015          TEMP=TEMP+H(I,K)*G(K,J)
0016 101    CONTINUE
0017          A(I,J)=TEMP
0018 100    CONTINUE
0019          RETURN
0020          END
```

```
0001 FTH4X,L,Y
0002 C
0003 C .....
0004 C
0005 C SUBROUTINE MINVD HP-VERSION
0006 C
0007 C PURPOSE
0008 C INVERT A MATRIX
0009 C
0010 C USAGE
0011 C CALL MINVD(A,N,D,L,M)
0012 C
0013 C DESCRIPTION OF PARAMETERS
0014 C A - INPUT MATRIX, DESTROYED IN COMPUTATION AND REPLACED BY
0015 C RESULTANT INVERSE.
0016 C N - ORDER OF MATRIX A
0017 C D - RESULTANT DETERMINANT
0018 C L - WORK VECTOR OF LENGTH N
0019 C M - WORK VECTOR OF LENGTH N
0020 C
0021 C REMARKS
0022 C MATRIX A MUST BE A GENERAL MATRIX
0023 C
0024 C SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
0025 C NONE
0026 C
0027 C METHOD
0028 C THE STANDARD GAUSS-JORDAN METHOD IS USED. THE DETERMINANT
0029 C IS ALSO CALCULATED. A DETERMINANT OF ZERO INDICATES THAT
0030 C THE MATRIX IS SINGULAR.
0031 C
0032 C .....
0033 C
0034 C SUBROUTINE MINVD(A,N,D,L,M)
0035 C IMPLICIT DOUBLE PRECISION (A-H,O-T,V-Z)
0036 C IMPLICIT REAL*4 (U)
0037 C DIMENSION A(1),L(1),M(1)
0038 C
0039 C SEARCH FOR LARGEST ELEMENT
0040 C
0041 C D=1.0D0
0042 C NK=-N
0043 C DO 80 K=1,N
0044 C NK=NK+N
0045 C L(K)=K
0046 C M(K)=K
0047 C KK=NK+K
0048 C BIGA=A(KK)
0049 C DO 20 J=K,N
0050 C IZ=N*(J-1)
0051 C DO 20 I=K,N
0052 C IJ=IZ+I
0053 C 10 IF(DABS(BIGA)-DABS(A(IJ))) 15,20,20
0054 C 15 BIGA=A(IJ)
0055 C L(K)=I
0056 C M(K)=J
0057 C 20 CONTINUE
0058 C
```

```

0059 C           INTERCHANGE ROWS
0060 C
0061           J=L(K)
0062           IF(J-K) 35,35,25
0063 25 KI=K-N
0064           DO 30 I=1,N
0065           KI=KI+N
0066           HOLD=-A(KI)
0067           JI=KI-K+J
0068           A(KI)=A(JI)
0069 30 A(JI) =HOLD
0070 C
0071 C           INTERCHANGE COLUMNS
0072 C
0073 35 I=M(K)
0074           IF(I-K) 45,45,38
0075 38 JP=N*(I-1)
0076           DO 40 J=1,N
0077           JK=NK+J
0078           JI=JP+J
0079           HOLD=-A(JK)
0080           A(JK)=A(JI)
0081 40 A(JI) =HOLD
0082 C
0083 C           DIVIDE COLUMN BY MINUS PIVOT (VALUE OF PIVOT ELEMENT IS
0084 C           CONTAINED IN BIGA)
0085 C
0086 45 IF(BIGA) 48,46,48
0087 46 D=0.0D0
0088           RETURN
0089 48 DO 55 I=1,N
0090           IF(I-K) 50,55,50
0091 50 IK=NK+I
0092           A(IK)=A(IK)/(-BIGA)
0093 55 CONTINUE
0094 C
0095 C           REDUCE MATRIX
0096 C
0097           DO 65 I=1,N
0098           IK=NK+I
0099           HOLD=A(IK)
0100           IJ=I-N
0101           DO 65 J=1,N
0102           IJ=IJ+N
0103           IF(I-K) 60,65,60
0104 60 IF(J-K) 62,65,62
0105 62 KJ=IJ-I+K
0106           A(IJ)=HOLD*A(KJ)+A(IJ)
0107 65 CONTINUE
0108 C
0109 C           DIVIDE ROW BY PIVOT
0110 C
0111           KJ=K-N
0112           DO 75 J=1,N
0113           KJ=KJ+N
0114           IF(J-K) 70,75,70
0115 70 A(KJ)=A(KJ)/BIGA
0116 75 CONTINUE
0117 C
0118 C           PRODUCT OF PIVOTS

```

```

0119 C
0120      D=D*BIGA
0121 C
0122 C      REPLACE PIVOT BY RECIPROCAL
0123 C
0124      A(KK)=1.000/BIGA
0125      80 CONTINUE
0126 C
0127 C      FINAL ROW AND COLUMN INTERCHANGE
0128 C
0129      K=N
0130      100 K=(K-1)
0131      IF(K) 150,150,105
0132      105 I=L(K)
0133      IF(I-K) 120,120,108
0134      108 JQ=N*(K-1)
0135      JR=N*(I-1)
0136      DO 110 J=1,N
0137      JK=JQ+J
0138      HOLD=A(KJ)
0139      JI=JR+J
0140      A(KJ)=-A(JI)
0141      110 A(JI)=HOLD
0142      120 J=M(K)
0143      IF(J-K) 100,100,125
0144      125 KI=K-N
0145      DO 130 I=1,N
0146      KI=KI+N
0147      HOLD=A(KI)
0148      JI=KI-K+J
0149      A(KI)=-A(JI)
0150      130 A(JI)=HOLD
0151      GO TO 100
0152      150 RETURN
0153      END

```

&EB11 J=00004 IS ON CR00011 USING 00004 BLKS R=0000

```
0001 FTH4X,L,Y
0002 C *****
0003 C *          FILENAME : &EB11          *
0004 C *
0005 C *  MULTIPLICATES A VECTOR (URE) AND A MATRIX (G) *
0006 C *
0007 C *****
0008 C
0009          SUBROUTINE EB11
0010          IMPLICIT DOUBLE PRECISION (A-H,K-Z)
0011          COMMON/URE/URE(4),DX(4)
0012          COMMON/BLG/G(4,4)
0013 C -----
0014          DO 100 J=1,4
0015             DX(J)=0,
0016             DO 101 I=1,4
0017                DX(J)=DX(J)+G(J,I)*URE(I)
0018 101          CONTINUE
0019             DX(J)=-DX(J)
0020 100          CONTINUE
0021             RETURN
0022             END
```

&EB12 T=00004 IS ON CR00011 USING 00012 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C *          FILENAME : &EB12          *
0004 C *                                          *
0005 C * ROUTINE TO CONVERT SECONDS TO HOURS MIN SEC. *
0006 C *                                          *
0007 C *****
0008 C
0009     SUBROUTINE EB12 (TMIN,THR)
0010     IMPLICIT DOUBLE PRECISION (A-Z)
0011     REAL THR
0012     INTEGER*4 HR,MIN,SEC
0013 C -----
0014     THR=(SNGL(TMIN)/3600.0)+.00005
0015     HR=INT(THR)
0016     THR=(THR-HR)*60
0017     MIN=INT(THR)
0018     THR=(THR-MIN)*60
0019     SEC=INT(THR)
0020     THR=HR+(MIN*.01)+(SEC*.0001)+.00005
0021     RETURN
0022     END
```

&EB14 T=00004 IS ON CR00011 USING 00024 BLKS R=0000

```
0001 FTN4,L,Y
0002 C *****
0003 C *          FILENAME : &EB14          *
0004 C * READS ALMANAC-DATA FROM DATA-TAPE, CONVERTS IT *
0005 C * INTO DOUBLE PRECISION AND CREATES ARRAY WITH *
0006 C * DATA FOR MAINPROGRAM.          *
0007 C *          *
0008 C *****
0009 C
0010          SUBROUTINE EB14
0011          DOUBLE PRECISION AD,A,B,C,DTC
0012          COMMON/ALM/AD(14,24),ID1(24)
0013          COMMON/NAC/A,B,C,DTC
0014          DIMENSION IALMAC(12,24),ISVPRN(24),ID(24)
0015          INTEGER ALMAC(24,24),IAR(2),IBUF(310),IDARY(24)
0016          EQUIVALENCE(IBUF(16),IALMAC)
0017          REAL OMD,OMO,MO
0018          INTEGER H
0019          DATA PI/3.14159265/,ISVPRN/4,7,6,8,5,9,18*0/
0020 C
0021 C  ISTAR IS THE STARTING ADDRESS OF ALMANAC DATA AND IWCNT IS THE NUMBER
0022 C  OF WORDS IN THE ALMANAC DATA.
0023 C
0024          DATA ISTAR/172700B/,IWCNT/310/,LUB/8/
0025 C
0026 C  CALL EXEC TO READ IN ALMANAC DATA.
0027 C
0028 100  CALL EXEC(1,LUB,IBUF,IWCNT)
0029      CALL ABREG(IERR,NWRD)
0030      IF(NWRD .NE. 288) GO TO 100
0031      DO 40 J=1,24
0032          DO 50 I=1,12
0033              I2=2*I
0034              I1=I2-1
0035              ITMP=IALMAC(I,J)
0036              ALMAC(I1,J)=IAND(ITMP,377B)
0037              ALMAC(I2,J)=ISHFT(ITMP,-8)
0038 50      CONTINUE
0039 40      CONTINUE
0040      WRITE(16,120)
0041      READ(16,*)DTC
0042 C
0043 C  GET SATELLITE ID(PRN NUMBER) FROM ALMANAC DATA.
0044 C
0045          DO 10 J=1,24
0046              DO 20 I=1,24
0047                  ID(I)=ALMAC(1,I)
0048 C
0049 C  TEST TO SEE IF SATELLITE IS IN PRN NUMBER ORDER.
0050 C
0051          IF(ID(I).EQ. 0)GO TO 20
0052          IF(ID(I).EQ. ISVPRN(J))GO TO 30
0053 20      CONTINUE
0054          GO TO 10
0055 C
0056 C  GET ECENTRICITY OF SATELLITE ORBIT FROM ALMANAC DATA.
0057 C
0058 30      IAR(2)=IOR(ISHFT(ALMAC(2,I),8),ALMAC(3,I))
```

```

0059      IDARY(J)=ID
0060      IAR(1)=0
0061      ID1(J)=ID(I)
0062 C
0063 C ECENTRICITY IS SCALED BY A FACTOR OF 2**-21.
0064 C
0065      E=DINTF(IAR)*4.7683716E-7
0066 C
0067 C GET TIME OF APPLICABILITY OF THE ALMANAC PARAMETERS.
0068 C
0069      IAR(2)=ALMAC(4,I)
0070      IAR(1)=0
0071 C
0072 C TOA(SECONDS) IS SCALED BY A FACTOR OF 2**12.
0073 C
0074      TOA=DINTF(IAR)*4096.0
0075 C
0076 C GET SATELLITE ORBIT INCLINATION FROM ALMANAC DATA.
0077 C
0078      IAR(2)=IOR(ISHFT(ALMAC(5,I),8),ALMAC(6,I))
0079      IAR(1)=0
0080      IF(IAR(2) .LT. 0) IAR(1)=-1
0081 C
0082 C DI(SEMICIRCLES) IS SCALED BY A FACTOR OF 2**-19 INCREMENTED
0083 C BY 1/3 AND MULTIPLIED BY PI TO YIELD RADIANS.
0084 C
0085      DI=((DINTF(IAR)*1.9073486E-6)+(1.0/3.0))*PI
0086 C
0087 C GET DRIFT RATE OF LONGITUDE OF ASCENDING NODE OF THE ORBIT
0088 C FROM ALMANAC DATA.
0089 C
0090      IAR(1)=0
0091      IAR(2)=IOR(ISHFT(ALMAC(7,I),8),ALMAC(8,I))
0092      IF(IAR(2) .LT. 0) IAR(1)=-1
0093 C
0094 C OMD (SEMICIRCLES/SEC) IS SCALED BY A FACTOR OF 2**-38 AND
0095 C MULTIPLIED BY PI TO YIELD RADIANS/SEC.
0096 C
0097      OMD=DINTF(IAR)*PI*3.6379788E-12
0098 C
0099 C GET HEALTH WORD FROM ALMANAC DATA.
0100 C
0101      H=ALMAC(9,I)
0102 C
0103 C GET THE SQUARE ROOT OF THE SEMI-MAJOR AXIS OF THE ORBIT
0104 C FROM ALMANAC DATA.
0105 C
0106      IAR(1)=ALMAC(10,I)
0107      IAR(2)=IOR(ISHFT(ALMAC(11,I),8),ALMAC(12,I))
0108 C
0109 C RA(METERS) IS SCALED BY A FACTOR OF 2**-11.
0110 C
0111      RA=DINTF(IAR)*4.8828125E-4
0112 C
0113 C GET THE RIGHT ASCENSION OF THE ORBIT FROM ALMANAC DATA.
0114 C
0115      IAR(2)=IOR(ISHFT(ALMAC(14,I),8),ALMAC(15,I))
0116      IAR(1)=ALMAC(13,I)
0117      IF(IAND(ALMAC(13,I),200B) .NE. 0) IAR(1)=IOR(IAR(1),177400B)
0118 C

```

```

0119 C OMO<SEMICIRCLES> IS SCALED BY A FACTOR OF 2** -23 AND
0120 C MULTIPLIED BY PI TO YIELD RADIANS.
0121 C
0122 C OMO=DINTF(IAR)*PI*1.1920929E-7
0123 C
0124 C GET THE ARGUMENT OF PERIGEE FROM ALMANAC DATA.
0125 C
0126 C IAR(1)=ALMAC(16,I)
0127 C IAR(2)=IOR(ISHFT(ALMAC(17,I),8),ALMAC(18,I))
0128 C IF(IAND(IAR(1),200B).NE.0)IAR(1)=IOR(IAR(1),177400B)
0129 C
0130 C W<SEMICIRCLES> IS SCALED BY A FACTOR OF 2** -23 AND
0131 C MULTIPLIED BY PI TO YIELD RADIANS.
0132 C
0133 C W=DINTF(IAR)*PI*1.1920929E-7
0134 C
0135 C GET MEAN ANOMALY AT TOA FROM ALMANAC DATA.
0136 C
0137 C IAR(1)=ALMAC(19,I)
0138 C IF(IAND(IAR(1),200B).NE.0)IAR(1)=IOR(IAR(1),177400B)
0139 C IAR(2)=IOR(ISHFT(ALMAC(20,I),8),ALMAC(21,I))
0140 C
0141 C MO<SEMICIRCLES> IS SCALED BY A FACTOR OF 2** -23 AND
0142 C MULTIPLIED BY PI TO YIELD RADIANS.
0143 C
0144 C MO=DINTF(IAR)*PI*1.1920929E-7
0145 C AD(1,J)=DBLE(E)
0146 C AD(2,J)=DBLE(TOA)
0147 C AD(3,J)=DBLE(DI)
0148 C AD(4,J)=DBLE(OMD)
0149 C AD(5,J)=DBLE(RA)
0150 C AD(6,J)=DBLE(OMO)
0151 C AD(7,J)=DBLE(W)
0152 C AD(8,J)=DBLE(MO)
0153 10 CONTINUE
0154 RETURN
0155 120 FORMAT(" ENTER COLLECTION DATE FOR ALMANAC DATA(NTH DAY)_" )
0156 END

```

&DINTF T=00004 IS ON CR00013 USING 00003 BLKS R=0000

0001	ASMB,L		
0002		NAM	DINTF
0003		ENT	DINTF
0004		EXT	.FLTD
0005	DINTF	NOP	
0006		ISZ	DINTF
0007		LDA	DINTF,I
0008		STA	IBF
0009		ISZ	DINTF
0010		OLD	IBF,I
0011		AND	B377
0012		JSB	.FLTD
0013		JMP	DINTF,I
0014	IBF	BSS	1
0015	B377	OCT	377
0016		END	

&PLSUB T=00004 IS ON CR00011 USING 00018 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C * FILENAME : &PLSUB *
0004 C * ***** *
0005 C * ROUTINE PLOTS THE DATA FOR MAINPROGRAM PLSIG. *
0006 C *****
0007 C
0008 SUBROUTINE PLSUB (IGCB,V1,V2,W1,W2,G1,N,TSTART,TEND,NSTART)
0009 DIMENSION IGCB(192),X1(10),X2(4),X3(6),X4(4),BUFF(24)
0010 EQUIVALENCE (BUFF(1),X1(1)),(BUFF(11),X2(1)),(BUFF(15),X3(1)),
0011 1(BUFF(21),X4(1))
0012 LOGICAL IFLAG,LOG
0013 C -----
0014 LOG=.TRUE.
0015 CALL VIEWP (IGCB,10.,100.,V1,V2)
0016 CALL WINDOW (IGCB,TSTART,TEND,W1,W2)
0017 CALL GRID (IGCB,0.25,G1)
0018 DO 100 I=1,N
0019 1000 CONTINUE
0020 CALL INPUT (TIME,X1,X2,X3,X4,IFLAG)
0021 IF(IFLAG) GOTO 1002
0022 IF(LOG) GOTO 1001
0023 CALL MOVE (IGCB,TIME1,X)
0024 CALL DRAW (IGCB,TIME,BUFF(NSTART+I-1))
0025 1001 CONTINUE
0026 LOG=.FALSE.
0027 CALL LINE (IGCB,I-1)
0028 IF(I.EQ.4) CALL LINE (IGCB,6)
0029 TIME1=TIME
0030 X=BUFF(NSTART+I-1)
0031 GOTO 1000
0032 1002 CONTINUE
0033 REWIND (2)
0034 LOG=.TRUE.
0035 100 CONTINUE
0036 RETURN
0037 END
```

&PSUB1 T=00004 IS ON CR00011 USING 00006 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C * FILENAME : &PSUB1 *
0004 C * ***** *
0005 C * ROUTINE PLOTS THE DATA FOR MAINPROGRAM PLSIG AND COMPUTES *
0006 C * THE SQUARE-ROOT OF THE SUMS OF THE DIAGONAL SIGMA-MATRIX *
0007 C * ELEMENTS. *
0008 C *****
0009 C
0010 SUBROUTINE PSUB1 (IGCB,V1,V2,W1,W2,G1,N,TSTART,TEND,NSTART)
0011 DIMENSION IGCB(192),X1(10),X2(4),X3(6),X4(4),BUFF(24)
0012 EQUIVALENCE (BUFF(1),X1(1)),(BUFF(11),X2(1)),(BUFF(15),X3(1)),
0013 1(BUFF(21),X4(1))
0014 LOGICAL IFLAG,LOG
0015 C -----
0016 LOG=.TRUE.
0017 CALL VIEWP (IGCB,10.,100.,V1,V2)
0018 CALL WINDW (IGCB,TSTART,TEND,W1,W2)
0019 CALL GRID (IGCB,0.25,G1)
0020 DO 100 I=1,N
0021 1000 CONTINUE
0022 CALL INPUT (TIME,X1,X2,X3,X4,IFLAG)
0023 IF(IFLAG) GOTO 1002
0024 IF(I.EQ.1) X2(1)=SQRT(X2(1)*X2(1)+X2(2)*X2(2))
0025 IF(I.EQ.2) X2(2)=SQRT(X2(1)*X2(1)+X2(2)*X2(2)+X2(3)*X2(3))
0026 IF(I.EQ.3) X2(3)=SQRT(X2(1)*X2(1)+X2(2)*X2(2)+X2(3)*X2(3)+X2(4)*
0027 1X2(4))
0028 IF(LOG) GOTO 1001
0029 CALL MOVE (IGCB,TIME1,X)
0030 CALL DRAW (IGCB,TIME,BUFF(NSTART+I-1))
0031 1001 CONTINUE
0032 LOG=.FALSE.
0033 CALL LINE (IGCB,I-1)
0034 IF(I.EQ.4.) CALL LINE (IGCB,6)
0035 CALL CSIZE (IGCB,1.,1.,0.)
0036 TIME1=TIME
0037 X=BUFF(NSTART+I-1)
0038 GOTO 1000
0039 1002 CONTINUE
0040 REWIND (2)
0041 LOG=.TRUE.
0042 100 CONTINUE
0043 RETURN
0044 END
```

&INPUT T=00004 IS ON CR00011 USING 00002 BLKS R=0000

```
0001 FTN4X,L,Y
0002 C *****
0003 C *          FILENAME : &INPUT          *
0004 C *
0005 C *    ROUTINE READS DATAFILE ON LU=2 OPENED IN    *
0006 C * MAINPROGRAM "PLSIG" RECORD BY RECORD AND      *
0007 C * CONVERTS THE TIME,IF END IS ENCOUNTERED A FLAG*
0008 C * IS SET.                                         *
0009 C *****
0010 C
0011     SUBROUTINE INPUT (TIME,X1,X2,X3,X4,IFLAG)
0012     DIMENSION X1(10),X2(4),X3(6),X4(4)
0013     LOGICAL IFLAG
0014     IFLAG=.FALSE.
0015     READ (2,1,ERR=1000,END=1000) TIME
0016 C     IF(TIME.EQ.0.E0) GOTO 1000
0017     READ (2,2,ERR=1000) X1
0018     READ (2,3,ERR=1000) X2
0019     READ (2,4,ERR=1000) X3
0020     READ (2,3,ERR=1000) X4
0021     IT=IFIX(TIME)
0022     T1=TIME-IT
0023     TIME=IT+T1/0.6
0024     RETURN
0025 1000 CONTINUE
0026     IFLAG=.TRUE.
0027     RETURN
0028 C
0029 C ***** FORMATS *****
0030 C
0031 1     FORMAT (G15.8)
0032 2     FORMAT (10E12.4)
0033 3     FORMAT (4E12.4)
0034 4     FORMAT (1H ,6G10.5)
0035     END
```

APPENDIX D EXAMPLES OF PROGRAM OUTPUTS

PROGRAM * E B 0 0 *

USER-POSITION :

LATITUDE : 39.449555 DEGREE
 LONGITUDE: -74.566777 DEGREE
 ALTITUDE : 46.260000 FEET
 ECEF-COORDINATES : X = 1312420.0 Y = -4753942.1 Z = 4030988.3

USERTIMES :

START (TSTART) : 36000.000 SEC. = 10.00 HOURS
 END (TFIN) : 40000.000 SEC. = 11.06 HOURS
 INCR. (TDEL) : 300.00000 SEC
 DATE (DTU) : 57.000000 DAYS

THE COMPUTATIONS ARE MADE WITH 4 SATELLITES

USED ALMANACS DTC= 57. TC= 300.

SAT. ID :	5	6	8	9
	.2305D-02	.1551D-02	.2207D-02	.8102D-02
	.3318D+06	.3318D+06	.3318D+06	.3318D+06
	.1112D+01	.1107D+01	.1103D+01	.1104D+01
	-.6195D-08	-.6457D-08	-.6343D-08	-.6503D-08
	.5154D+04	.5154D+04	.5154D+04	.5154D+04
	.5694D+00	-.1550D+01	.5653D+00	-.1546D+01
	-.2092D+01	.2049D+01	-.1983D+00	.1352D+01
	.6950D+00	-.1074D+01	.3566D+00	-.1142D+01
	.2656D+08	.2656D+08	.2656D+08	.2656D+08
	.4425D+00	.4472D+00	.4505D+00	.4503D+00
	.8968D+00	.8944D+00	.8928D+00	.8929D+00
	-.4977D+00	-.4606D+00	.9804D+00	.2167D+00
	-.8674D+00	.8876D+00	-.1970D+00	.9762D+00
	.1459D-03	.1459D-03	.1459D-03	.1459D-03

USED URS

SAT. ID :	5	6	8	9
	.3600E+05	.3600E+05	.3600E+05	.3600E+05
	.1000E+01	.2000E+01	.1000E+02	.3750E+01
	.3960E+05	.3960E+05	.3960E+05	.3960E+05
	.4320E+05	.4320E+05	.4320E+05	.4320E+05
	.4680E+05	.4680E+05	.4680E+05	.4680E+05
	.5040E+05	.5040E+05	.5040E+05	.5040E+05

INVERTED V-MATRIX

	.10000000D+01	.00000000D+00	.00000000D+00	.00000000D+00
	.00000000D+00	.10000000D+01	.00000000D+00	.00000000D+00
	.00000000D+00	.00000000D+00	.10000000D+01	.00000000D+00
	.00000000D+00	.00000000D+00	.00000000D+00	.10000000D+01

NAME OF PLOTFILE FOR SIGMA-MATRIX : PLS
 NAME OF PLOTFILE FOR HOOP : PLH
 NAME OF PLOTFILE FOR AZINUTH AND ELEVATION : PLA

STATUS OF COMPUTATION

TIME 10.0000 HOURS
 SATELLITE POSITIONS

X	Y	Z	ELV	H20
-1.173465330+08	-1.188474440+08	-1.207181650+07	-1.900031320+00	12.72182840+03
-1.443072780+07	-1.157347950+08	1.208706530+08	1.577122650+02	13.10781320+03
1.54997200+07	-1.133093440+08	1.225215720+08	1.656114370+02	15.63132240+01
-1.133098040+08	1.178342580+07	1.226658280+08	1.928415900+01	13.29143960+03

V-MATRIX

-1.839727170+00	-1.542790340+00	-1.153926800+01	1.100000000+01
-1.496582350+00	1.346883000+00	1.045199970+00	1.100000000+01
1.09164710-01	1.411576210+00	1.910456410+00	1.100000000+01
-1.182816550+00	1.849165140+00	1.161555330+00	1.100000000+01

U-MATRIX

1.25509330+02	-1.224473380+01	-1.721553310+01	1.938811670+01
-1.224473380+01	1.153762850+01	1.766012510+00	-1.173214970+01
-1.721553310+01	1.766012510+00	1.589317750+01	-1.608725820+01
1.938811670+01	-1.173214970+01	-1.608725820+01	1.761453250+01

SQUARE-ROOTS OF DIAGONAL ELEMENTS

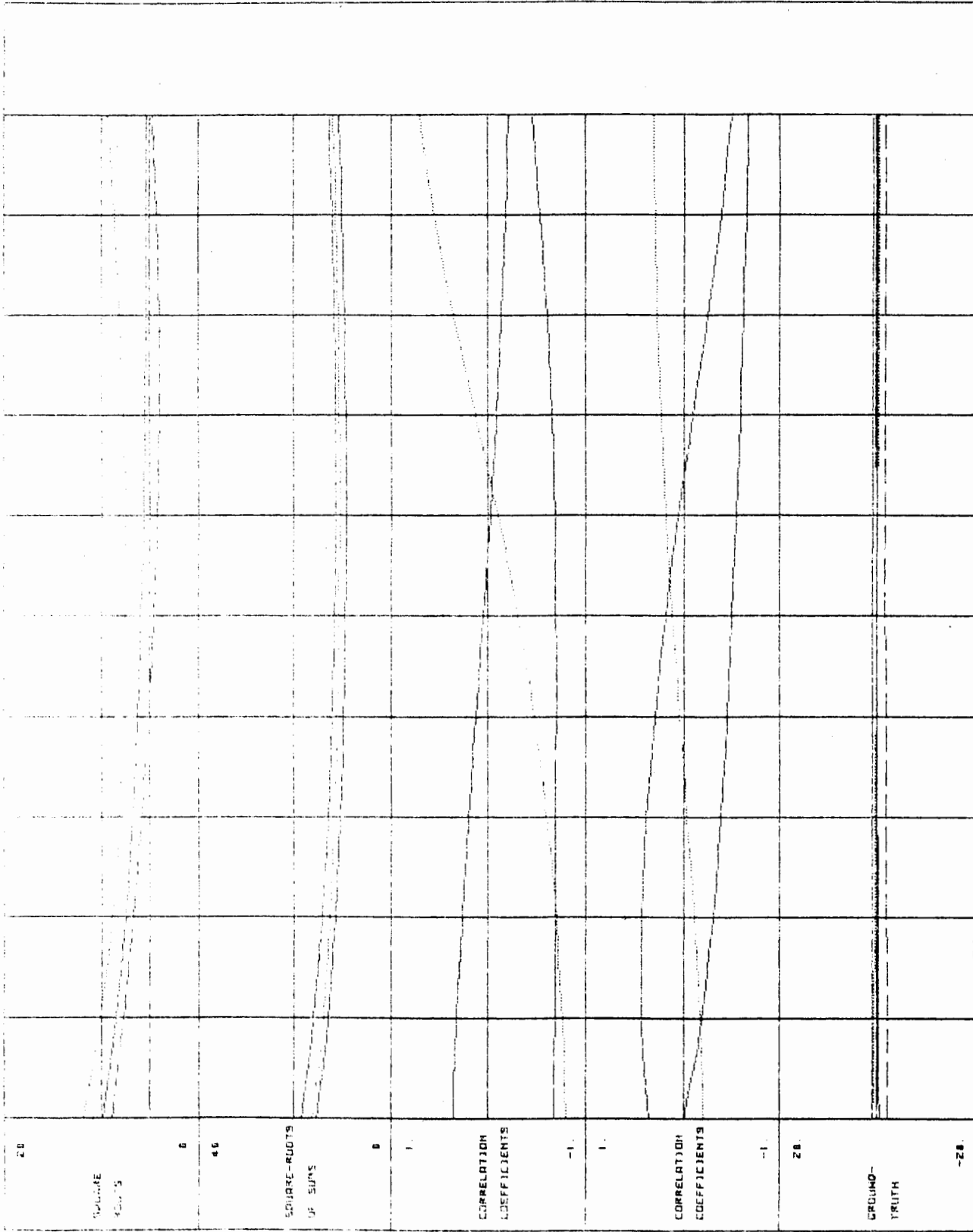
1.354273050+01	1.124001150+01	1.342758680+01	1.275944420+01
----------------	----------------	----------------	----------------

CORRELATION COEFFICIENTS

12	13	14	21	23	24	31	32	34	41	42	43
-.5110	-.8390	.96033	-.5110	1.25447	-.5062	-.8390	1.25447	-.9087	.96033	-.5062	-.9087

GROUND-TRUTH AND FIGURES OF MERIT

DX	DY	DZ	-DB	HDOP	PDOP	GDOP
-1.190982030+02	1.181073950+01	1.657840060+01	-1.159531730+02	3.753	4.470	5.253



TEND = 13.00

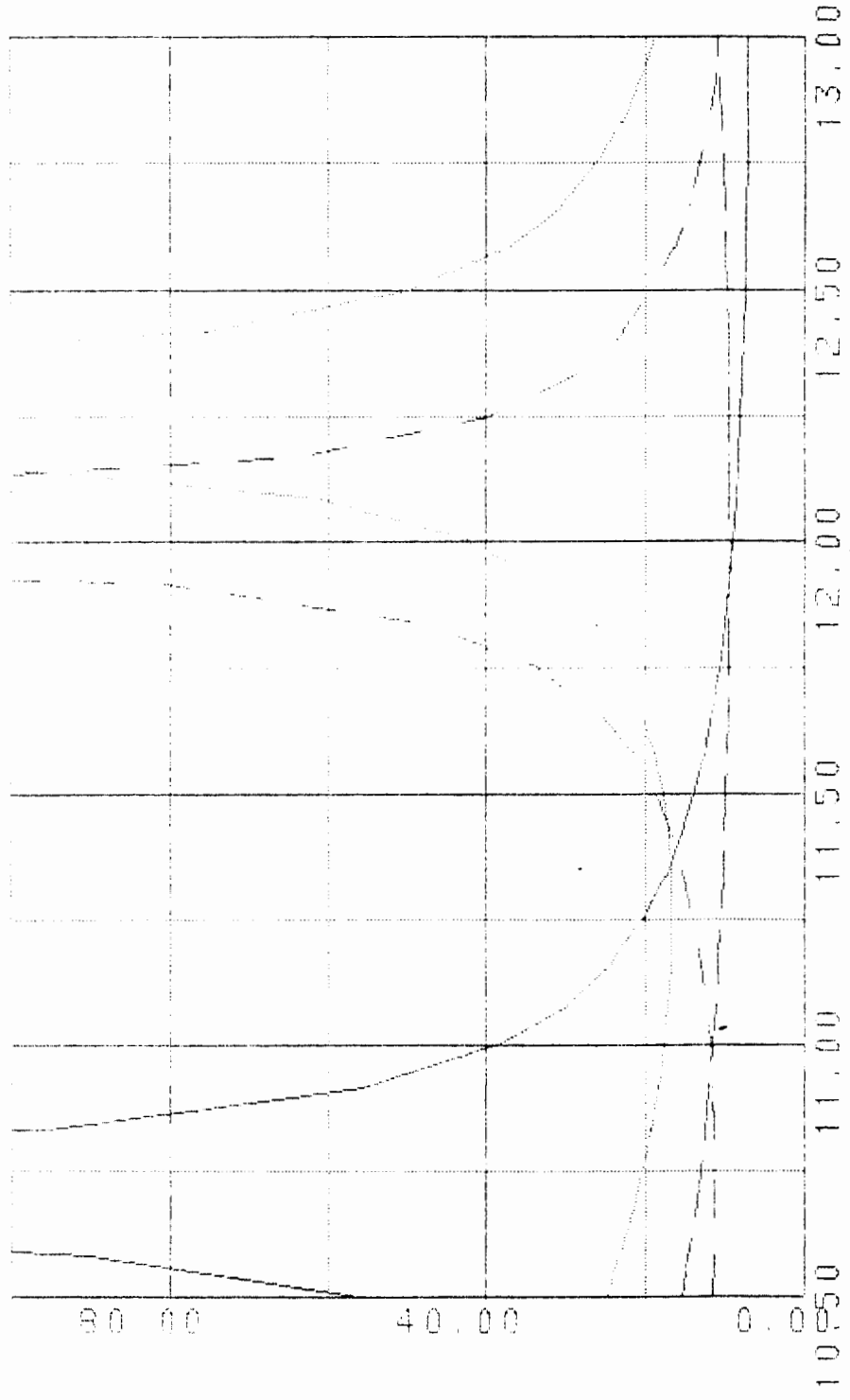
TIME IN HOURS

GROUND TRUTH COMPUTATIONS

TSTART = 10.50

PROGRAM PLOP --- DATE : 08-10-82

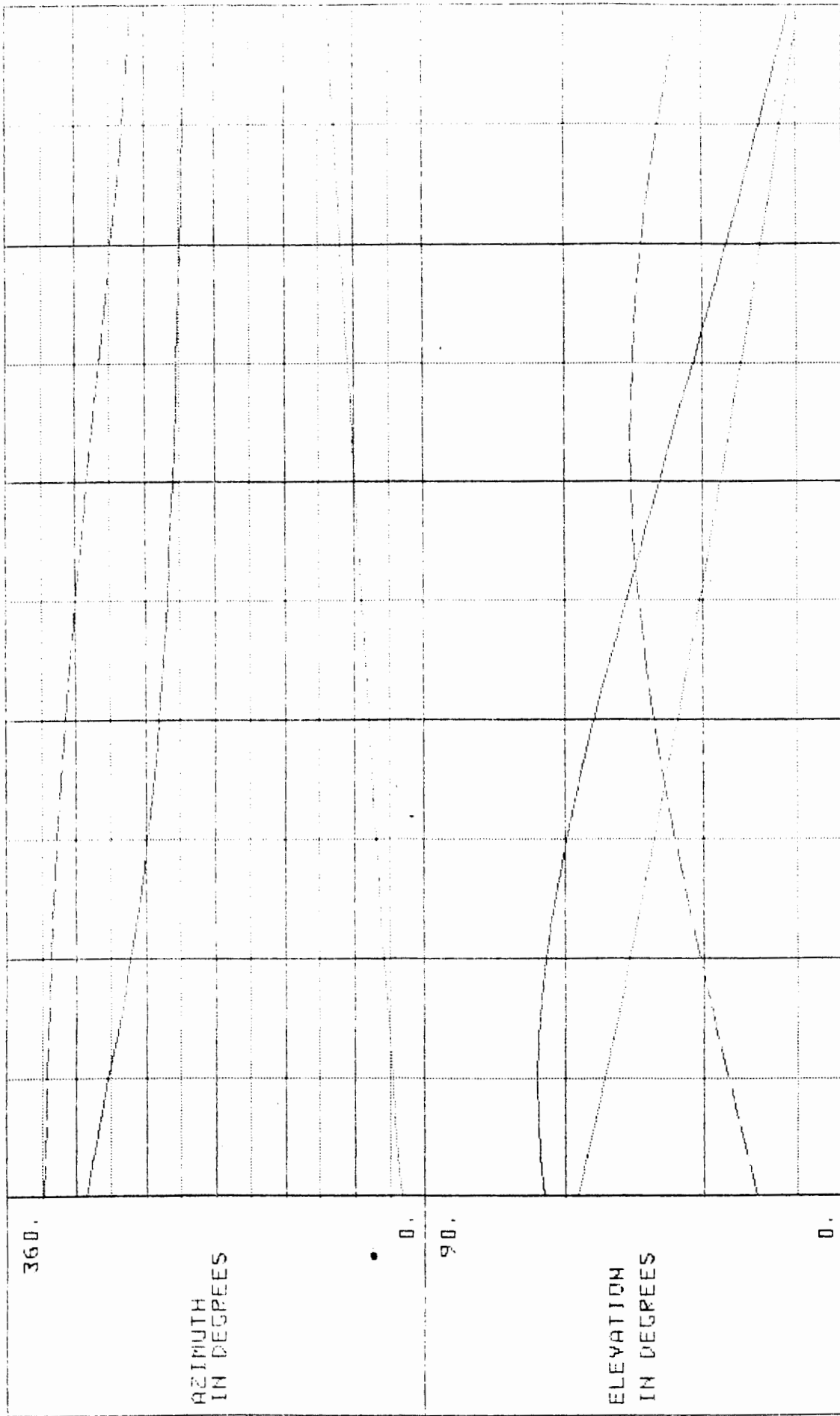
Plot 1000 1000 1000 1000 1000 1000 1000 1000 1000 1000



TWO-DIMENSIONAL OCCURRENCE

GATE TIME IN HOURS

PLOTPROGRAM PLSTF1



13.00

GMT-TIME IN HOURS

PLOTPROGRAM PLAEI

10.50

360.

AZIMUTH
IN DEGREES

0.

90.

ELEVATION
IN DEGREES

0.