GEODYN Documentation
SGP Version
Volume 5

March 6, 2019

Contents

1 INTRODUCTION

Volume 5 of the Geodyn II documentation series describes the input and output files used by the Tracking Data Formatter, the GEODYN IIS and the GEODYN IIE programs.

Section 1.0 provides descriptions for each of the input formats that can be read by the Tracking Data Formatter program. The primary output from the TDF program is the blocked GEODYN II binary format which is described in the input section for GEODYN IIS. The input formats that the TDF accepts are as follows:

- PCE Data
- GEODYN I Binary Format
- GEODYN I Binary Format Extended For Altimetry
- GEOS-C Card Image Format
- Metric Data Format
- VLBI binary Format

Section 2.0 provides descriptions for each of the input files that GEODYN IIS uses. The primary output files from IIS are the Interface files that are described in Section 3.0. A list of the IIS input files follows.

- Option Card File (see Volume 3)
- GEODYN II Blocked Binary Data (From TDF)
- Flux, Polar Motion and UT1 Tables
- JPL Planetary Ephemeris File
- Default Gravity Model File
- Station Geodetics File
- Default Spacecraft Area and Mass Tables

For data reduction runs the required IIS input files are the Option Card File, the Binary Data File from the TDF program, the JPL Planetary Ephemeris File, and the Flux, Polar motion and UT1 Tables Files. The Option Card File is discussed in great detail in Volume 3, and is therefore not discussed in this Volume. The Default Gravity Model and the Station Geodetics files are very useful, but they are not required.

The main functions of the GEODYN IIS program are to read and interpret the option cards; to read, select and rearrange the input observation data; to read the optional gravity model, station geodetics, and area/mass files; and to extract ephemeris and table data from the appropriate files for the time period covered by the given run. The option cards are read to determine which force and non-force model parameters are to be used in the run, and to determine the allocation requirements for the dynamic arrays and pointers that will be used in GEODYN IIE. The input observation blocks are selected based on the input options that were specified by the analyst, and the data is rearranged in vector form to minimize the amount of data manipulation in GEODYN IIE.

Section 3.0 provides the GEODYN IIS/IIE interface description. GEODYN IIE receives all of its required input from two interface files. One interface file contains the data in the internal form put out by IIS, and the other file contains all the information needed to run IIE. This information includes all the options that were selected by the user; the appropriate ephemeris, flux, polar motion and time data; the pointers and the sizes for the dynamic arrays; the defaults for all model parameters; and all control information needed to output the requested files.

Section 4.0 provides descriptions for the output files that the user may request GEODYN IIE to put out. GEODYN IIE performs all the computations normally associated with satellite orbit and geodetic parameter estimation programs. GEODYN IIE has been written to run efficiently on vector processing computers without having to handle the I/O intensive parts that are performed by IIS. The output from IIE contains all of the important information that the analyst needs to perform his work. Besides the normal printout GEODYN IIE can also output the following files upon user requests:

- Trajectory File
- Residual File
- Partial Derivative File

- Normal Equation File
- Force Model Partial Derivative File

2 TRACKING DATA FORMATTER OBSERVATION INPUT FILE

2.1 INTRODUCTION

The Tracking Data Formatter program is designed to convert data in a variety of formats to blocked GEODYN II binary format. Input data formats fall into one of the following categories:

1. PCE Data Format
2. Geodyn Binary Format
3. Geodyn Binary Format extended for Altimetry
4. GEOS-C Card Image Format
5. Metric
6. VLBI
7. Merit II
8. Merit-X
9. Doppler 90 Byte

A detailed description of the above format types is given in the following pages. The Tracking Data Formatter can use up to six different format types simultaneously if they are input on six different units between UNIT 22 and UNIT 40. For more details about the Tracking Data Formatter program see VOL 3 Section 4.

2.2 PCE DATA FORMAT

A PCE data file may be created by GEODYN II in orbit generator mode. The Tracking Data Formatter (TDF) reads this PCE data and converts it into GEODYN II blocked binary (G2B) format. The first record in the data stream must have a 90, 91, or 92 (True of Reference, True of Date, or Radial PCE data) in columns 2 and 3 and the satellite ID is columns 22-45 (format D24.16) . All data following this record goes with that satellite. If using data from more than one satellite then insert another such record each time the satellite ID changes. The PCE format is as follows:

First Record:

```
Columns   Format                         Description
-------------------------------------------------------------------------------
  2-3       I2          PCE DATA TYPE
                           90 - TRUE OF REFERENCE DATA
                           91 - TRUE OF DATE DATA
                           92 - RADIAL DATA*

 22-45     D24.16       Satellite ID.


Data Records:


Columns   Format                         Description
-------------------------------------------------------------------------------
  2-3       I2          Measurement type
                        16 - X                      Radial, if 92 in columns
                                                    2-3 of first card*
                        17 - Y                      Inertial
                        18 - Z                      Geocentric
                             .                      Cartesian
                        19 - X                      Coordinates
                             .
                        20 - Y
```

```
                            .
                      21 - Z
                      22 - a
                      23 - e                  Osculating
                      24 - i                  Geocentric
                      25 - Rt. ascension      Keplerian
                      26 - Arg. of perigee    Elements
                      27 - M
```

Columns	Format	Description
4-9	I6	Date of data (YYMMDD)
10-13	I4	Hours and minutes
14-21	F8.4	Seconds
22-45	D24.16	Measurement
46-55	D10.4	Measurement standard deviation

```
 Units for measurements and sigmas are:

     X,Y,Z,a,Radial -  meters (sigma - m)
     . . .
     X,Y,Z   - meters/seconds (sigma - cm/sec)

     e       - dimensionless  (sigma - ppm)

     i,rt.ascension,arg. of perigee,M - degrees (sigma - arc sec)

------------------------------------------------------------------------

*  For Radial PCE Data, the first card must have a 92 in columns 2-3,
   and the measurement type must be 16 (put a 16 in columns 2-3 of the
   the Data Card)
```

2.3 GEODYN BINARY FORMAT EXTENDED FOR ALTIMETRY

GEODYN BINARY EXTENDED ALTIMETER FORMAT

```
      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
 I*4         I*4         I*8         SAT. ID
 I*2         I*4         I*8         Meas Type
                                          42 overland altimeter
                                          43 over water altimeter
 I*2         I*4         I*8         Time System (nm)
                                     n    Altimeter Data Times
                                     -    --------------------
```

```
                                          1      Transmitter Time
                                          2      Ground Bounce Time
                                          3      Receiver Time

                                          m    Description
                                          -    -----------
                                          3      UTC
                                          4      A-1
                                          5      A-3 (IAT)
                                          6      AS
                                          7      ET

I*4         I*4         I*8         Station Number = 0

I*4         I*4         I*8         Preprocessing Indicators

                                    The preprocessing indicators are bit
                                    switches packed into a single 32 bit
                                    word.  The rightmost bit (bit 31) is
                                    of lowest order and the left most bit
                                    (bit 0) is of highest order.
                                    The preprocessing bits are configured
                                    as follows:

      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------

I*4(cont)   I*4(cont)   I*8(cont)   Bits    Value  Description
                                    -------------------------
                                    0              This bit should always
                                                   be zero filled.
                                    1-2            Format Indicator
                                                   (Types 40-41)
                                            1      Format 1  20 obs./frame
                                            2      Format 2  32 obs./frame
                                            3      Format 3 320 obs./frame

                                    3              Beacon Activity Indicator
                                                   (Types 10-14)
                                                   Beacon Inactive or
                                                   No Beacon
                                            1      Beacon Active
                                            or     Transponder Offset
                                                   Indicator (Range &
                                                   Range Rate Types)
                                            0      Data corrected for
                                                   offset
                                            1      Data uncorrected for
                                                   offset
                                            or     Net Instrument Corrections
                                                    Indicator (Types 42-43)
                                            0      Instrument corrections ap-
                                                    plied to observation.
                                            1      Instrument corrections
                                                    not applied
```

```
                         4              Equator Designation
                                        (Types 10-14)
                                0        Mean Equator and Equinox
                                1       True Equator and Equinox
                                or      Doppler Type for Average
                                        Range Rates*
                                0       Continuous Count
                                1       Destruct Type
```

----
*
Average range rate is any range rate measurement type where finite counting interval is specified. See bytes 49-52 for types 20-39.

```
      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
I*4(cont)   I*4(cont)   I*8(cont)   Bits    Value  Description
                                    -------------------------
                                    5-6            Date of Equator and
                                                   -------------------
                                                   Equinox (Types 10-14)
                                                   ---------------------
                                          0        Standard Equator and
                                                   Equinox (Jan 0.0 1950)
                                          1        Jan 0.0 of year of observation
                                          2        Equator and Equinox of Date
                                                   (instant of observation)
                                          3        DODS Reference Date (0 hr.
                                                   Sept. 19, 1957)

                                          or       Speed of Light Indicator
                                                   ------------------------
                                                   (Range, Range Rate and
                                                   Altimeter Types)
                                          0        2.997925x10^8 meters/sec
                                          3        2.99792458x10^8 meters/sec

                                    7              Annual Aberration
                                                   -----------------
                                                   (Types 10-14)
                                          0        Data has been corrected
                                          1        Data has not been corrected

                                          or     Barotoropic Correction Indicator
                                                 -------------------------------
                                                   (Types 42-43)
                                          0        Net Ocean Dynamic Corrections
                                                   do not include Barotropic
                                          1        Net Ocean Dynamic Corrections
                                                   do include Barotropic

                                     8             Diurnal Aberration
```

```
                                                      ------------------
                                                      (Type 10-14)
                                               0      Data has been corrected
                                               1      Data has not been corrected

                                               or     Solid Earth Tide Indicator
                                                      --------------------------
                                                      (Types 42-43)
                                               0      Net Ocean Dynamic Corrections
                                                      do not include solid
                                                      earth tide
                                               1      Net Ocean Dynamic Corrections
                                                      do include solid earth tide

      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
I*4(cont)   I*4(cont)   I*8(cont)   Bits    Value  Description
                                    -------------------------
                                     9            Parallactic Refraction
                                                  ----------------------
                                                  (Types 10-14)
                                          0       Data has been corrected
                                          1       Data has not been corrected

                                          or      Ocean Tide Indicator
                                                  --------------------
                                                  (Types 42-43)
                                          0       Net Ocean Dynamic Corrections
                                                  do not include ocean tide
                                          1       Net Ocean Dynamic Corrections
                                                  do include ocean tide

      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
I*4(cont)   I*4(cont)   I*8(cont)   Bits    Value  Description
                                    -------------------------

                                    10-12         Tropospheric Refraction
                                                  -----------------------
                                                  (all but types 10-14 and 42-43)
                                          0       Data has been corrected
                                          1       Data has not been corrected
                                          2       Data has been corrected
                                                  using the correction
                                                  formulas for international
                                                  laser data.  Correction
                                                  value is for zero zenith.
                                          3       Data has not been corrected.
                                                  Correction value is zero
                                                  zenith value to be used with
                                                  formulas for international
                                                  laser data.
                                          4       Data has been corrected.
                                                  Bytes 53-56 contain
```

```
                                        meteorological data.
                                   5    Data hs not been corrected.
                                        Bytes 53-56 contain
                                        meteorological data.

                              or bits 10-12 as follows for Type 42-43
                              --------------------------------------

                         10             Dry Tropospheric Refraction
                                        Indicator (Types 42-43)
                                   0    Net Media Corrections do
                                        not include Dry Tropo
                                   1    Net Media Corrections
                                        do include Dry Tropo

                         11             Wet Tropospheric Refraction
                                        Indicator
                                        (Types 42-43)

                                   0    Net Media Corrections do
                                        not include Wet Tropo

                                   1    Net Media Corrections do
                                        include Wet Tropo

      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
I*4(cont)   I*4(cont)   I*8(cont)   Bits    Value  Description
                                    -------------------------
                                (10-12 cont.)

                                    12             Ionospheric Refraction
                                                   Indicator
                                                   (Types 42-43)

                                           0       Net Media Corrections do
                                                   not include Ionosphere
                                           1       Net Media Corrections do
                                                   include Ionosphere

                                    13             Ionospheric Refraction
                                                   ----------------------
                                                   (all but types 10-14
                                                   and 42-43)
                                           0       Data has been corrected
                                           1       Data has not been corrected

                                           or   Net Media Connections Indicator
                                                -------------------------------
                                                   (Types 42-43)
                                           0       Net Media Corrections
                                                   applied to observation
                                           1       Net Media Corrections
                                                   not applied to observation

                                    14             Transponder Delay
```

```
                                                   -----------------
                                                  (Types 20-29)

                                             0     Data has been corrected
                                                   or no correction required

                                             1     Data has not been
                                                   corrected (correction
                                                   is required)

                                             or    Net Ocean Dynamic Correction
                                                   ----------------------------
                                                   Indicator (Types 42-43)
                                                   -----------------------

                                             0     Net Ocean Dynamics
                                                   Corrections applied
                                                   to observation

                                             1     Net Ocean Dynamics
                                                   Corrections not applied
                                                   to observation

      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
I*4(cont)   I*4(cont)   I*8(cont)   Bits  Value   Description
                                    -------------------------

                                    15             Antenna Axis Displacement
                                                   -------------------------
                                                   (Types 20-39)
                                             0     Data has been corrected
                                                   (or no correction required).
                                             1     Data has not been corrected
                                                   (correction is required).

                                    16-17          Received Mount Type
                                                   -------------------
                                                   (all but 10-14, 38-59)
                                             0     X-Y (East-West)
                                             1     X-Y (North-South)
                                             2     Azimuth-Elevation
                                             3     Hour Angle-Declination

                                    18-19          Transmitter Mount Type
                                                   ----------------------
                                                   (All but types 10-14,
                                                   38-59)
                                             0     X-Y (East-West)
                                             1     X-Y (North-South)
                                             2     Azimuth-Elevation
                                             3     Hour Angle-Declination

                                    20-21          Transponder Channel/Type
                                                   ------------------------
                                                   (Radar Data Only) or GEOS-3
```

```
                                                 Altimeter Mode (Data
                                                 Types 40-41)

                                                 Transponder Channel for
                                                 -----------------------
                                                 GRARR
                                                 -----
                                           0     Channel A
                                           1     Channel B
                                           2     Channel C

     FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------

I*4(cont)   I*4(cont)   I*8(cont)   Bits  Value   Description
                                    -------------------------
                                (20-21 cont.)     Altimeter Mode (GEOS-3)
                                                  -----------------------
                                           0      Global Track Mode
                                           1      Intensive Track Mode
                                          >1      Not in Track Mode
                                                  Transponder Type ATS
                                                  --------------------
                                                  Tracking Modes (Including SST
                                                  -----------------------------
                                           0      Side-Tone Direct Tracking
                                           1      Coherent Direct Tracking
                                           2      Crystal Relay (SST or
                                                  ground relay)
                                           3      Phase Locked Loop Relay
                                                  (SST or ground relay)
                                                  Transponder Type for
                                                  --------------------
                                                  Other Systems
                                                  -------------
                                           0      Skin Track
                                           1      Coherent
                                           2      Non-Coherent
                                    22-25         Range Ambiguity Levels
                                                  ----------------------
                                                  For DSN S-Band
                                                  --------------
                                           0      MARK 1A (824,809,582.0 m)
                                           1      TAU (151,285,510,38518 m)
                                                  For USB
                                                  -------
                                           1      824809582.0 m
                                                  For GRARR S-Band
                                                  ----------------
                                                  18737031.3 m
                                          2        3684257.8 m
                                          3         936851.6 m

     FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
```

```
-----------------------------------------------

I*4(cont)   I*4(cont)   I*8(cont)   Bits  Value   Description
                                    -------------------------
                                 (22-25 cont.)    Date Rate Indicator for
                                                  -----------------------
                                                  ATS Destruct Type Doppler
                                                  -------------------------
                                                  (including SST)
                                                  ---------------
                                            0     1/sec  N = 255960
                                            1     2/sec  N = 127980
                                            2     4/sec  N =  63990
                                            3     8/sec  N =  31995
                                            4     6/min  N = 2559600

                                    26      1     Two sigmas input for each
                                                  measurement

                                    27            Used for
                                    28            Altimeter Data Types 40 and 41
                                    29
                                    30            Unassigned
                                    31

I*4         I*4         I*8         Modified Julian Date (MJD) of observa-
                                    tion.  JD = MJD + 2400000.5

R*8         R*8         R*8         Fraction of Day Past Midnight (GMT)

R*8         R*8         R*8             Altimeter Observation
                                              in meters
                                                                -6
I*4         I*4         I*8         Satellite Geodetic Latitude (10  deg)(phi)
                                                             -6
I*4         I*4         I*8         Satellite East Longitude (10  deg)(lamda)

      FORTRAN Variable Type

BINARY-I16  BINARY-I32  BINARY-I64  Description
-----------------------------------------------
R*4         R*8         R*8         Meas. Standard Deviation in meters
                                          (sigma )
                                                H
I*4         I*4         I*8         Net Instrument Correction in
                                          millimeters (delta H )
                                                              I
I*4         I*4         I*8         Meteorological Data Word

I*4         I*4         I*8         Net Media Corrections in
                                          millimeters ( delta H    )
                                                               ATM
            I*4         I*8         Laser altimeter ID:  This is a 2 digit
                                    integer.  The first digit represents
                                    the receiving detector id and the second
                                    describes the transmitting instrument id.

R*4         R*8         R*8         Geoid Height Above Reference
```

			Ellipsoid (M)
I*4	I*4	I*8	Net Ocean Dynamic Corrections in millimeters (H)
I*4	I*4	I*8	Indicated Surface Elevation (H_{ss}) (mm) $H_{ss} = H_c + H_{RAW} + \text{delta } H$ where H_c is the computer height of the s/c above the reference ellipsoid and delta H is the net corrections $\text{delta } H = \text{delta } H_I + \text{delta } H_{ATM} - \text{delta } H_T$ as indicated by Surface Elevation PREPRO Word.
I*4	I*4	I*8	S/C Revolution Number
I*4	I*4	I*8	Mean Sea Surface Elevation (Marsh/Martin 1981) in millimeters
I*4	I*4	I*8	DOD - Reference Radial Orbit Difference in millimeters
I*2	I*4	I*8	H 1/3 in centimeters
I*2	I*4	I*8	AGC (db)
I*2	I*4	I*8	Wind Speed in cm/sec

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description
I*2	I*4	I*8	Surface Elevation PREPRO Word The preprocessing indicators for the surface elevation are bit switches packed into a single 16 bit word. The right-most bit (bit 15) is of lowest order and the leftmost bit (bit 0) is of highest order. The Surface Elevation preprocessing bits are configured as follows:

Bits	Value	Description
0		This bit should always be zero filled.
1	0	Indicated Surface

Bits	Value	Description
		Elevation Not Corrected for Net Instrument Corrections (delta H_I)
	1	Indicated Surface Elevation Corrected for delta H_I
2	0	Indicated Surface Elevation Not Corrected for Net Media Corrections (delta H_{ATM})
	1	Indicated Surface Elevation Corrected for delta H_{ATM}

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description		
I*2(cont)	I*4(cont)	I*8(cont)	Bits	Value	Description
			3	0	Indicated Surface Elevation Not Corrected for Net Ocean Dynamic Corrections (delta H_T)
				1	Indicated Surface Elevation Corrected for delta H_T
			4	0	Net Media Corrections do not include Dry Tropo
				1	Net Media Corrections include Dry Tropo
			5	0	Net Media Corretions do not include Wet Tropo
				1	Net Media Corrections do include Wet Tropo
			6	0	Wet Tropo used is FNOC
				1	Wet Tropo used is SMMR
			7	0	Net Media Corrections do not include Ionosphere
				1	Net Media Corrections do include Ionosphere

Bits	Value	Description
8	0	Net Ocean Dynamic Corrections do not include Barotropic
	1	Net Ocean Dynamic Corrections do include Barotropic

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description		
I*2(cont)	I*4(cont)	I*8(cont)	Bits	Value	Description
			9	0	Net Ocean Dynamic corrections do not include solid earth tide
				1	Net Ocean Dynamic Corrections do include solid earth tide
			10	0	Net Ocean Dynamic Corrections do not include Ocean Tide
				1	Net Ocean Dynamic Corrections do include Ocean Tide
			11	0	Ocean Tide used is Schwiderski
				1	Ocean Tide used is Parke
			12	0	Reference Ellipsoid is IUGG
				1	Reference Ellipsoid is not IUGG
			13	0	Reference orbits are GSFC PGS-S3
				1	Reference orbits are not GSFC PGS-S3
			14	0	Reference Geoid is GEM-10B Detailed
				1	Reference Geoid is not GEM-10B Detailed

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description		
I*2(cont)	I*4(cont)	I*8(cont)	Bits	Value	Description
			15	0	Reference Mean Sea Surface is Marsh/ Martin PGS-S3 (80002)
				1	Reference Mean Sea Surface is not

I*2	I*4	I*8	Dry Tropospheric Correction (mm)
I*2	I*4	I*8	FNOC Wet Tropo Correction (mm)
I*2	I*4	I*8	SMMR Wet Tropo Correction (mm)
I*2	I*4	I*8	Ionospheric Correction (mm)
I*2	I*4	I*8	Barotropic Dynamic Sea Surface Correction (mm)
I*2	I*4	I*8	Solid Earth Tide (mm)
I*2	I*4	I*8	Schwiderski Ocean Tide (mm)
I*2	I*4	I*8	Parke or other Ocean Tide (mm)
	I*4	I*8	Laser Altimeter Wavelength (microns)

2.4 GEOS-C DATA FORMAT

The GEOS-3 satellite was tracked by many different systems and networks of tracking stations. It is intended that this format will accommodate data taken from all tracking systems and networks as well as altimeter data taken by GEOS-3. As a consequence of its design characteristics this format not only meets the specifications of the GEOS-C project but also the precise orbit determination requirements of all contemporary satellites.

Since this format is a character representation, it is ideally suited for transferring data between the different types of computer facilities. The only character images used by the format are:

- integer numbers 0-9
- letters of the alphabet A-Z
- blanks, and
- minus signs

All decimal points are implied, therefore eliminating the need for that character representation.

FORMAT DESCRIPTION

Descriptions of columns 1-32 for all measurement types.

```
Columns      Type        Description
----------------------------------
1-7          I7          Satellite -ID
                         -------------

                         The satellite ID field is used for specification
                         of the 7 digit international satellite designator
                         which is composed of three items:

                         YYLLLCC

                         where

                         YY - is the two digit year of launch, 75 for
                         example is used to indicate the year 1975, when
```

GEOS-3 was launched.

LLL - is the three digit order of launch. The first vehicle launched in a given year is assigned the value 001. Each subsequent launch within that year increments the launch order by 1.

CC - is the component number assigned to each item which achieves orbit from a single launch vehicle. If the launch vehicle places more than one satellite in orbit, each will be assigned a unique component number. Orbiting debris from the launch will also be assigned a component number if it is of significant size to require monitoring for safety purposes.

The satellite ID field must contain a number greater than 5099999.

Columns	Type	Description
8-9	I2	Measurement Type

The measurement type field specifies a two digit type (ps) which is composed of a primary type (p) and a secondary type (s). The function of the primary type is to determine which modeling algorithm to be used in processing the data. The secondary type discriminates which frequency class is used and in some cases which coordinate reference to use (types 10-19 and 60-69). Frequency information is used to help ascertain which spacecraft antenna/transponder was used (see col. 7 OFFSET and DELAY cards).

Columns   Type   Description

10-14 Right Ascension and Declination

- 10 = Optical
- 11 = Laser Optical

15-19 Hour Angle and Declination

- 15 = DSN S-Band Radar

20-29 Range or Range Difference

- 20 = Laser
- 21 = C-Band Radar
- 22 = C-Band VLBI Range Difference Radars
- 23 = S-Band Radar (DSN, Weilheim, CNES, ESA, ISRO, Sweden)

```
                         24 =  USB Radar

                         25 =  GRARR S-Band Radar

                         26 =  GRARR ATS-R C-Band Radar

                         27 =  GRARR VHF Radar

                         28 =  Ku-Band Radar (CNES, Sweden, Usingen)

                        30-39  Range Rate or Range Rate Difference

                         30 =  Combined DSN/USB Radars

                         31 =  C-Band Radar

                         32 =  C-Band VLBI Range Rate Difference Radars

                         33 =  DSN S-Band Radar

                         34 =  USB Radar

                         35 =  GRARR S-Band Radar

                         36 =  GRARR ATS-R C-Band Radar

                         37 =  GRARR VHF Radar

                         38 =  TRANET Doppler
Columns     Type        Description
----------------------------------


                         39 =  Geoceiver Doppler

                        40-44  Altimeter Height

                        45-49  Available for additional measurement types
                               such as Altimeter Height Rate

                        50-54  l and m Direction Cosines

                         51 =  Minitrack Equatorial Mode

                         52 =  Minitrack Polar Mode

                        55-59  Available for additional angles or cosines

                        60-63  X-Y Angles (East-West)

                         60 =  USB Radar

                        64-69  X-Y Angles (North-South)

                         64 =  USB Radar
```

```
                  65 =  GRARR S-Band Radar

                  66 =  GRARR ATS-R C-Band Radar

                  67 =  GRARR VHF Radar

                 70-79  Azimuth and Elevation Angles

                  70 =  Laser

                  71 =  C-Band Radar

                  73 =  DSN S-Band Radar

                 80-89  Available for additional Range type
                        measurements

                 90-99  Available for additional Range Rate type
                        measurements

                 Some of the measurement types defined by the
                 GEOS-C format are not handled by GEODYN.  These
                 include:

                 Laser Optical, Hour Angle and X-Y (East-West)
                 Angles

Columns     Type        Description
----------------------------------


10-11       I2          Time System Indicator
                        ---------------------

                 The time system indicator is used to identify
                 whether satellite  or ground time is provided
                 and in which time system that information is
                 provided.  Some data forms are required by GEODYN
                 to be provided with station received time.  These
                 include all average range rates or average
                 Dopplers such as:

                        USB & DSN 2-way and 3-way average range
                             rate,
                        Geoceiver 1-way Doppler,
                        TRANET-II 1-way Doppler,
                        GRARR destruct Dopplers of all types
                             including ATS-6/GEOS-3 satellite-to-
                             satellite range rates,
                        GRARR continuous count ATS-6/GEOS-3
                             satellite-to-satellite range rates,
                        All TDRSS Doppler or range rate data, and
                        Weilheim 2-way and 3-way average range
                             rate.

                 These station received times are also required by
                 GEODYN to be at the end of the averaging
                 interval.
```

All angle data are also assumed to be station received time.

Columns	Type	Description
10	I1	0 = Ground Received Time 1 = Satellite Transponder/Transmitter Time 2 = Ground Transmitted Time 3 = Satellite Receiver Time
11	I1	0 = UT-0 1 = UT-1 2 = UT-2 3 = UT-C 4 = A.1 5 = A.3 (A.T. B.I.H.) 6 = A-S (Smithsonian)

Columns	Type	Description
12-16	I4	Station ID
		Except in the case of altimetry the station ID must be greater than zero. Otherwise any arbitrary value may be used. However, GEODYN does have a default set of tracking station coordinates. If the user does not specifically override this set of stations, then the number placed in this field will cause GEODYN to choose coordinates that correspond to this number if they are present in the default set of stations.
17-32		GMT of Observation
		The GMT of the observation is the observation time in the time system as specified by the time system indicator. It is composed of three components: the year of observation (75 indicates the year 1975); the day of the year (01 January is day 001); and time of the instant of observation in microseconds past midnight.
17-18	I2	Year YY
19-21	I3	Day of Year DDD
22-26	I5	Time of Day (Seconds from midnight GMT)
27-32	I6	Fractional Part of Seconds (in microseconds)

Columns 33-80 for Right Ascension/Declination and Hour Angle/Declination (Data Types 10-19)

```
Columns      Type        Description
-----------------------------------


33           I1          Beacon Activity Indivcator
                         -------------------------

                         Active beacon data is recorded when camera
                         observations are made while the spacecraft is
                         actively flashing its beacons as part of a
                         scheduled flash sequence.

                         0 = Beacon Active

                         1 = Beacon Inactive or no Beacon

34-35        I2          Equator and Equinox designation
                         -------------------------------
                         Right Ascension and Declination data are obtained
                         by photographing the spacecraft against a star
                         background and then deriving the spacecraft
                         coordinates by association with known stars
                         photographed in the same plate. The star
                         locations are provided by a star catalog which
                         typically provides their coordinates in the mean
                         equator and equinox of 1950.0. Some observatories
                         transform the observations from this system into
                         another system.  GEODYN uses true coordinates of
                         date (and time) for observation processing. If
                         the data are not in this system, GEODYN uses the
                         information in columns 34-35 to transform the
                         data.

34                       0 = Mean equator and equinox

                         1 = True equator and equinox

35                       Date of equator and equinox

                         1 = Standard equator and equinox (Jan. 0.0, 1950)

                         2 = Jan. 0.0 of year of observation

                         3 = Equator and equinox of date (instant of
                                observation)

                         4 = DODS reference date (0 hr. Sept. 18, 1957)

Columns      Type        Description
-----------------------------------


36-54                    Observation Data
                         ----------------

                         GEODYN reads the observation data in the format:

                                (I3,I2,F5.3,A1,I2,I2,F4.2)

                         to obtain respectively the hours,minutes and
```

		seconds of right ascension, sign of declination, and degrees, minutes and arc seconds of declination.
36-38	I3	R.A. or H.A. (hours)
39-40	I2	R.A. or H.A. (minutes of time)
41-45	DP	R.A. or H.A. (XX.XXX Seconds of time)
46	A1	Sign of declination
47-48	I2	Declination (degrees of arc)
49-50	I2	Declination (minutes of arc)
51-54	DP	Declination (XX.XX arc seconds)
55-57		Preprocessing Indicators
		Right ascension and declination data require correction for annual aberration, diurnal aberration, and parallactic refraction. Some observatories apply some or all of these corrections while other observatories apply none. The values in columns 55-57 provide GEODYN with the information necessary to know which of these corrections should be computed and applied by GEODYN.
55	I1	0 = Data has been corrected for annual aberration effects
		1 = Data not corrected for annual aberration
56	I1	0 = Data has been corrected for parallactic refraction
		1 = Data not corrected for parallactic refraction
Columns	Type	Description
57	I1	0 = Data has been corrected for diurnal aberration
		1 = Data not corrected for diurnal aberration
58-61		Standard deviatiuon in R.A or H.A.
		The observation standard deviations specified in columns 58-65 will be used by GEODYN unless SIGMA cards are used to override these values. GEODYN will divide the standard deviation of the right ascension by the cosine of the declination. This

is done because the quality of the right ascension degrades with the cosine of the declination.

XX.XX Arc Seconds multiplied by cosine of the declination.

62-65 Standard deviation in declination

XX.XX Arc Seconds

66 Preprocessing Report

GEODYN does not use the Preprocessing Report.

0 = Report not indicated

1-9, A-Z values to be assigned

67-80 Not Used.

Columns 33-80 for range and range difference measurements (Data Types 20-29)

Columns	Type	Description
33-35		Preprocessing Indicators

All ranging systems are subject to "range delay" caused by atmospheric propogation and transponder path delays.

Because of the frequency of light, ionospheric refraction effects are totally ignorable for lasers. For electronic systems, maximum vertical ionospheric delay varies from 10 cm. at 14 GHz to more than a kilometer at 400 MHz. GEODYN does not have a model adequate to correct for this effect. Data should be corrected for ionospheric effects outside of GEODYN and the ionospheric indicator set accordingly.

The Hopfield tropospheric refraction model used in GEODYN ignores the effect of frequency on the corrections for electronic systems and assumes a wavelength of 0.6 microns for lasers. This is valid for electronic systems and introduces only a few centimeters of error for lasers. Performing this correction outside of GEODYN has the advantage that the data are corrected only once, thus saving computer time. Also, different models may be used if the correction is performed outside of GEODYN. The tropospheric indicator should be set accordingly.

Transponder delays occur in electronic systems and are best handled outside of GEODYN because electronics vary considerably between spacecraft. If GEODYN is setup properly, it has the capability to apply delays as a polynomial in powers of the range rate. Although delays also occur in laser reflectors, these are generally modeled as part of center-of-gravity corrections computed externally. The transponder delay indicator should be set appropriately.

Columns	Type	Description
33	I1	0 = Data has been corrected for ionospheric refraction effects
		1 = Data not corrected for ionospheric refraction
34	I1	0 = Data has been corrected for tropospheric refraction effects
		1 = Data not corrected for tropospheric refraction
		2 = Data has been corrected for tropospheric refraction using the correction formulas for international laser data (see cols. 76-80)
		3 = Data not corrected for tropospheric refraction. Columns 76-80 contain coefficient for use with international laser formulas.
		4 = Data has been corrected for tropospheric refraction, columns 57-66 will contain meteorological data
		5 = Data not corrected for tropospheric refraction, columns 57-66 will contain meteorological data
35	I1	0 = Data has been corrected for transponder delay effects
		1 = Data not corrected for transponder delay
36-54		Observation Data ---------------- If corrections have been applied, the observation contained in columns 36-54 is the corrected value.
36-45	DP	Range or Range Difference (Km)

```
46-54        DP          Range or Range Difference

                                XXX.XXXXXX Meters

Columns      Type        Description
-----------------------------------

55           I1          Speed of Light
                         --------------

                         Column 55 indicates which value of the speed of
                         light was used to convert the range measurement
                         from units of time to meters.

                         0      2.997925x10**8 meters/sec.
                         3      2.99792458x10**8 meters/sec.

56           I1          Transponder Channel
                         -------------------

                         In the GRARR system transponder delay and range
                         ambiguity were a function of which sidetone was
                         used. Both coherent and non-coherent transponders
                         are used for C-Band tracking. The delays differ
                         for these two types of transponders.

                         Transponder Channels for GRARR:

                         1 = Channel A or 1st sidetone
                         2 = Channel B or 2nd sidetone
                         3 = Channel C or 3rd sidetone

                                or

                         Transponder type for other systems

                         1 - coherent
                         2 - non-coherent

Columns      Type        Description
-----------------------------------

57-68                    For most range sub-types columns 57-66 may
                         contain meteorological data and columns 67-68
                         remain blank.

                         For range difference data (type 22) the reference
                         station number should be provided in columns 57-
                         61 and columns 62-68 should remain blank. The
                         range difference observation is modeled as the
                         range from the satellite to the station (cols.
                         12-16) minus the range from the satellite to the
                         reference station (cols. 57-61).

                         For satellite-to-satellite relay (SST) range data
                         (type 26) the satellite ID of the relay satellite
                         is specified in columns 62-68 and columns 57-61
```

```
                    must remain blank. The SST range is modeled as
                    half of the round trip range from the station
                    (cols. 12-16) to the relay satellite (cols. 62-
                    68) to the user satellite (cols. 1-7).

                    For ground relay (or bi-lateration) range data
                    (type 26) the satellite ID of the relay satellite
                    is specified in both columns 1-7 and 62-68. The
                    relay station is specified in columns 57-61 and
                    the transmitting and receiving station is
                    specified in columns 12-16. Ground relay range is
                    modeled as half of the round trip range from the
                    station (cols. 12-16) to the relay satellite
                    (cols. 1-7 and 62-68) to the relay station (cols.
                    57-61).

57-61       I5      Reference station number for range differencing
                    or relay station number for station-to-satellite-
                    to-relay station-to-satellite-to-station data.

62-68       I7      Relay satellite-ID for satellite-to-satellite
                    data.

                    If column 34 contains a 4 or 5 and if the range
                    data type is not 22 or 26 then meteorological
                    data will be input in columns 57-66 as follows:

57-60       I4      Surface Pressure
                           XXXX Millibars

61-63       I3      Surface Temperature
                           XXX degrees  K

64-66       I4      Relative Humidity at Surface
                           XXX Percent

Columns     Type    Description
----------------------------------

69-73               Measurement standard deviation
                    ------------------------------
                           XX.XXX Meters

74          I1      Range ambiguity indicator
                    -------------------------

                    1  =   MARK1A
                           (2.75126334 sec, 824809582.0 m)

                    2  =   TAU
                           (0.504634073184553 sec,
                            1.51285510.38518 m)

                    3  =   1.0 x 10**10

                    4  =   0.0625 sec, 18737031.3 m

                    5  =   1.0 x 10**10
```

```
                        6  =   1.0 x 10**10

                        7  =   1.0 x 10**10

                        8  =   JPL Orbit Data File
                               (ODF, DOC. TRK-2-18)

75                      Not Used
                        --------

76-80                   Tropospheric refraction correction
                        ----------------------------------
                               XX.XXX Meters
```

Columns 33-80 for range rate, Doppler, and range rate difference measurements (Data types 30-39)

```
Columns     Type        Description
----------------------------------

33-35                   Preprocessing Indicators
                        ------------------------
```

GEODYN does not have a model adequate to correct for ionospheric Doppler effects. Data should be corrected for ionospheric effects outside of GEODYN and the ionospheric indicator set accordingly.

The Hopfield tropospheric refraction model used in GEODYN ignores the effect of frequency on the corrections for electronic systems. This is valid for electronic systems. Performing this correction outside of GEODYN has the advantage that the data are corrected only once, thus saving computer time. Also, different models may be used if the correction is performed outside of GEODYN. The tropospheric indicator should be set accordingly.

Both the DSN and USB tracking systems have a variety of antenna mounts. In all except the azimuth-elevation mount type, the two axes of rotation do not intersect. This results in a non-stationary tracking reference. The location of this reference is a function of the tracking angles and the physical displacement of the two axes. This distance between the two axes is refered to as the antenna axis displacement. The resulting correction to the data is known as the antenna axis displacement correction. Column 35 defines the mount type of the receiving antenna.

```
Columns     Type        Description
----------------------------------

33          I1          0  =   Data has been corrected for ionospheric
```

refraction correction

Columns	Type	Description
34	I1	0 = Data has been corrected for tropospheric refraction effects 1 = Data not corrected for tropospheric refraction
35	I1	Receiver Mount Type 1 = X-Y (East-West) 2 = X-Y (North-South) 3 = Azimuth-Elevation 4 = Hour angle-declination
36-42	DP	Counting interval for average range rate data (Types 30, 33, 34, 36, 38, 39) Average range rate (or integrated Doppler) data are observed over a finite interval. For data of this type the counting interval defines the duration of the observing interval. The end of the observing interval is specified in columns 17-32 and the start of the observing interval may be computed as the end minus the counting interval. XXXXX.XX seconds or Tropospheric refraction correction for other range rate data types XXXXX.XX cm/sec

Columns	Type	Description
43-55		Observation Data If corrections have been applied, the observation contained in columns 43-55 is the corrected value.
43-49	DP	Range rate or range rate difference XXXX.XXX km/second
50-55	DP	Range rate or range rate difference XXX.XXX millimeters/second Speed of Light

		Column 56 indicates which value of the speed of light was used to convert the range rate (or Doppler) measurement from units of Hetrz to meters/second. 0 2.997925x10**8 meters/sec. 3 2.99792458x10**8 meters/sec.
57-68		For range rate difference data (type 32) the reference station number should be provided in columns 57-61 and columns 62-68 should remain blank. The range rate difference observation is modeled as the range rate from the satellite to the station (cols. 12-16) minus the range rate from the satellite to the reference station (cols. 57-61). For satellite-to-satellite relay (SST) range rate data (type 36) the satellite ID of the relay satellite is specified in columns 62-68 and columns 57-61 must remain blank. The SST range rate is modeled as half of the round trip range rate from the station (cols. 12-16) to the relay satellite (cols. 62-68) to the user satellite (cols. 1-7) plus a scale factor times half of the round trip range rate from the station (cols. 12-16) to the relay satellite (cols. 62-68). Unfortunately, this format does not have sufficient free space for specification of the scale factor and much of the SST range rate data between ATS-6 and GEOS-3 was destruct Doppler requiring the precision in the counting interval to 10 nanoseconds. Please see the "GEODYN Binary Format" for the processing of SST range rate data.

Columns	Type	Description
		For ground relay (or bi-lateration) range rate data (type 36) the satellite ID of the relay satellite is specified in both columns 1-7 and 62-68. The relay station is specified in columns 57-61 and the transmitting and receiving station is specified in columns 12-16. Ground relay range rate is modeled as half of the round trip range rate from the station (cols. 12-16) to the relay satellite (cols. 1-7 and 62-68) to the relay station (cols. 57-61) plus a scale factor times half of the round trip range rate from the station (cols. 12-16) to the relay satellite (cols. 1-7 and 62-68). Unfortunately, this format does not have sufficient free space for specification of the scale factor and much of the bi-lateration range rate data from ATS-6 was destruct Doppler requiring the precision in the counting interval to 10 nanoseconds. Please see

Columns	Type	Description
		the "GEODYN Binary Format" for the processing of bi-lateration range rate data.
57-65		Reference station number for range differencing, or relay station number for station-to-satellite-to-relay station-to-satellite-to-station data or transmitting station for 3-way average range rate data.
62-68	I7	Relay satellite-ID for satellite-to-satellite data.
69-73	DP	Measurement Standard deviation XXX.XX millimeters/second

Columns	Type	Description
74	I1	Transmitter or reference station Mount Type Both the DSN and USB tracking systems have a variety of antenna mounts. In all except the azimuth-elevation mount type, the two axes of rotation do not intersect. This results in a non-stationary tracking reference. The location of this reference is a function of the tracking angles and the physical displacement of the two axes. This distance between the two axes is refered to as the antenna axis displacement. The resulting correction to the data is known as the antenna axis displacement correction. Column 74 defines the mount type of the transmitting antenna. Columns 75-77 define the displacement between the two axes for the receiving antenna. Columns 78-80 define the displacement between the two axes for the transmitting antenna. 1 = X-Y (East-West) 2 = X-Y (North-South) 3 = Azimuth-Elevation 4 = Hour angle-declination
75-77	DP	Receiver antenna axis displacement XX.X Meters
78-80	DP	Transmitter or reference station Antenna axis displacement XX.X Meters

Columns	Type	Description
33-41	DP	Altimeter Height Measurement (0)

If corrections have been applied, the observation contained in columns 33-41 is the corrected value.

X,XXX,XXX.XX Meters

42-44	DP	Measurement Standard Deviation ------------------------------ X.XX Meters
45-47		Tropospheric Refraction The Hopfield tropospheric refraction model used in GEODYN ignores the effect of frequency on the corrections for electronic systems. This is valid for the radar altimeter. Performing this correction outside of GEODYN has the advantage that the data are corrected only once, thus saving computer time. Also, different models may be used or as in the case of Seasat the spacecraft may have a water vapor radiometer that provides a much more accurate model of the wet component of the tropospheric delay. The tropospheric refraction correction should be provided if the data are corrected outside of GEODYN. = 0 - none applied > 0 - value applied X.XX Meters

Columns	Type	Description
48-49	DP	Ionospheric refraction ---------------------- For the radar altimeter maximum vertical ionospheric delay is 10 cm. at 14 GHz. GEODYN does not have a model adequate to correct for this effect. Data should be corrected for ionospheric effects outside of GEODYN and the ionospheric correction used should be provided. = 0 - none applied > 0 - value applied .XX Meters
50-55		Geoid Height ------------ The geoid height is a quantity that is subtracted

by GEODYN from the sea surface height in formulating the observation residual. GEODYN has the capability of computing a geoid height using it's gravitational model. However, much better values of the geoid are available external to GEODYN and using a much broader data set. This value should be supplied from one of these external sources.

50		Sign of Height
51-55	DP	Value of Height
		XXX.XX Meters

Columns	Type	Description
56-59		Tide Height
		GEODYN has the capability of computing deep ocean tides using the Henderschott ocean tide model. Much better models of the tides are available external to GEODYN. The value supplied in this field should include the solid earth tide component as well as the deep ocean component. This value is also subtracted from the sea surface height by GEODYN in forming the observation residual.
56		Sign of tide
57-59	DP	Value of Tide
		X.XX Meters

Columns	Type	Description
60-79		The satellite latitude, longitude and sea surface height fields are provided for users other than the GEODYN program. GEODYN recomputes all of these quantities from the integrated orbit of the spacecraft and from the observation for sea surface height.
60-66		Satellite Latitude
60		Sign of Latitude
61-66	DP	Value of Latitude
		$XX.XXXX^{o}$

```
67-73        DP          Satellite East Longitude
                         ------------------------
                                  o
                                XXX.XXXX


74-79                    Sea Surface Height (0-h)
                         ------------------------

                                Altimeter Height Measurement less
                                Satellite Height (h) above Spheroid

74                       Sign of Height

75-79                    Value of Height
                                XXX.XX Meters

80                       Speed of Light

                         Column 80 indicates which value of the speed of
                         light was used to convert the altimeter range
                         measurement from units of time to meters.

                         0      2.997925x10**8 meters/sec.
                         3      2.99792458.10**8 meters/sec.

Columns 33-80 for Minitrack Data (Types 50-54)

Columns      Type        Description
-----------------------------------

33-34        I1          Refraction Indicators
                         ---------------------

                         All electronic systems are
                         subject to path bending caused by
                         atmospheric propogation delays.

                         GEODYN does not have a model adequate to
                         to correct for ionospheric path bending.
                         Data should be corrected for ionospheric
                         effects outside of GEODYN and the ionospheric
                         indicator set accordingly.

                         The Hopfield tropospheric refraction
                         model used in GEODYN is valid for electronic
                         systems. Performing this correction outside
                         of GEODYN has the advantage that the data are
                         corrected only once, thus saving computer time.
                         Also, different models may be used if the
                         correction is performed outside of GEODYN.
                         The tropospheric indicator should be set
                         accordingly.

33           I1          0  = Data has been corrected for ionospheric
                              effects

                         1  = Data not corrected for ionosphere
```

```
34          I1          0  = Data has been corrected for tropospheric
                             effects

                        1  = Data not corrected for troposphere

35                      Not used
                        --------

36-54                   Observation Data
                        ----------------

                        If corrections have been applied,
                        the observations contained
                        in columns 36-54 are the corrected values.

36                      Not Used.

37-45       DP          Cosine l
                        XXXX.XXXXX Mils

46-54       DP          Cosine m
                        XXXX.XXXXX Mils

Columns     Type        Description
----------------------------------

55-57                   Not Used

58-61       DP          Standard Deviation in Cosine l
                        ------------------------------
                        XX.XX Mils

62-65       DP          Standard Deviation in Cosine m
                        ------------------------------
                        XX.XX Mils

66          I1          Preprocessing Report
                        --------------------

                        GEODYN does not use the Preprocessing Report.

                        0  = Report not indicated.
                        1-9, A-Z Values to be assigned.

Columns 33-80 for X-Y angles and Azimuth and Elevation angles (Types
60-79)

Columns     Type        Description
----------------------------------

33-34                   Refraction Indicators
                        ---------------------

                        All electronic systems are subject
                        to path bending caused by
                        atmospheric propogation delays.
```

```
                        GEODYN does not have a model adequate
                        to correct for ionospheric path bending.
                        Data should be corrected for ionospheric
                        effects outside of GEODYN and the ionospheric
                        indicator set accordingly.

                        The Hopfield tropospheric refraction model
                        used in GEODYN is valid for electronic systems.
                        Performing this correction outside of GEODYN
                        has the advantage that the data are corrected
                        only once, thus saving computer time. Also,
                        different models may be used if the correction
                        is performed outside of GEODYN. The tropospheric
                        indicator should be set accordingly.


33          I1          0  = Data has been corrected for ionospheric
                             effects

                        1  = Data not corrected for ionosphere

34          I1          0  = Data has been corrected for tropospheric
                             effects

                        1  = Data not corrected for troposphere

35                      Not Used
                        --------

Columns     Type        Description
----------------------------------

36-54                   Observation Data
                        ----------------

                        If corrections have been applied, the observations
                        contained in columns 36-54 are the corrected values.

36-38       I3          Azimuth or X angle (degrees).
                        Sign of X angle goes in column 36.

39-40       I2          Azimuth or X angle (arc minutes)

41-45       DP          Azimuth or X angle
                        XX.XXX Arc Seconds

46                      Sign of Y angle

47-48       I2          Elevation or Y angle (degrees)

49-50       I2          Elevation or Y angle (minutes)

51-54       DP          Elevation or Y angle
                        XX.XX Arc Seconds

55-57                   Not Used

58-61       DP          Standard deviation in X angle or azimuth
```

```
                         ---------------------------------------
                         XX.XX Arc Minutes

62-65       DP           Standard deviation in elevation or Y angle
                         -----------------------------------------
                         XX.XX Arc Minutes

Columns     Type         Description
---------------------------------

66                       Preprocessing Report
                         --------------------

                         GEODYN does not use the Preprocessing Report.

                         0  = Report not indicated

                         1-9, A-Z Values to be assigned.

67-71       DP           Tropospheric refraction correction to X angle
                         ---------------------------------------------
                         XXX.XX Arc Minutes

72-76       DP           Tropospheric refraction correction to Y angle
                         ---------------------------------------------
                         or elevation
                         ------------
                         XXX.XX Arc Minutes

77-80                    Not used
                         --------
```

2.5 GEODYN II BINARY METRIC TRACKING DATA FORMAT

This format has been designed to accommodate the precision metric tracking data forms that are currently available and that will become available over the next several years. Although not as compact as earlier formats, it is capable of handling complex observation forms with up to three stations and three satellites per measurement equation. Recent and planned data forms for which this format has been designed include: GPS ranges (phase or P-code), GPS single, double and triple differences, TDRSS relay ranges and Dopplers and single and double differences of TDRSS relay ranges and Dopplers.

In order to facilitate running the TDF on different computers, TDF versions starting with 9108 can accept 3 different data formats of the GEODYN binary format. The BINARY-I16 format contains I*2 and R*4 data formats. The BINARY-I32 format contains only I*4 and R*8 data formats, and can only be used with versions of the TDF starting with 9108. The BINARY-I64 format contains I*8 and R*8 data formats exclusively, and can only be used with versions of the TDF starting with 9108. To use the BINARY-I64 format, the TDF must be post-processed for the CRAY and run on a 64-bit integer (default) machine. To use the BINARY-I32 or BINARY-I16 formats, the TDF must be post-processed for the IBM. Refer to the TDF FORMAT card, in VOLUME 3, for more information on selecting types of binary format. The type of computer the TDF is run on determines the type of binary format that should be used.

2.5.1 BINARY FORMAT DESCRIPTION

```
      FORTRAN Variable Type

BINARY-I16 BINARY-I32 BINARY-I64  Description
-------------------------------------------------
```

```
I*4        I*4        I*8          Satellite ID No. 1 (S1) -- This is the
                                                           is the international
                                   international satellite designation yynnncc
                                   where:
                                   yy  - last two digits of the year of launch
                                         (e.g. 74 for 1974, 69 for 1969.)
                                   nnn - order of launch (nnn=025 for 25th
                                         launch of year).
                                   cc  - component identifier (identifies
                                         multiple satellites placed in orbit
                                         by the same launch vehicle).

I*4        I*4        I*8          Station ID for Station No. 1 (T1) (must be
                                   less than 2,000,000,000).  Only the eight
                                   low order digits will be used by GEODYN II.

I*4        I*4        I*8          Satellite ID for Satellite No. 2 (S2).

I*4        I*4        I*8          Station ID for Station No. 2 (T2) (must be
                                   less than 2,000,000,000).  Only the eight
                                   low order digits will be used by GEODYN II.

I*4        I*4        I*8          Satellite ID for Satellite No. 3 (S3).

I*4        I*4        I*8          Station ID for Station No. 3 (T3) (must be
                                   less than 2,000,000,000).  Only the eight
                                   low order digits will be used by GEODYN II.


      FORTRAN Variable Type

BINARY-I16 BINARY-I32 BINARY-I64   Description
----------------------------------------------
I*4        I*4        I*8          Measurement Type/Time System Indicator
                                   (nnmmtqppss).

                                   nn  - Reserved.  Must be set to zero.

                                   mm  - GEODYN-II Measurement Type

                                   t   - Time tag flag for Primary Observer.

                                         t  value   description
                                         --------   -----------
                                             0       Receiver time.
                                             2       Transponder/reflection time.
                                             4       Transmitter time.

                                   q   - Time tag flag for Secondary Observer.

                                         q  value    description
                                         --------    -----------
                                             0       Receiver time.
                                             2       Transponder/reflection time.
                                             4           Transmitter time.

                                   pp  - Time system flag for Primary Observer.
                                   ss  - Time system flag for Secondary Observer.
```

ss value pp value	description
0	UT-0
1	UT-1 (U.S.N.O.)
2	UT-2 (U.S.N.O.)
3	UTC (U.S.N.O.)
4	A.1 (U.S.N.O.)
5	TAI(International Atomic Time)
6	A-S (SMITHSONIAN)
7	TDT (Terrestrial Dynamic Time)
8	TDB (Barycenter Dynamic Time)
9	GPS (Global Positioning System Time)
11	UT-1 (B.I.H.)
12	UT-2 (B.I.H.)
13	UTC (B.I.H.)
17	E.T.(Ephemeris Time; Numerically equivalent to TDT since mid 1970's)

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description
I*4	I*4	I*8	Station No. 1 Meteorological Word.
I*4	I*4	I*8	Station No. 2 Meteorological Word.
I*4	I*4	I*8	Station No. 3 Meteorological Word.
I*4	I*4	I*8	Observation Preprocessing Word.
I*4	I*4	I*8	Observation Time in integral elapsed seconds from January 0.0, 1968 (Modified Julian Date 39855).
R*8	R*8	R*8	Primary Observer Observation Time in elapsed seconds from value specified in bytes 45-48 (i.e. Primary Observer Observation Time = value bytes 45-48 + value bytes 49-56).
R*8	R*8	R*8	Secondary Observer Observation Time in elapsed seconds from value specified in bytes 45-48 (i.e. Secondary Observer Observation Time = value bytes 45-48 + value bytes 57-64).
R*8	R*8	R*8	Observation value in meters for range types (simple range, TDRSS range, GPS, VLBI time delay, etc.) and meters per second for range rate types (all Doppler types). NOTE: Observation value is uncorrected except for ionosphere corrections from dual frequency instruments.
R*8	R*8	R*8	Observing interval in seconds for average

			range rates (integrated Dopplers) or for time differenced GPS phase observables, or Range ambiguity level for range data.
R*8	R*8	R*8	Ratio of 2-way and 4-way terms (SF2S) for Primary TDRSS (S2) tracking User Satellite (S1).
R*8	R*8	R*8	Ratio of 2-way and 4-way terms (SF3S) for Secondary TDRSS (S3) tracking User Satellite (S1).
R*8	R*8	R*8	Ratio of 2-way and 4-way terms (SF2T) for Primary TDRSS (S2) tracking User Station (T1).
R*8	R*8	R*8	Ratio of 2-way and 4-way terms (SF3T) for Secondary TDRSS (S3) tracking User Station (T1).

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description
R*8	R*8	R*8	Satellite antenna preprocessing word.
R*4	R*8	R*8	Sum of the spacecraft Center of Gravity corrections.
R*4	R*8	R*8	Sum of the Antenna Axis Displacement corrections.
R*4	R*8	R*8	Sum of the Tropospheric Refraction corrections.
R*4	R*8	R*8	Sum of the Ionospheric Refraction corrections.
R*4	R*8	R*8	Sum of the Transponder Delay corrections.
R*4	R*8	R*8	Sum of the Relativistic corrections.
R*4	R*8	R*8	Spare.
R*4	R*8	R*8	Speed of Light in meters/sec minus 299792458.
R*4	R*8	R*8	Operational wavelength in microns.
R*4	R*8	R*8	Observation Standard Deviation.

2.5.2 METEOROLOGICAL WORD DEFINITION

The meteorological word for the Binary Metric Tracking Format contains the pressure, temperature and relative humidity packed into a single 32 bit integer word. The rightmost bit (bit 0) is of the lowest order and the leftmost bit (bit 30) is of the highest order with bit 31 of the 32 bits being left blank. The meteorological bits are configured as follows:

BITS	DESCRIPTION
0-6	Humidity in %
7-17	(Temperature in Degrees Kelvin - 200) x 10

```
18-30         (Pressure in Millibars - 700) x 10
```

2.5.3 OBSERVATION PREPROCESSING WORD DEFINITION

```
BITS    DESCRIPTION
---     --------------------------------------------------------------------

1-3     Reserved.
 03     Is clock calibration bias provided.
 04     Has precession to date been comleted
 05     Has nutation to date been completed
 07     Sum of c.g. corrections includes Satellite No. 1 correction.
 08     Sum of c.g. corrections includes Satellite No. 2 correction.
 09     Sum of c.g. corrections includes Satellite No. 3 correction.
 10     Sum of Antenna Axis corrections includes Station No. 1 correction.
 11     Sum of Antenna Axis corrections includes Station No. 2 correction.
 12     Sum of Antenna Axis corrections includes Station No. 3 correction.
 13     Sum of Tropospheric corrections includes Station No. 1 correction.
 14     Sum of Tropospheric corrections includes Station No. 2 correction.
 15     Sum of Tropospheric corrections includes Station No. 3 correction.
 16     Sum of Ionospheric corrections includes Station/Satellite No. 1 corr.
 17     Sum of Ionospheric corrections includes Station No. 2 correction.
 18     Sum of Ionospheric corrections includes Station No. 3 correction.
 19     Sum of Xponder Delay corr. includes Station/Satellite No. 1 cor.
 20     Sum of Xponder Delay corr. includes Station No. 2 correction.
 21     Sum of Xponder Delay corr. includes Station No. 3 correction.
 22     Sum of Relativity corrections includes the direct effect of general
        relativistic light time correction.
 23     Sum of Relativity corrections includes the direct effect of the
        difference between TDB and proper atomic time over the measurement
        interval between transmission and reception.
 24     Reserved for relativity (bytes 141-144).
 25     Reserved for spare bytes 145-148.
 26     Reserved for spare bytes 145-148.
 27     Reserved for spare bytes 145-148.
 28     GPSATP and GPSATS contain Trop Correction for satellites  2 and 3.
    Trop. Correction for satellite 1 is computed.
 29     Reserved.
 30     Range rates are instantaneous rather than integrated Dopplers.
 31     Integrated Dopplers are destruct type rather than continuous.
```

2.5.4 SATELLITE ANTENNA PREPROCESSING WORD DEFINITION

In the satellite antenna preprocessing word, each of the (up to 3) satellites has separate antenna information. Each satellite can have up to 4 antennae. For each satellite, the word identifies the proper antenna to be used (1 - 4) for up to 2 neighbors. Antenna information requires 13 bits.

```
Consider the following integer:

      [a1*2**0 +a2*2**1
      +a3*2**2 +a4*2**3]
   +
     [ a5*2**4 +a6*2**5
      +a7*2**6 +a8*2**7 ]
   +
```

```
   [ a9*2**8 +a10*2**9
   +a11*2**10+a12*2**11]
  +
    a13*2**12

where a1 - a12 can be a's or 0's (independently).

a1 is bit 1, a7 is bit 7 and so forth. The bits are allocated as
as follows:

      a1  a2          sat 1 antenna for neighbor 1
      a3  a4          sat 1 antenna for neighbor 2

      a5  a6          sat 2 antenna for neighbor 1
      a7  a8          sat 2 antenna for neighbor 2

      a9  a10         sat 3 antenna for neighbor 1
      a11 a12         sat 3 antenna for neighbor 2

      a13             is there antenna information
                      (1 => yes ; 0 => no)

A pair of bits such as (a1,a2) or (a7,a8) will give a number (for
an antenna) from 1 throught 4 as follows:

            (0,0) => 1
            (1,0) => 2
            (0,1) => 3
            (1,1) => 4
```

2.6 VLBI BINARY FORMAT FOR GEODYN II (INPUT FOR TDF)

BINARY FORMAT DESCRIPTION

```
           DATA
WORD       TYPE        DESCRIPTION
---------------------------------------------
  1        Integer     Source ID number

  2          ,,        Station ID number for site 1

  3          ,,        Station ID number for site 2

  4          ,,        Not used

  5          ,,        Not used

  6          ,,        Not used

  7          ,,        Measurement Type / Time system indicator
                       nn mm t q pp ss
                       _ nn set to zero
                       _ mm GEODYN II measurement type
                             _ 31 for VLBI delay
                             _ 32 for VLBI delay rate
                       _ t time tag flag for primary observer (site 1)
                             _ 0 for receiver time
```

```
                                  _ 2 for transponder/reflector time
                                  _ 4 for transmitter time
                            _ q time tag flag for secondary observer (site 2)
                                  ( not used for VLBI )
                            _ pp time system flag for primary observer (site 1)
                            _ ss time system flag for secondary observer (site 2)
                                  _ 0 for UT0
                                  _ 1 for UT1 (USNO)
                                  _ 2 for UT2 (USNO)
                                  _ 3 for UTC (USNO)
                                  _ 4 for A1 (USNO Atomic time)

            DATA
WORD        TYPE         DESCRIPTION
--------------------------------------------
 7 cont.    Integer               _ 5 for TAI (International Atomic Time)
                                  _ 6 for A-S (Smithsonian)
                                  _ 7 for TDT (Terrestrial Dynamic Time)
                                  _ 8 for TDB (Barycentric Dynamic Time)
                                  _ 9 for GPS (Global Positioning Time)
                                  _ 11 for UT1 (BIH)
                                  _ 12 for UT2 (BIH)
                                  _ 13 for UTC (BIH)

 8            ''         Observation preprocessing word. Bit switches packed
                         into a 32 bit word. In the following numbering bit 0
                         is of highest order and bit 31 of lowest order.

                         Bits

                         1-4 reserved
                          5  ionospheric refraction correction(s) provided
                          6  cable calibration correction(s) provided
                          7  water vapor radiometer correction(s) provided
                          8  antenna axis displacement correction(s) provided
                          9  tropospheric refraction correction(s) provided
                         10  ionospheric refraction correction for site 1 has
                             been applied to the observation
                         11  ionospheric refraction correction for site 2 has
                             been applied to the observation
                         12  cable calibration correction for site 1 has been
                             applied to the observation
                         13  cable calibration correction for site 2 has been
                             applied to the observation
                         14  water vapor radiometer correction for site 1 has
                             been applied to the observation
                         15  water vapor radiometer correction for site 2 has
                             been applied to the observation
                         16  antenna axis displacement correction for site 1 has
                             been applied to the observation
                         17  antenna axis displacement correction for site 2 has
                             been applied to the observation
                         18  tropospheric refraction correction for site 1 has
                             been applied to the observation
                         19  tropospheric refraction correction for site 2 has
                             been applied to the observation
                         20  if ionospheric correction for site 1 has been
                             included in the observation remove, OR if it has not
```

```
                         been included apply
                     21  if ionospheric correction for site 2 has been
                         included in the observation remove, OR if it has not
                         been included apply
                     22  if cable calibration correction for site 1 has been
                         included in the observation remove, OR if it has not
                         been included apply

           DATA
WORD       TYPE          DESCRIPTION
-------------------------------------------
8 cont.    Integer   23  if cable calibration correction for site 2 has been
                         included in the observation remove, OR if it has not
                         been included apply
                     24  if water vapor radiometer correction for site 1 has
                         been included in the observation remove, OR if it has
                         not been included apply
                     25  if water vapor radiometer correction for site 2 has
                         been included in the observation remove, OR if it has
                         not been included apply
                     26  if antenna axis displacement for site 1 has been
                         included in the observation remove, OR if it has not
                         been included apply
                     27  if antenna axis displacement for site 2 has been
                         included in the observation remove, OR if it has not
                         been included apply
                     28  if tropospheric refraction correction for site 1 has
                         been included in the observation remove, OR if it has
                         not been included apply
                     29  if tropospheric refraction correction for site 2 has
                         been included in the observation remove, OR if it has
                         not been included apply
                     30  ionospheric correction error included in observation
                         standard deviation
                     31  re-weighting number included in observation std
                         deviation

                     Note that bits 10 to 19 when on indicate that the
                     observation value has been corrected, whereas bits 20 to
                     29 when on indicate that action should be taken to change
                     the status of the observation (eg when bit 28 is on
                     correction will be applied if bit 18 is off, and will be
                     subtracted from the observation if bit 18 is on)

 9         Real           Packed meteorological word for the first station:
                     (TEMP + 273.15D0)*1.D10 + PRES*1.D4 + 500.0D0,
                      where TEMP -- air temperature in Kelvins,
                      PRES -- surface air pressure in Pascals.

 10         ,,            Packed meteorological word for the second station:
                     (TEMP + 273.15D0)*1.D10 + PRES*1.D4 + 500.0D0,
                      where TEMP -- air temperature in Kelvins,
                      PRES -- surface air pressure in Pascals.

                     * The temperature, pressure and relative humidity are
                       packed in to a single 64 bit word as follows:
                       _ H : relative humidity in XX.X
                       _ P : atmospheric pressure in millibars in XXXX.X
```

```
                     _ T : temperature in degrees Kelvin in XXX.XX
                     Then the MET word=(T*100)*10**8+(P*10)*10**3+H*10


 11          ,,          Not used for VLBI

 12          ,,          Observation time tag at site 1 given in:
                         YYYY MM DD HH MM

            DATA
WORD        TYPE         DESCRIPTION
---------------------------------------------
 13         Real         The seconds part of the observation time at sit  e 1
                         given in bytes 57-64.

 14          ''          Observed time delay in seconds.

 15          ''          Not used

 16          ,,          Not used

 17          ,,          Not used

 18          ,,          Not used

 19          ,,          Not used

 20          ,,          Time delay calibration which should be added to
                         theoretical path delay in seconds.

 21          ,,          Delay bias which should be added to theoretical path
                 delay

 22          ,,          Not used

 23          ,,          Not used

 24          ,,          Reserved for testing: external theoretical path delay

 25          ,,          Reserved for testing

 26          ,,          Not used

 27          ,,          Not used

 28          ,,          Not used

 29          ,,          Not used

 30          ,,          Observable type: 1.0D0

 31          ,,          Estimate of Path delay error


Note : The observation standard deviation is the total estimated error
       associated with the observation and includes the ionospheric
```

correction error and the re-weighting number.

2.7 MERIT II FORMAT

BINARY FORMAT DESCRIPTION

A 130 byte ASCII character record
13000 fixed byte blocks

Field	Description	Example
1-7	Satellite COSPAR ID -7 digit CODPAR satellite identification number	'7603901'
8-9	Year of Century - 2 digits with leading zero fill	'87'
10-12	Day of Year - 3 digits with leading blank fill	'76'
13-24	Time of Day - from midnight GMT with a .1 microsecond granularity and leading blank fill	'36005000000'
25-28	Station ID - 4 digit monument identification number from the NASA Directory of Station Locations	'7505'
29-30	Crustal Dynamic Project: System Number - 2 digit system number assigned by the Crustal Dynamics Project with leading zero fill	'07'
31-32	Crustal Dynamics Project: Occupancy Sequence Number - 2 digit monument occupancy number assigned by the Crustal Dynamics Project with leading zero fill	'02'
33-39	Azimuth - the geometric or true azimuth angle with a .1 millidgree granularity and leading blank fill	'987500'
40-45	Elevation - the geometric or true elevation angle with a .1 millidegree granularity and leading blank fill	'292500'
46-57	Laser Range - 1 picosecond granularity with leading blank fill	'26017999000'
58-64	Laser Range Standard Deviation - 1 picosecond granularity with leading blank fill	'33'
65-68	Wavelength - .1 nanometer granularity with leading blank fill	'5320'

Field	Description	Example
69-73	Surface Pressure - .1 millibar granularity with leading blank fill	'10135'
74-77	Surface Temperature - .1 degree Kelvin granularity with leading blank fill	'2905'
78-80	Reletive Humidity at Surface - percentage with leading	'55'

```
        blank fill

81-85   Tropospheric refraction correction - 1 picosecond          '16978'
        granularity with leading blank fill

86-91   Center of Mass Correction - 1 picosecond granularity         '801'
        with leading blank fill

92-96   Receive Amplitude - a Positive linear scale value,           '700'
        usually between 0 and 2000, with leading blank fill

97-104  Applied System Delay - the system delay applied in the     '95942'
        current record with a 1 picosecond granularity and
        leading blank fill.

105-110 Calibration Delay Shift - a measure of calibration            '33'
        stability with a 1 picosecond granularity and
        leading blank fill.  The type of shift is indicated
        in column 127.

111-114 Calibration Standard Deviation - 1 picosecond                 '20'
        granularity with leading blank fill

115     Normal Point Window Indicator - indicates whether or           '0'
        not the record represents a normal point and the
        time span of the normal point
           0 = Range not a normal point
           5 = 30 second normal point
           6 = 1 minute normal point
           7 = 2 minute normal point
           8 = 3 minute normal point

116-119 Number of raw ranges compressed into normal point -            ' '
        leading blank fill

120     Epoch Event - Indicates the time event reference.              '1'
        Currently, only 1 and 2 are used for laser data.

          0 = Ground receive time
          1 = Satellite transmit time
          2 = Ground transmit time
          3 = Satellite receive time

121     Epoch Time Scale - indicates the time scale reference.         '3'
        Other flags may appear for historical data.
          3 = UTC (USNO)
          7 = UTC (BIH)

Field   Description                                              Example
---------------------------------------------------------------------------
122     Angle Origin Indicator - source of angle values.               '3'
          0 = Unknown (converted from MERIT I)
          1 = Computed (from range)
          2 = Command (predicts and operator inputs)
          3 = Measured (calibrated instrument readings)

123     Tropospheric Refraction Correction Indicator - Range           '0'
          0 = Data has been corrected using the
```

```
     Marini-Murray formula
   1 = Data has not been corrected

124       Center of Mass Correction Application - Indicator               '0'
   0 = Applied
   1 = Not applied

125       Receive Amplitude Correction Indicator                          '1'
    0 = Data has been receive amplitude
        corrected
    1 = Data has been receive amplitude
        corrected

126       System Calibration Method Inidcator                             '0'
    0 = External Calibration
    1 = Internal Calibration
    2 = Burst Calibration - 3 minute bursts

127       Calibration Delay Shift Inidcator - specifies the type          '0'
          of delay shift represented in columns 105 to 110
    0 = Pre to Post shift
    1 = Peak to Peak shift

128       System Configuration Flag Indicator - is a flag to be           '1'
          incremented for every major system configuration
          change.  The flag sill be initially set at '1' at
          the time of MERIT II implementation. Data prior
          to MERIT II that is converted into the MERIT II
          format will have a flag of '0'.

129       Format Revision Number Indicator - indicates the                '1'
          version of the MERIT II format for the current
          record.  Data prior to MERIT II that is converted into
          MERIT II format will have a revision number of '0'.

130       Release Flag Indicator - indicates when this record             'A'
          first appeared on a release tape.  Foreign stations
          which send release tapes to the DIS will use a
          numbering scheme beginning with '1'.  Release tapes
          from the DIS will have a labelling scheme
          beginning with 'A'. Non-operational engineering
          data will have a release flag of 'Z'.
          Data released prior to the MERIT II implementation will
          have a release flag of '0'

          Specifications on the MERIT II format:

   1) A field should be blank if a value does not apply or if the
      value  is unknown.

   2) All fields should have trailing '0' fill when the accuracy of
      the field value is less than the accuracy of the MERIT II
      format.

   3) The range and all correction fields are in units of
      picoseconds for both accuracy and consistency.

   4) All correction field values, except the center of mass, are
```

represented such that they would be subtracted from the laser range when applied. The center of mass value is represented such that it would be added to the laser range when applied.

5) The possible historical values for the Epoch Time Scale field are as follows:

   0 = UT0
   1 = UT1
   2 = UT2
   3 = UTC (USNO)
   4 = A.1 (USNO)
   5 = TAI
   6 = A-S (Smithsonian)
   7 = UTC (BIH)
   8 = Unassigned
   9 = Other

2.8 MERIT-X FORMAT

BINARY FORMAT DESCRIPTION

A 151 byte ASCII character record
13000 fixed byte blocks

Field	Description	Example
1-7	Satellite COSPAR ID -7 digit CODPAR satellite identification number	'7603901'
8-9	Year of Century - 2 digits with leading zero fill	'87'
10-12	Day of Year - 3 digits with leading blank fill	'76'
13-34	Time of Day - from midnight GMT with a .1 microsecond granularity and leading blank fill	'36005000000000000000'
35-38	Station ID - 4 digit monument identification number from the NASA Directory of Station Locations	'7505'
39-40	Crustal Dynamic Project: System Number - 2 digit system number assigned by the Crustal Dynamics Project with leading zero fill	'07'
41-42	Crustal Dynamics Project: Occupancy Sequence Number - 2 digit monument occupancy number assigned by the Crustal Dynamics Project with leading zero fill	'02'
43-49	Azimuth - the geometric or true azimuth angle with a .1 millidgree granularity and leading blank fill	'987500'
50-55	Elevation - the geometric or true elevation angle with a .1 millidegree granularity and leading blank fill	'292500'
56-69	Laser Range - 1 picosecond granularity with leading blank fill	'2601799900000'

```
70-76    Laser Range Standard Deviation - 1 picosecond                  '33'
         granularity with leading blank fill

77-84    Wavelength - .1 nanometer granularity with leading       '53200000'
         blank fill

Field    Description                                              Example
---------------------------------------------------------------------------
85-90    Surface Pressure - .1 millibar granularity with            '101350'
         leading blank fill

91-95    Surface Temperature - .1 degree Kelvin granularity          '29050'
         with leading blank fill

96-100   Reletive Humidity at Surface - percentage with leading       '0055'
         blank fill

101-105  Tropospheric refraction correction - 1 picosecond           '16978'
         granularity with leading blank fill

106-111  Center of Mass Correction - 1 picosecond granularity          '801'
         with leading blank fill

112-116  Receive Amplitude - a Positive linear scale value,            '700'
         usually between 0 and 2000, with leading blank fill

117-125  Applied System Delay - the system delay applied in the     '959420'
         current record with a 1 picosecond granularity and
         leading blank fill.

126-131  Calibration Delay Shift - a measure of calibration             '33'
         stability with a 1 picosecond granularity and
         leading blank fill.  The type of shift is indicated
         in column 127.

132-135  Calibration Standard Deviation - 1 picosecond                  '20'
         granularity with leading blank fill

136      Normal Point Window Indicator - indicates whether or            '0'
         not the record represents a normal point and the
         time span of the normal point
            0 = Range not a normal point
            5 = 30 second normal point
            6 = 1 minute normal point
            7 = 2 minute normal point
            8 = 3 minute normal point

137-140  Number of raw ranges compressed into normal point -             ' '
         leading blank fill

141      Epoch Event - Indicates the time event reference.               '1'
         Currently, only 1 and 2 are used for laser data.

           0 = Ground receive time
           1 = Satellite transmit time
           2 = Ground transmit time
           3 = Satellite receive time
```

142	Epoch Time Scale - indicates the time scale reference. Other flags may appear for historical data. 3 = UTC (USNO) 7 = UTC (BIH)	’3’

Field	Description	Example
143	Angle Origin Indicator - source of angle values. 0 = Unknown (converted from MERIT I) 1 = Computed (from range) 2 = Command (predicts and operator inputs) 3 = Measured (calibrated instrument readings)	’3’
144	Tropospheric Refraction Correction Indicator - Range 0 = Data has been corrected using the Marini-Murray formula 1 = Data has not been corrected	’0’
145	Center of Mass Correction Application - Indicator 0 = Applied 1 = Not applied	’0’
146	Receive Amplitude Correction Indicator 0 = Data has been receive amplitude corrected 1 = Data has been receive amplitude corrected	’1’
147	System Calibration Method Inidcator 0 = External Calibration 1 = Internal Calibration 2 = Burst Calibration - 3 minute bursts	’0’
148	Calibration Delay Shift Inidcator - specifies the type of delay shift represented in columns 105 to 110 0 = Pre to Post shift 1 = Peak to Peak shift	’0’
149	System Configuration Flag Indicator - is a flag to be incremented for every major system configuration change. The flag sill be initially set at ’1’ at the time of MERIT-X implementation. Data prior to MERIT-X that is converted into the MERIT-X format will have a flag of ’0’.	’1’
150	Format Revision Number Indicator - indicates the version of the MERIT-X format for the current record. Data prior to MERIT-X that is converted into MERIT-X format will have a revision number of ’0’.	’1’
151	Release Flag Indicator - indicates when this record first appeared on a release tape. Foreign stations which send release tapes to the DIS will use a numbering scheme beginning with ’1’. Release tapes from the DIS will have a labelling scheme beginning with ’A’. Non-operational engineering data will have a release flag of ’Z’.	’A’

```
Data released prior to the MERIT-X implementation
will have a release flag of '0'

Specifications on the MERIT EXTENDED format:

  1) A field should be blank if a value does not apply or if the
     value  is unknown.

  2) All fields should have trailing '0' fill when the accuracy of
     the field value is less than the accuracy of the MERIT-X
     format.

  3) The range and all correction fields are in units of
     picoseconds for both accuracy and consistency.

  4) All correction field values, except the center of mass, are
     represented such that they would be subtracted from the laser
     range when applied.  The center of mass value is represented
     such that it would be added to the laser range when applied.

  5) The possible historical values for the Epoch Time Scale field
     are as follows:

       0 = UT0
       1 = UT1
       2 = UT2
       3 = UTC (USNO)
       4 = A.1 (USNO)
       5 = TAI
       6 = A-S (Smithsonian)
       7 = UTC (BIH)
       8 = Unassigned
       9 = Other
```

2.9 DOPPLER 90 BYTE FORMAT

BINARY FORMAT DESCRIPTION

```
C.17 data_archive

  This file contains all the Doppler data input into the Doppler Orbital
Computer (DOC). If there is a problem with the format of the data that is
input into the DOC, the program TDF will crash and the data_archive file
may have mistakes.  These mistakes will show up as lines usually at the top
of the file that do not have the same format as the rest of the file, and
they should be deleted. This file will need to be edited periodically to keep
it from getting to large.

Column    Format    Description
1-7       I7        7 digit SATID
8-9       I2        Measurement type, The OOD will use 39 (geoceiver Doppler)
10-11     I2        Time system indicator
12-16     I4        Station ID
17-18     I2        Year
19-21     I3        Day of Year
22-26     I5        Integral seconds of Day
27-32     I6        Fraction part of seconds (in microseconds)
```

33-35		Preprocessing Indicators
33	I1	Ionospheric refraction correction
34	I1	Tropospheric refraction
35	I1	Receiver mount Type
36-45	I10	Counting interval in 0.1 microseconds
46-56	I11	Range Rate (micrometers/second)
57-66		Meteorological data
57-60	I4	Surface pressure (millibars)
61-63	I3	Surface Temperature (degrees Kelvin)
64-66	I3	Relative Humidity (percent)
67-72	I6	Observation standard deviation (micrometers/sec)
73-80	I8	Ionospheric refraction correction (micrometers/sec)
81-87	I7	Tropospheric refraction correction (micrometers/sec)
88-90		Spare

3 GEODYN II BINARY TRACKING DATA FORMAT

3.1 INTRODUCTION

The GEODYN II Binary Tracking Data Format (G2B) has been designed to be a comprehensive format for all tracking data forms used by GEODYN II.

Adaptability has been designed into the format so that it may be used with data forms that may evolve in the future.

3.2 DATA STRUCTURE

3.2.1 INTRODUCTION

The word structure of the data records is such that the format may be used on both a 32-bit machine or any machine with 64-bit (or greater) floating point word structure.

G2B is a buffered format with a buffer size of 2000 eight byte (64-bit) floating point words. Each buffer contains ten partitions of 200 contiguous eight byte words. One logical record spans all ten partitions and contains ten eight byte words. Using this scheme, the buffer 'BUF' may be accessed as an array dimensioned:

```
BUF(200, 10)
```

Therefore, to load the j^{th} word of the i^{th} logical record into the scalar "A" would require the following statement in Fortran:

```
A = BUF(I, J)
```

To provide the greatest efficiency in a vector processing environment, the data are stored in Logical Blocks. Each Logical Block contains data of a single type, traversing the same paths between satellites, sources, and stations, but recorded at different times. Each Logical Block typically will constitute a single pass or tracking span.

Logical Blocks may span multiple buffers or may be significantly shorter than one buffer. For this reason an individual buffer may contain multiple Logical Blocks or portions of Logical Blocks. Within each Logical Block all logical data of like type will share the same partition and therefore be contiguous within the constraints of the buffer size. This data organization permits vector addressing of the data within each Logical Block.

At the beginning of each Logical Block are several Block Header Records which contain information pertinent to all of the observations within the Logical Block. A Location Data Descriptor Header Record may follow directly after the Block Header Records.

Following all of the header records will be the Observation Records. After all of these, come the set of Observation Corrections Records (optional), followed by the set of Ocean Parameters Records (optional; altimetry only) and the set of Location Data Records (optional; altimetry only) or the set of Target Parameters Records (required for optical navigation data). The number of the above mentioned records in each contiguous set or subset will be the same as the number of Observation Records in the Logical Block.

3.2.2 RANGE DATA

3.2.2.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1    1.4     Date and integral seconds of Data Pass Start Time in
                Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

   2    1.4     Elapsed Time in Seconds from Pass Start to Data Block
```

Start [FSEC].

3		Elapsed Time in Seconds from Data Block Start to Data Block End
4		Speed of Light Associated with Data in this Block
5	1.3	Measurement Type/Time System Indicator (mm.ppxxss) (see NOTE)
6	1.3	Geodyn II Tracking Data Formatter version number (YYMM.xx) or the GEODYN II Tracking Data Editor version number (1YYMM.xx) used to create this file.
7		Observation Record Count in Block
8	1.6	Number of Auxiliary Records (a) Associated with Each Observation Record and the Maximum Number of Physical Blocks (bbbbb) that may be used for any one Logical Block (a.bbbbb).
9		Master Prepro Word (designated #9)
10		Record Type Indicator = -9,000,000

NOTE: For description of mm.ppxxss see page 2-34

3.2.2.2 Block Header Record #N (N=1,2 or 3)

Buffer Part.	REV NO.	Description
1		Station #N Meteorological Data Temperature for Accelerometer Data only
2		Range ambiguity level (N=1 and range data only) or Destruct Doppler counter value (N=1 and non-continuous Doppler data only). Land or Water index (altimetry data) IND=0 (Water) IND=1 (Land)
3	1.5	Reference frequency (N=1 only). SST short path/long path Doppler frequency ratio (SFnS) for tracked user satellite (N=2,3 only). Laser altimeter wavelength (altimetry data)
4	1.5	Doppler frequency bias (N=1 only) or SST short path/long path Doppler frequency ratio (SFnT) for tracked remote station (N=2,3 only). Laser altimeter ID (altimetry data)
5	1.6	Coordinate system ref date (meas. types 1-14 and N=1 only). (Currently acceptable ref date values are 1950.0 and 2000.0) Pass standard error for normal point data (meas. type 39-99 and N=1 only).

```
  6    1.3      Date and time (YYMMDDHHMMSS.) this data file was formed
                (N=1 only) by the GEODYN II Tracking Data Formatter or
                the GEODYN II Tracking Data Editor.

  7             Station ID #N

  8             Satellite ID #N     (Source id for VLBI)

  9             Prepro Word #N

 10             Record Type Indicator = -9,000,000+N*1,000,000


 DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

 GEODYN II FORMAT:

 47-----32  31-----14  13-----0
   TEMP       PRESS      HUMID

 BITS  0-13 : HUMIDITY IN .01%
 BITS 14-31 : PRESSURE IN .01 MILLIBARS
 BITS 32-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.2.3 Ramp Header Record (Present when master PREPRO word bit 19 is .FALSE.)

```
  1             DOWNLINK BAND ID (0=>Ku, 1=>S, 2=X, 3=>Ka)

  2             UPLINK BAND ID (0=>Ku, 1=>S, 2=X, 3=>Ka)

  3             EXCITER BAND ID (0=>Ku, 1=>S, 2=X, 3=>Ka)

  4             0 (NOT FILLED)

  5             NUMBER OF RAMP PERIODS COVERED (TWO RAMP PERIODS
                STORED PER RECORD TYPE 6,000,000)

  6             SF1 -FOR RANGE NOT APPLICABLE

  7             SF2 -FOR RANGE THE SCALE FACTOR TO BE APPLIED TO THE RAMP
                INTEGRAL

  8             BASE FREQUENCY OF RAMP RECORDS
                (ADD THIS NUMBER TO THE START FREQUENCY OF EACH RAMP)

  9             0

 10             Record Type Indicator  =  -5000000
```

3.2.2.4 Observation Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------
```

1		Observation Units are meters unless the data are ramped DSN data. For ramped DSN ranges the units are "range units". For ramped data (data are ramped when transmit frequencies are changing linearly with time), there is no direct conversion from range units to meters. A rough conversion is given by (C/FREQT)*(75/11) where C is the speed of light and FREQT is the frequency at transmit time. Given the frequencies that we usually deal with the factor is about 0.284 (multiply a "range unit" by 0.284 to get a rough conversion in meters). Also note that for ramped DSN data the range observation is the round trip range (usually modulo some ambiguity level). For all other two way or three way ranges, the range observation is the round trip range divided by two.
2	1.5	Range ambiguity level This field usually only applies to ramped DSN ranges. In his case the units are range units and GEODYN is expecting the actual range ambiguity level divided by 2.
3		Sum of Observation Corrections
4	1.6	Normal Point Reduction Value (FRi-avgFri).
5		Sum of Time Corrections
6		Elapsed Time from Block Start to Time of Observation in Seconds (Primary Observer Time for differenced measurement types)
7	1.6	Observation Sigma or Bin Standard Error for Normal Points.
8	1.6	Number of Observations Used for Normal Point.
9	1.6	Secondary Observer Time Tag for differenced measurement types (Seconds elapsed from Primary Time Tag - Word 6)
10		Record Type Indicator = 0

3.2.2.5 Observation Corrections Record #N (N=1,2 or 3)

Buffer Part.	REV NO.	Description
1		Meteorological Data for Station #N
2		Spacecraft #N Center of Gravity Correction
3		Dry Tropospheric Refraction for Station #N
4		Wet Tropospheric Refraction for Station #N

```
   5          Antenna Axis Displacement Correction for
              Station #N

   6          Ionospheric Refraction #N

   7          Ionospheric Refraction #N' (Sat-Sat links only)

   8          Relativity Correction for Station #N

   9          Transponder Delay Range Correction for Satellite #N

  10          Record Type Indicator  =  N,000,000
```

3.2.2.6 Ramp Data Record (Present when master PREPRO word bit 19 is .FALSE.)

```
     NOTE   RAMPING INFORMATION IS PERTINENT YO TRANSMITTING STATION

   1          ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
              AT START OF RAMP INTERVAL

   2          ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
              AT END OF RAMP INTERVAL

   3          TRANSMIT FREQUENCY AT START OF RAMP INTERVAL (Hz)

   4          TRANSMIT FREQUENCY RATE OF CHANGE (Hz/SEC) DURING INTERVAL

   5          ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
              AT START OF RAMP INTERVAL

   6          ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
              AT END OF RAMP INTERVAL

   7          TRANSMIT FREQUENCY AT START OF RAMP INTERVAL (Hz)

   8          TRANSMIT FREQUENCY RATE OF CHANGE (Hz/SEC) DURING INTERVAL

   9          0 (NOT FILLED)

  10          Record Type Indicator  =  6000000
```

3.2.3 ALTIMETRY DATA

3.2.3.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.    Description
---------------------------

   1    1.4    Date and integral seconds of Data Pass Start Time in
               Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

   2    1.4    Elapsed Time in Seconds from Pass Start to Data Block
                       Start [FSEC].
```

Buffer Part.	REV NO.	Description
3		Elapsed Time in Seconds from Data Block Start to Data Block End
4		Speed of Light Associated with Data in this Block
5	1.3	Measurement Type/Time System Indicator (mm.ppxxss) (see NOTE)
6	1.3	Geodyn II Tracking Data Formatter version number (YYMM.xx) or the GEODYN II Tracking Data Editor version number (1YYMM.xx) used to create this file.
7		Observation Record Count in Block
8	1.6	Number of Auxiliary Records (a) Associated with Each Observation Record and the Maximum Number of Physical Blocks (bbbbb) that may be used for any one Logical Block (a.bbbbb).
9		Master Prepro Word (designated #9)
10		Record Type Indicator = -9,000,000

NOTE: For description of mm.ppxxss see page 2-34

3.2.3.2 Block Header Record #N (N=1,2 or 3)

Buffer Part.	REV NO.	Description
1		Station #N Meteorological Data Temperature for Accelerometer Data only
2		Range ambiguity level (N=1 and range data only) or Destruct Doppler counter value (N=1 and non-continuous Doppler data only). Land or Water index (altimetry data) IND=0 (Water) IND=1 (Land)
3	1.5	Reference frequency (N=1 only). SST short path/long path Doppler frequency ratio (SFnS) for tracked user satellite (N=2,3 only). Laser altimeter wavelength (altimetry data)
4	1.5	Doppler frequency bias (N=1 only) or SST short path/long path Doppler frequency ratio (SFnT) for tracked remote station (N=2,3 only). Laser altimeter ID (altimetry data)
5	1.6	Coordinate system ref date (meas. types 1-14 and N=1 only). (Currently acceptable ref date values are 1950.0 and 2000.0) Pass standard error for normal point data (meas. type 39-99 and N=1 only).
6	1.3	Date and time (YYMMDDHHMMSS.) this data file was formed

```
              (N=1 only) by the GEODYN II Tracking Data Formatter or
              the GEODYN II Tracking Data Editor.

   7          Station ID #N

   8          Satellite ID #N     (Source id for VLBI)

   9          Prepro Word #N

  10          Record Type Indicator = -9,000,000+N*1,000,000


  DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

  GEODYN II FORMAT:

  47-----32  31-----14  13-----0
    TEMP       PRESS      HUMID

  BITS  0-13 : HUMIDITY IN .01%
  BITS 14-31 : PRESSURE IN .01 MILLIBARS
  BITS 32-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.3.3 Location Data Descriptor Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1            Semi-major Axis of Reference Ellipsoid in Meters

   2            Inverse of the Flattening of Reference Ellipsoid

   3            Eight Character Reference Ellipsoid Descriptor

   4            Eight Character Geoid Descriptor

   5            Eight Character Mean Sea Surface Descriptor

   6            Eight Character Orbit Descriptor

   7

   8

   9

  10    1.6     Record Type Indicator = -2,000,000
```

3.2.3.4 Observation Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------
```

1		Observation
2		Altimeter Derived Surface Elevation
3		Sum of Observation Corrections
4		Sum of Surface Elevation Corrections
5		Sum of Time Corrections
6		Elapsed Time from Block Start to Time of Observation in Seconds
7	1.6	Observation Sigma or Bin Standard Error for Normal Points.
8		AGC
9		Significant Waveheight
10		Record Type Indicator = 0

3.2.3.5 Observation Corrections Record

Buffer Part.	REV NO.	Description
1		Meteorological Data
2		Net Instrument Corrections
3		Dry Tropospheric Refraction
4		Wet Tropospheric Refraction (from Met Data and Model)
5		Wet Tropospheric Refraction (from Radiometer)
6		Ionospheric Refraction
7		Sea State
8		Attitude/Sea State
9	1.6	Normal Point Reduction Value (FRi-avgFri).
10		Record Type Indicator = 1,000,000

3.2.3.6 Ocean Parameters Record (Altimetry)

Buffer Part.	REV NO.	Description

```
  1            Barotropic Correction

  2            Solid Earth Tide

  3            Ocean Tide #1

  4            Ocean Tide #2

  5    1.6     Static Sea Surface Topography

  6            Q1 quaternion (when external attitude is provided
          on the data records. See ALTIM option card)
          The set is given in words 6-9 of this record.
          The user must edit the G2B file and add this information.
  7            Q2

  8            Q3

  9            Q4

 10    1.6     Record Type Indicator  =  4,000,000
```

3.2.3.7 Location Data Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

  1            Subsatellite Geodetic Latitude

  2            Subsatellite Geodetic East Longitude

  3            Computed Height of Spacecraft Above Reference
               Ellipsoid

  4            Geoid Height

  5            Mean Sea Surface Elevation Above Reference
               Ellipsoid

  6    1.6     Altimeter crossover key (MTYPES=101)

               If MTYPE=101,     the keys are even-odd, where the first
                                 key is even, and the second is +1
                                 (ex. 0,1 or 4,5)

  7            If MTYPE=110, Distance
               If MTYPE=111, Radial Separation
                             (earlier radius minus later radius)

  8

  9    1.6     Number of Observations Used for Normal Point.

 10    1.6     Record Type Indicator  =  7,000,000
```

3.2.4 DOPPLER DATA

3.2.4.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.      Description
---------------------------

   1    1.4      Date and integral seconds of Data Pass Start Time in
                 Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

   2    1.4      Elapsed Time in Seconds from Pass Start to Data Block
                         Start [FSEC].

   3             Elapsed Time in Seconds from Data Block Start to
                         Data Block End

   4             Speed of Light Associated with Data in this Block

   5    1.3      Measurement Type/Time System Indicator (mm.ppxxss)
                 (see NOTE)

   6    1.3      Geodyn II Tracking Data Formatter version number (YYMM.xx)
                 or the GEODYN II Tracking Data Editor version number
                 (1YYMM.xx) used to create this file.

   7             Observation Record Count in Block

   8    1.6      Number of Auxiliary Records (a) Associated with Each
                 Observation Record and the Maximum Number of Physical Blocks
                 (bbbbb) that may be used for any one Logical Block (a.bbbbb).

   9             Master Prepro Word (designated #9)

  10             Record Type Indicator  = -9,000,000
```

NOTE: For description of mm.ppxxss see page 2-34

3.2.4.2 Block Header Record #N (N=1,2 or 3)

```
Buffer  REV
 Part.  NO.      Description
---------------------------

   1             Station #N Meteorological Data
                 Temperature for Accelerometer Data only

   2             Range ambiguity level (N=1 and range data only) or
                 Destruct Doppler counter value (N=1 and non-continuous
                 Doppler data only).
                 Land or Water index (altimetry data) IND=0 (Water)
                                                      IND=1 (Land)
   3    1.5      Reference frequency (N=1 only).
                 SST short path/long path Doppler frequency ratio (SFnS) for
```

```
              tracked user satellite (N=2,3 only).
              Laser altimeter wavelength (altimetry data)

 4    1.5     Doppler frequency bias (N=1 only) or
              SST short path/long path Doppler frequency ratio (SFnT) for
              tracked remote station (N=2,3 only).
              Laser altimeter ID  (altimetry data)

 5    1.6     Coordinate system ref date (meas. types 1-14 and N=1 only).
              (Currently acceptable ref date values are 1950.0 and 2000.0)
              Pass standard error for normal point data (meas. type 39-99
              and N=1 only).

 6    1.3     Date and time (YYMMDDHHMMSS.) this data file was formed
              (N=1 only) by the GEODYN II Tracking Data Formatter or
              the GEODYN II Tracking Data Editor.

 7            Station ID #N

 8            Satellite ID #N     (Source id for VLBI)

 9            Prepro Word #N

10            Record Type Indicator = -9,000,000+N*1,000,000



DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

GEODYN II FORMAT:

47-----32  31-----14  13-----0
  TEMP       PRESS      HUMID

BITS  0-13 : HUMIDITY IN .01%
BITS 14-31 : PRESSURE IN .01 MILLIBARS
BITS 32-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.4.3 Ramp Header Record (Present when master PREPRO word bit 19 is .FALSE.)

```
 1            DOWNLINK BAND ID (0=>Ku, 1=>S, 2=X, 3=>Ka)

 2            UPLINK BAND ID (0=>Ku, 1=>S, 2=X, 3=>Ka)

 3            EXCITER BAND ID (0=>Ku, 1=>S, 2=X, 3=>Ka)

 4            0 (NOT FILLED)

 5            NUMBER OF RAMP PERIODS COVERED (TWO RAMP PERIODS
              STORED PER RECORD TYPE 6,000,000)

 6            SF1 -FOR RANGE NOT APPLICABLE
              FOR DOPPLER THE SCALE FATOR TO BE APPLIED TO THE RECEIVE
              TIME PORTION OF THE RAMP INTEGRAL (USUALLY 0)

 7            SF2 -FOR RANGE THE SCALE FACTOR TO BE APPLIED TO THE RAMP
              INTEGRAL
```

```
              FOR DOPPLER THE SCALE FATOR TO BE APPLIED TO THE TRANSMIT
              TIME PORTION OF THE RAMP INTEGRAL

   8          BASE FREQUENCY OF RAMP RECORDS
              (ADD THIS NUMBER TO THE START FREQUENCY OF EACH RAMP)

   9          REFERENCE FREQUENCY SCALED BY
              X2/X1 WHERE:
              XF1=749.D0/880.D0
              IF( EXCITER BAND IS X)  XF2=-XF1*880.D0/749.D0 ;
              OTHERWISE XF2=-XF1*880.D0/221.D0

  10          Record Type Indicator  =  -5000000
```

3.2.4.4 Observation Record

```
Buffer  REV
 Part.  NO.    Description
---------------------------

   1           Observation

               Units are meters/s unless the data are ramped DSN data. For
               ramped DSN ranges the units are Hz.

   2           Doppler Counting Interval

   3           Sum of Observation Corrections

   4    1.6    Normal Point Reduction Value (FRi-avgFri).

   5           Sum of Time Corrections

   6           Elapsed Time from Block Start to Time of Observation
               in Seconds (Primary Observer Time for differenced
        measurement types)

   7    1.6    Observation Sigma or Bin Standard Error for Normal Points.

   8    1.6    Number of Observations Used for Normal Point.

   9    1.6    Secondary Observer Time Tag for differenced measurement
        types (Seconds elapsed from Primary Time Tag - Word 6)

  10           Record Type Indicator = 0
```

3.2.4.5 Observation Corrections Record #N (N=1,2 or 3)

```
Buffer  REV
 Part.  NO.    Description
---------------------------

   1           Meteorological Data for Station #N

   2           Spacecraft #N Center of Gravity Correction
```

```
   3            Dry Tropospheric Refraction for Station #N

   4            Wet Tropospheric Refraction for Station #N

   5            Antenna Axis Displacement Correction for
                Station #N

   6            Ionospheric Refraction #N

   7            Ionospheric Refraction #N' (Sat-Sat links only)

   8            Relativity Correction for Station #N

   9            Transponder Delay Doppler Correction for Satellite #N

  10            Record Type Indicator = N,000,000
```

3.2.4.6 Ramp Data Record (Present when master PREPRO word bit 19 is .FALSE.)

```
      NOTE   RAMPING INFORMATION IS PERTINENT YO TRANSMITTING STATION

   1            ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
                AT START OF RAMP INTERVAL

   2            ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
                AT END OF RAMP INTERVAL

   3            TRANSMIT FREQUENCY AT START OF RAMP INTERVAL (Hz)

   4            TRANSMIT FREQUENCY RATE OF CHANGE (Hz/SEC) DURING INTERVAL

   5            ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
                AT START OF RAMP INTERVAL

   6            ELAPSED UTC SECONDS SINCE JANUARY 1, 2000 12 HR
                AT END OF RAMP INTERVAL

   7            TRANSMIT FREQUENCY AT START OF RAMP INTERVAL (Hz)

   8            TRANSMIT FREQUENCY RATE OF CHANGE (Hz/SEC) DURING INTERVAL

   9            0 (NOT FILLED)

  10            Record Type Indicator  =  6000000
```

3.2.5 ANGLES DATA

3.2.5.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1    1.4     Date and integral seconds of Data Pass Start Time in
```

		Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].
2	1.4	Elapsed Time in Seconds from Pass Start to Data Block Start [FSEC].
3		Elapsed Time in Seconds from Data Block Start to Data Block End
4		Speed of Light Associated with Data in this Block
5	1.3	Measurement Type/Time System Indicator (mm.ppxxss) (see NOTE)
6	1.3	Geodyn II Tracking Data Formatter version number (YYMM.xx) or the GEODYN II Tracking Data Editor version number (1YYMM.xx) used to create this file.
7		Observation Record Count in Block
8	1.6	Number of Auxiliary Records (a) Associated with Each Observation Record and the Maximum Number of Physical Blocks (bbbbb) that may be used for any one Logical Block (a.bbbbb).
9		Master Prepro Word (designated #9)
10		Record Type Indicator = -9,000,000

NOTE: For description of mm.ppxxss see page 2-34

3.2.5.2 Block Header Record #N (N=1,2 or 3)

Buffer Part.	REV NO.	Description
1		Station #N Meteorological Data Temperature for Accelerometer Data only
2		Range ambiguity level (N=1 and range data only) or Destruct Doppler counter value (N=1 and non-continuous Doppler data only). Land or Water index (altimetry data) IND=0 (Water) IND=1 (Land)
3	1.5	Reference frequency (N=1 only). SST short path/long path Doppler frequency ratio (SFnS) for tracked user satellite (N=2,3 only). Laser altimeter wavelength (altimetry data)
4	1.5	Doppler frequency bias (N=1 only) or SST short path/long path Doppler frequency ratio (SFnT) for tracked remote station (N=2,3 only). Laser altimeter ID (altimetry data)
5	1.6	Coordinate system ref date (meas. types 1-14 and N=1 only). (Currently acceptable ref date values are 1950.0 and 2000.0)

```
                Pass standard error for normal point data (meas. type 39-99
                and N=1 only).

  6     1.3     Date and time (YYMMDDHHMMSS.) this data file was formed
                (N=1 only) by the GEODYN II Tracking Data Formatter or
                the GEODYN II Tracking Data Editor.

  7             Station ID #N

  8             Satellite ID #N     (Source id for VLBI)

  9             Prepro Word #N

 10             Record Type Indicator = -9,000,000+N*1,000,000



 DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

 GEODYN II FORMAT:

 47-----32  31-----14  13-----0
   TEMP       PRESS      HUMID

 BITS  0-13 : HUMIDITY IN .01%
 BITS 14-31 : PRESSURE IN .01 MILLIBARS
 BITS 32-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.5.3 Observation Record Angles

```
Buffer  REV
 Part.  NO.     Description
---------------------------

  1             Observation #1

  2             Observation #2

  3             Sum of Observation #1 Corrections

  4             Sum of Observation #2 Corrections

  5             Sum of Time Corrections

  6             Elapsed Time from Block Start to Time of Observation
                in Seconds

  7             Observation #1 Sigma

  8             Observation #2 Sigma

  9

 10             Record Type Indicator  =  0
```

3.2.5.4 Observation Corrections Record (Right Ascension/Declination)

Buffer Part.	REV NO.	Description
1		Obs #1 Coordinate System Transformation to True of Date.
2		Obs #2 Coordinate System Transformation to True of Date.
3		Obs #1 Annual Aberration
4		Obs #2 Annual Aberration
5		Obs #1 Diurnal Aberration
6		Obs #2 Diurnal Aberration
7		Obs #1 Parallactic Refraction
8		Obs #2 Parallactic Refraction
9		Satellite Clock Calibration Bias
10		Record Type Indicator = 1,000,000

3.2.5.5 Observation Corrections Record (Azimuth/Elevation, X-Y Angles, Hour Angle/Declination and Direction Cosines)

Buffer Part.	REV NO.	Description
1		Meteorological Data
2		
3		Obs #1 Dry Tropospheric Refraction
4		Obs #2 Dry Tropospheric Refraction
5		Obs #1 Wet Tropospheric Refraction
6		Obs #2 Wet Tropospheric Refraction
7		Obs #1 Ionospheric Refraction
8		Obs #2 Ionospheric Refraction
9		
10		Record Type Indicator = 1,000,000

3.2.6 PCE DATA

3.2.6.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1    1.4     Date and integral seconds of Data Pass Start Time in
                Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

   2    1.4     Elapsed Time in Seconds from Pass Start to Data Block
                        Start [FSEC].

   3            Elapsed Time in Seconds from Data Block Start to
                        Data Block End

   4            Speed of Light Associated with Data in this Block

   5    1.3     Measurement Type/Time System Indicator (mm.ppxxss)
                (see NOTE)

   6    1.3     Geodyn II Tracking Data Formatter version number (YYMM.xx)
                or the GEODYN II Tracking Data Editor version number
                (1YYMM.xx) used to create this file.

   7            Observation Record Count in Block

   8    1.6     Number of Auxiliary Records (a) Associated with Each
                Observation Record and the Maximum Number of Physical Blocks
                (bbbbb) that may be used for any one Logical Block (a.bbbbb).

   9            Master Prepro Word (designated #9)

  10            Record Type Indicator  = -9,000,000


NOTE: For description of mm.ppxxss see page 2-34
```

3.2.6.2 Block Header Record #N (N=1,2 or 3)

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1            Station #N Meteorological Data
                Temperature for Accelerometer Data only

   2            Range ambiguity level (N=1 and range data only) or
                Destruct Doppler counter value (N=1 and non-continuous
                Doppler data only).
                Land or Water index (altimetry data) IND=0 (Water)
                                                     IND=1 (Land)
   3    1.5     Reference frequency (N=1 only).
                SST short path/long path Doppler frequency ratio (SFnS) for
                tracked user satellite (N=2,3 only).
                Laser altimeter wavelength (altimetry data)

   4    1.5     Doppler frequency bias (N=1 only) or
```

```
              SST short path/long path Doppler frequency ratio (SFnT) for
              tracked remote station (N=2,3 only).
              Laser altimeter ID  (altimetry data)

   5    1.6   Coordinate system ref date (meas. types 1-14 and N=1 only).
              (Currently acceptable ref date values are 1950.0 and 2000.0)
              Pass standard error for normal point data (meas. type 39-99
              and N=1 only).

   6    1.3   Date and time (YYMMDDHHMMSS.) this data file was formed
              (N=1 only) by the GEODYN II Tracking Data Formatter or
              the GEODYN II Tracking Data Editor.

   7          Station ID #N

   8          Satellite ID #N     (Source id for VLBI)

   9          Prepro Word #N

  10          Record Type Indicator = -9,000,000+N*1,000,000


  DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

  GEODYN II FORMAT:

  47-----32  31-----14  13-----0
    TEMP       PRESS      HUMID

  BITS  0-13 : HUMIDITY IN .01%
  BITS 14-31 : PRESSURE IN .01 MILLIBARS
  BITS 32-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.6.3 Observation Record

```
Buffer  REV
 Part.  NO.   Description
---------------------------

   1    1.4   Observation

   2

   3

   4

   5

   6    1.4   Elapsed Time from Block Start to Time of
              Observation in Seconds

   7    1.4   Observation Sigma

   8
```

```
   9

  10     1.4      Record Type Indicator  =  0



         NOTE: PCE data are s/c orbital elements and therefore have no
                applicable corrections.
```

3.2.7 VLBI DATA

3.2.7.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1     1.4      Date and integral seconds of Data Pass Start Time in
                  Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

   2     1.4      Elapsed Time in Seconds from Pass Start to Data Block
                        Start [FSEC].

   3              Elapsed Time in Seconds from Data Block Start to
                        Data Block End

   4              Speed of Light Associated with Data in this Block

   5     1.3      Measurement Type/Time System Indicator (mm.ppxxss)
                  (see NOTE)

   6     1.3      Geodyn II Tracking Data Formatter version number (YYMM.xx)
                  or the GEODYN II Tracking Data Editor version number
                  (1YYMM.xx) used to create this file.

   7              Observation Record Count in Block

   8     1.6      Number of Auxiliary Records (a) Associated with Each
                  Observation Record and the Maximum Number of Physical Blocks
                  (bbbbb) that may be used for any one Logical Block (a.bbbbb).

   9              Master Prepro Word (designated #9)

  10              Record Type Indicator  = -9,000,000


NOTE: For description of mm.ppxxss see page 2-34
```

3.2.7.2 Block Header Record #N (N=1 or 2)

```
Buffer  REV
 Part.  NO.     Description
---------------------------
```

```
  1

  2             Eight (8) character alphanumeric name for station #N

  3             Eight (8) character alphanumeric name for quasar.
                (N=1 only).

  4

  5    1.6      Coordinate system ref date (meas. types 1-14 and N=1 only).
                (Currently acceptable ref date values are B1950.0 and J2000.0)

  6    1.3      Date and time (YYMMDDHHMMSS.) this data file was formed
                (N=1 only) by the GEODYN II Tracking Data Formatter or
                the GEODYN II Tracking Data Editor.

  7             Station ID for site #N (integer)

  8             Source ID # (integer) (N=1, only)

  9             Prepro Word #N

 10             Record Type Indicator = -9,000,000+N*1,000,000


 DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

 GEODYN II FORMAT:

 47-----32  31-----14  13-----0
   TEMP       PRESS      HUMID

 BITS  0-13 : HUMIDITY IN .01%
 BITS 14-32 : PRESSURE IN .01 MILLIBARS
 BITS 33-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.7.3 Observation Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

  1             Observation

  2             Three input data codes packed into one:
                =EEx10**4 + QQx10**2 + TT , where :
                EE = editing flag, QQ = quality code, TT = delay type.

  3             Sum of Observation Corrections
                (To be applied to the observation in IIS and IIE).

  4             Error in the sum of ionospheric refraction corrections

  5

  6             Elapsed Time from Block Start to Time of
```

```
                Observation in Seconds

   7            Observation Sigma (as given by the input obs. std. deviation)

   8            Re-weighting number (as defined by the data processing at GSFC).

   9

  10            Record Type Indicator  =  0
```

3.2.7.4 Observation Corrections Record #N (N=1,2)

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1            Meteorological Data for Station #N
                passed only when valid, otherwise set to zero.

   2

   3            Tropospheric Refraction for Station #N

   4

   5            Antenna Axis Displacement Correction for
                Station #N

   6            Ionospheric Refraction for Station #N

   7

   8            Cable calibration correction for site #N

   9            Water vapor radiometer correction for Site #N.

  10            Record Type Indicator  =  N,000,000
```

3.2.8 ACCELEROMETER DATA

3.2.8.1 Master Block Header Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1    1.4     Date and integral seconds of Data Pass Start Time in
                Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

   2    1.4     Elapsed Time in Seconds from Pass Start to Data Block
                        Start [FSEC].

   3            Elapsed Time in Seconds from Data Block Start to
                        Data Block End
```

```
   4            Speed of Light Associated with Data in this Block

   5    1.3     Measurement Type/Time System Indicator (mm.ppxxss)
                (see NOTE)

   6    1.3     Geodyn II Tracking Data Formatter version number (YYMM.xx)
                or the GEODYN II Tracking Data Editor version number
                (1YYMM.xx) used to create this file.

   7            Observation Record Count in Block

   8    1.6     Number of Auxiliary Records (a) Associated with Each
                Observation Record and the Maximum Number of Physical Blocks
                (bbbbb) that may be used for any one Logical Block (a.bbbbb).

   9            Master Prepro Word (designated #9)

  10            Record Type Indicator  = -9,000,000
```

NOTE: For description of mm.ppxxss see page 2-34

3.2.8.2 Block Header Record #N (N=1,2 or 3)

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1            Station #N Meteorological Data
                Temperature for Accelerometer Data only

   2            Range ambiguity level (N=1 and range data only) or
                Destruct Doppler counter value (N=1 and non-continuous
                Doppler data only).
                Land or Water index (altimetry data) IND=0 (Water)
                                                     IND=1 (Land)
   3    1.5     Reference frequency (N=1 only).
                SST short path/long path Doppler frequency ratio (SFnS) for
                tracked user satellite (N=2,3 only).
                Laser altimeter wavelength (altimetry data)

   4    1.5     Doppler frequency bias (N=1 only) or
                SST short path/long path Doppler frequency ratio (SFnT) for
                tracked remote station (N=2,3 only).
                Laser altimeter ID  (altimetry data)

   5    1.6     Coordinate system ref date (meas. types 1-14 and N=1 only).
                (Currently acceptable ref date values are 1950.0 and 2000.0)
                Pass standard error for normal point data (meas. type 39-99
                and N=1 only).

   6    1.3     Date and time (YYMMDDHHMMSS.) this data file was formed
                (N=1 only) by the GEODYN II Tracking Data Formatter or
                the GEODYN II Tracking Data Editor.

   7            Station ID #N
```

```
  8            Satellite ID #N     (Source id for VLBI)

  9            Prepro Word #N

 10            Record Type Indicator = -9,000,000+N*1,000,000


 DESCRIPTION OF WORD 1 (METEOROLOGICAL DATA)

 GEODYN II FORMAT:

 47-----32  31-----14  13-----0
   TEMP       PRESS      HUMID

 BITS  0-13 : HUMIDITY IN .01%
 BITS 14-31 : PRESSURE IN .01 MILLIBARS
 BITS 32-47 : TEMPERATURE IN DEGREES KELVIN
```

3.2.8.3 Observation Record

```
Buffer  REV
 Part.  NO.     Description
---------------------------

  1             Observation   - Total Acceleration (MTYPE=200)
                                X  component       (MTYPE=201)
                                Y  component       (MTYPE=202)
                                Z  component       (MTYPE=203)

  2

  3             Sum of Observation Corrections

  4

  5

  6             Elapsed Time from Block Start to Time of
                Observation in Seconds

  7    1.6      Observation Sigma or Bin Standard Error for Normal Points.

  8             Y component  (MTYPE=201)
                Z component  (MTYPE=202)
                X component  (MTYPE=203)

  9             Z component  (MTYPE=201)
                X component  (MTYPE=202)
                Y component  (MTYPE=203)

 10             Record Type Indicator = 0
```

3.2.8.4 Observation Corrections Record #N (N=1,2 or 3)

```
Buffer  REV
 Part.  NO.     Description
---------------------------

   1            Temperature

   2

   3

   4

   5

   6

   7

   8

   9

  10            Record Type Indicator  =  N,000,000
```

3.2.9 PREPRO WORD DEFINITIONS

The prepro word bit ordering is defined to go from right to left. Example:

bits –> 0 1 1 0 0 1 bit# –> 6 5 4 3 2 1

Altimetry data prepro word #9

```
BIT     DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---     ------------------------------------------------------------------

 01     MET data used in tropospheric refraction model.
 02     Net instrument corrections provided.
 03     Dry tropospheric refraction correction provided.
 04     Wet tropospheric refraction correction provided (MET data and model).
 05     Wet tropospheric refraction correction provided (radiometer).
 06     Ionospheric refraction correction provided.
 07     Sea state correction provided.
 08     Attitude/sea state correction provided.
 09
 10     Barotropic correction provided.
 11     Solid earth tide provided.
 12     Ocean tide #1 provided.
 13     Ocean tide #2 provided.
 14     Static Sea Surface Topography provided.
 15
 16
 17
 18
 19
 20
 21     Reference frequency not provided.
```

```
 22
 23
 24
```

Altimetry data prepro word #1

```
BIT      DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---      ------------------------------------------------------------------

 01      MET data present on observations corrections record #1.
 02      Sum of obs-corr. includes net instrument correction.
 03      Sum of obs-corr. includes dry tropo. refr.
 04      Sum of obs-corr. includes wet tropo. refr.
 05      Wet tropo refraction in sum of obs.-corr. is from radiometer data.
 06      Sum of obs-corr. includes iono. refr.
 07      Sum of obs-corr. includes sea state correction.
 08      Sum of obs-corr. includes attitude/sea state correction.
 09
 10      Sum of surf-elev-corr. includes barotropic.
 11      Sum of surf-elev-corr. includes solid earth tide.
 12      Sum of surf-elev-corr. includes ocean tide.
 13      Ocean tide model used is #2.
 14      Sum of surf-elev-corr. includes static sea surface topography.
 15
 16
 17
 18
 19      Block header record MET data used in tropo. refr. model.
 20
 21
 22
 23
 24
```

Range and Range rate data prepro word #9 (Modified for REV 1.5)

```
BIT      DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---      ------------------------------------------------------------------

 01      MET data used in tropospheric refraction correction.
 02      S/C c.g. correction provided.
 03      Dry tropospheric refraction correction provided.
 04      Wet tropospheric refraction correction provided.
 05      Antenna axis displacement correction provided.
 06      Ionospheric refraction correction provided.
 07
 08      Relativity delay correction provided.
 09
 10      No antenna information is provided.
 11
 12
 13
 14
 15
 16
 17
 18
```

```
 19     Ramp records (HEADER AND DATA RECORDS) not present
 20     Range ambiguity level not provided (range only) or
        Doppler is continuous (destruct count not provided).
 21     Range ambiguity is constant for pass and found in partition #2 of
        Block Header Record #1. If bit off, ambiguity varies with time and
        is found in partition #2 of range observation record.
 22     Doppler is integrated (not instantaneous).
 23
 24
```

Range and Range rate data prepro word #N (Modified for REV 1.5)

```
BIT     DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---     ----------------------------------------------------------------

 01     MET data for station #N present on observations corrections record #N.
 02     Sum of obs-corr. includes S/C c.g. correction for sat. #N.
 03     Sum of obs-corr. includes dry tropo. refr. for sta. #N.
 04     Sum of obs-corr. includes wet tropo. refr. for sta. #N.
 05     Sum of obs-corr. includes antenna axis displacement for sta. #N.
 06     Sum of obs-corr. includes iono. refr. for sta. #N (non-SST links).
 07     Sum of obs-corr. includes iono. refr. for sat. #N (SST links only).
 08     Sum of obs-corr. incl. relativistic measurement corrections.
 09     Sum of obs-corr. incl. sat. #N delay corr. (satellite Xponder only).
 10
 11     Sat N antenna for neighbor 1. (See note below)
 12      "  "    "     "     "     "
 13     Sat N antenna for neighbor 2. (See note below)
 14      "  "    "     "     "     "
 15
 16
 17
 18
 19     Block header MET data used for tropospheric correction.
 20
 21     Reference frequency not provided (N=1).
        SST short path/long path frequency ratio not provided
        for station N tracking user satellite (N=2,3).
 22     Doppler frequency bias not provided (N=1) or
        SST short path/long path frequency ratio not provided
        for station N tracking remote station (N=2,3).
 23
 24

  NOTE : A pair of bits (11,12) or (13,14) will give a number (for
         an antenna) from 1 through 4 as follows:

                 (.FALSE.,.FALSE.) => 1
                 (.TRUE.,.FALSE.)  => 2
                 (.FALSE.,.TRUE.)  => 3
                 (.TRUE.,.TRUE.)   => 4
```

Right ascension / declination data prepro word #9

```
BIT     DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---     ----------------------------------------------------------------
```

```
 01      Coordinate system transformation to true-of-date provided.
 02
 03      Annual aberration corrections provided.
 04
 05      Diurnal aberration corrections provided.
 06
 07      Parallactic refraction corrections provided.
 08
 09      Satellite clock calibration bias provided.
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23      Obs. do not require precession from ref. date to epoch of obs.
 24      Obs. do not require nutation from Mean to True.
```

Right ascension / declination data prepro word #1

```
BIT      DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---      --------------------------------------------------------------------

 01      Sum of obs-corr. includes coord. system transform. to true-of-date
 02
 03      Sum of obs-corr. includes annual aberration.
 04
 05      Sum of obs-corr. includes diurnal aberration.
 06
 07      Sum of obs-corr. includes parallactic refraction.
 08
 09      Sum of time corrections includes satellite clock calibration bias.
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23
 24
```

Angular data prepro word #9

BIT	DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
01	MET data used in tropospheric refraction corrections.
02	
03	Dry tropospheric refraction corrections provided.
04	
05	Wet tropospheric refraction corrections provided.
06	
07	Ionospheric refraction corrections provided.
08	
09	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	Reference frequency not provided.
22	
23	
24	

Angular data prepro word #1

BIT	DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
01	MET data for station #1 present on observations corrections record.
02	
03	Sum of obs-corr. includes dry tropo. refr. for station #1.
04	
05	Sum of obs-corr. includes wet tropo. refr. for station #1.
06	
07	Sum of obs-corr. includes ionospheric refraction for station #1.
08	
09	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	Block header MET data used for tropospheric refraction corrections.
20	
21	
22	
23	
24	

PCE data prepro word #9 (REV's 1.4 and later)

```
BIT      DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---      --------------------------------------------------------------------

 01
 02
 03
 04
 05
 06
 07
 08
 09
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23
 24
```

PCE data prepro word #1 (REV's 1.4 and later)

```
BIT      DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---      --------------------------------------------------------------------

 01
 02
 03
 04
 05
 06
 07
 08
 09
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22      Observations are in True of Reference.
```

```
 23     Observations are NOT Radial PCE data.
 24
```

VLBI Delay and Delay Rate data prepro word #9

```
BIT     DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---     ---------------------------------------------------------------

 01     MET data used in tropospheric refraction correction.
 02     Cable calibration correction provided.
 03     Dry tropospheric refraction correction provided.
 04     Wet tropospheric refraction correction provided.
 05     Antenna axis displacement correction provided.
 06     Ionospheric refraction correction provided.
 07     Water vapor radiometer correction provided.
 08
 09
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23
 24
```

VLBI Delay and Delay Rate data prepro word #N

```
BIT     DESCRIPTION OF CONDITIONS THAT EXIST IF REFERENCED BITS ARE "ON"
---     ---------------------------------------------------------------

 01     MET data for station #N present on observations corrections record #N.
 02     Sum of obs-corr. includes cable calibration for sta. #N.
 03     Sum of obs-corr. includes dry tropo. refr. for sta. #N.
 04     Sum of obs-corr. includes wet tropo. refr. for sta. #N.
 05     Sum of obs-corr. includes antenna axis displacement for sta. #N.
 06     Sum of obs-corr. includes iono. refr. for sta. #N.
 07
 08     Sum of obs-corr. includes cable calibration corr. for sta. #N.
 09     Sum of obs-corr. incl. water vapor radiometer corr. for sta. #N.
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19     Block header MET data used for tropospheric correction.
```

```
 20
 21
 22
 23
 24
```

3.2.10 MEASUREMENT TYPES

```
TYPE
 NO.    MEASUREMENT DESCRIPTION (REV's 1.5 and later)
----    ------------------------------------------------------------

 01     INERTIAL TRUE OF DATE "X" POSITION (S1) or radial  [Note 1]
 02     INERTIAL TRUE OF DATE "Y" POSITION (S1)
 03     INERTIAL TRUE OF DATE "Z" POSITION (S1)
 04     INERTIAL TRUE OF DATE "X" VELOCITY (S1)
 05     INERTIAL TRUE OF DATE "Y" VELOCITY (S1)
 06     INERTIAL TRUE OF DATE "Z" VELOCITY (S1)

 07     OSCULATING SEMI-MAJOR AXIS                     (S1)
 08     OSCULATING ECCENTRICITY                        (S1)
 09     OSCULATING INCLINATION                         (S1)
 10     OSCULATING RIGHT ASCENSION OF ASCENDING NODE (S1)
 11     OSCULATING ARGUMENT OF PERIGEE                 (S1)
 12     OSCULATING MEAN ANOMALY                        (S1)

 13     INERTIAL RIGHT ASCENSION (S1-->T1) or Laser Illum. (T2-->S1-->T1)
 14     INERTIAL DECLINATION     (S1-->T1) or Laser Illum. (T2-->S1-->T1)
 15     LOCAL HOUR ANGLE (S1-->T1)
 16     DECLINATION      (S1-->T1)
 17     AZIMUTH   (S1-->T1)
 18     ELEVATION (S1-->T1)
 19     X-ANGLE (S1-->T1)
 20     Y-ANGLE (S1-->T1)

 21     l DIRECTION COSINE (S1-->T1)
 22     m DIRECTION COSINE (S1-->T1)
 23     LANDMARK SCAN ELEMENT (S1-->T1)
 24     LANDMARK SCAN LINE    (S1-->T1)
 25     PLANETARY EDGE SCAN ELEMENT (S1-->T1)
 26     PLANETARY EDGE SCAN LINE    (S1-->T1)
 27     CELESTIAL LANDMARK S/C B.C.F. RIGHT ASCENSION (S1-->T1)
 28     CELESTIAL LANDMARK S/C B.C.F. DECLINATION     (S1-->T1)
 29     PLANETARY EDGE S/C B.C.F. RIGHT ASCENSION (S1-->T1)
 30     PLANETARY EDGE S/C B.C.F. DECLINATION     (S1-->T1)
```

```
-----------------------------------------
NOTE 1 : See section 1.1 for explanation.


        GEODYN-II MEASUREMENT TYPES (Continued)

TYPE
 NO.    MEASUREMENT DESCRIPTION
----    ------------------------------------------------------------

 31     VLBI DELAY (Q1-->T1,T2)
 32     VLBI DELAY RATE (Q1-->T1,T2)
 33     LANDMARK CROSSOVER CONSTRAINTS
 34     LANDMARK DATA (PLANET/ASTEROID ORBITING MODE OR HELIOCENTRIC MODE)
 35
 36     DELTA-DOR ((S1-->T1)-(S1-->T2)) - (Q1-->T1,T2)
 37     ONE-WAY PLANET-EARTH RANGE   (P1T1-->T2)
 38     ONE-WAY PLANET-EARTH DOPPLER (P1T1-->T2)
 39     ONE-WAY STA-SAT RANGE (T1-->S1)
 40     ONE-WAY STA-SAT DOPPLER (T1-->S1)  (DORIS)

 41     ONE-WAY RANGE   (S1-->T1)
 42     ONE-WAY DOPPLER (S1-->T1)
 43     ONE-WAY SAT-SAT RANGE   (S2-->S1)
 44     ONE-WAY SAT-SAT DOPPLER (S2-->S1)
 45     TWO-WAY GROUND TRANSPONDER RANGE (S1-->T1-->S1)
 46     TWO-WAY GROUND TRANSPONDER DOPPLER (S1-->T1-->S1)
 47     TWO-WAY EARTH-PLANET-EARTH RANGE   (T2-->P1T1-->T2)
 48     TWO-WAY EARTH-PLANET-EARTH DOPPLER (T2-->P1T1-->T2)
 49     TWO-WAY SAT-SAT RANGE   (S2-->S1-->S2)
 50     TWO-WAY SAT-SAT DOPPLER (S2-->S1-->S2)



 51     TWO-WAY RANGE   (T1-->S1-->T1)
 52     TWO-WAY DOPPLER (T1-->S1-->T1)
 53     THREE-WAY RANGE   (T2-->S1-->T1)
 54     THREE-WAY DOPPLER (T2-->S1-->T1)
 55     THREE-WAY SAT-SAT RELAY RANGE   (S2-->S1-->T2)
 56     THREE-WAY SAT-SAT RELAY DOPPLER (S2-->S1-->T2)
 57     FOUR-WAY SAT-SAT RELAY RANGE   (T3-->S3-->S1-->S2-->T2)
 58     FOUR-WAY SAT-SAT RELAY DOPPLER (T3-->S3-->S1-->S2-->T2)+SF*
                                       (T2-->S2-->T2)
 59     FOUR-WAY SAT-TARGET RELAY RANGE   (T3-->S3-->T1-->S2-->T2)
 60     FOUR-WAY SAT-TARGET RELAY DOPPLER (T3-->S3-->T1-->S2-->T2)+SF*
                                          (T2-->S2-->T2)


        GEODYN-II MEASUREMENT TYPES (Continued)

TYPE
 NO.    MEASUREMENT DESCRIPTION
----    ------------------------------------------------------------

 61     SINGLY DIFFERENCED ONE-WAY RANGES   (S1-->T1)-(S1-->T2)
 62     SINGLY DIFFERENCED ONE-WAY DOPPLERS (S1-->T1)-(S1-->T2)
 63     SINGLY DIFFERENCED ONE-WAY RANGES   (S1-->T1)-(S2-->T1)
```

```
 64      SINGLY DIFFERENCED ONE-WAY DOPPLERS (S1-->T1)-(S2-->T1)
 65      SINGLY DIFFERENCED ONE-WAY SAT-SAT RANGES   (S2-->S1)-(S3-->S1)
 66      SINGLY DIFFERENCED ONE-WAY SAT-SAT DOPPLERS (S2-->S1)-(S3-->S1)
 67      SINGLY DIFFERENCED ONE-WAY SAT-SAT RANGES   (S2-->S1)-(S2-->T1)
 68      SINGLY DIFFERENCED ONE-WAY SAT-SAT DOPPLERS (S2-->S1)-(S2-->T1)
 69      SINGLY DIFFERENCED ONE-WAY PLANETRY RANGES   (P1T1-->T2)-(P1T1-->T3)
 70      SINGLY DIFFERENCED ONE-WAY PLANETRY DOPPLERS (P1T1-->T2)-(P1T1-->T3)

 71      SINGLY DIFFERENCED ONE- AND TWO-WAY RANGES   (S2-->S1-->T2)-
                                                      (S2-->T2)
 72      SINGLY DIFFERENCED ONE- AND TWO-WAY DOPPLERS (S2-->S1-->T2)-
                                                      (S2-->T2)
 73      SINGLY DIFFERENCED THREE-WAY SAT-SAT RANGES   (S1-->S2-->T2)-
                                                       (S1-->S3-->T3)
 74      SINGLY DIFFERENCED THREE-WAY SAT-SAT DOPPLERS (S1-->S2-->T2)-
                                                       (S1-->S3-->T3)
 75      SINGLY DIFFERENCED THREE-WAY SAT-SAT RANGES   (S2-->S1-->T2)-
                                                       (S3-->S1-->T3)
 76      SINGLY DIFFERENCED THREE-WAY SAT-SAT DOPPLERS (S2-->S1-->T2)-
                                                       (S3-->S1-->T3)
 77      SINGLY DIFFERENCED TWO- AND THREE-WAY RANGES   (T2-->S1-->T1)-
                                                        (T2-->S1-->T2)
 78      SINGLY DIFFERENCED TWO- AND THREE-WAY DOPPLERS (T2-->S1-->T1)-
                                                        (T2-->S1-->T2)
 79      SINGLY DIFFERENCED FOUR-WAY SAT-SAT RANGES (T3-->S3-->S1-->S2-->T2)-
                                                    (T3-->S3-->S1-->S3-->T3)
 80      SINGLY DIFFERENCED FOUR-WAY SAT-SAT DOPPLERS(T3-->S3-->S1-->S2-->T2)
               +SF2S*(T2-->S2-->T2)-(T3-->S3-->S1-->S3-->T3)-SF3S*(T3-->S3-->T3)
 81      SINGLY DIFFERENCED FOUR-WAY SAT-TARGET RANGES(T3-->S3-->T1-->S2-->T2)-
                                                      (T3-->S3-->T1-->S3-->T3)
 82      SINGLY DIFFERENCED FOUR-WAY SAT-TARGET DOPPLERS(T3-->S3-->T1-->S2-->T2)
               +SF2T*(T2-->S2-->T2)-(T3-->S3-->T1-->S3-->T3)-SF3T*(T3-->S3-->T3)


         GEODYN-II MEASUREMENT TYPES (Continued)

TYPE
 NO.     MEASUREMENT DESCRIPTION
----     ---------------------------------------------------------------------

 83      SINGLY DIFFERENCED FOUR-WAY SAT&TARGET RANGES  (T3-->S3-->S1-->S2-->T2)-
                                                       (T3-->S3-->P1T1-->S2-->T2)
 84      SINGLY DIFFERENCED FOUR-WAY SAT&TARGET DOPPLERS (T3-->S3-->S1-->S2-->T2)
              +SF2S*(T2-->S2-->T2)-(T3-->S3-->P1T1-->S2-->T2)-SF2T*(T2-->S2-->T2)
 85      DOUBLY DIFFERENCED ONE-WAY RANGES   [(S2-->T1)-(S3-->T1)]-
                                             [(S2-->S1)-(S3-->S1)]
 86      DOUBLY DIFFERENCED ONE-WAY DOPPLERS [(S2-->S1)-(S3-->S1)]-
                                             [(S2-->T1)-(S3-->T1)]
 87      DOUBLY DIFFERENCED ONE-WAY RANGES   [(S1-->T1)-(S2-->T1)]-
                                             [(S1-->T2)-(S2-->T2)]
 88      DOUBLY DIFFERENCED ONE-WAY DOPPLERS [(S1-->T1)-(S2-->T1)]-
                                             [(S1-->T2)-(S2-->T2)]
 89      DOUBLY DIFFERENCED ONE- AND TWO-WAY RANGES   [(S2-->S1-->T2)-(S2-->T2)]-
                                                      [(S3-->S1-->T3)-(S3-->T3)]
 90      DOUBLY DIFFERENCED ONE- AND TWO-WAY DOPPLERS [(S2-->S1-->T2)-(S2-->T2)]-
                                                      [(S3-->S1-->T3)-(S3-->T3)]
 91      DOUBLY DIFFERENCED ONE- AND THREE-WAY RANGES [ (P1T1-->S2-->T2)
                            -(P1T1-->T2)]-[P1T1-->S3-->T3)-(P1T1-->T3)]
```

```
 92     DOUBLY DIFFERENCED ONE- AND THREE-WAY DOPPLERS (P1T1-->S2-->T2)
                              -(P1T1-->T2)]-[P1T1-->S3-->T3)-(P1T1-->T3)]
 93     DOUBLY DIFFERENCED TWO- AND THREE-WAY RANGES   (S1-->S2-->T2)
                         -(T1-->S2-->T2)]-[(S1-->S3-->T3)-(T1-->S3-->T3)]
 94     DOUBLY DIFFERENCED TWO- AND THREE-WAY DOPPLERS  (S1-->S2-->T2)
                         -(T1-->S2-->T2)]-[(S1-->S3-->T3)-(T1-->S3-->T3)]
 95     DOUBLY DIFFERENCED FOUR-WAY RANGES   [(T3-->S3-->S1-->S2-->T2)-
                    (T3-->S3-->S1-->S3-->T3)]-[(T3-->S3-->T1-->S2-->T2)
                                             -(T3-->S3-->T1-->S3-->T3)]
 96     DOUBLY DIFFERENCED FOUR-WAY DOPPLERS [(T3-->S3-->S1-->S2-->T2)+
                           SF2S*(T2-->S2-->T2)-(T3-->S3-->S1-->S3-->S3)-
                                                 SF3S*(T3-->S3-->T3)]-
                                             [(T3-->S3-->T1-->S2-->T2)+
                           SF2T*(T2-->S2-->T2)-(T3-->S3-->T1-->S3-->S3)-
                                                 SF3T*(T3-->S3-->T3)]

 97     RESERVED
 98     RESERVED
 99     ALTIMETRY
100     ALTIMETRY CROSSOVERS
101     DYNAMIC CROSSOVERS
110 ALTIMETRY CONSTRAINT - LINEAR DISTANCE OF BOUNCE POINT
111 ALTIMETRY CONSTRAINT - RADIAL DISTANCE OF BOUNCE POINT


        GEODYN-II MEASUREMENT TYPES (Continued)

NOTE:

SYMBOL  LEGEND
------  --------------------------------------------------------------------

  Sn    REFERS TO THE SATELLITE WHICH IS DEFINED ON BLOCK HEADER RECORD
        NUMBER "n" OF THE GEODYN-II BINARY TRACKING DATA FORMAT.

  Tn    REFERS TO THE TRACKING STATION WHICH IS DEFINED ON BLOCK HEADER
        RECORD NUMBER "n" OF THE GEODYN-II BINARY TRACKING DATA FORMAT.

  Pn    REFERS TO THE PLANET ON WHICH THE TRACKING STATION Tn EXISTS.
        AN IMPLICIT REFERENCE TO PLANETARY BODIES IS MADE SIMPLY BY
        SPECIFICATION OF THE TRACKING STATION Tn. THIS IS BECAUSE EACH
        TRACKING STATION MUST BE REFERENCED TO A PLANETARY BODY WHEN
        INPUT TO GEODYN-II. THE EXPLICIT REFERENCE IN THE ABOVE MEASUREMENT
        DESCRIPTIONS TO PLANETARY BODY Pn IS DONE TO REMIND THE READER OF
        THIS FORMAT THAT THESE MEASUREMENTS ARE COMMON OR LIKELY INTER-
        PLANETARY MEASUREMENT TYPES. IN SOME INSTANCES, THE MEASUREMENTS
        ONLY MAKE SENSE WITHIN AN INTER-PLANETARY FRAMEWORK. LIKEWISE, IT
        IS POSSIBLE FOR MEASUREMENTS NOT EXPLICITLY DENOTED WITH Pn TO BE
        OF AN INTER-PLANETARY NATURE.

  SFnX  REFERS TO TWO-WAY DOPPLER SCALING FACTOR FOR SATELLITE n TRACKING
        USER A SATELLITE (X=S) OR REMOTE RELAY STATION (X=T).

  Qn    REFERS TO THE QUASAR WHICH IS DEFINED ON BLOCK HEADER RECORD
        NUMBER "n" OF THE GEODYN-II BINARY TRACKING DATA FORMAT.
```

3.2.11 TIME SYSTEM INDICATORS

```
 FORM           DESCRIPTION (REV's 1.3 and later)
------          ----------------------------------------------------

ppxxss          Where "pp" defines the pass segment as follows:

                        Value   Description
                        -----   -----------

                         00     This Logical Data Block constitutes an entire
                                tracking pass.

                         01     This Logical Data Block is the first portion
                                of a multiple-Block tracking pass.

                         02     This Logical Data Block is a center portion
                                of a multiple-Block tracking pass.

                         03     This Logical Data Block is the last portion
                                of a multiple-Block tracking pass.

                Where "xx" defines the transmission/reception state as follows:

                        Value   Description
                        -----   -----------

                         00     Receiver Time

                         01     Satellite Transponder/Reflector Time
                                or Altimeter Ground Reflection Time

                         02     Transmitter Time

                Where "ss" defines the system of time measurement as follows:

                        Value   Description
                        -----   -----------

                         03     UTC

                         04     A.1

                         05     IAT (A.3)

                         06     A-S (Smithsonian)

                         07     ET
```

3.3 DEFAULT GRAVITY MODEL FILE DESCRIPTION

3.3.1 INTRODUCTION

The Default Gravity Model File has been created to provide default gravity information for any GEODYN II run. The presence of a Default Gravity Model File on input UNIT12 is not mandatory. Gravity information can instead be included on input UNIT05. In case gravity information is included on both units, information on UNIT05 overrides any information on UNIT12.

The structure of this file is such that the first card is a TITLE card followed immediately by an EARTH card and then as many GCOEF or GCOEFC and GCOEFS cards as necessary to define all the spherical harmonic coefficients. (The set of GCOEFS cards follows the set of GCOEFC cards).

The format and the description of all the above cards is given explicitly in the following pages.

The Default Gravity Model File can be created by the Gravity File Generation Program which is one of GEODYN II's support programs and is described in detail in GEODYN II VOL 3, section 3.0.

3.3.2 DEFAULT GRAVITY FILE CARDS

TITLE

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
USER SPECIFIED JOB DESCRIPTION - CARD 1
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0

COLUMNS FORMAT         DESCRIPTION                        DEFAULT VALUE & UNITS

1-80    10A8      User may specify on this card information
                  description of the gravity field.
                  This cards may also remain blank, but
                  must always be present.
```

GCOEF

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
GCOEF 2         2  1
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0


COLUMNS FORMAT         DESCRIPTION                        DEFAULT VALUE & UNITS

1-5     A5     GCOEF - Modifies and/or requests
               the estimation of coefficients in
               the geopotential model.

7       I1     Normalization indicator.                        0

               =  0  values unnormalized C,S

               =  1  values normalized C,S

               =  2  values ignored C,S

15-17   I3     Degree of C and S coefficients                  0
               (N index).

18-20   I3     Order of C and S coefficients                   0
               (M index).

25-44   D20.8  A priori (or starting) value of C               0.
               coefficient.

45-59   D15.3  A priori (or starting) value of S               0.
               coefficient.
```

GCOEFC

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
```

```
GCOEFC1       002000          -.48416600D-03
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

COLUMNS	FORMAT	DESCRIPTION	DEFAULT VALUES & UNIT
1-6	A6	GCOEFC - Modifies and/or requests the estimation of C coefficients in the geopotential model.	
7	I1	Normalization indicator.[NOTE 1] = 0 values unnormalized = 1 values normalized = 2 values ignored	0
15-17	I3	Degree of C coefficient (n index).	0.
18-20	I3	Order of C coefficient (m index).	0.
25-44	D20.8	A priori (or starting) value of C coefficient.	0.

GCOEFS

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
GCOEFS
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

COLUMNS	FORMAT	DESCRIPTION	DEFAULT VALUE & UNITS
1-6	A6	GCOEFS - Modifies and/or requests the estimation of S coefficients in the geopotential model.	
7	I1	Normalization indicator. [NOTE 1] = 0 values unnormalized = 1 values normalized = 2 values ignored	0
15-17	I3	Degree of S coefficient (n index).	0
18-20	I3	Order of S coefficient (m index).	0
25-44	D20.8	A priori (or starting) value of S coefficient.	0.

3.4 STATION GEODETICS FILE DESCRIPTION

3.4.1 INTRODUCTION

The Station Geodetics File is an optional input file on UNIT 16 of any GEODYN IIS setup. It is a card image file containing default information for station positions. This information for station position will be used by GEODYN IIS unless other information refering to the same stations is included on UNIT 5

Cards which can be included as input to the Station Geodetics File are the following:

1. STAPOS which introduces the station position subgroup
2. GEODETIC which defines station geodetic information
3. EXTRAGEO which specifies planetary shape parameters
4. ELCUTOFF which sets station elevation cutoff angle
5. INSTRMNT which sets station antenna and provides operating frequency information
6. STATION COORDINATE which gives the station positions
7. ENDSTA which denotes the end of the station position subgroup

The structure of this file is such that the first card should be a STAPOS card and the last card is an ENDSTA card. STATION COORDINATE cards follow the appropriate cards of other types that are used to specify the conditions that apply to those station locations.

Cards which contain adjustment information (ADJUSTED, CORREL, CONSTADJ, CONSTEND) are not to be included on UNIT16.

Detailed description of the valid Station Position Card Group on UNIT16 is presented in the next pages. The format of all cards in the group is as follows:

A8,2I1,I2,I8,3D15.6,I5,10X

3.4.2 STATION GEODETICS FILE CARDS

STAPOS

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
STAPOS
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0


COLUMNS FORMAT         DESCRIPTION                               DEFAULT VALUE & UNITS

1-6     A6          STAPOS - Introduces station
                    position sub-group cards.

11-14   I4          Maximum number of stations for which data       50
                    is available in this run.
```

The conditions stated on an ELCUTOFF card are imposed until another ELCUTOFF card is encountered. (Default - ELCUTOFF is zero degrees.)

The conditions stated on an INSTRMNT card are imposed until another INSTRMNT card is encountered.

The conditions stated on a GEODETIC card or an EXTRAGEO card are imposed until another GEODETIC or EXTRAGEO card is encountered.

Station Location cards follow the appropriate cards of other types necessary to specify the conditions that are to apply to those station locations.

Unless specified otherwise (using GEODETIC or EXTRAGEO) all stations are considered to be located on the earth (see Keyword Option Card EARTH).

STATION GEODETICS FILE CARDS (CONTINUED)

GEODETIC

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
GEODETIC            6378145.0      298.255
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

COLUMNS	FORMAT	DESCRIPTION	DEFAULT VALUE & UNITS	
1-8	A8	GEODETIC - Specifies Earth ellipsoid parameters for stations which follow.		
21-35	D15.6	Earth semi-major axis in meters. [NOTE 1]	0.	M
36-50	D15.6	Inverse of the flattening (1/f) of the earth. [NOTE 1]	0.	

NOTES:

[1] Defaults will be obtained in the following order:

Default values built into GEODYN IIS
Values obtained from Gravity Model File
Values obtained from EARTH card
Values from GEODETIC card

UNITS: KM =Kilometers; M =Meters ; S =Seconds ; M/S=Meters per second
DEG=Degrees ; RAD=Radians ; AS =Arc seconds; MAS=Milli-arc seconds

EXTRAGEO

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
EXTRAGEO        0300    6378145.0  298.255
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

COLUMNS	FORMAT	DESCRIPTION	DEFAULT VALUE & UNITS	
1-8	A8	EXTRAGEO - Specifies planetary shape parameters for stations which follow.		
17-20	I4	Planetary body number: Mercury 0100 Venus 0200 Earth 0300 Earth's Moon 0301 Mars 0400 Jupiter 0500 Saturn 0600 Uranus 0700 Neptune 0800 Pluto 0900 Sun 9999	0300	
21-35	D15.6	Semi-major axis for planet.	6378138.	M
36-50	D15.6	Inverse of polar flattening of the planet.	298.255	

```
51-65   D15.6  Inverse of equatorial flattening                    0.
               of the planet.
```

```
UNITS:  KM =Kilometers; M  =Meters    ; S  =Seconds    ; M/S=Meters per second
        DEG=Degrees   ; RAD=Radians   ; AS =Arc seconds; MAS=Milli-arc seconds
```

IF CARD OMITTED: DEFAULT VALUES FOR EARTH APPLY.

ELCUTOFF

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
ELCUTOFF            10.
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

```
COLUMNS FORMAT         DESCRIPTION                           DEFAULT VALUE & UNITS

1-8     A8     ELCUTOFF - Specifies elevation
               angle below which data will auto-
               matically be edited.

21-35   D15.6  Elevation cutoff angle.                              0.       DEG
```

```
UNITS:  KM =Kilometers; M  =Meters    ; S  =Seconds    ; M/S=Meters per second
        DEG=Degrees   ; RAD=Radians   ; AS =Arc seconds; MAS=Milli-arc seconds
```

IF CARD OMITTED: ELEVATION CUTOFF OF ZERO DEGREES IS USED.

INSTRMNT

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
INSTRMNT 3          1.0             0.
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

```
COLUMNS FORMAT         DESCRIPTION                           DEFAULT VALUE & UNITS

1-8     A8     INSTRMNT - Specifies tracking
               instrument parameters.

10      I1     Antenna mount type.                                 3

                =1  X-Y East-West
                =2  X-Y North- South
                =3  Azimuth-Elevation
                =4  Hour Angle-Declination
```

```
21-35   D15.6  Antenna axis displacement in meters.           0.        M

36-50   D15.6  Nominal received wavelength in microns.        0.    M*1.0D-6
               ( 0. indicates nominal wavelength will
                 be used from observation file as
                 supplied by the Tracking Data
                 Formatter Program.)

51-65   D15.6  Turn around factor (TRF).                      1.
               (TRF=Wavelength trans./wavelength rec.)


NOTES:

        Inclusion of an INSTRMNT card which is blank except for columns 1-8
        negates any previous INSTRMNT card and reverts back to the station
        complement defaults.


UNITS:  KM =Kilometers; M  =Meters    ; S  =Seconds    ; M/S=Meters per second
        DEG=Degrees   ; RAD=Radians   ; AS =Arc seconds; MAS=Milli-arc seconds


IF CARD IS OMITTED:  NO INSTRUMENT CORRECTION WILL BE APPLIED.
```

STATION COORDINATE CARD

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
STALAS      000070631130719.3758    -4831370.1542   3994089.0480
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0


COLUMNS FORMAT         DESCRIPTION                         DEFAULT VALUE & UNITS

1-8     A8        Station name.                              no default

9       I1        Coordinate system indicator:                    0

                    = 0  Geodyn will determine if input
                         is geodetic or cartesian.

                    = 1  Geodetic     - Phi,Lambda,Height
                    = 2  Cartesian    - X,Y,Z
                    = 3  Cylindrical  - S.A.D,Lambda,Z
                    = 4  Spherical    - Phi,Lambda,R

11-12   I2        Plate number.                                   0

13-20   I8        Station number.                                 0

21-35   D15.6     First coordinate:                               0.
                   (+ or -)DDMMSS.SSS
                   (+ or -)XXXXXXX.XXX meters

36-50   D15.6     Second coordinate:                              0.
                           DDMMSS.SSS
                   (+ or -)XXXXXXX.XXX meters
```

```
51-65   D15.6     Third coordinate:                         0.
                   (+ or -) XXXXXXX.XXX meters

67-70   I4        Site number for ocean loading.            0

71-80   A10       Available for comments.
```

ENDSTA

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
ENDSTA
----+----0----+----0----+----0----+----0----+----0----+----0----+----0----+----0
```

```
COLUMNS FORMAT         DESCRIPTION

1-8     A8     ENDSTA - Ends STAPOS Subgroup.
               This card is required if a STAPOS
               card is present.



IF CARD OMITTED: RUN WILL TERMINATE IF A STAPOS CARD IS PRESENT AND NO
                 ENDSTA CARD IS INCLUDED
```

3.5 DEFAULT SPACECRAFT AREA AND MASS TABLE

The Default Spacecraft Area and Mass Table is an optional input file on UNIT15 of any GEODYN II setup. It consists of records each containing the following information: Name of the satellite, satellite ID number, cross sectional area of the satellite in m**2 and mass of the satellite in kilograms.

BE-C	6503201	52.6170	1.2460
GEOS-1	6508901	172.5000	1.2300
GEOS-2	6800201	212.5000	1.2300
IMP-5	6905301	66.9000	1.0500
ATS-5	6906901	351.5340	2.0670
IMP-6	7101901	289.3900	2.6450
MARINER-9	7105101	1000.3500	13.7270
LANDSAT-1	7205801	898.0000	6.5800
ANCHOR IMP	7207301	67.0000	1.2000
RAE-B	7303901	333.3900	1.3560
ATS-6	7403901	1397.0700	33.1600
LANDSAT-2	7500401	913.4000	6.5800
GEOS-3	7502701	345.9090	1.4365
APOLLO	7506601	14007.0000	27.9600

3.6 FLUX, POLAR MOTION AND UT1 TABLES FILE

3.6.1 INTRODUCTION

The Flux, Polar Motion and UT1 Tables File contains values of A1-UT1, Polar Motion, Solar Flux, Magnetic Flux Ap and Magnetic Flux Kp. Its presence is mandatory as input in UNIT 1 of any GEODYN II setup.

The Flux, Polar Motion and UT1 Tables File is the output binary file of a GEODYN II support program which is called Table Update Program and is described in detail in VOL 4 section 1.1.

The File contains six different sets of data and each set consists of one Header record followed by the Data records. Each record of this binary file is 192 bytes long.

The Header record contains the start and end dates for each section of data, a flag indicating which BIH system was used for the Pole and A1-UT1 data and the date and time when this particular binary file was created.

3.6.2 BINARY FILE DESCRIPTION

Header Record For Binary File

Bytes	Type	Description
1-8	R*8	GDYNTBLE
9-12	I*4	Start date for A1-UTC data (YYMMDD)
13-16	I*4	End date for A1-UTC data (YYMMDD)
17-20	I*4	Start date for pole and A1-UT1 data (YYMMDDHH)
21-24	I*4	End date for pole and A1-UT1 data (YYMMDDHH)
25-28	I*4	Start date for solar flux data (YYMMDD)
29-32	I*4	End date for solar flux data (YYMMDD)
33-36	I*4	Start date for magnetic A_p data (YYMMDD)
37-40	I*4	End date for magnetic A_p data (YYMMDD)
41-44	I*4	Start date for magnetic K_p data (YYMMDD)
45-48	I*4	End date for magnetic K_p date (YYMMDD)
49-52	I*4	Number of A1-UTC values per record
53-56	I*4	Number of A1-UT1 values per record
57-60	I*4	Number of pole values per record
61-64	I*4	Number of solar flux values per record
65-68	I*4	Number of magnetic flux A_p values per record
69-72	I*4	Number of magnetic flux K_p values per record

Header Record For A1-UTC Data

Bytes	Type	Description

73-76	I*4	Number of A1-UTC values in file
77-80	I*4	Number of K_p values per day (always = 1)
81-84	I*4	Flag for indicating BIH system used for polar motion and UT1 data 0 - Combination of old system for data prior to May 1, 1979 and new system for data after April 30, 1979. 1 - All data converted to BIH old system 2 - All data converted to BIH new system
85-88	I*4	Creation date of this file in form YYMMDD
89-92	I*4	Creation time of this file in form HHMMSS
93-192	25 I*4	Dummy integer words set to zero

Header Record For A1-UTC Data

Bytes	Type	Description
1-8	R*8	A1-UTC
9-12	I*4	Number of A1-UTC dat records. Each record contains A1-UTC, A1-UTC rate and time for A1-UTC correction date.
13-16	I*4	Number of non-zero values in last record.
17-20	I*4	Total number of A1-UTC values in file.
21-192	43 I*4	Dummy integer words, set to zero

Data Records For A1-UTC Data

Bytes	Type	Description
1-8	R*8	A1-UTC time difference in seconds
9-16	R*8	Time rate of difference between A1 and UTC second in seconds per day.
17-24	R*8	Time of A1-UTC correction in days from January 1, 1966.
25-192	21 R*8	Seven (7) more sets of A1-UTC, A1-UTC rate and A1-UTC time values

Header Record For A1-UT1 Data - BINARY FILE

Bytes	Type	Description
1-8	R*8	A1-UT1
9-12	I*4	Number of A1-UT1 data records
13-16	I*4	Number of A1-UT1 values in last record
17-20	I*4	Total number of A1-UT1 values in file
21-192	43 I*4	Dummy integer words, set to zero

Data Records For A1-UT1 Data - BINARY FILE

Bytes	Type	Description
1-8	R*8	A1-UT1 time difference in seconds at 5 day intervals starting 570918
9-192	23 R*8	Twenty three (23) more A1-UT1 time differences

Header Record For Pole Data

Bytes	Type	Description
1-8	R*8	POLE
9-12	I*4	Number of pole data records
13-16	I*4	Number of non-zero values in last record
17-20	I*4	Number of X_p,Y_p pairs in file
21-192	43 I*4	Dummy integer words, set to zero

Data Records For Pole Data - BINARY FILE

Bytes	Type	Description
1-2	I*2	X of the pole in milli-arc-seconds starting 570918
3-4	I*2	Y of the pole in milli-arc-seconds starting 570918
5-192	94 I*2	Forty-seven (47) more pairs

(X_p , Y_p) of pole data at 5 day intervals

Header Record For Solar Flux Data - BINARY FILE

Bytes		Type	Description
1-8		R*8	FLUXS
9-12		I*4	Number of solar flux data records
13-16		I*4	Number of solar flux values in last record (multiple of 32)
17-20		I*4	Actual number of solar flux values in file
21-192	43	I*4	Dummy integer words, set to zero

Data Records For Solar Flux Data - BINARY FILE

Bytes		Type	Description
1-62	31	I*2	Daily values of solar flux (times 10) for one month starting 580301. For months with less than 31 days, the solar flux values are set to zero for any remaining days up to 31.
63-64		I*2	Year and month of solar flux data in form YYMM
65-126	31	I*2	Daily values of solar flux (times 10) for the next month
127-128		I*2	Year and month of solar flux data in form YYMM
129-190	31	I*2	Daily values of solar flux (times 10) for the next month
191-192		I*2	Year and month of solar flux data in form YYMM

Header Record For Magnetic Flux (Ap) Data

Bytes		Type	Description
1-8		R*8	FLUXAP
9-12		I*4	Number of magnetic flux data records

13-16	I*4	Number of magnetic flux values in last record (multiple of 32)
17-20	I*4	Actual number of magnetic flux values in file
21-192	43 I*4	Dummy integer words, set to zero

Data Records For Magnetic Flux (Ap) Data

Bytes	Type	Description
1-62	31 I*2	Daily values of magnetic flux (A_p) for one month, starting 580301. For months with less than 31 days the flux values are set to zero for any remaining days up to 31.
63-64	I*2	Year and month of magnetic flux data in form YYMM
65-126	31 I*2	Daily values of magnetic flux (A_p) for the next month
127-128	I*2	Year and month of magnetic flux data in form YYMM
129-190	31 I*2	Daily values of magnetic flux (A_p) for the next month
191-192	I*2	Year and month of magnetic flux data in form YYMM

Header Record For Magnetic Flux (Kp) Data

Bytes	Type	Description
1-8	R*8	FLUXKP
9-12	I*4	Number of magnetic flux (K_p) data records
13-16	I*4	Number of magnetic flux (K_p) values in last record (multiple of 32)
17-20	I*4	Actual number of magnetic flux (K_p) values in file
21-192	43 I*4	Dummy integer words, set to zero

Data Records For Magnetic Flux (Kp) Data

Bytes	Type	Description
1-62	31 I*2	Daily values of magnetic flux (K_p) times 100 for one month starting 580301 For months with less than 31 days the flux values are set to zero for any remaining days up to the 31st.
63-64	I*2	Year and month of magnetic flux data in form YYMM.
65-126	31 I*2	Daily values of magnetic flux (K_p) times 100 for one month starting 580301. For months with less than 31 days the flux values are set to zero for any remaining days up to the 31st.
63-64	I*2	Year and month of magnetic flux data in form YYMM.
65-126	31 I*2	Daily values of magnetic flux (K_p) times 100 for the next month
127-128	I*2	Year and month of magnetic flux data in form YYMM.
129-190	31 I*2	Daily values of magnetic flux (K_p) times 100 for the next month
191-192	I*2	Year and month of magnetic flux data in form YYMM.

3.7 JPL PLANETARY EPHEMERIS DATA FILE

The JPL Planetary Ephemeris File contains all the information required by GEODYN II to interpolate during ephemeris calculations. Its presence is mandatory as input in UNIT 1 of any GEODYN II setup.

The JPL Planetary Ephemeris File can be the output binary file of a support program called the JPL Planetary Ephemeris Selection Program.It can be also a file that is created by dumping the JPL Planetary Ephemeris Tape to disk. Description of the JPL Planetary Ephemeris Selection Program and the JPL Planetary ephemeris tape is given in detail in GEODYN II VOL 4 Section 3.0.

3.7.1 DESCRIPTION OF THE BINARY FILE

The Ephemeris File is written using unformatted Fortran statements. All information is collected into blocks of records called groups. The first record of each group is a five (5) word integer Header record, the remaining in between records contain data, all of one type (ie. double precision, integer etc.)

Header Record

Word 1: Number of single precision words in largest record in group.

Word 2: A zero

Word 3: A zero

Word 4: KEY1 the integer numerical label for this group.

Word 5: A zero

Data Records

The first word of every data record is the count N of the remaining words in the record. N always refers to the number of words of the group data type. N itself is an integer regardless of the data type in the record.

Trailer Record

The final record of any group is called a Trailer record. The word count N of a trailer record is 1 and the only word in the record is a 1 of the group data type.

There are 3 groups on a GEODYN II input ephemeris file described below and identified by their KEY1 value:

KEY1: 1030

KEY1: 1050

KEY1: 1070

The first two words in each Ephemeris records are the earliest and the latest epochs covered by the record. The remaining data are for the bodies in the order specified in group 1050. For each body the components are arranged in the order x, y and z with respect to the solar system barycenter. For nutations the data represent d(psi) and d(epsilon) in that order. The order of the bodies in the data records is: Mercury, Venus, Earth-Moon barycenter, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Moon (geocentric), Sun, Nutations.

For any one component of a particular body the data are in an array nc words long, arranged as follows:

Words 1-NC: The Chebyshev coefficients for position in the interval covered by the array (in kilometers).

3.8 GEODYN EXTERNAL ACCELERATION FILE

3.8.1 INTRODUCTION

The implementation of the external acceleration capability is designed to give the user the ability to supply GEODYN with accelerometer measurements (X, Y, Z) to be used to drive the satellite instead of performing state vector integration. This capability may be used with multiple satellite runs.

The external acceleration file will be read in GEODYN IIS if there are DYNSEL options in the input setup. The values from the external file then will substitute the integrator values during the times specified on the DYNSEL options.

3.8.2 BINARY FILE DESCRIPTION

The External Accelerometer File is a binary file where all records contain 9, 64-bit real words. This file is a GEODYN IIE input file and must have the following filename: EXACxx, where xx is the number of the arc for which this external attitude file applies. For a single arc run, the filename must be EXAC01. Refer to the Volume 3 DYNCEL cards for more details on the application of external accelerometer information.

```
1) GENERAL HEADER RECORD
   ---------------------
   There is only one of these records and it must be first in the file.

WORD            DESCRIPTION
----------------------------------------------------------------------
1               Record Indicator                         -6666666.00
2               Version Number
```

```
3               Number of Satellites represented
                   in this file.
4               Not used at present time
5               Not used at present time
6               Not used at present time
7               Not used at present time
8               Not used at present time
9               Not used at present time

2) SATELLITE INFORMATION HEADER RECORDS
   The number of these records equals the number of satellites from the
   General Header Record. All of these header records must directly follow
   the above General Header Record.

WORD            DESCRIPTION
------------------------------------------------------------------------
1               Record Indicator                        -7777777.00
2               Data type indicator                     1 = x,y,z
3               Satellite ID*
4               Interval        (10 secs)               SSSSS.SSSSS
5               Start time                              YYMMDDHHMMSS.00  ET
6               Start (fractional seconds)              00.SS            ET
7               Stop time                               YYMMDDHHMMSS.00  ET
8               Stop (fractional seconds)               00.SS            ET
9               not used at present

*Note: Satellite ID must match that of the GEODYN SATPAR cards in order
       to be loaded during a GEODYN run.



3) DATA RECORDS
   These records  must be in time ascending order.

WORD            DESCRIPTION
-----------------------------------------------------------------------

1         time of obs.                      YYMMDDHHMMSS.00
2         time (fractional seconds)         00.SS
3         X
4         Y
5         Z
6         Not used at present time
7         Not used at present time
8         Not used at present time
9         Not used at present time

----------------------------------------------------------------------------
```

3.9 GEODYN EXTERNAL THERMAL ACCELERATION FILE

3.9.1 INTRODUCTION

The implementation of the external thermal acceleration capability is designed to give the user the ability to supply GEODYN with temperatures and emissivities to be used to compute the thermal emission acceleration on a variable number of satellites with variable number of panels.

The external thermal acceleration file, EXTHAC## must be constructed as described in the Binary File Description and is read in GEODYN IIS when SATPAR column 14 is set to 1. Linear interpolation is used to find temperatures and emissivities at integration and measurement times. Temperature and emissivity data must start and stop at least 10 integration steps before and after the EPOCH start and stop times for each satellite. PANEL cards must be present in order to apply the external thermal acceleration.

3.9.2 BINARY FILE DESCRIPTION

The External Thermal Acceleration file is a binary file where all records contain 9, 64-bit real words. This file is a GEODYN IIS input file and must have the following filename: EXTHAC##, where ## is the number of the arc for which this external thermal acceleration file applies. Currently, this option is only set up for a single arc run and the filename must be EXTHAC01. Refer to the Volume 3 SATPAR card for details on the application of external thermal acceleration information.

```
1) GENERAL HEADER RECORD
   ---------------------
   There is only one of these records and it must be first in the file.

WORD            DESCRIPTION
-----------------------------------------------------------------------
1               Record Indicator                             -6666666.00
2               Version Number
3               Number of Satellites represented
                   in this file.
4               Not used at present time
5               Not used at present time
6               Not used at present time
7               Not used at present time
8               Not used at present time
9               Not used at present time


2) SATELLITE INFORMATION HEADER RECORDS
   The number of these records equals the number of satellites from the
   General Header Record. All of these records must directly follow the
   above General Header Record.

WORD            DESCRIPTION
------------------------------------------------------------------------
1               Record Indicator                             -7777777.00
2               Not used at present time
3               Satellite ID*
4               Interval                                     SSSSS.SSSSS
5               Start time                                   YYMMDDHHMMSS.00
6               Start (fractional seconds)                   00.SS
7               Stop time                                    YYMMDDHHMMSS.00
8               Stop (fractional seconds)                    00.SS
9               Number of panels                             NNN

*Note: Satellite ID must match that of the GEODYN SATPAR cards in order
       to be loaded during a GEODYN run.


3) TEMPERATURE/EMISSIVITY SET HEADER RECORD
   This header record must precede the temperature/emissivity data
   records for a particular set of temps/emis.
```

WORD	DESCRIPTION	
1	Record Indicator	-8888888.00
2	Satellite ID	
3	Panel Number	MMM
4	Not used at present time	
5	Start time*	YYMMDDHHMMSS.00
6	Start (fractional seconds)*	00.SS
7	Stop time*	YYMMDDHHMMSS.00
8	Stop (fractional seconds)*	00.SS
9	Interval*	SSSSS.SSSSS

*Note: Temperature/emissivity satellite information must match that on the satellite information header record.

4) DATA RECORDS
These records apply to a particular temp/emis set and must follow (in time ascending order) the temp/emis set header record.

WORD	DESCRIPTION	
1	Not used at present time	
2	Not used at present time	
3	Temperature	K
4	Emissivity	
5	Not used at present time	
6	Not used at present time	
7	Not used at present time	
8	Not used at present time	
9	Not used at present time	

Notes: 1) All temperature sets for a particular satellite ID must have the same interval, as well as the same start and stop times.
2) Temp/emis information must include 10 Integration steps before & after the EPOCH of the satellite in the GEODYN run.
3) A panel must not have a designation number of 0.

3.10 EXTERNAL SELF SHADOWING FILE

THE DATA STRUCTURE FOR SHADOWING FILE

One shadowing file should be used for each satellite. Each shadowing file should have one general header record and one or two blocker header record. The block header record must be followed by data records. The shadowing file could be either ascii or binary file.

ASCII SHADOWING FILE

General Header Record: four integers
1: number of blocks
2: number of panels for this satellite
   This number must match the panel cards in the IIS setup file.
3: model indicator
   0 for ratio
   1 for actual cross-section
4: satellite ID number

```
Block Header Record: one integer followed by three real numbers
1 (integer): block indicator
             0 for solar radiation
             1 for drag
2 (real):   start time in UTC YYMMDDHHMMSS.SS format
3 (real):   stop time in UTC YYMMDDHHMMSS.SS format
4 (real):   time step in seconds
Data Record:
Each data record includes the time tag followed by the values for each panel.

BINARY SHADOWING FILE
The binary has exactly the same structure as the ascii shadowing file. One
should be careful that the size of integers in binary file should be consistent
with the GEODYN versions (i32 or i64).

Note if one wants to use binary shadowing file and has multiple satellites, one
must set the 7th columns on all the SLFSHD cards to 1, otherwsie GEODYN IIS
will assume ascii shadowing files shall be used for all the satellites. In
other words, one could only use either ascii or binary files  simultaneously
for all those satellites.
```

3.11 INPUT FILE STRUCTURE FOR LRA RANGE CORRECTION FOURIER COEFFICIENTS

```
This is the format descriptor for the LRA input file (read in RDLRA).

Format:  3I2,4E16.7

where    Item 1 = elevation
                  1 =  0.0 deg
                  2 =  2.5 deg
                  3 =  5.0 deg
                    etc.
                  9 = 20.0 deg
                 10 = 25.0 deg
                    etc.
                 17 = 60.0 deg

         Item 2 = X order of Fourier coefficient

         Item 3 = Y order of Fourier coefficient

         Item 4 = Dnm Fourier coefficient value
                  (multiplies COSX*COSY term)

         Item 5 = Enm Fourier coefficient value
                  (multiplies COSX*SINY term)

         Item 6 = Fnm Fourier coefficient value
                  (multiplies SINX*COSY term)

         Item 7 = Gnm Fourier coefficient value
                  (multiplies SINX*SINY term)

There are 425 lines for each set of detector type dependent range
corrections.  The Fourier coefficients for each set are listed
```

sequentially in this input file. The order and accompanying stations are as follows:

```
MCP Stations:
 =1  Wuhan
 =2  Wettzel
     Tokyo

 =3  MOBLAS-5 (Yarragadee)
     HOLLAS   (Haleakala, HI)
     TLRS-4
 =4  MOBLAS-4 (Monument Peak, CA)
     MOBLAS-8 (Quincy, CA)
     TLRS-3
     MLRS     (Ft. Davis, TX)
 =5  MOBLAS-7 (Greenbelt, MD)
 =6  TLRS-1
 =7  TLRS-2
 =8  Bar Giyyora
 =9  Orroral
     MTLRS-2

PMT Stations:
=10  Herstmonceux
=11  Zimmerwald
     Borowiec, Poland
=12  Grasse
=13  Shanghai
     San Fernando, Spain
=14  MTLRS-1
=15  Helwan
=16  Beijing
=17  Chang Chun
     Katsively, Ukraine
     Riga, Latvia
=18  Postsdam
     Dunaovcy, Ukraine
     Maidanak, Uzbekistan
     Evpatoria, Ukraine
     Komsomolsk, Russia
     Balkash, Russia
     Simeiz, Ukraine
     Metsahovi, Finland
=19  Santiago, Cuba

SPAD Stations:
=20  Herstmonceux
     Graz
     Simosato
     MTLRS-1
     FTLRS

Matera Station:
=21  Matera
```

3.12 GEODYN GRID FILES FOR OCEAN TIDES AND SEA SURFACE TOPOGRAPHY

The implementation of the ocean tide model that employs Proudman functions, and the sea surface topography model that employs similar functions in GEODYN enables the user to choose a set of models for these corrections that differ from the conventional harmonic expansion models.

These two models in GEODYN are introduced by the use of OTMOD (tides) and SSTMOD (Sea surface topography) cards. (See Vol. 3 global section, GEODYN II documentation). Descriptions and references for the above models are given in Vol. 1. Geodyn II documentation.

In this section we provide a general description of the input function files.

```
FILE 20:   Binary-I32 /Binary-I64 depending on the machine on which
           GEODYN IIS is executed. All R*4.

Record 1:         PTS, GRIDSIZE

PTS: total number of points for which Proudman functions are provided.
GRIDSIZE: length in degrees between two neighboring grid points.


Record 2:         LONGITUDE ARRAY(K), K=1,PTS

Sequence for longitude is  180 degrees to 360 degrees then
0 degrees to 180 degrees.


Record 3:         COLATITUDE ARRAY(K), K=1,PTS
Sequence for colatitude is 0 degrees to +180 degrees.


Record 4:         to (NF+4):  Proudman Functions ARRAY(K), K=1,PTS
```

Where NF is the total number of Proudman functions available per grid point. This number is evaluated in GEODYN by reading the model coefficeints in UNIT 5 from the OTCOEF cards. It is very important that the functions provided in UNIT 20 follow the same significance order as the coefficients in UNIT 5. The user may cut down the model and therefore the dynamic space evaluated in GEODYN by cutting down the number of input coefficients on UNIT 5.

```
FILE 21:   Binary-I32 /Binary-I64 depending on the machine on which
           GEODYN IIS is executed. All R*4.

Record 1:         PTS, GRIDSIZE

PTS: total number of points for which sea surface topography functions are
     provided.
GRIDSIZE: length in degrees between two neighboring grid points.


Record 2:         LONGITUDE ARRAY(K), K=1,PTS

Sequence for longitude is 180 degrees to 360 degrees then
0 degrees to 180 degrees.



Record 3:         COLATITUDE ARRAY(K), K=1,PTS
Sequence for colatitude is  -90 degrees to +90 degrees.
```

```
Record 4:        to (NF+4):  Sea Surface Topography ARRAY(K), K=1,PTS
```

Where NF is the total number of sea surface topography functions available per grid point. This number is evaluated in GEODYN by reading the model coefficients in UNIT 5 from the SSTCOF cards. It is very important that the functions provided in UNIT 21 follow the same significance as the coefficients in UNIT 5.

The user may cut down the model and therefore the dynamic allocation evaluated in GEODYN by cutting down the number of input coefficients on UNIT 5.

Important note:

For records 3 - (NF+4), PTS includes the boundary location points, but the boundary points are all at the end of the array.

Example for the longitude array:

```
                                   _                 _
 -180  degrees                      |                 |
 -180  degrees                      |                 |
   .                                |                 |
   .                                |                 |
   .                                |                 |
 -179  degrees                      |                 |
   .                                |                 |
   .                                |                 |
   .                                |                 |
   0   degrees                      |-GRID            |
   .                                |                 |
   .                                |                 |
   .                                |                 |
  179  degrees                      |                 |
  180  degrees                      |                 |
  180  degrees                      |                 |-PTS
   .                                |                 |
   .                                |                 |
   .                                |                 |
  180  degrees                     _|                 |
                                   _                  |
 -180  degrees                      |                 |
   .                                |                 |
   .                                |                 |
   .                                |                 |
   0   degrees                      |-BOUNDARY        |
   .                                |                 |
   .                                |                 |
   .                                |                 |
 -180  degrees                     _|                _|
```

GEODYN IIE GRID FILES

FILE 27: DIRECT ACCESS FUNCTION FILE

FILE 28: BINARY GRID FILE

In the case of large function and grid files, it is recommended that the user chooses to read the files in GEODYN IIE. This option is available on the SSTMOD option card. (See Global Section in Vol. 3)

```
FILE 27:  This is a direct access file containing as many records as the number
          of grid points available.  Each record contains NF+2 R*8 words
```

structured as follows:

```
Word 1:   = The longitude of the grid point
Word 2:   = The latitude of the grid point
Word 3:   = NF+2, the function values of the grid point.
```

FILE 28: Binary-I32 /Binary-I64 depending on the machine on which GEODYN IIS is executed. All R*8.

Record 1: PTS, GRIDSIZE

PTS: total number of points for which sea surface topography functions are provided.
GRIDSIZE: length in degrees between two neighboring grid points.

Record 2: LONGITUDE ARRAY(K), K=1,PTS

Sequence for longitude is 180 degrees to 360 degrees then 0 degrees to 180 degrees.

Record 3: COLATITUDE ARRAY(K), K=1,PTS
Sequence for colatitude is 0 degrees to 180 degrees.

The user may reduce the model size by reducing the number of input coefficients on UNIT 5.

4 GEODYN II-S/II-E INTERFACE

4.1 INTRODUCTION

Section 3.0 describes the conceptual design of the interface between GEODYN II-S and GEODYN II-E, and it also provides the formats for the interface files.

4.2 GEODYN II-S/II-E INTERFACE DESIGN

The GEODYN II program is a totally redesigned GEODYN program, the primary function of which is highly efficient optimized operation on a vector processing computer.

GEODYN II's design has been very strongly influenced by the structure of GSFC's vector processing computer facilty and by the volume and nature of the data bases used by the Geodynamics Branch in its utilization of GEODYN. For these reasons GEODYN II has been structured as two separate programs, one of which (GEODYN II-S) is executed only on the IBM front-end computers and the other (GEODYN II-E) which is executed primarily on the vector computer (currently Cray Y-MP), but which may also be executed on the front end computers. Currently it is possible to run both 2S and 2E on the IBM front end computer, or both on the vector computer as well as running 2S on the front end and 2E on the vector computer.

GEODYN II-S has been designed to perform the I/O intensive setup portion of the GEODYN II execution. In performing this function, GEODYN II-S reads the Keyword Control Card input file many times, creates temporary scratch disk files, reads the tracking data file selecting and reformatting the subset data set to be conveyed to GEODYN II-E, reads the tracking station reference coordinates file, and reads and selects subsets of the planetary ephemeris file, the solar and geomagnetic flux file and the polar motion and UT1 file. From all of this data, GEODYN II-S gleans that information required by GEODYN II-E to performed the task requested by the analyst. Additionally, GEODYN II-S structures the data in such a manner that further manipulations of the data by GEODYN II-E are minimized.

GEODYN II-E has been designed to perform the CPU intensive computational portion of the GEODYN II execution. In performing this function, GEODYN II-E reads the GEODYN II Interface File created by GEODYN II-S, loading the various parameters into the appropriate arrays and then utilizes vector pipelining capabilities to full advantage to process the satellite tracking data and compute the least squares determination of orbit and geodetic parameters. In addition to print files of the GEODYN results, GEODYN II-E also outputs trajectory files, edited data files, measurement partial derivative and residual files, and normal equation files for use by various other programs.

There are two distinct interface files that are passed from II-S to II-E The first file contains the observation data records, and the second file contains the remainder of the interface information. Both the tracking data file and the interface file are discussed in the following sections.

4.2.1 INTERFACE DATA FILE

The tracking data file that is passed from II-S to II-E contains the data that subroutine BINARY outputs in the internal tracking data format. The tracking data file is separate from the interface file because of its potential size and its different format. It is also a better design to have subroutine BINARY output it directly to the interface file rather than waiting for the remaining interface information that is not output until the end of the II-S run.

Conceptually, the tracking data set contains logical blocks of data within which all of the observations are of one type, have the same station/satellite tracking configuration, and span a length of time governed by the integration step size and the core available and limited to be a single pass or less. These blocks are formed by GEODYN II-S such that quantities which serve identical purposes for each observation are arranged contiguously in core. This allows the quantities to be treated as vectors by the vector computer, thus taking full advantage of the vector pipelining. Some of the quantities are null filled as received from GEODYN II-S, but are later used by GEODYN II-E to store measurement correction values or computed event times.

4.2.2 INTERFACE FILE

The interface file contains all the interface information that is needed to control and perform the requested orbit generator or data reduction run. The seven major components of this interface file are listed below in the order in which they are output to the interface file.

1. General Information
2. Global Common Blocks
3. Global Dynamic Arrays
4. Planetary Ephemeris and Table Data
5. Tracking Data directory
6. Arc Common Blocks
7. Arc Dynamic Arrays

Sections 4.2.2.1 – 4.2.2.7 provide an overview of the purpose for each of these interface components.

4.2.2.1 General Information

This first section passed from II-S to II-E contains information about buffer sizes that II-E will need for reading the rest of the interface file. It also provides the run version numbers, and run dates and times for the TDF and II-S programs that were used for this run. The remainder of this section is used to pass a copy of the II-S option cards for printout in II-E.

4.2.2.2 Global Common Blocks

GEODYN II-S determines from the Keyword Control Card file the counts of all of the various parameter types, the sizes of all of the various models and model data requirements, default values for most parameters, the maximum number of satellites per set and per arc, the maximum number of sets per arc, and the number of arcs. Most of this information is saved in common blocks. Subroutine IFWGCB outputs to the interface file common block information that is global in nature; information that is the same for all arcs. Each common block contains information of only one type (i.e real, logical, integer) and is output as a single logical record to the interface file. The length of each common block is stored in the last variable in the common block so that writing the common block to disk is easier and so that differences in lengths between II-S and II-E can be detected and corrected.

4.2.2.3 Global Dynamic Arrays

Most of the quantities input to GEODYN by the analyst will be accessed from dynamic memory by GEODYN II-E. Additionally, some of the instructions provided to GEODYN II-S by the analyst will cause large quantities of previously initialized data values to be loaded into the dynamic array areas of GEODYN II. An example of this is the automatic loading of one of the default sets of gravitational coefficients from the gravitational coefficients file to the dynamic arrays. All quantities loaded into dynamic memory areas, whether through input or by default must be transported from GEODYN II-S to GEODYN II-E. To allow for ease of transport and to permit these quantities to be directly loaded into dynamic memory when read from the file, each dynamic array is written to the file as a single logical record.

The global dynamic arrays are divided into the following major categories with each category being output to the interface file by a separate IFWGDx routine.

- INTEGRATION AND FORCE MODEL PARAMETERS
- INTERPOLATION ARRAYS
- COORDINATE SYSTEM INFORMATION
- MEASUREMENT MODELING
- STATISTICS
- ESTIMATION ARRAYS

4.2.2.4 Planetary Ephemeris and Table Data

The flux, polar motion, and UT1 data are obtained from the tables file by GEODYN II-S. These data may be further supplemented by keyword control inputs. GEODYN II-S scans the Keyword Control Card file to determine the time span of the GEODYN run to be performed. Using this information, GEODYN II-S reads the planetary ephemeris file, selecting the subset time span required and appends the appropriate flux, polar motion, and UT1 data to each 32 day span of ephemeris data. This is then passed to GEODYN II-E, where it is accessed randomly as needed.

4.2.2.5 Arc Common Blocks

The remaining data to be communicated between GEODYN II-S and GEODYN II-E is of an arc dependent nature and must be stored on disk for use in processing each of the arcs. Since GEODYN II-S gleans this information from the input data on an arc by arc basis, it is communicated between the two programs in a similar fashion.

The arc common blocks provide arc parameter counts and other information that is necessary for each arc. Subroutine IFWACB is called once per arc to output these common blocks. Each arc common block contains information of only one type (i.e real, logical, integer) and is output as a single logical record to the interface file. The length of each common block is stored in the last variable in the common block so that writing the common to disk is easier and so that differences in lengths between II-S and II-E can be detected and corrected.

4.2.2.6 Arc Dynamic Arrays

Arc dependent dynamic array information is stored by II-S on scratch disks on an arc by arc basis. For output to II-E each array is retrieved from disk and output as a single record to the interface file. Alphanumeric data is converted from EBCDIC to ASCII in II-S, but floating point data is converted from IBM to the vector computer format in II-E. When II-E reads the interface file it reads the arc common blocks to get the pointers and the sizes for the various arc dynamic arrays prior to reading and loading the actual arc dynamic arrays.

The arc dynamic arrays are divided into the following major categories with each category being output to the interface file by a separate IFWADx routine.

- INTEGRATION AND FORCE MODEL PARAMETERS
- INTERPOLATION ARRAYS
- MEASUREMENT MODELING ARRAYS
- ESTIMATION ARRAYS

4.2.2.7 Tracking Data Directory

For each logical tracking data block written to the Interface Data File, one logical record is entered into the Tracking Data Directory. The information contained in this record tells GEODYN II-E the nature and volume of the data contained in the tracking data logical block, as well as the type of processing to be performed on the data and the physical block numbers and logical word numbers associated with the start and end of each logical block.

Originally, the order of the Tracking Data Directory is the same as that of the tracking data. However, because logical blocks read from the external tracking data file may exceed internal time duration or measurement count limits, each external logical block may produce multiple internal logical blocks. Although the external file is block time ordered, the internal file may no longer be block time ordered due to the subdivision of the external blocks and the overlapping of tracking spheres of the observing stations. Since GEODYN II-E requires that data be processed in block time order, it then becomes necessary for GEODYN II-S to time sort the Tracking Data Directory.

Thus the Tracking Data Directory provides block time-sorted access to the tracking data for the arc. The directory is used sequentially during the processing of each arc while all of the other arc dependent data are accessed from virtual storage only at the start of processing for each arc.

4.3 GEODYN II INTERNAL TRACKING DATA FORMAT

4.3.1 INTRODUCTION

The GEODYN II Internal Tracking Data Format (G2I) has been designed to be compatible with the GEODYN II Binary Tracking Data Format (G2B). Adaptability has been designed into the format so that it may be used with data forms that may evolve in the future.

The word structure of the data records is such that the format may be used on both the vector computer or on a machine with IBM architecture.

In addition to the buffered data file, the format also describes a directory file.

4.3.2 TRACKING DATA FORMAT

The G2I data file has optimum buffer and block sizes, as yet undetermined, but limited by virtual memory paging considerations. The format has a similar structure to G2B except that, apart from the header records (which occupy a ten partition sub-structure), the remaining records in each Block (observations, corrections, locations, etc.) occupy sub- structures with only as many partitions as required to store the quantities necessary for the particular GEODYN II job execution. In addition to the logical records defined in G2B, the G2I format also contains logical records for observation event times necessary for observation processing.

This dynamic data structuring is accomplished through the construction of a data directory which points to each Block and specifies the starting location and length, as well as the internal Block structure and the time span covered by the Block.

Master Block Header Record

```
Buffer
Partition        Description
---------        -----------

   1             MJD of Data Block Start

   2             Time of Data Block Start in Seconds

   3             Elapsed Time in Seconds from Data Block Start to
                 Data Block End

   4             Speed of Light Associated with Data in this Block

   5             Measurement Type

   6             Time System Indicator

   7             Observation Record Count in Block

   8             Number of Auxiliary Records Associated with Each
                 Observation Record

   9             Master Prepro Word (designated #9)

  10             Record Type Indicator  = -9,000,000
```

Block Header Record #1

```
Buffer
Partition                Description
```

```
---------                  -----------

   1             Station #1 Meteorological Data

   2

   3

   4

   5

   6

   7             Station ID #1

   8             Satellite/Source ID #1

   9             Prepro Word #1

  10             Record Type Indicator = -8,000,000
```

Block Header Record #2

```
Buffer
Partition                  Description
---------                  -----------

   1             Station #2 Meteorological Data

   2

   3

   4

   5

   6

   7             Station ID #2

   8             Satellite/Source ID #2

   9             Prepro Word #2

  10             Record Type Indicator = -7,000,000
```

Block Header Record #3

```
Buffer
Partition                  Description
---------                  -----------

   1             Station #3 Meteorological Data

   2
```

Buffer Partition	Description
3	
4	
5	
6	
7	Station ID #3
8	Satellite/Source ID #3
9	Prepro Word #3
10	Record Type Indicator = -6,000,000

Location Data Descriptor Record (Altimetry)

Buffer Partition	Description
1	Semi-major Axis of Reference Ellipsoid in Meters
2	Inverse of the Flattening of Reference Ellipsoid
3	Eight Character Reference Ellipsoid Descriptor
4	Eight Character Geoid Descriptor
5	Eight Character Mean Sea Surface Descriptor
6	Eight Character Orbit Descriptor
7	
8	
9	Uniqueness Indicator
10	Record Type Indicator =

Observation Record (Altimetry)

Buffer Partition	Description
1	Observation
2	Altimeter Derived Surface Elevation
3	Sum of Observation Corrections
4	Sum of Surface Elevation Corrections

5	Sum of Time Corrections
6	Elapsed Time from Block Start to Time of Observation in Seconds
7	Observation Sigma
8	AGC
9	Significant Waveheight
10	Record Type Indicator = 0

Observation Corrections Record (Altimetry)

Buffer Partition	Description
1	Meteorological Data
2	Net Instrument Corrections
3	Dry Tropospheric Refraction
4	Wet Tropospheric Refraction (from Met Data and Model)
5	Wet Tropospheric Refraction (from Radiometer)
6	Ionospheric Refraction
7	Sea State
8	Attitude/Sea State
9	
10	Record Type Indicator = 1,000,000

Ocean Parameters Record (Altimetry)

Buffer Partition	Description
1	Barotropic Correction
2	Solid Earth Tide
3	Ocean Tide #1
4	Ocean Tide #2
5	
6	

7	
8	
9	
10	Record Type Indicator = 2,000,000

Location Data Record (Altimetry)

Buffer Partition	Description
1	Subsatellite Geodetic Latitude
2	Subsatellite Geodetic East Longitude
3	Computed Height of Spacecraft Above Reference Ellipsoid
4	Geoid Height
5	Mean Sea Surface Elevation Above Reference Ellipsoid
6	
7	
8	
9	Uniqueness Indicator
10	Record Type Indicator = 4,000,000

Observation Record (Range)

Buffer Partition	Description
1	Observation
2	
3	Sum of Observation Corrections
4	
5	Sum of Time Corrections
6	Elapsed Time from Block Start to Time of Observation in Seconds
7	Observation Sigma

```
  8

  9           VLBI Source Identifier (Modified IAU Star Number)

 10           Record Type Indicator  =  0
```

Observation Corrections Record (Range) #N

```
Buffer
Partition                Description
---------                -----------

  1           Meteorological Data for Station #N

  2           Spacecraft #N Center of Gravity Correction

  3           Dry Tropospheric Refraction for Station #N

  4           Wet Tropospheric Refraction for Station #N

  5           Antenna Axis Displacement Correction for
              Station #N

  6           Ionospheric Refraction #N

  7           Ionospheric Refraction #N (1)

  8

  9

 10           Record Type Indicator  =  N,000,000
```

Observation Record (Doppler)

```
Buffer
Partition                Description
---------                -----------

  1           Observation

  2           Doppler Counting Interval

  3           Sum of Observation Corrections

  4

  5           Sum of Time Corrections

  6           Elapsed Time from Block Start to Time of
              Observation in Seconds

  7           Observation Sigma

  8
```

9	VLBI Source Identifier (Modified IAU Star Number)
10	Record Type Indicator = 0

Observation Corrections Record (Doppler) #N

Buffer Partition	Description
1	Meteorological Data for Station #N
2	Spacecraft #N Center of Gravity Correction
3	Dry Tropospheric Refraction for Station #N
4	Wet Tropospheric Refraction for Station #N
5	Antenna Axis Displacement Correction for Station #N
6	Ionospheric Refraction #N
7	Ionospheric Refraction #N (1)
8	
9	
10	Record Type Indicator = N,000,000

Observation Record Angles

Buffer Partition	Description
1	Observation #1
2	Observation #2
3	Sum of Observation #1 Corrections
4	Sum of Observation #2 Corrections
5	Sum of Time Corrections
6	Elapsed Time from Block Start to Time of Observation in Seconds
7	Observation #1 Sigma
8	Observation #2 Sigma
9	Source Identifier (Modified IAU Star Number)
10	Record Type Indicator = 0

Observation Corrections Record (Right Ascension/Declination)

Buffer Partition	Description
1	
2	
3	Obs #1 Annual Aberration
4	Obs #2 Annual Aberration
5	Obs #1 Diurnal Aberration
6	Obs #2 Diurnal Aberration
7	Obs #1 Parallactic Refraction
8	Obs #2 Parallactic Refraction
9	
10	Record Type Indicator = 1,000,000

Observation Corrections Record (Azimuth/Elevation, X-Y Angles and Direction Cosines)

Buffer Partition	Description
1	Meteorological Data
2	
3	Obs #1 Dry Tropospheric Refraction
4	Obs #2 Dry Tropospheric Refraction
5	Obs #1 Wet Tropospheric Refraction
6	Obs #2 Wet Tropospheric Refraction
7	Obs #1 Ionospheric Refraction
8	Obs #2 Ionospheric Refraction
9	
10	Record Type Indicator = 1,000,000

Target Parameters Record (Optical Navigation Data)

Buffer Partition	Description

Buffer Partition	Description	
1	Latitude of Landmark	
2	Longitude of Landmark	
3	Height of Landmark	
4	B Angle	
5	X Coordinate of Landmark in Meters	Target Body Centered Fixed Coordinates
6	Y Coordinate of Landmark in Meters	
7	Z Coordinate of Landmark in Meters	
8		
9		
10	Record Type Indicator = 4,000,000	

Observation Event Times Record

Buffer Partition	Description
1	Elapsed Time from Start of Block to Event #1 in Seconds
2	Elapsed Time from Start of Block to Event #2 in Seconds
3	Elapsed Time from Start of Block to Event #3 in Seconds
4	Elapsed Time from Start of Block to Event #4 in Seconds
5	Elapsed Time from Start of Block to Event #5 in Seconds
6	Elapsed Time from Start of Block to Event #6 in Seconds
7	Elapsed Time from Start of Block to Event #7 in Seconds
8	Elapsed Time from Start of Block to Event #8 in Seconds
9	Elapsed Time from Start of Block to Event #9 in Seconds
10	Elapsed Time from Start of Block to Event #10 in Seconds

4.3.3 TRACKING DATA DIRECTORY FORMAT

Each Block has an entry in the Tracking Data Directory (TDD). This directory consists of a time sorted set of pointers and logical switches stored on a sequential file. The TDD is formed by GEODYN IIS as the observations are selected from an external file in GEODYN 2 internal format and written onto disk in GEODYN 2 internal format. Since the data selection process involves reblocking the observations, it becomes necessary to resort the TDD into Block time order. When this has been accomplished, the TDD then constitutes a sequentially ordered direct access directory to the GEODYN 2 Tracking Data File.

Internal Observation Directory Record

```
Word            Description
----            -----------

  1             MJDSEC of Data Block Start

  2             Fractional Seconds of Data Block Start

  3             Buffer Number of Start of Block

  4             Buffer Number of End of Block

  5             Word Location within Starting Buffer of Word Zero
                of Master Block Header Record

  6             Number of Header Records

  7             Number of Observations in Block

  8             Number of Words Stored (excluding event times) for
                each Observation (Limit = 80)**

  9             *Switches indicating which of first 40 possible
                words are present

 10             *Switches indicating which of second 40 possible
                words are present

 11             Switches indicating which measurement event times
                are present; also, switches indicating which of the
                modified observation sigmas and corrections sums are
                present. Average range rates have twice as many event
                times as indicated by switches.

 12             Number of Location Data Descriptor Records present

 13             Tracking Configuration/Measurement Type sequence number

 14             Contains "ppxxss" where
                     "pp" defines the pass segment
                     "xx" defines the transmission/reception state
                     "ss" defines the system of time measurement

 NOTE: For a description of "ppxxss" see page 2-34
```

Internal Observation Directory Record

```
Word            Description
```

```
----           -----------

 15            Master header record Prepro word

 16            Header record number one Prepro word

 17            Header record number two Prepro word

 18            Header record number three Prepro word

 19            Spare

 20            Spare

 21            Index to Electronic Bias.
               If it is a paired observation, this is the electronic bias
               for the first observation in the pair.
               bias type: 0xx  where: xx=measurement type

 22            Reserved for electronic bias drift.
               If it is a paired observation, this is the electronic bias
               drift for the first observation in the pair.
               bias type: 1xx  where: xx=measurement type

 23            Index to Electronic Bias.
               If it is a paired observation, this is the electronic bias
               for the second observation in the pair.
               bias type: 0xx  where: xx=measurement type

 24            Reserved for electronic bias drift.
               If it is a paired observation, this is the electronic bias
               drift for the second observation in the pair.
               bias type: 1xx  where: xx=measurement type
```

Internal Observation Directory Record

```
Word           Description
----           -----------

 25            Index to Measurement Bias.
               If it is a paired observation, this is the bias for the
               first observation in the pair.
               bias type: 0xx  where: xx=measurement type

 26            Index to Measurement Bias.
               If it is a paired observation, this is the bias for the
               second observation in the pair.
               bias type: 0xx  where: xx=measurement type

 27            Index to Measurement Scale Bias.
               bias type: 1xx  where: xx=measurement type

 28            Index to Measurement Time Tag Bias.
               bias type: 9x0

 29            Reserved for tropospheric bias for the first station in
               a configuration
               bias type: 5x0
```

```
 30             Reserved for tropospheric bias for the second station in
                a configuration
                bias type: 5x0
```

Internal Observation Directory Record

```
Word            Description
----            -----------

 31             Reserved for tropospheric bias for the third station in
                a configuration
                bias type: 5x0

 32             Reserved for ionospheric bias for the first station in
                a configuration
                bias type: 6x0

 33             Reserved for ionospheric bias for the second station in
                a configuration
                bias type: 6x0

 34             Reserved for ionospheric bias for the third station in
                a configuration
                bias type: 6x0

 35             Index to the station clock bias for the first station
                in a configuration.
                bias type: 3x0

 36             Index to the station clock frequency bias for the first
                station in a configuration.
                bias type: 3x1

 37             Index to the station clock frequency drift for the first
                station in a configuration.
                bias type: 3x2

 38             Index to the station clock frequency acceleration for the
                first station in a configuration.
                bias type: 3x3

 39             Index to the station clock bias for the second station
                in a configuration.
                bias type: 3x0

 40             Index to the station clock frequency bias for the second
                station in a configuration.
                bias type: 3x1
```

Internal Observation Directory Record

```
Word            Description
----            -----------

 41             Index to the station clock frequency drift for the second
                station in a configuration.
```

```
             bias type: 3x2

42           Index to the station clock frequency acceleration for the
             second station in a configuration.
             bias type: 3x3

43           Index to the satellite clock bias for the first satellite
             in a configuration.
             bias type: 4x0

44           Index to the satellite clock frequency bias for the first
             satellite in a configuration.
             bias type: 4x1

45           Index to the satellite clock frequency drift for the first
             satellite in a configuration.
             bias type: 4x2

46           Index to the satellite clock frequency acceleration for the
             first satellite in a configuration.
             bias type: 4x3

47           Index to the satellite clock bias for the second satellite
             in a configuration.
             bias type: 4x0

48           Index to the satellite clock frequency bias for the second
             satellite in a configuration.
             bias type: 4x1

49           Index to the satellite clock frequency drift for the second
             satellite in a configuration.
             bias type: 4x2

50           Index to the satellite clock frequency acceleration for the
             second satellite in a configuration.
             bias type: 4x3

51           Clock Bias (Spline)
     Index to the first parameter in the string for station 1
             in the configuration.

52           Clock Bias (Spline)
     Index to node time closest to the observation (to the left)
     for station 1 in the configuration.

53           Clock Bias (Spline)
     Index to the first parameter in the string for station 2
             in the configuration.

54           Clock Bias (Spline)
     Index to node time closest to the observation (to the left)
     for station 2 in the configuration.

55           Tropospheric Zenith Delay (Spline)
     Index to the first parameter in the string for station 1
             in the configuration.
```

```
56             Tropospheric Zenith Delay (Spline)
       Index to node time closest to the observation (to the left)
       for station 1 in the configuration.

57             Tropospheric Zenith Delay (Spline)
       Index to the first parameter in the string for station 2
               in the configuration.

58             Tropospheric Zenith Delay (Spline)
       Index to node time closest to the observation (to the left)
       for station 2 in the configuration.

59             Tropospheric Gradient North (Spline)
       Index to the first parameter in the string for station 1
               in the configuration.

60             Tropospheric Gradient North (Spline)
       Index to node time closest to the observation (to the left)
       for station 1 in the configuration.

61             Tropospheric Gradient North (Spline)
       Index to the first parameter in the string for station 2
               in the configuration.

62             Tropospheric Gradient North (Spline)
       Index to node time closest to the observation (to the left)
       for station 2 in the configuration.

63             Tropospheric Gradient East (Spline)
       Index to the first parameter in the string for station 1
               in the configuration.

64             Tropospheric Gradient East (Spline)
       Index to node time closest to the observation (to the left)
       for station 1 in the configuration.

65             Tropospheric Gradient East (Spline)
       Index to the first parameter in the string for station 2
               in the configuration.

66             Tropospheric Gradient East (Spline)
       Index to node time closest to the observation (to the left)
       for station 2 in the configuration.

67             Index to baseline clock bias (VLBI)

68 - 83        (Not Defined)

84             Index to Cycle Slip parameter

85 - 100       (Not Defined)
```

Internal Observation Directory Record

```
*Note:  Switches are determined based upon 40 low order bits of integer
        values stored in 64-bit floating point numbers. Least significant
        bit is switch #1.
```

```
        Switches 1-10 apply to Buffer Partitions for records of type = 0.

        Switches N*10+1 - N*10+10 apply to Buffer Partitions for records of
        type = N,000,000

**Note: Record types are limited to 8.
```

4.4 INTERFACE FILE STRUCTURE

The Interface File uses a block oriented structure to transmit information from GEODYN IIS to IIE . Each block consists of a fixed length integer Header record that contains a block number,a group number,a data type indicator and a count of the number of records in the block.

Currently all Interface File blocks conform to one of the following formats.

```
FORMAT #1

HEADER RECORD  - INTEGER - Always 20 words long
DATA RECORDS   - NOTE 1  - As many data records as indicated in the Header
                           record. All data records have the length specified
                           by the length variable in the Header record.
FORMAT #2

HEADER RECORD  - INTEGER - Always 20 words long
LENGTH RECORD  - INTEGER - Contains one word (a length) for each data record
                           that follows.
DATA RECORDS   - NOTE 1  - As many data records as indicated in the Header
                           record. The length of each data record is contained
                           in the length record. The length variable in the
                           Header record is set to zero for this format.



NOTE 1 - Record type may be real,integer or logical as indicated by the
         record type variable in the Header record. All data records in a
         block are of the same type.
```

Header Records

```
IFFHDR(1) - Block number   - Currently the following block numbers are defined

                             01 - GENERAL INFORMATION
                             10 - GLOBAL COMMON BLOCKS
                             20 - GLOBAL DYNAMIC ARRAYS
                             30 - EPHEMERIS,POLAR MOTION AND FLUX DATA
                             40 - ARC DIRECTORY INFORMATION
                             50 - ARC COMMON BLOCKS
                             60 - ARC DYNAMIC ARRAYS
                             70 - ARC TRACKING DATA DIRECTORY DATA

IFFHDR(2) - IGROUP - Used to sub-divide large blocks such as Global
                             Dynamic Arrays. Currently the following groups
                             are identified for Global Dynamic Arrays.

                              1 - INTEGRATION AND FORCE MODEL ARRAYS
                              3 - COORDINATE SYSTEM ARRAYS
                              4 - MEASUREMENT MODELING ARRAYS
```

```
                              5 - STATISTICAL ARRAYS
                              6 - ESTIMATION ARRAYS
                              7 - A PRIORI ESTIMATION ARRAYS

IFFHDR(3) - IRTYPE    - Tells data type for data records in this block

                              1 - REAL
                              2 - INTEGER
                              3 - LOGICAL

IFFHDR(4) - NRECS  - Number of records that follows.NRECS=Number of data
                     records for format #1 and number of data records +1 for
                     format #2 blocks.

IFFHDR(5) - IRECL  - Record length for data records. If IRECL is greater than
                     zero, all data records have this length and there is no
                     lengths record. If IRECL = 0 , one lengths record follows
                     that contains the lengths of all data records in this
                     block.

IFFHDR(6) - IARCNO - ARC Number for Arc related parameters.

IFFHDR(7) - IFFHDR(20)   Not currently defined. Set to zero.
```

5 GEODYN II OUTPUT FILE DESCRIPTION

5.1 GEODYN II TRAJECTORY FILE FORMAT

5.1.1 INTRODUCTION

The GEODYN II Satellite Trajectory Data Format (G2T) has been designed to be a comprehensive format for all spacecraft. Adaptability has been designed into the format so that it may evolve with changes in user needs.

5.1.2 DATA STRUCTURE

The word structure of the data records is such that the format may be used on any machine with 64-bit (or greater) floating point word structure. G2T is a buffered format with a buffer size of 2048 eight byte (64-bit) floating point words.

The first buffer in the format is a header record that provides information concerning the contents of the remaining buffers. Buffers 2 through NA+1 contain alphanumeric information about the file contents and a copy of the GEODYN II input control deck. Next come the trajectory data buffers followed by a sentinel buffer.

5.1.3 HEADER BUFFER FORMAT

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    -----------------------------------------------------------

    1   R*8     -9,000,000,000.0D0

    2   R*8     Number of alphanumeric data buffers to follow.(NA)

    3   R*8     Number of card images in the GEODYN II input control
                        deck (NC).

    4   R*8     Arc Number.

    5   R*8     Global Iteration Number.

    6   R*8     Inner Iteration Number.

    7   R*8     Number of satellites on this file (NSATS=1 or number of sats.
                        in Set if Master and Slaves to be concurrently
                        output.) This quantity has an upper limit of 50.

    8   R*8     Actual number of words per satellite per time point
                        (NWDSAT <= 39).

    9   R*8     Number of words of data per time point (NWDATA=NSATS*NWDSAT).

   10   R*8     Number of time points per Data Buffer (NTIMBF).

   11   R*8     Trajectory Start Date & Time in form YYMMDDHHMMSS.0D0   UTC

   12   R*8     Fractional seconds of Start Time.                       UTC

   13   R*8     Trajectory Stop Date & Time in form YYMMDDHHMMSS.0D0    UTC

   14   R*8     Fractional seconds of Stop Time.                        UTC
```

```
   15   R*8      Trajectory Start Date & Time in Modified Julian Day      ET
                         Seconds (MJDS=(JD-2430000.5D0)*86400+ISEC).

   16   R*8      Fractional seconds of Start Time.                        ET

   17   R*8      Trajectory Stop Date & Time in Modified Julian Day       ET
                         Seconds (MJDS=(JD-2430000.5D0)*86400+ISEC).

   18   R*8      Fractional seconds of Stop Time.                         ET

   19   R*8      Nominal interval between trajectory times in seconds.    ET

   20   R*8      Nominal number of trajectory times.


64-BIT  WORD
 WORD   TYPE     DESCRIPTION
------  ----     ------------------------------------------------------------

   21   R*8      zero

   22   R*8      Output S/C ephemeris
                 reference system index
                 0 = TOD
                 1 = TOR
                 2 = Mean of J2000


23->100 R*8      Spares.

  101   R*8      Speed of Light.

  102   R*8      GM for Earth.

  103   R*8      Semi-major axis of Earth reference ellipsoid.

  104   R*8      Equatorial Flattening of Earth reference ellipsoid.

  105   R*8      Gravitational Potential Checksum.

  106   R*8      Maximum Degree of Gravitational Expansion.

  107   R*8      Maximum Order of Gravitational Expansion.

 108->  R*8      Spares.
  200

  201   R*8      Value greater than zero indicates presence of right ascension
                         of Greenwich for each time point in each Buffer.

  202   R*8      Value greater than zero indicates presence for each satellite
                         of inertial X coordinate for each time point.

  203   R*8      Value greater than zero indicates presence for each satellite
                         of inertial Y coordinate for each time point.
```

204	R*8	Value greater than zero indicates presence for each satellite of inertial Z coordinate for each time point.

64-BIT WORD	WORD TYPE	DESCRIPTION
205	R*8	Value greater than zero indicates presence for each satellite of inertial X velocity for each time point.
206	R*8	Value greater than zero indicates presence for each satellite of inertial Y velocity for each time point.
207	R*8	Value greater than zero indicates presence for each satellite of inertial Z velocity for each time point.
208	R*8	Value greater than zero indicates presence for each satellite of geodetic latitude for each time point.
209	R*8	Value greater than zero indicates presence for each satellite of east longitude for each time point.
210	R*8	Value greater than zero indicates presence for each satellite of ECF X coordinate for each time point.
211	R*8	Value greater than zero indicates presence for each satellite of ECF Y coordinate for each time point.
212	R*8	Value greater than zero indicates presence for each satellite of ECF Z coordinate for each time point.
213	R*8	Value greater than zero indicates presence for each satellite of ECF X velocity for each time point.
214	R*8	Value greater than zero indicates presence for each satellite of ECF Y velocity for each time point.
215	R*8	Value greater than zero indicates presence for each satellite of ECF Z velocity for each time point.

64-BIT WORD	WORD TYPE	DESCRIPTION
216	R*8	Value greater than zero indicates presence for each satellite of polar motion X for each time point.
217	R*8	Value greater than zero indicates presence for each satellite of polar motion Y for each time point.
218	R*8	Value greater than zero indicates presence for each satellite of beta prime angle for each time point.
219	R*8	Value greater than zero indicates presence for each satellite

```
                        of yaw angle for each time point.

  220   R*8     Value greater than zero indicates presence for each satellite
                        of orbit angle for each time point.

 221->  R*8     Spares.
  300

 301->  R*8     Satellite ID's for all Satellites on File. Trajectory data is
  350                   ordered based upon order of these Satellite ID's.

 351->  R*8     Spares.
 2048
```

5.1.4 ALPHANUMERIC BUFFER FORMAT

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    -------------------------------------------------------------

    1   R*8     -8,000,000,000.0D0

    2   R*8     Alphanumeric Buffer Sequence Number.

    3   CH*8    GEODYN II Interface File creation date.
                ( GEODYN II-S Run date )

    4   CH*8    Time of creation of GEODYN II Interface File.
                ( GEODYN II-S Run time )

    5   CH*8    GEODYN II-S version used.

    6   CH*8    GEODYN II-E version used.

    7   CH*8       GEODYN II-E Run date

    8   CH*8    GEODYN II-E Run time

    9   CH*8    Eight character alphanumeric label for right ascension of
                        Greenwich.
                      (NOT YET DEFINED)

   10   CH*8    Eight character alphanumeric label for inertial X coordinate.
                      (NOT YET DEFINED)

   11   CH*8    Eight character alphanumeric label for inertial Y coordinate.
                      (NOT YET DEFINED)

   12   CH*8    Eight character alphanumeric label for inertial Z coordinate.
                      (NOT YET DEFINED)

   13   CH*8    Eight character alphanumeric label for inertial X velocity.
                      (NOT YET DEFINED)

   14   CH*8    Eight character alphanumeric label for inertial Y velocity.
                      (NOT YET DEFINED)

   15   CH*8    Eight character alphanumeric label for inertial Z velocity.
```

```
                    (NOT YET DEFINED)

   16   CH*8    Eight character alphanumeric label for geodetic latitude.
                     (NOT YET DEFINED)

   17   CH*8    Eight character alphanumeric label for east longitude.

64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    --------------------------------------------------------------

   18   CH*8    Eight character alphanumeric label for height above
                       Earth reference spheroid.
                     (NOT YET DEFINED)

 19->   CH*8    Eight character alphanumeric label for
  48                   (NOT YET DEFINED. AVAILABLE FOR FUTURE EXPANSION.)

 49->   CH*8    Card images of GEODYN II Input Control Deck.
 2048
```

5.1.5 DATA BUFFER FORMAT

```
64-BIT WORD
 WORD   TYPE    DESCRIPTION
------  ----    --------------------------------------------------------------
    1   R*8     Data Buffer Count starting with 1.0D0 for first Data Buffer.

    2   R*8     Data Buffer Start Date & Time in form YYMMDDHHMMSS.0D0  UTC

    3   R*8     Fractional seconds of Start Time.                       UTC

    4   R*8     Data Buffer Start Date & Time in Modified Julian Day    ET
                       Seconds (MJDSBF=(JDBF-2430000.5D0)*86400+ISECBF).

    5   R*8     Number of trajectory times in this Data Buffer (NTB<=NTIMBF).

   6->  R*8     Trajectory Times in elapsed ET seconds from MJDSBF.
  NTB+5


(NTIMBF+6) ->
(NTIMBF+5) + NTB

        R*8     Right Ascension of Greenwich Values (radians)
                for each time in Buffer.


(2*NTIMBF+6) ->
(2*NTIMBF+5) + NWDSAT

        R*8     Satellite Data Packet for first satellite
                for first time point in this Data Buffer.


(2*NTIMBF+6) + (NSAT-1)*NWDSAT ->
(2*NTIMBF+5) + NSAT    *NWDSAT
```

```
        R*8     Satellite Data Packet for last satellite
                for first time point in this Data Buffer.
     .
         .
         .

((NSAT+1)*NTIMBF+6) + (NSAT-1)*NWDSAT ->
((NSAT+1)*NTIMBF+5) + NSAT    *NWDSAT

        R*8     Satellite Data Packet for last satellite
                for last time point in this Data Buffer.

((NSAT+1)*NTIMBF+5) + NSAT*NWDSAT+1 ->
2048

        R*8     Spare.



*  When a leap second occurs within the UTC time span of the data buffer, then
   the value of the 0.5 is added to the buffer count to serve as a flag
   (interpreted by pgm TJTORV).


Satellite Data Packet Contents:

      1  Satellite Inertial X coordinate  (meters)
      2  Satellite Inertial X coordinate  (meters)
      3  Satellite Inertial Z coordinate  (meters)
      4  Satellite Inertial X velocity    (meters/second)
      5  Satellite Inertial Y velocity    (meters/second)
      6  Satellite Inertial Z velocity    (meters/second)
      7  Satellite Geodetic Latitude      (degrees)
      8  Satellite East Longitude         (degrees)
      9  Satellite Height                 (meters)
     10  Satellite ECF X coordinate       (meters)
     11  Satellite ECF Y coordinate       (meters)
     12  Satellite ECF Z coordinate       (meters)
     13  Satellite ECF X velocity         (meters/second)
     14  Satellite ECF Y velocity         (meters/second)
     15  Satellite ECF Z velocity         (meters/second)
     16  Polar Motion X                   (milliarcsec)
     17  Polar Motion Y                   (milliarcsec)
     18  Beta prime angle                 (degrees)
     19  Yaw angle                        (degrees)
     20  Orbit Angle                      (degrees)
     21  Q(1) -| Quaternions describing
     22  Q(2)  | the total rotation from
     23  Q(3)  | ICRS(J200) to ITRF for
     24  Q(4) _| this time
```

5.1.6 SENTINEL BUFFER FORMAT

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    -------------------------------------------------------------

    1   R*8     +9,000,000,000.0D0
```

```
   2   R*8     Count of the number of Data Buffers.

   3   R*8    GEODYN II Interface File creation date and time.

   4   R*8    GEODYN II-S version used.

   5   R*8    GEODYN II-E version used.

   6   R*8     Spare.

  7->  R*8     Spare.
 2048
```

5.2 GEODYN II OBSERVATION RESIDUAL FILE FORMAT

5.2.1 INTRODUCTION

The GEODYN II Observation Residual File Format (G2R) has been designed to be a comprehensive format for all data types. Implicit in the design is the option to allow an external program to edit the file and recreate an input observation file from which undesirable observations have been removed. The file will also optionally contain all location information used by GEODYN II in forming the computation of light times and observation residuals as well as all observation corrections whether computed by GEODYN II or supplied by the input observation file.

Adaptability has been designed into the format so that it may evolve with changes in user needs.

5.2.2 DATA STRUCTURE

The word structure of the data records is such that the format may be used on any machine with 64-bit (or greater) floating point word structure. G2R is an unblocked format.

The first record in the format is a header record that provides information concerning the contents of the remaining records. Records 2 through NA+1 contain alphanumeric information about the file contents and a copy of the GEODYN II input control deck. Preceding each set of observation residuals is a lengths record which describes the information contained in the following data records. Next come optional location data records followed by the residual data records and optional observation data and observation corrections records. After the final set of data a sentinel record will appear in the same format as the lengths record preceding each set of data.

5.2.3 GLOBAL HEADER RECORD

This will be the first record on the file.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------

   1    R*8     Number of card images in the GEODYN II input control
                        deck (NC).

   2    R*8     Number of Arcs in this GEODYN II setup.

   3    R*8     Speed of Light.

   4    R*8     GM for Earth.

   5    R*8     Semi-major axis of Earth reference ellipsoid.
```

6	R*8	Equatorial Flattening of Earth reference ellipsoid.
7	R*8	Gravitational Potential Checksum.
8	R*8	Maximum Degree of Gravitational Expansion.
9	R*8	Maximum Order of Gravitational Expansion.
10	R*8	Number of tracking stations present (NSTA).
11	R*8	Length in 64-bit words of the longest record in this file.
12	R*8	Switch to indicate if run is interplanetary (0=no, 1=yes)
13	R*8	Spare
14	R*8	Tracking Data File creation date. (YYMMDD.)
15	R*8	Time of creation of Tracking Data File. (HHMMSS.)
16	R*8	Tracking Data Formatter version used. (YYMM.)
17	R*8	GEODYN II Interface File creation date. (YYMMDD.)
18	R*8	Time of creation of GEODYN II Interface File. (HHMMSS.)
19	R*8	GEODYN II-S version used. (YYMM.PP)
20	R*8	GEODYN II-E version used. (YYMM.PP)

5.2.4 GEODYN II UNIT 5 INPUT

There will be NC of these records.

64-BIT WORD	WORD TYPE	DESCRIPTION
1-10	CH*8	Image of one input control card.

5.2.5 TRACKING STATION COORDINATE RECORDS

There will be NSTA of these records.

64-BIT WORD	WORD TYPE	DESCRIPTION
1	CH*8	Tracking station name.
2	R*8	Tracking station number.
3	R*8	X coordinate of mean tracking station location.
4	R*8	Y coordinate of mean tracking station location.

```
   5     R*8      Z coordinate of mean tracking station location.

   6     R*8      Geodetic Latitude.

   7     R*8      East Longitude.

   8     R*8      Spheroidal Height.

   9     R*8      Spin Axis Distance.
```

5.2.6 ARC HEADER RECORD

An arc header record will precede the data for each arc in which the residual file option has been exercised.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    -------------------------------------------------------------

    1   R*8     -10**12

    2   R*8     Arc Number.

    3   R*8     Global Iteration Number.

    4   R*8     Inner Iteration Number.

    5   R*8     Editing multiplier.

    6   R*8     Editing RMS.

    7   R*8     A value greater than zero indicates that location data
                        records are present on this file.

    8   R*8     A value greater than zero indicates that observation data
                        records are present on this file.
                A value greater than one in this word indicates that
                        observation corrections records are present on
                        this file.

 9->20  R*8     Spares.
```

5.2.7 LENGTHS RECORD

A lengths record will precede each block of data.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    -------------------------------------------------------------

    1   R*8     Date and integral seconds of pass start time in
                Modified Julian Date Seconds [MJDS=(JD-2430000.5D0)*86400].

    2   R*8     Seconds and fractional seconds from pass start time to
                data block start time.

    3   R*8     Date and integral seconds of pass start time in the
```

```
             form year, month, day, hour, minute, second (YYMMDDHHMMSS.)

    4   R*8     Measurement type indicator.

    5   R*8     Difference measurement indicator. Must be set =1. unless
                        =2. for singly differenced range or Doppler, or
                        =4. for doubly differenced range or Doppler.

    6   R*8     Finite interval observation indicator (=1. except
                        =2. for average range rate data.)

    7   R*8     Number of computed elevation angles.

    8   R*8     Number of observations in this data block (NM).

    9   R*8     Number of stations involved in this obs. block (NSTAB).

   10   R*8     Number of satellites involved in this obs. block (NSATB).

   11   R*8     Station ID #1.

   12   R*8     Satellite ID #1.

   13   R*8     Station ID #2.

   14   R*8     Satellite ID #2.

   15   R*8     Station ID #3.

   16   R*8     Satellite ID #3.

NOTE: The pass start time is initially set in the Tracking Data Formatter,
      so it may precede the first observation by a short period of time
      if observations were deleted at the beginning of the pass.


64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------
   17   R*8     Antenna ID word (6 digit - abcdef)
                a=> sat 1 antenna for neighbor 1
                b=> sat 1 antenna for neighbor 2
                c=> sat 2 antenna for neighbor 1
                d=> sat 2 antenna for neighbor 2
                e=> sat 3 antenna for neighbor 1
                f=> sat 3 antenna for neighbor 2

   18  R*8      Laser Altimeter Id (-9999.D0 if this block does
                not contain laser altimeter data)

   19  R*8      Laser Altimeter Wavelength (-9999.D0 if this block
                block does not contain laser altimeter data)

   20  R*8      Spare
```

5.2.8 LOCATION DATA HEADER RECORD

(Optional: see Arc Header Record, Word 7)

If the location data option has been invoked, a location data header record will precede the location data records. Written from ANGHD and METHD for angles and metric data, respectively.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------
 1->20  R*8     Indexes in the Lengths Record of the station/satellite ID
                to which the following location data records apply. Odd
                indexes relate to tracking station locations and even to
                satellite locations.
                Tracking station locations provided are corrected for polar
                motion, tides, and possibly ocean loading. These coordinates
                are provided for all observation times. Satellite locations
                are provided for all observation times.

                Measurements other than differenced ranges and Dopplers will
                have non-zero indexes some or all of the first five words.

                Singly differenced ranges and Dopplers will have non-zero
                indexes in some or all of the first ten words.

                Doubly differenced ranges and Dopplers will have non-zero
                indexes in some or all words.

                Average range rate data will have two sets of location data
                records: one set for the start of the finite Doppler counting
                interval and one set for the end of that interval.
```

5.2.9 STATION LOCATION DATA RECORDS

(Optional: see Arc Header Record, Word 7)

The number of these records will be determined by the location data header record and by whether or not the data is average range rate.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------

 1-NM   R*8     Station time of each observation in elapsed seconds from
                pass starting MJDS.  (See Lengths Record, Word 1)

  NM+1  R*8     Cosine of right ascension of greenwich at each observation time.
 ->2NM
 2NM+1  R*8     Sine of right ascension of greenwich at each observation time.
 ->3NM
 3NM+1  R*8     Inertial X coordinate of station location at each observation
 ->4NM          time.

 4NM+1  R*8     Inertial Y coordinate of station location at each observation
 ->5NM          time.

 5NM+1  R*8     Inertial Z coordinate of station location at each observation
 ->6NM          time.
```

```
6NM+1   R*8      Inertial X velocity of station location at each observation
 ->7NM           time.

7NM+1   R*8      Inertial Y velocity of station location at each observation
 ->8NM           time.

8NM+1   R*8      Inertial Z velocity of station location at each observation
 ->9NM           time.
```

5.2.10 SATELLITE LOCATION DATA RECORDS

(Optional: see Arc Header Record, Word 7)

The number of these records will be determined by the location data header record and by whether or not the data is average range rate.

For interplanetary runs only, there will be 2 satellite location data records, as described below.

```
     THIS RECORD IS WRITTEN ONLY FOR INTERPLANETARY RUNS

64-BIT  WORD
 WORD   TYPE     DESCRIPTION
------  ----     -------------------------------------------------------------

 1-NM   R*8      Satellite times of observations in elapsed seconds from
                 pass starting MJDS.  (See Lengths Record, Word 1)

  NM+1  R*8      Inertial X coordinates of satellite position.
 ->2NM           True of date, center of integration coordinates.

 2NM+1  R*8      Inertial Y coordinates of satellite position.
 ->3NM           True of date, center of integration coordinates.

 3NM+1  R*8      Inertial Z coordinates of satellite position.
 ->4NM           True of date, center of integration coordinates.

 4NM+1  R*8      True of date satellite latitude wrt center of
 ->5NM           integration.

 5NM+1  R*8      True of date satellite longitude wrt center of
 ->6NM           integration.

 6NM+1  R*8      True of date satellite height above the ellipsoid
 ->7NM           of the center of integration.

64-BIT  WORD
 WORD   TYPE     DESCRIPTION
------  ----     -------------------------------------------------------------

 1-NM   R*8      Satellite times of observations in elapsed seconds from
                 pass starting MJDS.  (See Lengths Record, Word 1)

  NM+1  R*8      Inertial X coordinates of satellite position.
 ->2NM           Barycentric coordinates for interplanetary runs

 2NM+1  R*8      Inertial Y coordinates of satellite position.
```

```
 ->3NM          Barycentric coordinates for interplanetary runs

 3NM+1  R*8     Inertial Z coordinates of satellite position.
 ->4NM          Barycentric coordinates for interplanetary runs

 4NM+1  R*8     Inertial X coordinates of satellite velocity.
 ->5NM          Barycentric coordinates for interplanetary runs

 5NM+1  R*8     Inertial Y coordinates of satellite velocity.
 ->6NM          Barycentric coordinates for interplanetary runs

 6NM+1  R*8     Inertial Z coordinates of satellite velocity.
 ->7NM          Barycentric coordinates for interplanetary runs
```

5.2.11 RESIDUAL DATA RECORDS

Each data block will have one residual data record.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------

 1-NM   R*8     Elapsed seconds from pass start MJDS for each
                observation in the block (See Lengths Record, Word 1).

NM+1->  R*8     Observation residuals.
 2NM

 2NM+1  R*8     Observation editing sigmas.
 ->3NM

 3NM+1  R*8     Observation time derivatives.
 ->4NM

 4NM+1  R*8     Right Ascension of Greenwich.
 ->5NM

 5NM+1  R*8     Elevation angle from first link.
 ->6NM

 6NM+1  R*8     Elevation angle from second link.
 ->7NM

 7NM+1  R*8     Elevation angle from third link.
 ->8NM

 8NM+1  R*8     Elevation angle from fourth link.
 ->9NM

 9NM+1  R*8     Elevation angle from fifth link.
 ->10NM

 10NM+1  R*8     Elevation angle from sixth link.
 ->11NM

 11NM+1  R*8     Elevation angle from seventh link.
```

```
 ->12NM

 12NM+1  R*8     Elevation angle from eight link.
 ->13NM

 13NM+1  R*8     Elevation angle from ninth link.
 ->14NM

 14NM+1  R*8     Elevation angle from tenth link.
 ->15NM

64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    -------------------------------------------------------------

 15NM+1  R*8     Elevation angle from eleventh link.
 ->16NM

 16NM+1  R*8     Elevation angle from twelfth link.
 ->17NM

Note:  The link definition is dependent on the measurement configuration.

Note:  This record length is variable. It is at least 8NM long, and may
       be 17NM long, depending on measurement type.
```

5.2.12 OBSERVATION DATA HEADER RECORD

(Optional: see Arc Header Record, Word 8)

If the observation data option has been invoked one of these records will precede the observation data partitions records and indicate which observation data partitions will be present.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION (See GEODYN II Internal Tacking Data Format)
------  ----    -------------------------------------------------------------

    1   R*8     Number of partitions stored for each observation (i.e.
                        number of observation data records to follow).

  * 2   R*8     Switches indicating which of first 40 possible partitions
                are present.

  * 3   R*8     Switches indicating which of second 40 possible partitions
                are present.

 4-13   R*8     Observation data master header record.

 14->   R*8     Observation data header record #'s 1 -> NHDR. Where
10*NHDR         NHDR=MAX0(NSTAB,NSATB).
  +13

*  See section 3.3.3 for decomposition of switches.
```

5.2.13 OBSERVATION DATA PARTITIONS RECORDS

(Optional: see Arc Header Record, Word 8)

The data in these records will represent individual observation partitions as described in the GEODYN II Internal Tracking Data Format. Which partitions are present will be indicated by the observation data header record.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION (See GEODYN II Internal Tracking Data Format)
------  ----    ------------------------------------------------------------

 1->NM  R*8     Contents of the i th observation data partition.
```

5.2.14 SENTINEL RECORD

(See also ARC HEADER RECORD and LENGTHS RECORD)

This record is the same length as the Arc Header Record and the Lengths Record. The sentinel record will be encountered at the end of a file in place of an expected record of one of these types.

```
64-BIT  WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------

   1    R*8     +10**12

 2-20   R*8     Zero filled.
```

5.3 GEODYN-II OBSERVATION PARTIAL DERIVATIVE FILE

5.3.1 INTRODUCTION

The format of the GEODYN-II Observation Partial Derivative File has been designed to be very similar to the GEODYN-I Partial Derivative File. This has been done so as to minimize modifications to programs which presently utilize the GEODYN-I format.

On option GEODYN will output a binary file containing the measurement partial derivatives in the same order in which they are stored internally. This binary partial derivative file consists of a header record and five parameter information records followed by one partial derivative record for each weighted observation. After the last partial derivative record is a sentinel record. In GEODYN-II each arc generates a separate partial derivative file. Physically separating these files with file marks is optional. For this reason, programs reading the GEODYN-II Observation Partial Derivative File should expect a new file to follow each sentinel record unless a file mark is encountered.

The header record has a fixed number of words and all other records contain a variable number of words depending on the parameters used in the run. All words are 64-bit floating point words.

A description of the eight types of records contained in the GEODYN-II Observation Partial Derivative File follows:

```
RECORD         RECORD DESCRIPTION
 TYPE
-----------------------------------------------------------------

   1           HEADER RECORD

                    Contains speed of light, creation date, number of
                    parameters and other general information (30 Words).

   2           PARAMETER GROUP IDENTIFIERS

                    Fifteen digit numbers used to identify the different
                    groups of estimated parameters (e.g. drag,tides,etc.)
```

```
  3          NUMBER OF PARAMETERS IN EACH GROUP

                  The number of estimated parameters in each group.

  4          PARAMETER LABELS

                  Parameter identification (label) for each estimated
                  parameter. These are the same as the E-Matrix parameter
                  labels.

  5          PARAMETER VALUES

                  Current value for each estimated parameter in this run.

  6          PARAMETER A PRIORI VALUES

                  A priori value for each estimated parameter in this run.

  7          MEASUREMENT PARTIAL DERIVATIVE RECORDS

  8          SENTINEL RECORD
```

5.3.2 HEADER RECORD

The Header Record contains the file creation date which uniquely identifies this partial derivative file, the GEODYN version used to create the file, the number of estimated parameters in this run and other information describing the run. Words 5-8 of the header record contain information from the next to last inner iteration of the first global iteration of the GEODYN-II execution. If this file is output on the first inner iteration then words 5-8 will be zero. Consequently word 5 will not necessarily be representative of the number of Measurement Partial Derivative Records to follow.

```
 WORD        DESCRIPTION
-----------------------------------------------------------------------

  1          Negative of the Partial Derivative File number (the
             positive number input in columns 25-44 of the PARFIL card).

  2          Negative of the E-Matrix number (E-Matrix number is the
             positive number input in columns 25-44 of the EMATRX card).

  3          Total number of estimated parameters in the run (N).

  4          Number of parameter description records. (Currently=0).

  5          Number of weighted observations.

  6          Total variance.

  7          Weighted variance.

  8          Arc variance.

  9          Number of satellites in run.

 10          Central forcing body and center of integration (Earth=0300).
```

11	Date of job (YYMMDD.).
12	Time of job (HHMMSS.).
13	Surface density/gravity anomaly switch (currently=0).
14	GEODYN version (e.g 8604.0).
15	Number of parameter groups(NGI).
16	Speed of light used by GEODYN.
17-30	Spares

Length for Header Record = 30 words (1 word = 64 bits = 8 bytes)

5.3.3 PARAMETER GROUP IDENTIFIERS

The parameter group identifier record contains numbers that uniquely define the different groups of estimated parameters such as drag, solar radiation, etc.. These fifteen digit identifiers are derived from the E-Matrix label. This record contains NGI of these identifiers, where NGI is the number of groups indicated in the HEADER RECORD. Following is a list of the currently defined group identifiers.

GROUP IDENTIFIER	DESCRIPTION
0.	Satellite epoch elements
10000200000000.	Drag parameters
10000400000000.	Solar radiation parameters
10000800000000.	General acceleration parameters
20000000000000.	Arc geopotential parameters
30000000000000.	Thermal Drag parameters
30002000000000.	Panel area parameters
30003000000000.	Panel secular reflectivity parameters
30004000000000.	Panel diffuse reflectivity parameters
30005000000000.	Panel emmissivity parameters
30006000000000.	Panel temperature A parameters
30007000000000.	Panel temperature C parameters
30008000000000.	Panel time D parameters
30009000000000.	Panel time F parameters
30010000000000.	Panel theta x parameters
39999900000000.	Offset parameters

40000000000000.	Measurement and timing biases
50010000000000.	Arc FANTOM Geometric model parameters.
50020000000000.	Arc FANTOM Force model parameters.
50100000000000.	Attitude parameters.
50200000000000.	Dynamic crossover radial separator.
60000000000000.	Global geopotential parameters
70000000000000.	Standard tide parameters (K2,K3,k2 phase)
71000000000000.	New earth and ocean tide model
75000000000000.	Tidal Model using Proudman Function
80000000000000.	Local gravity
88000000000000.	Figure axis scale factor for dynamic polar motion
90000000000000.	GM
90000100000000.	Planetary Ephemeris correction parameters
90000200000000.	Semi-major axis
90000300000000.	Polar flattening
90000400000000.	Equatorial flattening
90001000000000.	Planetary Moon
90010000000000.	Speed of light
90011000000000.	Ephemeris correction for central body
90012000000000.	Ephemeris correction for tracking body
91000000000000.	Solid earth tidal displacement
92000000000000.	Ocean loading parameters
95000000000000.	Polar motion and ut1
97000000000000.	Planet Orientation parameters
90000000000000.	Common measurement biases
110000000000000.	Station coordinates
110000000001000.	Global geometric model FANTOM parameters
110000000002000.	Global force model FANTOM parameters
110000000010000.	Lense-Thirring parameters

```
 120000000000000.       Sea Surface topography parameters

 120100000000000.       Sea Surface topography using Proudman Functions

 130000000000000.       Station velocities

 130010000000000.       Station L2

 130020000000000.       Station H2

Length for this type of record = NGI words (1 word = 64 bits = 8 bytes)

This record contains the number of estimated parameters for each
group of parameters included in the Group Identifier Record. There are
NGI words in this record, where NGI is the number of groups indicated in the
Header Record.
```

5.3.4 NUMBER OF PARAMETERS RECORD

This record contains the number of estimated parameters for each group of parameters included in the Group Identifier Record. There are NGI words in this record, where NGI is the number of groups indicated in the Header Record.

Following is an example of a Group Identifier Record, a Number Of Parameters Record and a description of what they mean.

```
GROUP IDENTIFIER       NUMBER OF                  DESCRIPTION
  RECORD              PARAMETERS
-----------------------------------------------------------------------

              0.        6              Number of satellite epoch elements

  10000200000000.       1              Drag parameters

  10000400000000.       1              Solar radiation parameters

  50000000000000.       10             Global geopotential parameters

  85000000000000.       6              Polar motion and ut1

  90000000000000.       1              Common measurement biases

 100000000000000.       9              Station coordinates


Length for this type of record = NGI words (1 word = 64 bits = 8 bytes)
```

5.3.5 PARAMETER LABELS RECORD

```
  WORD NO.          DESCRIPTION
-----------------------------------------------------------------------

    1               Word count for remainder of this record = (3N+1) - where N
                    is the number of estimated parameters

    2 - 3N+1        Parameter labels - each parameter label consists of
                    three words. The first N words output correspond to the
```

```
                 first word for each parameter label, the next N words
                 correspond to the second word for each parameter label,
                 and the next N words correspond to the third word for
                 each parameter label


Length for this type of record = 3N+1 words (1 word = 64 bits = 8 bytes)


NOTE: See DESCRIPTION OF E-MATRIX PARAMETER LABELS section for more details
```

5.3.6 PARAMETER VALUES RECORD

```
  WORD NO.         DESCRIPTION
------------------------------------------------------------------------

    1              Word count for remainder of this record = N - where N
                   is the number of estimated parameters

    2 - (N+1)      Current values for all estimated parameters



Length for this type of record = N+1 words (1 word = 64 bits = 8 bytes)
```

5.3.7 PARAMETER A PRIORI VALUES

```
  WORD NO.         DESCRIPTION
------------------------------------------------------------------------

    1              Word count for remainder of this record = N - where N
                   is the number of estimated parameters

    2 - (N+1)      A priori values for all estimated parameters


Length for this type of record = N+1 words (1 word = 64 bits = 8 bytes)
```

5.3.8 MEASUREMENT PARTIAL DERIVATIVE RECORDS

The Measurement Partial Derivative records contain the measured observation, the observation residual (observed minus computed), the observation weight, the time of observation, spacecraft ephemeris at the observation time and other identifying information in addition to the observation partial derivatives with respect to the set of estimated parameters.

Each logical record corresponds to one measurement observation and its associated partial derivatives, observation residual, etc.

```
  WORD NO.   DESCRIPTION
------------------------------------------------------------------------

    1        Observation UTC date and time to the integral second.
             (YYMMDDHHMMSS.)

    2        Fraction of UTC seconds of observation time.

    3        Modified Julian Day Seconds (ET) of observation time.
```

```
          (MJDS = (Julian Date - 2430000.5) * 86400   truncated to
          integral seconds)

   4      Fraction of ET seconds of observation time.

   5      Observation type/time tag identifier (mm.tt). Where "mm" is the
          GEODYN-II measurement type and "tt" defines the transmission/
          reception state as follows:

             00  Receiver Time
             01  Satellite Transponder/Reflector Time
                 or Altimeter Ground Reflection Time
             02  Transmitter Time

   6      Speed of light in meters/second.

   7      Tracking Station Number 1 ID.

   8      Tracking Station Number 2 ID.

   9      Tracking Station Number 3 ID.

  10      Satellite Number 1 ID.

  11      Satellite Number 2 ID.

 WORD NO. DESCRIPTION
-----------------------------------------------------------------------

  12      Satellite Number 3 ID.

  13      Observation Value (units: length - meters, time - seconds,
                             angles - radians).

  14      Sum of observation time corrections (seconds).

  15      Sum of observation corrections (same units as observation).

  16      Sum of ocean parameters for altimetry only (type = 99).
              (same units as observation)

  17      Observation residual (observed minus computed).
              (same units as observation)

  18      Observation weight (square of same units as observation).

  19      Altimeter Crossover Key (type = 99) or Counting Interval
          (seconds) for average range rates (even types 40-98).

  20      Spare.

  21      Time of Satellite No. 1 ephemeris information in elapsed seconds
          (ET) from value specified in word 3 of this record.

  22      Inertial True-of-Date X coordinate of Satellite Number 1 (m).
  23      Inertial True-of-Date Y coordinate of Satellite Number 1 (m).
  24      Inertial True-of-Date Z coordinate of Satellite Number 1 (m).
```

```
   25        Inertial True-of-Date X velocity of Satellite Number 1 (m/s).
   26        Inertial True-of-Date Y velocity of Satellite Number 1 (m/s).
   27        Inertial True-of-Date Z velocity of Satellite Number 1 (m/s).

   28        Sub-satellite Latitude (degrees) for Satellite Number 1.
   29        Sub-satellite East Longitude (degrees) for Satellite Number 1.
   30        Sub-satellite Ellipsoidal Height (m) for Satellite Number 1.

  WORD NO.   DESCRIPTION
--------------------------------------------------------------------------


   31        Time of Satellite No. 2 ephemeris information in elapsed seconds
             (ET) from value specified in word 3 of this record.

   32        Inertial True-of-Date X coordinate of Satellite Number 2 (m).
   33        Inertial True-of-Date Y coordinate of Satellite Number 2 (m).
   34        Inertial True-of-Date Z coordinate of Satellite Number 2 (m).

   35        Inertial True-of-Date X velocity of Satellite Number 2 (m/s).
   36        Inertial True-of-Date Y velocity of Satellite Number 2 (m/s).
   37        Inertial True-of-Date Z velocity of Satellite Number 2 (m/s).

   38        Sub-satellite Latitude (degrees) for Satellite Number 2.
   39        Sub-satellite East Longitude (degrees) for Satellite Number 2.
   40        Sub-satellite Ellipsoidal Height (m) for Satellite Number 2.

   41        Time of Satellite No. 3 ephemeris information in elapsed seconds
             (ET) from value specified in word 3 of this record.

   42        Inertial True-of-Date X coordinate of Satellite Number 3 (m).
   43        Inertial True-of-Date Y coordinate of Satellite Number 3 (m).
   44        Inertial True-of-Date Z coordinate of Satellite Number 3 (m).

   45        Inertial True-of-Date X velocity of Satellite Number 3 (m/s).
   46        Inertial True-of-Date Y velocity of Satellite Number 3 (m/s).
   47        Inertial True-of-Date Z velocity of Satellite Number 3 (m/s).

   48        Sub-satellite Latitude (degrees) for Satellite Number 3.
   49        Sub-satellite East Longitude (degrees) for Satellite Number 3.
   50        Sub-satellite Ellipsoidal Height (m) for Satellite Number 3.

51 - N+50    Measurement partial derivatives.
             (units: length - meters, time - seconds, angles - radians)


Length for this type of record = N+50 words (1 word = 64 bits = 8 bytes)
```

5.3.9 MEASUREMENT PARTIAL DERIVATIVE FILE SENTINEL RECORD

```
  WORD NO.         DESCRIPTION
--------------------------------------------------------------------------

   1 - 50          -999999.

  51 - N+50        Undefined.
```

```
Length for this type of record = N+50 words (1 word = 64 bits = 8 bytes)
```

5.4 GEODYN II: E-MATRIX FILE

5.4.1 INTRODUCTION

On option GEODYN will output a binary file containing the normal equations in the same form in which they are stored internally. This binary E-Matrix file consists of a header record followed by six different types of data records. The header record has a fixed number of words and all other records contain a variable number of words depending on the parameters used in the run. All words are 64 bit floating point words.

A description of the seven types of records contained in the E-MATRIX file follows:

```
RECORD        RECORD DESCRIPTION
 TYPE
-----------------------------------------------------------------------
   1          HEADER RECORD

                   Contains E-matrix number, creation date, number of
                   parameters and other general information (30 Words)

   2          PARAMETER GROUP IDENTIFIERS

                   Fifteen digit numbers used to identify the different
                   groups of estimated parameters (e.g. drag,tides,etc.)

   3          NUMBER OF PARAMETERS IN EACH GROUP

                   The number of estimated parameters in each group

   4          PARAMETER LABELS

                   Parameter identification (label) for each estimated
                   parameter in the normal matrix

   5          PARAMETER VALUES

                   Current value for each estimated parameter in this run

   6          PARAMETER A PRIORI VALUES

                   A priori value for each estimated parameter in this run

   7          NORMAL MATRIX DATA

                   Normal matrix data elements by rows (starting with diagonal
                   term and ending with residual column term)
```

5.4.2 HEADER RECORD

The Header Record contains the E-Matrix number and creation date that uniquely identify this E-Matrix file, the Geodyn version used to create the file, the number of estimated parameters in this run and other general information describing the run.

```
 WORD         DESCRIPTION
-----------------------------------------------------------------------
  1           Negative of the E-Matrix number (E-Matrix number is the
```

	positive number input in columns 25-44 of the EMATRX card)
2	Negative of the E-Matrix number (E-Matrix number is the positive number input in columns 25-44 of the EMATRX card)
3	Total number of estimated parameters in the run
4	Number of parameter description records. (Currently=0)
5	Number of weighted observations.
6	Total variance.
7	Weighted variance
8	Arc variance
9	Number of satellites in run
10	Central forcing body and center of integration (Default=0300 Earth)
11	G2S run date and time (YYMMDDHHMMSS).
12	G2E run date and time (YYMMDDHHMMSS).
13	Surface density/gravity anomaly switch (currently=0)
14	Geodyn version (e.g 8407.1)
15	Number of parameter groups(NGI)
16	Speed of light used by GEODYN.
17	1 mean E-matrix data is compressed
18	YYMMDDHHMM.SS of reference date of run
19	Number of extra words output at end of parameter label record. These are associated with the TIEOUT option.
21	Number to be added to all global emat labels for all the GEODYN versions in the future.
22-30	Spares

Length for Header Record = 30 words (1 word = 64 bits = 8 bytes)

5.4.3 PARAMETER GROUP IDENTIFIERS

The parameter group identifier record contains numbers that uniquely define the different groups of estimated parameters such as drag, solar radiation, etc.. These fifteen digit identifiers are derived from the E-Matrix label. This record contains NGI of these identifiers, where NGI is the number of groups indicated in the HEADER RECORD. Following is a list of the currently defined group identifiers.

GROUP IDENTIFIER DESCRIPTION

0.	Satellite epoch elements
10000200000000.	Drag parameters
10000400000000.	Solar radiation parameters
10000800000000.	General acceleration parameters
20000000000000.	Arc geopotential parameters
30000000000000.	Thermal Drag Parameters
30002000000000.	Panel area parameters.
30003000000000.	Panel secular reflectivity parameters.
30004000000000.	Panel diffuse reflectivity parameters.
30005000000000.	Panel emmissivity parameters.
30006000000000.	Panel temperature A parameters.
30007000000000.	Panel temperature C parameters.
30008000000000.	Panel time D parameters.
30009000000000.	Panel time F parameters.
30010000000000.	Panel theta X parameters.
39999900000000.	Offset parameters.
40000000000000.	Measurement and timing biases
50010000000000.	Arc FANTOM Geometric model parameters.
50020000000000.	Arc FANTOM Force model parameters.
50100000000000.	Attitude parameters.
50200000000000.	Dynamic crossover radial separator.
50300000000000.	Accelerometer bias parameters
50400000000000.	DSTATE parameters
60000000000000.	Global geopotential parameters
70000000000000.	Standard tide parameters (K2,K3,k2 phase)
71000000000000.	New earth and ocean tide model
75000000000000.	Tidal Model using Proudman Function.
80000000000000.	Local gravity
88000000000000.	Figure axis scale factor for dynamic polar motion.

90000000000000.	GM
90000100000000.	Planetary ephemeris correction parameters
90000200000000.	Semi-major axis
90000300000000.	Polar flattening
90000400000000.	Equatorial flattening
90001000000000.	Planetary moon
90010000000000.	Speed of light
90011000000000.	Ephemeris correction for central body
90012000000000.	Ephemeris correction for tracking body
91000000000000.	Solid earth tidal displacement
92000000000000.	Ocean loading parameters
95000000000000.	Polar motion and UT1
96000000000000.	Polar motion and UT1 Rate parameters
97000000000000.	VLBI parameters
98000000000000.	Planet orientation parameters
100000000000000.	Common measurement biases
110000000001000.	Global geometric model FANTOM parameters
110000000002000.	Global force model FANTOM parameters.
110000000010000.	Lense-Thirring parameters.
110001000000000.	Station coordinates
120000000000000.	Sea surface topography parameters.
120100000000000.	Sea surface topography using Proudman Functions.
130000000000000.	Station velocities.
130010000000000.	Station L2.
130020000000000.	Station H2.

```
Length for this type of record = NGI words (1 word = 64 bits = 8 bytes)
This record contains the number of estimated parameters for each
group of parameters included in the Group Identifier Record. There are
NGI words in this record, where NGI is the number of groups indicated in the
Header Record.
```

Following is an example of a Group Identifier Record, a Number of Parameters Record and a description of what they mean.

5.4.4 NUMBER OF PARAMETERS RECORD

This record contains the number of estimated parameters for each group of parameters included in the Group Identifier Record. There are NGI words in this record, where NGI is the number of groups indicated in the Header Record.

Following is an example of a Group Identifier Record, a Number of Parameters Record and a description of what they mean.

GROUP IDENTIFIER RECORD	NUMBER OF PARAMETERS	DESCRIPTION
0.	6	Number of satellite epoch elements
10000200000000.	1	Drag parameters
10000400000000.	1	Solar radiation parameters
50000000000000.	10	Global geopotential parameters
85000000000000.	6	Polar motion and ut1
90000000000000.	1	Common measurement biases
100000000000000.	9	Station coordinates

Length for this type of record = NGI words (1 word = 64 bits = 8 bytes)

5.4.5 PARAMETER LABELS RECORD

WORD NO.	DESCRIPTION
1	Word count for the labels portion of this record =(3N+1) where N is the number of estimated parameters. The actual number of words remaining in the entire record is (3N+1) plus the number indicated in word 19 of the header record. The extra words (if present) are associated with the TIEOUT option.
2 - 3N+1	Parameter labels - each parameter label consists of three words. The first N words output correspond to the first word for each parameter label, the next N words correspond to the second word for each parameter label, and the next N words correspond to the third word for each parameter label
3N+2	Residual column label (200000000000000.)
3N+3	YYMMDDHHMMSS.SS of reference time associated with the TIEOUT option.

```
    3N+4            TIEOUT output time in elasped UTC seconds since 2430000.5

    3N+5            Number of satellites. Each satellite will have a block of
                    7+6N words associated with it.

    3N+6            NSAT (number of satellites.  Each satellite will have a
                    block of (6*(N+1)+1) words.

    3N+7            GM of the central body used in the run.

    3N+8            The following 6(N+1)+1 words are repeated for each satellite:
    NSAT*           Satellite ID, State vector at TIEOUT time (6), for each
(6(N+1)+1)          parameter the partial derivative of the state with respect
    +3N+7           each of the N estimated parameters (6,N).


 NOTE: See DESCRIPTION OF E-MATRIX PARAMETER LABELS section for more details



Length for this type of record = 3N+2 words (1 word = 64 bits = 8 bytes)
```

5.4.6 PARAMETER VALUES RECORD

```
  WORD NO.          DESCRIPTION
------------------------------------------------------------------------

    1               Word count for remainder of this record = N - where N
                    is the number of estimated parameters

    2 - (N+1)       Current values for all estimated parameters



Length for this type of record = N+1 words (1 word = 64 bits = 8 bytes)
```

5.4.7 PARAMETER A PRIORI VALUES

```
  WORD NO.          DESCRIPTION
------------------------------------------------------------------------

    1               Word count for remainder of this record = N - where N
                    is the number of estimated parameters

    2 - (N+1)       A priori values for all estimated parameters


Length for this type of record = N+1 words (1 word = 64 bits = 8 bytes)
```

5.4.8 MATRIX DATA RECORDS

The normal matrix data records are use to output the entire normal matrix. Each logical record corresponds to one row of the matrix, and thus each record contains one less element than the preceding record until the last row of the matrix has been output. Since the normal matrix is upper triangulated the first element from each row is the diagonal element.

```
  WORD NO.         DESCRIPTION
------------------------------------------------------------------------

    1              Normal matrix row number

    2              Number of elements in this row of the normal matrix (Ne)

    3 - (Ne+2)     Matrix elements for this row of the normal matrix

    4              Element Rj of residual contributions vector
```

Length for this type of record = Ne+3 words (1 word = 64 bits = 8 bytes)

5.4.9 E-MATRIX LABELS DESCRIPTION

```
WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1     0ssnnfcddddddd. EPOCH ELEMENTS OF A SATELLITE, WHERE

                        ssnn - INTERNAL SATELLITE NUMBER USED BY GEODYN
                                (ss IS SET #, nn IS SEQ. # WITHIN SET)

                        f - FORM OF THE ELEMENTS
                                0 - CARTESIAN
                                1 - KEPLERIAN
                                2 - NON-SINGULAR KEPLERIAN (LOW e, LOW i)

                        c - COMPONENT, SUCH THAT

                                \f| 0 | 1 | 2
                                c\|   |   |
                                __|___|___|_______________
                                  |   |   |
                                1 | X | a | a
                                __|___|___|_______________
                                  |   |   |
                                2 | Y | e | eCOS(W+N)
                                __|___|___|_______________
                                  |   |   |
                                3 | Z | i | eSIN(W+N)
                                __|___|___|_______________
                                  | . |   |
                                4 | X | N | SIN(i/2)SIN(N)
                                __|___|___|_______________
                                  | . |   |
                                5 | Y | W | SIN(i/2)COS(N)
                                __|___|___|_______________
                                  | . |   |
                                6 | Z | M | M+W+N
                                __|___|___|_______________

                        ddddddd - INTERNATIONAL SATELLITE ID
```

```
WORD    LABEL           DESCRIPTION
----    --------------  ------------------------------------------------------

  1     1ssnnptfcmmmmm. SATELLITE DEPENDENT FORCE MODEL PARAMETERS.

                        ssnn - INTERNAL SATELLITE NUMBER USED BY GEODYN

                        p - PARAMETER TYPE
                                2 - DRAG COEFFICIENT
                                4 - SOLAR REFLECTIVITY
                                6 - ALBEDO REFLECTIVITY
                                8 - EMPIRICAL ACCELERATION COEFFICIENT

                        t - TAYLOR SERIES COMPONENT
                                0 - FIRST ORDER COEFFICIENT
                                i - iTH COEFFICIENT TIME DERIVATIVE

                                FOR EXAMPLE:

                                        p=2, t=0 IMPLIES C
                                                          D
                                                         .
                                        p=2, t=1 IMPLIES C
                                                          D
                        f - ACCELERATION TYPE

                                0 - NON-DESCRIPT
                                1 - R,C,L
                                2 - B.C.F. X,Y,Z
                                3 - IN-PLANE
                                4 - LONGITUDINAL

                        c - COMPONENT
                                0 - SCALAR
                                1 - RADIAL OR X
                                2 - CROSS TRACK OR Y
                                3 - ALONG TRACK OR Z

                        mmmmm - INTERNAL SEQUENCE NUMBER USED BY GEODYN
                                FOR THIS PARAMETER.

  2         tttttttttt. tttttttttt - START TIME IN "MJDSEC" FOR THIS PARAMETER.
                                        WHERE
                                        "MJDSEC"=(DJ-2430000.5D0)*86400+ISEC

  3         tttttttttt. tttttttttt - STOP TIME IN "MJDSEC" FOR THIS PARAMETER.

WORD    LABEL           DESCRIPTION
----    --------------  ------------------------------------------------------

  1     300ppssnn00000. TOPEX BOXWING PARAMETERS.

                        pp - PARAMETER IDENTIFIER
                             (SAME AS ON PANEL CARD)

                                01 - Normal vector in body-fixed coordinates
                                02 - Area
```

```
                    03 - Specular Reflectivity
                    04 - Diffuse Reflectivity
                    05 - Emissivity
                    06 - Temperature A
                    07 - Temperature C
                    08 - Temperature Decay Time D
                    09 - Temperature Decay Time F
                    10 - Temperature/Satellite rotation x
                         (divisor for cos(theta) term in heating
                         equation)

                ss - INTERNAL SATELLITE NUMBER

                nn - PLATE NUMBER


  2             8 DIGIT SATELLITE ID


  3     00000000


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1     3ssnn000000000. THERMAL DRAG SPIN AXIS DIRECTION

                        ssnn - INTERNAL SATELLITE NUMBER USED BY GEODYN
                        ss   - SET NUMBER
                        nn   - SATELLITE NUMBER WITHIN SET (MIN = 0101)


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1     399999ssnn0alc. Offset Parameter

                               ss - SET NUMBER (internally used by GEODYN)
                               nn - SEQUENCE NUMBER FOR THE SATELLITE
                                       WITHIN THE SET
                                a - ANTENNA NUMBER
                                l - LINK 1 OR 2
                                c - x,y or z       1,2 or 3


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1     4mmmnnnnnnnnss. ARC MEASUREMENT BIASES.

                        mmm - BIAS TYPE, SUCH AS TIMING, RANGE, REFRACTION, etc.

                        nnnnnnnn - TRACKING STATION NUMBER OF FIRST STATION
                                        IN CONFIGURATION.

                        ss - ABBREVIATED GEODYN INTERNAL SEQUENCE NUMBER FOR
                                STATION nnnnnnnn BIASES OF TYPE mmm.
                                ss RANGES FROM 0 TO 99. FOR NUMBERS GREATER
```

```
                              THAN 99, THE VALUE 99 IS ASSIGNED.

      NOTE: Arc Bias 800/800 (VLBI Station Baseline Bias) has a slightly different
        definition

        4800ssssstttttt.

                        sssss - first ststion in the baseline
            ttttt - second station in the baseline


   2    xxxxtttttttttt. xxxx - GEODYN INTERNAL SEQUENCE NUMBER FOR STATION
                              nnnnnnnn BIASES OF TYPE mmm.
                              xxxx RANGES FROM 0 TO 9999.

                        tttttttttt - BIAS START TIME IN FORM "MJDSEC",
                                    WHERE
                                    "MJDSEC"=(DJ-2430000.5D0)*86400+ISEC

   3    yyyytttttttttt. yyyy - BIAS CONFIGURATION POINTER.

                        tttttttttt - BIAS STOP TIME IN FORM "MJDSEC".

        NOTE: For Measurement Biases 304 (clock bias spline), 501 (trop zenith spline),
          502 (trop gradient east component) and 503 (trop gradient north component)
          the  third word is defined as follows:

          sttt

            s   - degree of the spline
            ttt - total number of parameters in the string


WORD    LABEL           DESCRIPTION
----    --------------  ------------------------------------------------------
   1    500bcccccccdmn  ARC PHANTOM PARAMETERS

                        b - INDEX TO MODELING OPTION
                             1 - GEOMETRIC MODEL
                             2 - FORCE MODEL

                        ccccccc - SATELLITE ID

                        m - THIRD WORD CONTENTS
                             0 - NO TIME INCLUDED
                             1 - WORD 3 CONTAINS EPOCH TIME FOR THIS PARAMETER
                             2 - WORD 3 CONTAINS START TIME FOR A TIME DEPENDENT
                                 OPTION

                        n - COMPONENT INDICATOR
                             0 - NO COMPONENTS
                             1,2,3  - UP TO 3 COMPONENTS TO BE SPECIFIED BY
                                      THE USER

   2   tttttttttt.tttttttttt - END TIME IN "MJDSEC" FOR THIS PARAMETER WHERE
                             "MJDSEC" = (D3-2430000.5D0)*86400+ISEC
                             NOTE: WORD 2 WILL CONTAIN END TIMES ONLY
                             IN CASE OF TIME DEPENDENT FANTOM PARAMETERS
```

```
  3    tttttttttt.tttttttttt - SPECIFIED BY m IN WORD 1 AND EXPRESSED IN
                               "MJDSEC".


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------
  1     503aaaaaaabcde  ACCELEROMETER BIASES

                        aaaaaaa - SATELLITE ID

                        b - 0

                        c - Type of Bias


                           1 - ABSOLUTE
                           2 - SCALE
                           3 - TIMING

                        d - component

                           1 - TOTAL (dsqrt(X**2+Y**2+Z**2))
                           2 - X
                           3 - Y
                           4 - Z

                        e - order

                           1 - CONSTANT
              2 - LINEAR
              3 - QUADRATIC
              4 - PERIODIC (COSWT)
              5 - PERIODIC (SINWT)

  2    tttttttttt.tttttttttt - START TIME IN "MJDSEC" FOR THIS PARAMETER WHERE
                               "MJDSEC" = (D3-2430000.5D0)*86400+ISEC

  3    tttttttttt.tttttttttt - END TIME IN "MJDSEC" FOR THIS PARAMETER WHERE
                               "MJDSEC" = (D3-2430000.5D0)*86400+ISEC


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------
  1     504abbbbbbbccd  DELTA STATE PARAMETERS

                        a - 0 (not defined)

                        bbbbbbb - SATELLITE ID

                        cc - NUMBER OF DELTA STATE EVENTS
                             FOR THIS SATELLITE


                        d - component

                           1 - X
                           2 - Y
```

```
                       3 - Z
                       4 - X dot
                       5 - Y dot
                       6 - Z dot


  2    tttttttttt.tttttttttt - TIME TAG IN "MJDSEC" FOR THIS DELTA STATE EVENT
                               "MJDSEC" = (D3-2430000.5D0)*86400+ISEC

  3    0000000000.0000000000 -


WORD    LABEL           DESCRIPTION
----    --------------  ----------------------------------------------------
  1     505aabcccccccd  Solar Radiation TUM model Box-Wing Parameter Labels

                        aa - Sequence of Spacecraft (1-32)

                        b  - Block type (1-5)

                        ccccccc - SATELLITE ID

                        d  - Parameter type

                           1 - Solarpanel scale factor φ
                           2 - Solarpanel rotation factor θ
                           3 - Box wing X+ (α + δ)
                           4 - Box wing X+ (e)
                           5 - Box wing Z+ (α + δ)
                           6 - Box wing Z+ (e)
                           7 - Box wing Z- (α + δ)
                           8 - Box wing Z- (e)
                           9 - Y-bias


WORD    LABEL           DESCRIPTION
----    --------------  ----------------------------------------------------
  1     599ssnnptfcmmm  GLOBAL SATELLITE DEPENDENT FORCE MODEL PARAMETERS

                        ssnn - INTERNAL SATELLITE NUMBER USED BY GEODYN

                        p - PARAMETER TYPE
                             2 - DRAG COEFFICIENT
                             4 - SOLAR REFLECTIVITY
                             6 - ALBEDO REFLECTIVITY
                             8 - EMPIRICAL ACCELERATION COEFFICIENT

                        t - TAYLOR SERIES COMPONENT
                             0 - FIRST ORDER COEFFICIENT
                             1 - 1TH COEFFICIENT TIME DERIVATIVE

                        f - ACCELERATION TYPE
                             0 - NON-DESCRIPT
                             1 - R,C,L
                             2 - B.C.F. X,Y,Z
                             3 - IN-PLANE
                             4 - LONGITUDINAL
```

```
                  c - COMPONENT
                       0 - SCALAR
                       1 - RADIAL OR X
                       2 - CROSS TRACK OR Y
                       3 - ALONG TRACK OR Z

                  mmm - INTERNAL SEQUENCE NUMBER USED BY GEODYN
                        FOR THIS PARAMETER.

  2     tttttttttt.  tttttttttt - START TIME IN "MJDSEC" FOR THIS PARAMETER.
                                  WHERE
                                  "MJDSEC"=(DJ-2430000.5D0)*86400+SEC


  3     tttttttttt.  tttttttttt - STOP TIME IN "MJDSEC" FOR THIS PARAMETER.


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1     6bbbbjknnnmmml. COMMON GRAVITATIONAL COEFFICIENTS.

                  bbbb - BODY IDENTIFIER
                          0100  MERCURY
                          0200  VENUS
                          0300  EARTH
                          0301  EARTH'S MOON
                          0400  MARS
                          0500  JUPITER
                          0600  SATURN
                          0700  URANUS
                          0800  NEPTUNE
                          0900  PLUTO
                          9999  SUN

                  j - COEFFICIENT TYPE
                          1 - COEFFICIENT OF COSINE (C)
                          2 - COEFFICIENT OF  SINE  (S)
                          3 - COEFFICIENT OF COSINE (C) TERM FOR
                              TIME DEPENDENT GRAVITY
                          4 - COEFFICIENT OF  SINE  (S) TERM FOR
                              TIME DEPENDENT GRAVITY
                          5 - COEFFICIENT OF COSINE (C) TERM FOR
                              TIME PERIOD GRAVITY
                          6 - COEFFICIENT OF SINE (S) TERM FOR
                              TIME PERIOD GRAVITY


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

                  k - TIME DEPENDENT GRAVITY INDICATOR
                          0 - NO TERM
                          1 - RATE TERM (C dot or S dot)
                          2 - A COEFFICIENT
                          3 - B COEFFICIENT
                          _
                         | nnn - DEGREE                      _
```

```
                  |                                     | nnn - DEGREE
          k > 0   | mmm - ORDER              k = 0     |
                  |                                     |_mmml - ORDER
                  |_l - NUMBER OF PERIOD

  2     tttttttttt      EPOCH TIME IN "MJDSEC" FOR THIS PARAMETER
                        WHERE: "MJDSEC" = (DJ-2430000.50)*86400 SEC

  3     tttttttttt      PERIOD IN YEARS FOR THIS PARAMETER


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1     7tcnnmmsMKHJJB. EARTH TIDAL COEFFICIENTS.

                        t - MODEL AND SENSE INDICATOR.
                                0 - LOVE NUMBER MODEL
                                1 - DEMOS SOLID EARTH TIDE MODEL
                                2 - DEMOS OCEAN TIDE MODELS
                                3 - NORMALIZED SYMMETRIC TIDE (EARTH)
                                4 - NORMALIZED SYMMETRIC TIDE (OCEAN)
                                5 - OCEAN TIDE MODEL  (PROUDMAN FUNCTIONS)
                6 - DOODSON EARTH TIDES
                7 - C COEF FOR OCEAN RAY TIDES (DOODSON)
                8 - S COEF FOR OCEAN RAY TIDES (DOODSON)
                    FOR DOODSON (RAY) LABELS GO TO THE
                    END OF THIS SECTION 7 (*)

                        c - COEFFICIENT INDICATOR

                                \t|   0    |  >0
                                c\|        |
                                __|________|___________________
                                  |        |
                                1 | Ampl.  | Cosine Coefficient
                                __|________|___________________
                                  |        |
                                2 | Phase  |  Sine  Coefficient
                                __|________|___________________
                       --
                      | nn - DEGREE
                      |
                      | mm - ORDER
                      |
               5>t>0  | s - SIGNS (EARTH TIDES HAVE ONLY POSITIVE HARMONIC)
                      |         0 - POSITIVE DEMOS # AND POSITIVE HARMONIC
                      |         1 - POSITIVE DEMOS # AND NEGATIVE HARMONIC
                      |         2 - NEGATIVE DEMOS # AND POSITIVE HARMONIC
                      |         3 - NEGATIVE DEMOS # AND NEGATIVE HARMONIC
                      |__
                       --
                      | nn - N/A
                      |
                      | mm - Tidal constituent indicator
                      |        1  M2
                      |        2  K2
                      |        3  S2
```

```
              t=5  |        4  N2
                   |        5  K1
                   |        6  O1
                   |        7  P1
                   |        8  Q1
                   |
                   |
                   | s - N/A
                   |__

                     DOODSON TIDAL EMAT LABELS

  1     7tcdnnmmMKHJJB. DOODSON TIDAL COEFFICIENTS.
                     t - COEFFICIENT INDICATRO FOR DOODSON OCEAN TIDES
             7 - C COEF FOR RAY  TIDES (DOODSON)
             8 - S COEF FOR RAY  TIDES (DOODSON)
                     c - FORCING DEGREE
                     d - FORCING ORDER
         nn- RECEIVING DEGREE
         mm- RECEIVING ORDER
                 MKHJJB- DOODSON NUMBER

              The original DOODSON number has been altered
              for the retrograde frequencies to characterize
              uniquely the parameters.

              M=0,1,2 for prograde frequencies
              M=6,7,8 for retrograde frequencies

  2            abcd.  Second label for DOODSON TIDAL COEFICIENTS

          a- INDEX FOR SIGN TERM OF EXPANSION

             1- PROGRADE TIDE
             2- RETROGRADE TIDE

                      b- INTEGER FLAG FOR SIDELINES

                         0- no sidelines
             1- turn n sidelines with input
               tidal constituent.
             2- turn n sidelines with input
                tidal group.

          c- INTEGER PHASE INCREMENT

          d- PARAMETER TYPE COEFFICIENT INDEX

             1- OCEAN TIDE COEFFICIENT
             2- ATMOSPHERIC TIDE COEFFICIENT

  3               0.  Third label for DOODSON TIDAL COEFICIENTS


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------
```

```
  1     7tcnnfdfordrom. EXTENDED EARTH TIDE MODEL IAU 2000

                        t- 0
                        c- 1
                        nn- advancing index from 1-20
                            1-10 a coefficients
                            11-20 b coefficients

                            The extended IAU 2000 tidal model has 10 a and
                            10 b coefficients grouped always in the same order
                            and in two groups of a and b

                         fd- forcing degree
                         fo- forcing order
                         rd- receiving degree
                         ro- receiving order
                         m- 1 a coefficient or
                            2 b coefficient

                         example: 70101020002001


WORD    LABEL           DESCRIPTION
----    --------------  ---------------------------------------------------
                       --
                      | MKH - MKH EXPANSION ARGUMENTS OF THE DEMOS NUMBER
                      |         M=0,1,2
                      |         K=0,1,2
              t>5>0   |         H=0,1,2
                      |
                      | JJ - J EXPANSION ARGUMENT OF DEMOS NUMBER + 10
                      |__       JJ=J+10, -10<J<10
                       --
                t=5   | MKHJJ - ORDER OF COEFFICIENT WITHIN THE STREAM
                      |__       OF COEFFICIENTS

                        B - DISTURBING BODY
                                0 - MOON AND SUN
                                1 - MOON
                                2 - SUN

                                EXAMPLE:
                                        K2 WOULD HAVE THE FOLLOWING LABEL
                                                60102000000000.

                                EXAMPLE:
                                        FOR THE SECOND DEGREE ZONAL OCEAN TIDE,
                                        POSTIVE SENSE, NEGATIVE COEFFICIENT OF
                                        SINE, FOR
                                                M=2, K=1, H=0, J=-3 AND
                                                MOON ONLY, THE LABEL WOULD BE
                                                62202001210071.


WORD    LABEL           DESCRIPTION
----    --------------  ---------------------------------------------------
  1     80ccccccbbbbbb. LOCAL GRAVITY PARAMETERS.
```

```
                   cccccc - GRID NUMBER.

                   bbbbbb - IS THE PARAMETER NUMBER
                            UNIQUE IDENFIFIER FROM USER INPUT

  2     cccccccceeeeeee. ccccccc - IS THE COLATITUDE OF THE CENTER OF THE
                AREA REPRESENTED BY THE PARAMETER.
                            MEASURED IN UNITS OF 0.0001 DEGREES FROM
                            NORTH POLE.

                   eeeeeee - IS THE LONGITUDE OF THE CENTER OF THE
                            AREA REPRESENTED BY THE PARAMETER.
                MEASURED IN UNITS OF 0.0001 DEGREES.

  3     cccccccceeeeeee. ccccccc - IS THE LATITUDE EXTENT FROM THE AREA
                REPRESENTED BY THE PARAMETER.
                            MEASURED IN UNITS OF 0.0001 DEGREES.

                   eeeeeee - IS THE LONGITUDE EXTENT OF THE AREA
                REPRESENTED BY THE PARAMETER.
                            MEASURED IN UNITS OF 0.0001 DEGREES


WORD    LABEL           DESCRIPTION
----    --------------  ------------------------------------------------------

  1     88000000000000. FIGURE AXIS SCALE FACTOR FOR DYNAMIC POLAR MOTION

  2     00000000000000.

  3     00000000000000.


WORD    LABEL           DESCRIPTION
----    --------------  ------------------------------------------------------

  1     90000pbbbb00dc. PLANETARY PARAMETERS

                   p - PARAMETER TYPE
                            0 - GM
                            1 - EPHEMERIS ERROR
                            2 - SEMI-MAJOR AXIS
                            3 - POLAR FLATTENING
                            4 - EQUATORIAL FLATTENING

                   bbbb - PLANETARY BODY
                            0300  EARTH

                   d - EPHEMERIS ERROR DERIVATIVE NUMBER

                   c - EPHEMERIS ERROR COMPONENT
                            1 - X
                            2 - Y
                            3 - Z


WORD    LABEL           DESCRIPTION
```

```
----     --------------  ----------------------------------------------------
  1      90010000000000. SPEED OF LIGHT.


WORD     LABEL           DESCRIPTION
----     --------------  ----------------------------------------------------
  1      9001mbbbbfc000  EPHEMERIS CORRECTIONS

                         m - Indicator of centeral vs tracking body
                             1 - Central body
                             2 - Tracking body

                         bbbb - BODY IDENTIFIER
                                0300 EARTH

                         f - FORM OF THE ELEMENTS

                                1 - KEPLERIAN
                                2 - BROUWER-CLEMENCE SET III


WORD     LABEL           DESCRIPTION
----     --------------  ----------------------------------------------------

                         c - COMPONENT, SUCH THAT
```

f	1	2			
c					
1	*Delta a*	1#1			
2	*Delta e*	*Delta e*			
3	*Delta i*	2#2			
4	*Delta N*	*Delta p*			
5	*Delta W*	*Delta q*			
6	*Delta M*	*e Delta w*			

```
  2      YYYYMMDDHHMMSS  Epoch for correction to osculating elements


WORD     LABEL           DESCRIPTION
----     --------------  ----------------------------------------------------
  1      9tcnnmm0000000. SOLID EARTH TIDAL DISPLACEMENTS.

                         t - VERTICAL/SHEAR DISPLACEMENT INDICATOR
                                0 - VERTICAL DISPLACEMENT
                                1 - SHEAR DISPLACEMENT
```

```
                        c - COEFFICIENT INDICATOR
                                1 - AMPLITUDE
                                2 - PHASE

                        nn - DEGREE

                        mm - ORDER
                                EXAMPLES:
                                        H2 WOULD HAVE THE FOLLOWING LABEL
                                                80102000000000.
                                        L2 WOULD HAVE THE FOLLOWING LABEL
                                                81102000000000.


WORD    LABEL           DESCRIPTION
----    --------------  ---------------------------------------------------
  1     9abbbbcddddddd  GEOMETRIC DISPLACEMENT AT TIDAL FREQUENCIES.
                        OCEAN LOADING(OL) or CENTER of MASS(COM) or
                        EARTH ORIENTATION PARAMETERS(EOP)
                        GEOMETRIC DISPLACEMENT AT TIDAL FREQUENCIES

                        a - OCEAN LOADING or COM or EOP
                            2= East component of OL
                               or x COM
                               or xy (linked) of pole
                            3= North component of OL
                               or y COM
                            4= Vertical component of OL
                               or z COM
                               or UT1

                        bbbb -
                               1= COM
                               2= EOP
                               3-9999 = OCEAN LOADING SITE #

                        c - Coefficients

                            1= A COEF
                            2= B COEF

                        d - Doodson # 1-8999990 (as input on OLOAD card)

  NOTES:

  1)  For polar motion at tidal frequencies the X and Y of the pole are
      determined from the same pairs of A and B coefficients (Site=2 DIR=1).

  2)  Earth orientation uses retrograde frequencies. There is no way
      for a Doodson # to convey retrograde information.  So as a covention,
      if the Doodson number is entered with a leading digit greater than 6,
      then the frequency is taken to be retrograde with the same Doodson
      number as if 6 were removed from the leading digit.


WORD    LABEL           DESCRIPTION
----    --------------  ---------------------------------------------------
```

```
  1     95tttttttttt0c. POLAR MOTION AND UT1 PARAMETERS.

                        tttttttttt - (*)

                        c - COMPONENT
                                1 - delta X
                                2 - delta Y
                                3 - delta UT1

  2       tttttttttttt. (**)

(*)  MID POINT OF THE POLAR MOTION/UT1 TIME INTERVAL IN YYMMDDHHMMSS.

(**) START TIME OF THE POLAR MOTION/UT1 TIME INTERVAL IN YYMMDDHHMMSS.

  3       tttttttttttt - END TIME OF THE POLAR MOTION/UT1 TIME INTERVAL IN
                         YYMMDDHHMMSS.


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------
  1     96tttttttttt0c  POLAR MOTION AND UT1 PARAMETER RATES

                        tttttttttt - (*)

                        c - COMPONENT
                                1 - X pole rate
                                2 - Y pole rate
                                3 - UT1 rate

  2       tttttttttttt. (**)

(*)  MID POINT OF THE POLAR MOTION/UT1 TIME INTERVAL IN YYMMDDHHMMSS.

(**) START TIME OF THE POLAR MOTION/UT1 TIME INTERVAL IN YYMMDDHHMMSS.

  3       tttttttttttt - END TIME OF THE POLAR MOTION/UT1 TIME INTERVAL IN
                         YYMMDDHHMMSS.


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------
  1     9700000tttttaa  VLBI PARAMETERS

                         ttttt - quasar ID

                         aa - Parameters
                                11 - Right Ascension
                                22 - Declination
                                33 - Right Ascension Rate
                                44 - Declination Rate

  2       000000000000.

  3       000000000000.
```

```
WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1    11aaaaaaaabcmn   GLOBAL PHANTOM PARAMETERS

                        a - aaaaaaaa = 00000000

                        b - INDEX TO MODELING OPTION
                             1 -  GEOMETRIC MODEL
                             2 -  FORCE MODEL

                        c - USER SPECIFIC INDEX (SEE FANTOM OPTION VOL. 3)

                        m - TIME INDICATOR
                             1 - WORD 3 CONTAINS EPOCH TIME FOR THIS PARAMETER
                             2 - WORD 3 CONTAINS START TIME FOR A TIME DEPENDENT
                                OPTION
                        n - NOT DEFINED.

  2    tttttttttt.tttttttttt - END TIME IN "MJDSEC" FOR THIS PARAMETER WHERE
                               "MJDSEC" = (D3-2430000.5D0)*86400+ISEC
                               NOTE: WORD 2 WILL CONTAIN END TIMES ONLY
                               IN CASE OF TIME DEPENDENT FANTOM PARAMETERS

  3    tttttttttt.tttttttttt - SPECIFIED BY m IN WORD 1 AND EXPRESSED IN
                               "MJDSEC".


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

  1    11nnnnnnnbbbsc.  TRACKING STATION COORDINATES

                        nnnnnnnn - STATION NUMBER

                        bbb - PLANETARY BODY
                                300  EARTH

                        s - COORDINATE SYSTEM


WORD    LABEL           DESCRIPTION
----    --------------  -----------------------------------------------------

                        c - COMPONENT

                                \c| 1 | 2 | 3
                                s\|   |   |
                                __|___|___|_______
                                  |   |   |
                                1 |LAT|LON| HEIGHT
                                __|___|___|_______
                                  |   |   |
                                2 | X | Y | Z
                                __|___|___|_______
                                  |   |   |
```

```
                               3 |SAD|LON| Z
                               --|___|___|_______
                                 |   |   |
                               4 |LAT|LON| RADIUS
                               --|___|___|_______


WORD   LABEL          DESCRIPTION
----   -------------  -----------------------------------------------------

  1   120abbjksnnnmmm. SEA SURFACE TOPOGRAPHY.

                       a  - SEA SURFACE TOPOGRAPHY MODEL
                               0 - MODELED AS A SPHERICAL HARMONIC
                                   EXPANSION
                               1 - COMPUTED BY INTERPOLATING EVALUATED
                                   FUNCTIONS ON A UNIFORM GRID.

                       bb - BODY IDENTIFIER
                               10  MERCURY
                               20  VENUS
                               30  EARTH
                               31  EARTH'S MOON
                               40  MARS
                               50  JUPITER
                               60  SATURN
                               70  URANUS
                               80  NEPTUNE
                               90  PLUTO
                               99  SUN


WORD   LABEL          DESCRIPTION
----   -------------  -----------------------------------------------------

                       j - COEFFICIENT TYPE
                            _
               For a=0     |   1 - COEFFICIENT OF COSINE (C)
                           |_  2 - COEFFICIENT OF  SINE  (S)

                            _
               For a=1     |   0 - CONSTANT COEFFICIENT
                           |   1 - COEFFICIENT OF COSWT
                           |_  2 - COEFFICIENT OF  SINWT

           k - PARAMETER TYPE
```

	J=1	J=2			
K=0	*barc*	*bars*			
K=1	*dotc*	*dots*			
K=2	a_{ci}	a_{si}			
K=3	b_{ci}	b_{si}			

```
WORD    LABEL            DESCRIPTION
----    --------------   -----------------------------------------------------

                         s - SEQUENCE NUMBER FOR PERIODIC FREQUENCY
                        -
                       |  nnn - DEGREE
       For a = 0       |
                       |_ mmm - ORDER
                        -
                       |  nnnmmm - INTEGER THAT SPECIFIES THE POSITION OF
       For a = 1       |           THE ADJUSTED COEFFICIENT IN THE STREAM
                       |_          OF COEFFICIENTS

  2    yymmddhhmmss.

       For a = 0         EPOCH TIME (t0) FOR APPLICATION OF TIME DEPENDENT
                         SST

       For a = 1         BLANK

  3    ddd.dd

       For a = 0         PERIOD (wi) OF PERIODIC SST TERMS
                        -
       For a = 1       |  BLANK FOR CONSTANT TERMS
                       |_ PERIOD (sec) FOR PERIODIC TERMS


WORD    LABEL            DESCRIPTION
----    --------------   -----------------------------------------------------

  1    13aabnnnnnnnnsc. TRACKING STATION RELATED PARAMETERS

                         aa - not defined

                         b - STATION PARAMETERS
                               0  - STATION LINEAR VELOCITIES
                               1  - STATION L2
                               2  - STATION H2

                         nnnnnnnn - STATION NUMBER
```

```
                                                         -----
                              s - COORDINATE SYSTEM           |
                                                              |
                              c - COMPONENT                   |
                                                              |
                                     \c| 1 | 2 | 3            |
                                     s\|   |   |              |
                                     --|---|---|-------       |
                                       |   |   |              |
                                     1 |LAT|LON| HEIGHT       |
                                       |   |   |              |   b=0
                                     2 | X | Y | Z            |
                                     --|---|---|-------       |
                                       |   |   |              |
                                     3 |SAD|LON| Z            |
                                     --|---|---|-------       |
                                       |   |   |              |
                                     4 |LAT|LON| RADIUS       |
                                     --|---|---|-------       |
                                                         -----|

  2     yymmddhhmmss.    REFERENCE TIME FOR STATION VELOCITIES APPLICATION


WORD    LABEL            DESCRIPTION
----    --------------   -----------------------------------------------------

  1     14ttttttttttttc. NUTATION PARAMETERS

                         tttttttttttt - MIDPOINT OF THE DPSI/EPST
                                        CORRECTIONS IN YYMMDDHHMMSS

                         c - PARAMETER IDENTIFIER
                               1 - DPSI (NUTATION IN LONGITUDE)
                               2 - EPST (NUTATION IN TRUE OBLIQUITY)

  2     tttttttttttt.  START TIME OF THE DPSI/EPST CORRECTION TIME
                       INTERVAL IN YYMMDDHHMMSS.

  3     tttttttttttt.  STOP TIME OF THE DPSI/EPST CORRECTION TIME
                       INTERVAL IN YYMMDDHHMMSS.
```

5.5 GEODYN II V-MATRIX FILE FORMAT

5.5.1 GEODYN-II FORCE MODEL PARTIAL DERIVATIVE FILE

The format of the GEODYN-II Force Model Partial Derivative File (V-Matrix File) has been designed to be very similar to the GEODYN-I V-Matrix File. This has been done so as to minimize modifications to programs which presently utilize the GEODYN-I format.

On option GEODYN will output a binary file containing the force model partial derivatives in the same order in which they are stored internally. This file consists of a header record and three parameter information records for each satellite followed by force model partials at regular time intervals for each satellite. After the last partial derivative record is a sentinel record. In GEODYN-II each arc generates a separate partial derivative file. Physically separating these files with file marks is optional. For this reason, programs reading the GEODYN-II V-Matrix File should expect a new file to follow each sentinel record unless a file mark is encountered.

The Header Record and Satellite Parameters Records are fixed length and all other records contain a variable number of words depending on the parameters used in the run. All words are 64-bit floating point words.

A description of the six types of records contained in the GEODYN-II V-Matrix File follows is presented below. Each file will contain only one Header Record. After the Header Record will be a set of three records (Record Types 2.0, 2.1 and 2.2) for the first satellite. If there is more than one satellite a three record set will follow successively for each satellite. After all of this header information come the partial derivative records. These records follow for all satellites at a single time, within the time constraints imposed by the start and stop times specified for each satellite. The time is then incremented in accordance with the output rate specified in word three of the the Header Record. After the last Force Model Partial Derivative Record comes a Sentinel Record denoting the end of the file.

```
RECORD         RECORD DESCRIPTION
 TYPE
------------------------------------------------------------------------------

  1.0          HEADER RECORD

                    Contains creation date, number of satellites
                    and other general information (30 Words).

  2.0          SATELLITE PARAMETERS RECORD

                    Contains information about one specific satellite,
                    including the start and stop times for it's force model
                    partials.

  2.1          GROUP IDENTIFIERS AND PARAMETER COUNTS

                    Fifteen digit numbers used to identify the different
                    groups of force model parameters (e.g. drag,tides,etc.),
                    and the number of force model parameters in each group.

  2.2          PARAMETER LABELS

                    Parameter identification (label) for each force model
                    parameter. These are the same as the E-Matrix parameter
                    labels.

  3.0          FORCE MODEL PARTIAL DERIVATIVE RECORDS

  4.0          SENTINEL RECORD
```

5.5.2 HEADER RECORD

The Header Record contains the file creation date which uniquely identifies this partial derivative file, the GEODYN version used to create the file, the number of satellites in this arc and other information describing the arc.

```
 WORD          DESCRIPTION
 -----------------------------------------------------------------------------


  1            Negative of the E-Matrix number (the positive number input
               in columns 25-44 of the EMATRX card).

  2            Negative of the E-Matrix number (E-Matrix number is the
               positive number input in columns 25-44 of the EMATRX card).

  3            Time Interval Between Force Model Partial Derivative Records in
               ET Seconds

  4            Unused at this time.
```

```
  5            Start of Earliest Force Model Partials in MJDS ET.

  6            Fraction of ET Seconds of Start Time.

  7            Stop of Latest Force Model Partials in MJDS ET.

  8            Fraction of ET Seconds of Stop Time.

  9            Number of satellites in arc.

 10            Central forcing body and center of integration (Earth=0300).

 11            Date and time of IIS job (YYMMDDHHMMSS.).

 12            Date and time of IIE job (YYMMDDHHMMSS.).

 13            Surface density/gravity anomaly switch (currently=0).

 14            GEODYN version (e.g 8604.0).

 15            Number of parameter groups(NGI).

 16            Speed of light used by GEODYN.

17-30         Spares


Length for Header Record = 30 words (1 word = 64 bits = 8 bytes)
```

5.5.3 SATELLITE PARAMETERS RECORD

The Satellite Parameters Record contains information specific to one particular satellite of the arc to which this file applies.

```
 WORD          DESCRIPTION
-------------------------------------------------------------------------

   1           Satellite ID.

   2           Integration Mode Indicator:
               0 - Fixed Step
               1 - Variable Step

   3           Integration Step Size Used for Orbit (Initial Step Size for
                   Variable Step Integration).

   4           Integration Order for Orbit.

   5           Integration Step Size Used for Force Model Partials (Initial
                   Step Size for Variable Step Integration).

   6           Integration Order for Force Model Partials.

   7           UTC Epoch Date of Initial Orbit Elements (YYMMDD).

   8           UTC Epoch Time of Initial Orbit Elements (HHMMSS.SSSS).
```

9	Epoch of Initial Orbit Elements in Modified Julian Day Seconds. MJDS = (JD - 2430000.5D0) * 86400 + (Time of Day in ET Seconds)
10	Fraction of ET Seconds of Epoch Time.
11	UTC Start Date of Force Model Partials for this S/C (YYMMDD).
12	UTC Start Time of Force Model Partials (HHMMSS.SSSS).
13	Start of Force Model Partials for this Satellite in MJDS ET.
14	Fraction of ET Seconds of Start Time.
15	UTC Stop Date of Force Model Partials for this S/C (YYMMDD).
16	UTC Stop Time of Force Model Partials (HHMMSS.SSSS).
17	Stop of Force Model Partials for this Satellite in MJDS ET.
18	Fraction of ET Seconds of Stop Time.
19->30	Unused at this time.

5.5.4 GROUP IDENTIFIERS AND PARAMETER COUNTS RECORD

The parameter group identifiers are numbers that uniquely define the different groups of force model parameters such as drag, solar radiation, etc.. These fifteen digit identifiers are derived from the E-Matrix label. This record contains NGI of these identifiers, where NGI is the number of groups indicated in the HEADER RECORD. Following is a list of the currently defined group identifiers for which force model partials may be generated by GEODYN.

GROUP IDENTIFIER	DESCRIPTION
0.	Satellite epoch elements
10000200000000.	Drag parameters
10000400000000.	Solar radiation parameters
10000800000000.	General acceleration parameters
20000000000000.	Arc geopotential parameters
30002000000000.	Panel area parameters
30003000000000.	Panel secular reflectivity parameters
30004000000000.	Panel diffuse reflectivity parameters
30005000000000.	Panel emissivity parameters
30006000000000.	Panel temperature A parameters
30007000000000.	Panel temperature C parameters
30008000000000.	Panel time D parameters

30009000000000.	Panel time F parameters
30010000000000.	Panel theta X parameters
31000000000000.	Thermal drag parameters
50020000000000.	Arc FANTOM force model parameters
50100000000000.	Attitude parameters
50200000000000.	Dynamic crossover radial separator
50300000000000.	Accelerometer bias parameters
60000000000000.	Global geopotential parameters
70000000000000.	Standard tide parameters (K2,K3,k2 phase)
71000000000000.	Expanded Earth and ocean tide model
80000000000000.	Local gravity
88000000000000.	Figure axis scale factor for dynamic polar motion
90000000000000.	GM
90001000000000.	Planetary Moon parameters
95000000000001.	Dynamic polar motion (X)
95000000000002.	Dynamic polar motion (Y)
95000000000003.	Dynamic polar motion (UT1)
97000000000000.	Planet orientation parameters
110000000000000.	Global force model FANTOM parameters

The next NGI words of this record contain the number of force model parameters from each group for this satellite. The last word in this record (word 2*NGI+1) contains the sum force model parameter counts (Ni). Please note that Ni will be different for different satellites in the same arc.

Following is an example of a Group Identifiers and Parameter Counts Record.

WORD	GROUP IDENTIFIER	WORD	NUMBER OF PARAMETERS	DESCRIPTION
1	0.	NGI+1	6	S/C epoch elements
2	10000200000000.	NGI+2	1	Drag parameters
3	10000400000000.	NGI+3	1	Solar radiation parameters

```
  4    50000000000000.     NGI+4     10         Global geopotential parameters

                          2*NGI+1    18         Sum of force model parameters
                                                (Ni). Ni will be different for
                                                each satellite.
```

```
Length for this type of record = 2*NGI+1 words (1 word = 64 bits = 8 bytes)
```

5.5.5 PARAMETER LABELS RECORD

```
  WORD NO.          DESCRIPTION
-----------------------------------------------------------------------

    1               Word count for remainder of this record = (3Ni+1) - where
                    Ni is the number of force model parameters for the "i"th
                    satellite.

  2->3Ni+1          Parameter labels - each parameter label consists of
                    three words. The first Ni words output correspond to the
                    first word for each parameter label, the next Ni words
                    correspond to the second word for each parameter label,
                    and the next Ni words correspond to the third word for
                    each parameter label.

  3Ni+2             200000000000000. This word was added for the convenience
                    of those people who feel the need to make the VMATRIX
                    parameter labels record look as much like the EMATRIX
                    label as possible. It corresponds to the residual column
                    label in the EMATRIX parameter labels record. Note that
                    there are no residuals in a VMATRIX file. Note also that
                    this record will have a different length than the EMATRIX
                    parameter labels record if there are any geometric
                    parameters.

Length for this type of record = 3Ni+2 words (1 word = 64 bits = 8 bytes)


NOTE: See DESCRIPTION OF E-MATRIX PARAMETER LABELS section for more details
```

5.5.6 FORCE MODEL PARTIAL DERIVATIVE RECORDS

The Force Model Partial Derivative records contain the time, spacecraft ephemeris at that time and the force model partial derivatives at that time. Each logical record corresponds to only one satellite.

Please note that in reading these records the start and stop times (from records 2.0) must be compared against the expected time of the next set of Force Model Partial Derivative Records to determine which satellites are present in that set. The expected time will be the previous time plus the output interval (word 3 of the Header Record). Initially, the expected time will be the start time from Header Record words 5 and 6. The expected time should not be incremented until Force Model Partial Derivative Records have been read for all of the expected satellites. Please also note that Ni is different for each satellite.

```
  WORD NO.   DESCRIPTION
-----------------------------------------------------------------------

    1        UTC date and time to the integral second (YYMMDDHHMMSS.).

    2        Fraction of UTC seconds of time.
```

```
    3         Modified Julian Day Seconds (ET) of time
              (MJDS = (Julian Date - 2430000.5) * 86400   truncated to
              integral seconds).

    4         Fraction of ET seconds of time.

    5         Inertial True-of-Date X coordinate of Satellite (m).

    6         Inertial True-of-Date Y coordinate of Satellite (m).

    7         Inertial True-of-Date Z coordinate of Satellite (m).

    8         Inertial True-of-Date X velocity of Satellite (m/s).

    9         Inertial True-of-Date Y velocity of Satellite (m/s).

   10         Inertial True-of-Date Z velocity of Satellite (m/s).

   11         Satellite ID.

   12         Word Count of Remainder of Record (6*Ni).

 13->6*Ni+12 Force model partial derivatives.
              (units: length - meters, time - seconds, angles - radians)


NOTE: The partial derivatives are taken in the following order:
                    . . .
      wrt. X,Y,Z.X,Y,Z for each of the force model parameters.

Length for this type of record = Ni+12 words (1 word = 64 bits = 8 bytes)
```

5.5.7 FORCE MODEL PARTIAL DERIVATIVE FILE SENTINEL RECORD

```
  WORD NO.          DESCRIPTION
-----------------------------------------------------------------------

  1->12             -999999.

 13->max(Ni)+12     Undefined.


Length for this type of record = max(Ni)+12 words (1 word = 64 bits = 8 bytes)
```

5.6 A1UTC FILE

5.6.1 INTRODUCTION

This is an unformatted file written from subroutine EPHMRD GEODYN IIS to provide A1-UTC information for the TOPEX POD system.

```
        WORD
RECORD  TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------
```

```
  1      A8      'a1-utc'

 2-N    R*8      Word1 - Date of A1-UTC.  Value (YYMMDD.)
                 Word2 - A1-UTC value in units of seconds
```

5.7 TELEM FILE

5.7.1 INTRODUCTION

There are three types of TELEM files: The first type of TELEM file is output from GEODYN IIE and contains all information associated with the TOPEX satellite macro- models. The second type corresponds to a LEO in a GPS run. The third type is associated with GPS satellite information when the TUM solar radiation model is used also in a GPS run The information is written at every integration step time during the last iteration of a GEODYN run.

5.7.2 FILE STRUCTURE

The TELEM file is unformatted, and is written on unit 97. It consists of a set of header records followed by groups of data records. One group of data records is written out at each integration step. Please note when running GEODYN on the CRAY-YMP the TELEM file is written in 64-bit IEEE format.

5.7.3 HEADER RECORD FORMAT

The TELEM file header consists of (13 +NUMPNL) unformatted records of varying length, where NUMPNL is the number of plates in the satellite force model.

```
                WORD
RECORD          TYPE        DESCRIPTION
------          ----        ------------------------------------------------------------
  1             A8          G2E Runtime = file creation time.

  2             2A8          1 G2S Version
                R*8          2 G2E Version
                             3 Number of Satellites (NSAT) in run.

  3             (NSAT)      Satellite model number as on SATPAR.
                R*8

  4             (NSAT)      Number of panels per SAT (NUMPNL)
                R*8

                WORD
RECORD          TYPE        DESCRIPTION
------          ----        --------------------------------------------------------------
  5             3R*8        Body Fixed Normal Vector for Plate 1
                             1 x component
                             2 y component
                             3 z component
    .             .              .
    .             .              .
    .             .              .
4+NUMPNL        3R*8        Body Fixed Normal Vector for Plate NUMPNL
                             1 x component
                             2 y component
                             3 z component
```

5+NUMPNL	(NUMPNL) R*8	Plate Areas in m**2 for plates 1 -> NUMPNL
6+NUMPNL	(NUMPNL) R*8	Specular Reflectivity for plates 1 -> NUMPNL
7+NUMPNL	(NUMPNL) R*8	Diffuse Reflectivity for plates 1 -> NUMPNL
8+NUMPNL	(NUMPNL) R*8	Emissivity for plates 1 -> NUMPNL
9+NUMPNL	(NUMPNL) R*8	Temperature A in degrees K for plates 1 -> NUMPNL
10+NUMPNL	(NUMPNL) R*8	Temperature C in degrees K for plates 1 -> NUMPNL
11+NUMPNL	(NUMPNL) R*8	Time D (seconds) for plates 1 -> NUMPNL
12+NUMPNL	(NUMPNL) R*8	Time F (seconds) for plates 1 -> NUMPNL
13+NUMPNL	(NUMPNL) R*8	Theta X (radians) for plates 1 -> NUMPNL

NOTE: 5 to 13+NUMPNL are repeated for each SAT with a non-zero NUMPNL.

RECORD	WORD TYPE	DESCRIPTION
1	A8	G2E Runtime = file creation time.
2	2A8 R*8	1 G2S Version 2 G2E Version 3 Number of Satellites (NSAT) in run.
3	(NSAT) R*8	Satellite model number as on SATPAR.
4	(NSAT) R*8	Number of panels per SAT (NUMPNL)

RECORD	WORD TYPE	DESCRIPTION
1	A8	G2E Runtime = file creation time.
2	R*8 R*8	1 G2E Version 2 SATELLITE ID

```
                      3 Number of Satellites (NSAT) in run.

  3          (NSAT)      Satellite model number as on SATPAR.
             R*8

  4          (NSAT)      Number of panels per SAT (NUMPNL)
             R*8
```

5.7.4 DATA RECORD GROUP FORMAT

These groups are written out at each satellite integration time.

```
             WORD
RECORD       TYPE        DESCRIPTION
------       ----        --------------------------------------------------------

  1          20R*8       1) Integration step time(UTC) YYMMDD
                         2) Integration step time(UTC) HHMM
                         3) Integration step time(UTC) SECONDS
                         4) Beta Prime Angle (degrees)
                         5) S/C Orbit Angle (degrees)
                         6) Nominal Yaw Angle  (degrees)
                            YAW = ATAN2(-DTAN(betaprime),DSIN(orbitangle))
                            (Bar-Sever, 1995)
                         7) Computed Yaw Angle during eclipses and maneuvers
                            (degrees)
                         (based on Jan Kouba's 2008 paper in GPS Solutions and
                          2014 Note and on his subroutine "eclips",
                          January  2014 GEODYN version
                         8) Fraction of the solar disk that is visible at any
                            time (ARFR)
                         9) Solar Irradiance Factor (SOFACT)
                        10) NOPHI index
                            =0.0 - Signals that the True Maneuvering Yaw is used.
                            =1.0 - Signals that the Nominal Yaw is used.
                        11) NOON  index
                            =0.0 - Output NOT during a noon maneuver
                            =1.0 - Output during a noon maneuver
                        12) NIGHT index
                            =0.0 - Output NOT during a midnight maneuver
                            =1.0 - Output during a midnight maneuver
                        13) -999.0

                        14-17) S/C TOD x,y,z position
                        17-19) S/C TOD x,y,z velocity
                        20) SATID

   2         5R*8        External attitude information.
                         *If all words are zero then no external attitude was applied.
                         **Quaternions are SBF to J2000.

                         1) Integration step time in TDT.(YYMMDDHHMMSS.SS)
                         2) q1 quaternion vector element
                         3) q2 quaternion vector element
                         4) q3 quaternion vector element
                         5) q4 quaternion scalar component
```

```
            6-9) SBF to TOD quaternions

  3          1R*8       Solar occultation ratio (percentage of sun seen by satellite)

  4          8R*8       Panel Temperatures (degrees K) for plates 1-8

  5          6R*8       Solar Radiation Acceleration (m/s2).

                        1) Along Track
                        2) Cross Track
                        3) Radial

                        Drag Acceleration (m/s2).

                        4) Along Track
                        5) Cross Track
                        6) Radial

  6          6R*8       Albedo Acceleration (m/s2).

                        1) Along Track
                        2) Cross Track
                        3) Radial

                        Thermal Imbalance Acceleration (m/s2).

                        4) Along Track
                        5) Cross Track
                        6) Radial
```

5.7.4.1 DATA RECORD GROUP FORMAT (LEO IN A GPS RUN)

These groups are written out at each satellite integration time.

```
             WORD
RECORD       TYPE       DESCRIPTION
------       ----       ----------------------------------------------------

  1          8R*8       BLANKS


  2          1R*8       BLANK

  3          8R*8       1) Integration step time(UTC) YYMMDD
                        2) Integration step time(UTC) HHMM
                        3) Integration step time(UTC) SECONDS
                        4-8) BLANK

  4          6R*8       Solar Radiation Acceleration (m/s2).

                        1) Along Track
                        2) Cross Track
                        3) Radial

                        Drag Acceleration (m/s2).
```

```
                          4) Along Track
                          5) Cross Track
                          6) Radial

  5          6R*8         Albedo Acceleration (m/s2).

                          1) Along Track
                          2) Cross Track
                          3) Radial

                          Thermal Imbalance Acceleration (m/s2).

                          4) Along Track
                          5) Cross Track
                          6) Radial
```

5.8 RV FILE FORMAT

5.8.1 INTRODUCTION

An RV file is a satellite ephemeris file which is output by GEODYN specifically for use by the DELTA analysis and graphics program. An RV file is a binary file written without format control. The first record on the file is a header record with the same content as words one through ten of the data record with the exception that the information contained in these words is for the epoch conditions.

5.8.2 HEADER RECORD FORMAT

```
Word            Type         Description
----            ----         -----------
  1              DP          Epoch time in days from January 0.0
                             of the reference year for the arc.

  2               I          Date in YYMMDD.
                                                         --
  3               I          Hours and minutes in HHMM.    | UTC
                                                           | Epoch
  4               R          Seconds.                    __| Time

5-10             DP          Satellite inertial cartesian epoch
                             elements in meters and meters/second.


----------------------------------------

Total = 68 bytes
```

5.8.3 DATA RECORD GROUP FORMAT

```
Word            Type         Description
----            ----         -----------
  1              DP          Days from January 0.0 of the reference

  2               I          Date in YYMMDD.
                                                         --
  3               I          Hours and minutes in HHMM.    | UTC
                                                           | Time
```

```
  4               R         Seconds.                    __| System

5-10             DP         Satellite inertial position-velocity
                            vector in meters and meters/second.

 11              DP         Satellite latitude in degrees.

 12              DP         Satellite longitude in degrees.

 13              DP         Satellite height in meters.
----------------------------------------

Total = 92 bytes.

The last record has a value of 999.0D0 in the first word.
```

5.9 GEOLOCATION FILE FORMAT

A GEOLOCATION file is a binary output of GEODYN II-E on UNIT 18 and contains information about the spacecraft's body fixed coordinates and attitude, the body fixed coordinates of the ground bounce point, and observation corrections. The file is requested through the ALTOUT option on the UNIT 5.

```
64-BIT WORD
 WORD   TYPE    DESCRIPTION
------  ----    ------------------------------------------------------------
     1  R*8     Modified Julian Day Seconds of the final receive time of the
                1st observation in the block. (UTC sec.)

     2  R*8     Elapsed seconds from the 1st observation of the block time
                (WORD 1) of the current observation. (UTC sec.)

     3  R*8     Mission elapsed seconds from Mission Reference time at ground
                bounce time.  The Mission Reference Time is provided in GEODYN
                via the ALTOUT option. (UTC sec.)

     4  R*8     True of Date inertial X-coordinates of the spacecraft. (meters)

     5  R*8     True of Date inertial Y-coordinates of the spacecraft. (meters)

     6  R*8     True of Date inertial Z-coordinates of the spacecraft. (meters)

     7  R*8     Body fixed X-coordinates of the spacecraft center of mass. (meters)

     8  R*8     Body fixed Y-coordinates of the spacecraft center of mass. (meters)

     9  R*8     Body fixed Z-coordinates of the spacecraft center of mass. (meters)

    10  R*8     Spacecraft geodetic latitude. (deg)

    11  R*8     Spacecraft east longitude. (deg)

    12  R*8     Spacecraft height above the reference ellipsoid. (meters)

    13  R*8     Body fixed X-coordinates of the ground bounce point. (meters)

    14  R*8     Body fixed Y-coordinates of the ground bounce point. (meters)

    15  R*8     Body fixed Z-coordinates of the ground bounce point. (meters)
```

```
  16    R*8      Planetary radius to the ground bounce point. (meters)

  17    R*8      Geodetic latitude of the ground bounce point. (deg)

  18    R*8      East longitude of the ground bounce point. (deg)

  19    R*8      Ground bounce point height above the reference ellipsoid. (meters)

  20    R*8      Body fixed X-coordinate of the altimeter line of sight unit
                 vector.

  21    R*8      Body fixed Y-coordinate of the altimeter line of sight unit
                 vector.

  22    R*8      Body fixed Z-coordinate of the altimeter line of sight unit
                 vector.

  23    R*8      Laser altimeter observation corrected for troposphere and
                 constant measurement bias. (meters)

  24    R*8      Original laser altimeter observation. (meters)

  25    R*8      Geocentric latitude of the ground bounce point. (deg)

  26    R*8      Angle between actual observation direction and geocentric
                 direction. (deg)
                 ---
  27    R*8         |
                    | Quaternions describing the
  28    R*8         | total rotation from
                    | laser reference frame ->
  29    R*8         | local vertical/local horizontal
                    | reference frame.
  30    R*8      ___|

  31    R*8      Mean sea surface.

  32    R*8      Dry tropospheric correction.

  33    R*8      Wet tropospheric correction.

  34    R*8      Solid earth tide correction.

  35    R*8      Ocean tides.
```

5.10 PDOUT FILE FORMAT

A PDOUT file is a formatted output of GEODYN II-E on UNIT 17 and contains information about the spacecraft's latitude and longitude and observation corrections. The file is requested through the ALTOUT option on the UNIT 5.

```
 WORD   TYPE     DESCRIPTION
------  ----     -------------------------------------------------------------
     1  R*8      Modified Julian Date. (UTC)

     2  I*4      Spacecraft geodetic latitude. (deg*1x106)
```

3	I*4	Spacecraft east longitude. (deg*1x106)
4	I*4	Mean sea surface. (mm)
5	I*4	Dry tropospheric correction. (mm)
6	I*4	Wet tropospheric correction. (mm)
7	I*4	Solid earth tide correction. (mm)
8	I*4	Ocean tides. (mm)

```
FORMAT(F20.8,I15,I15,I7,I7,I7,I7,I7)
```