

# GEODYN Documentation

## Volume 5

February 24, 2022

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# 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 . 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 applied 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)
			8
			0 2.997925x10 meters/sec
			8
			3 2.99792458x10 meters/sec
			7 Annual Aberration ----- (Types 10-14)
			0 Data has been corrected
			1 Data has not been corrected
			or Barotropic 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

5 meteorological data.  
Data has 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 ) (mm) ss
			$H_{ss} = H_c + H_{RAW} + \Delta H$
			where $H_c$ is the computer height of the s/c above the reference ellipsoid and $\Delta H$ is the net corrections
			$\Delta H = \Delta H_I + \Delta H_{ATM} - \Delta H_T$
			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 preprocess-  
ing bits are configured as follows:

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



Elevation Not  
Corrected for Net  
Instrument Cor-  
rections (delta H )  
I  
1 Indicated Surface  
Elevation Cor-  
rected 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 Cor- rected 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

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 Schwidorski
				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	FNOG 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:

YYLLCC

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.

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 = Geceiver Doppler   |
|  |  | 40-44 Altimeter Height  |
|  |  | 45-49 Available for additional measurement types<br>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,
- Geceiver 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.

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 Indicator -----  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.  0 = Mean equator and equinox  1 = True equator and equinox
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 deviation 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 propagation 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 referred 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

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 Hertz 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



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 referred 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
-----		
<p>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.</p>		
56		Sign of tide
57-59	DP	Value of Tide
<p>X.XX Meters</p>		
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

o  
 XX.XXXX

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 propagation 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

-----

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 propagation 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

Columns	Type	Description
62-65	DP	----- XX.XX Arc Minutes Standard deviation in elevation or Y angle ----- XX.XX Arc Minutes
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	<p>Satellite ID No. 1 (S1) -- This is the  is the international  international satellite designation yynncc  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).</p>
I*4	I*4	I*8	<p>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.</p>
I*4	I*4	I*8	<p>Satellite ID for Satellite No. 2 (S2).</p>
I*4	I*4	I*8	<p>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.</p>
I*4	I*4	I*8	<p>Satellite ID for Satellite No. 3 (S3).</p>
I*4	I*4	I*8	<p>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.</p>

FORTRAN Variable Type

BINARY-I16	BINARY-I32	BINARY-I64	Description																														
-----																																	
I*4	I*4	I*8	<p>Measurement Type/Time System Indicator  (nnmmtqppss).</p> <p>nn - Reserved. Must be set to zero.</p> <p>mm - GEODYN-II Measurement Type</p> <p>t - Time tag flag for Primary Observer.</p> <table border="0" style="margin-left: 40px;"> <tr> <td style="text-align: right;">t</td> <td style="text-align: right;">value</td> <td style="text-align: left;">description</td> </tr> <tr> <td></td> <td style="text-align: center;">-----</td> <td style="text-align: center;">-----</td> </tr> <tr> <td></td> <td style="text-align: center;">0</td> <td>Receiver time.</td> </tr> <tr> <td></td> <td style="text-align: center;">2</td> <td>Transponder/reflection time.</td> </tr> <tr> <td></td> <td style="text-align: center;">4</td> <td>Transmitter time.</td> </tr> </table> <p>q - Time tag flag for Secondary Observer.</p> <table border="0" style="margin-left: 40px;"> <tr> <td style="text-align: right;">q</td> <td style="text-align: right;">value</td> <td style="text-align: left;">description</td> </tr> <tr> <td></td> <td style="text-align: center;">-----</td> <td style="text-align: center;">-----</td> </tr> <tr> <td></td> <td style="text-align: center;">0</td> <td>Receiver time.</td> </tr> <tr> <td></td> <td style="text-align: center;">2</td> <td>Transponder/reflection time.</td> </tr> <tr> <td></td> <td style="text-align: center;">4</td> <td>Transmitter time.</td> </tr> </table> <p>pp - Time system flag for Primary Observer.</p> <p>ss - Time system flag for Secondary Observer.</p>	t	value	description		-----	-----		0	Receiver time.		2	Transponder/reflection time.		4	Transmitter time.	q	value	description		-----	-----		0	Receiver time.		2	Transponder/reflection time.		4	Transmitter time.
t	value	description																															
	-----	-----																															
	0	Receiver time.																															
	2	Transponder/reflection time.																															
	4	Transmitter time.																															
q	value	description																															
	-----	-----																															
	0	Receiver time.																															
	2	Transponder/reflection time.																															
	4	Transmitter time.																															



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)

#### FORTTRAN 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

### 2.5.3 OBSERVATION PREPROCESSING WORD DEFINITION

BITS	DESCRIPTION
1-3	Reserved.
03	Is clock calibration bias provided.
04	Has precession to date been completed
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:

$$\begin{aligned}
 & [a_1 * 2^{**0} + a_2 * 2^{**1} \\
 & + a_3 * 2^{**2} + a_4 * 2^{**3}] \\
 + \\
 & [ a_5 * 2^{**4} + a_6 * 2^{**5} \\
 & + a_7 * 2^{**6} + a_8 * 2^{**7} ] \\
 +
 \end{aligned}$$

$$[ a_9 \cdot 2^{**8} + a_{10} \cdot 2^{**9} + a_{11} \cdot 2^{**10} + a_{12} \cdot 2^{**11} ] + a_{13} \cdot 2^{**12}$$

where  $a_1 - a_{12}$  can be a's or 0's (independently).

$a_1$  is bit 1,  $a_7$  is bit 7 and so forth. The bits are allocated as follows:

$a_1$	$a_2$	sat 1 antenna for neighbor 1
$a_3$	$a_4$	sat 1 antenna for neighbor 2
$a_5$	$a_6$	sat 2 antenna for neighbor 1
$a_7$	$a_8$	sat 2 antenna for neighbor 2
$a_9$	$a_{10}$	sat 3 antenna for neighbor 1
$a_{11}$	$a_{12}$	sat 3 antenna for neighbor 2
$a_{13}$		is there antenna information (1 => yes ; 0 => no)

A pair of bits such as ( $a_1, a_2$ ) or ( $a_7, a_8$ ) will give a number (for an antenna) from 1 through 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

WORD	DATA 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)

WORD	DATA TYPE	DESCRIPTION
7 cont.	Integer	<ul style="list-style-type: none"> <li>- 5 for TAI (International Atomic Time)</li> <li>- 6 for A-S (Smithsonian)</li> <li>- 7 for TDT (Terrestrial Dynamic Time)</li> <li>- 8 for TDB (Barycentric Dynamic Time)</li> <li>- 9 for GPS (Global Positioning Time)</li> <li>- 11 for UT1 (BIH)</li> <li>- 12 for UT2 (BIH)</li> <li>- 13 for UTC (BIH)</li> </ul>
8	' '	<p>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.</p> <p>Bits</p> <ul style="list-style-type: none"> <li>1-4 reserved</li> <li>5 ionospheric refraction correction(s) provided</li> <li>6 cable calibration correction(s) provided</li> <li>7 water vapor radiometer correction(s) provided</li> <li>8 antenna axis displacement correction(s) provided</li> <li>9 tropospheric refraction correction(s) provided</li> <li>10 ionospheric refraction correction for site 1 has been applied to the observation</li> <li>11 ionospheric refraction correction for site 2 has been applied to the observation</li> <li>12 cable calibration correction for site 1 has been applied to the observation</li> <li>13 cable calibration correction for site 2 has been applied to the observation</li> <li>14 water vapor radiometer correction for site 1 has been applied to the observation</li> <li>15 water vapor radiometer correction for site 2 has been applied to the observation</li> <li>16 antenna axis displacement correction for site 1 has been applied to the observation</li> <li>17 antenna axis displacement correction for site 2 has been applied to the observation</li> <li>18 tropospheric refraction correction for site 1 has been applied to the observation</li> <li>19 tropospheric refraction correction for site 2 has been applied to the observation</li> <li>20 if ionospheric correction for site 1 has been included in the observation remove, OR if it has not</li> </ul>

- 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

WORD	DATA 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

WORD	DATA TYPE	DESCRIPTION
13	Real	The seconds part of the observation time at site 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	Delay bias which should be added to theoretical path
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	Relative Humidity at Surface - percentage with leading	'55'



blank fill

81-85	Tropospheric refraction correction - 1 picosecond granularity with leading blank fill	'16978'
86-91	Center of Mass Correction - 1 picosecond granularity with leading blank fill	'801'
92-96	Receive Amplitude - a Positive linear scale value, usually between 0 and 2000, with leading blank fill	'700'
97-104	Applied System Delay - the system delay applied in the current record with a 1 picosecond granularity and leading blank fill.	'95942'
105-110	Calibration Delay Shift - a measure of calibration stability with a 1 picosecond granularity and leading blank fill. The type of shift is indicated in column 127.	'33'
111-114	Calibration Standard Deviation - 1 picosecond granularity with leading blank fill	'20'
115	Normal Point Window Indicator - indicates whether or 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	'0'
116-119	Number of raw ranges compressed into normal point - leading blank fill	' '
120	Epoch Event - Indicates the time event reference. 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	'1'
121	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
122	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'
123	Tropospheric Refraction Correction Indicator - Range 0 = Data has been corrected using the	'0'

Marini-Murray formula

1 = Data has not been corrected

124	Center of Mass Correction Application - Indicator 0 = Applied 1 = Not applied	'0'
125	Receive Amplitude Correction Indicator 0 = Data has been receive amplitude corrected 1 = Data has been receive amplitude corrected	'1'
126	System Calibration Method Inidicator 0 = External Calibration 1 = Internal Calibration 2 = Burst Calibration - 3 minute bursts	'0'
127	Calibration Delay Shift Inidicator - specifies the type of delay shift represented in columns 105 to 110 0 = Pre to Post shift 1 = Peak to Peak shift	'0'
128	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 II implementation. Data prior to MERIT II that is converted into the MERIT II format will have a flag of '0'.	'1'
129	Format Revision Number Indicator - indicates the 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'.	'1'
130	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'. Data released prior to the MERIT II implementation will have a release flag of '0'	'A'

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 granularity with leading blank fill	'33'
77-84	Wavelength - .1 nanometer granularity with leading blank fill	'53200000'
Field	Description	Example
85-90	Surface Pressure - .1 millibar granularity with leading blank fill	'101350'
91-95	Surface Temperature - .1 degree Kelvin granularity with leading blank fill	'29050'
96-100	Relative Humidity at Surface - percentage with leading blank fill	'0055'
101-105	Tropospheric refraction correction - 1 picosecond granularity with leading blank fill	'16978'
106-111	Center of Mass Correction - 1 picosecond granularity with leading blank fill	'801'
112-116	Receive Amplitude - a Positive linear scale value, usually between 0 and 2000, with leading blank fill	'700'
117-125	Applied System Delay - the system delay applied in the current record with a 1 picosecond granularity and leading blank fill.	'959420'
126-131	Calibration Delay Shift - a measure of calibration stability with a 1 picosecond granularity and leading blank fill. The type of shift is indicated in column 127.	'33'
132-135	Calibration Standard Deviation - 1 picosecond granularity with leading blank fill	'20'
136	Normal Point Window Indicator - indicates whether or 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	'0'
137-140	Number of raw ranges compressed into normal point - leading blank fill	' '
141	Epoch Event - Indicates the time event reference. 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	'1'

142 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
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 Inidicator 0 = External Calibration 1 = Internal Calibration 2 = Burst Calibration - 3 minute bursts	'0'
148	Calibration Delay Shift Inidicator - 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 too large.

Column	Format	Description
1-7	I7	7 digit SATID
8-9	I2	Measurement type, The OOD will use 39 (geociever 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 Part.	REV 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.ppxss) (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 (bbbb) 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.ppxss see page 2-34

### 3.2.2.2 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

**3.2.2.3 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 AND CONSTRAINTS DATA

#### 3.2.3.1 Master Block Header Record

Buffer Part.	REV 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 (bbbbbb) 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	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

3.2.3.3 Location Data Descriptor Record

Buffer Part.	REV 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 Part.	REV 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 Part.	REV 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=101,110,111)  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) If MTYPE=110/111, the keys are odd-even, where the first key is odd, and the second key is +1 (ex. 1,2 or 3,4)
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 Part.	REV 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 (bbbbbb) that may be used for any one Logical Block (a.bbbbbbb).
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 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

**3.2.4.3 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.DO/880.DO  
IF( EXCITER BAND IS X) XF2=-XF1\*880.DO/749.DO ;  
OTHERWISE XF2=-XF1\*880.DO/221.DO

10 Record Type Indicator = -5000000

### 3.2.4.4 Observation Record

Buffer Part.	REV 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 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 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 Part.	REV 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 (bbbbbb) that may be used for any one Logical Block (a.bbbbbb).
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 Part.	REV 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	REV	
Part.	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 Parallax Refraction
8		Obs #2 Parallax 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	REV	
Part.	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 Part.	REV 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.ppxss) (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 (bbbb) 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.ppxss see page 2-34

#### 3.2.6.2 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

**3.2.6.3 Observation Record**

Buffer Part.	REV 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 Part.	REV 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.ppxss) (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 (bbbb) 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.ppxss see page 2-34

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

Buffer Part.	REV 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 Part.	REV NO.	Description
1		Observation
2		Three input data codes packed into one: =EEEx10**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 Part.	REV 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 Part.	REV 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 (bbbbbb) 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 Part.	REV 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 Part.	REV NO.	Description
1		Temperature
2		
3		
4		
5		
6		
7		
8		
9		
10		Record Type Indicator = N,000,000

### 3.2.9 OPTICAL DATA

#### 3.2.9.1 Master Block Header Record

Buffer Part.	REV 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.ppxss) (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

(bbbbbb) that may be used for any one Logical Block (a.bbbbbbb).

9 Master Prepro Word (designated #9)  
10 Record Type Indicator = -9,000,000

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

### 3.2.9.2 Block Header Record #N (N=1 and 2)

Buffer	REV	
Part.	NO.	Description
-----		
1		
2		
3		
4		Laser ID # (if applicable)
5		
6		
7		
8		Satellite ID # (integer)
9		Prepro Word #N
10		Record Type Indicator = -9,000,000+N*1,000,000

### 3.2.9.3 Location Data Descriptor Record

Buffer	REV	
Part.	NO.	Description
-----		
1		
2		
3		
4		
5		
6		
7		



8  
 9  
 10 1.6 Record Type Indicator = -2,000,000

**3.2.9.4 Observation Record**

Buffer Part.	REV NO.	Description
1		
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		
8		
9		
10		Record Type Indicator = 0

**3.2.9.5 Observation Corrections Record #N (N=1 and 2)**

Buffer Part.	REV NO.	Description
1		
2		
3		
4		
5		
6		
7		
8		

9

10                    Record Type Indicator = N,000,000

### 3.2.9.6 Location Data Record (Normal Integration)

Buffer	REV	
Part.	NO.	Description
-----		
1		
2		
3		
4		
5		
6		Key
7		Pixel 1
8		Pixel 2
9		Camera ID # (integer)
10	1.6	Record Type Indicator = 7,000,000

### 3.2.9.7 Location Data Record (Rapid Integration ONLY)

Buffer	REV	
Part.	NO.	Description
-----		
1		
2		
3		
4		Pixel 1 of first image
5		Pixel 2 of first image
6		Camera ID # (integer)
7		Pixel 1 of second image
8		Pixel 2 of second image
9		Camera ID # (integer)

10 1.6 Record Type Indicator = 7,000,000

### 3.2.10 LANDMARK DATA

#### 3.2.10.1 Master Block Header Record

Buffer Part.	REV 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.ppxss) (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 (bbbb) 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.ppxss see page 2-34

#### 3.2.10.2 Block Header Record #N (N=1)

Buffer Part.	REV NO.	Description
1		
2		
3		
4		Laser ID # (if applicable)

5	
6	
7	Target ID # (integer)
8	Satellite ID # (integer)
9	Prepro Word #N
10	Record Type Indicator = $-9,000,000+N*1,000,000$

### 3.2.10.3 Location Data Descriptor Record

Buffer Part.	REV NO.	Description
1		
2		
3		
4		
5		
6		
7		
8		
9		
10	1.6	Record Type Indicator = $-2,000,000$

### 3.2.10.4 Observation Record

Buffer Part.	REV NO.	Description
1		Pixel 1
2		Pixel 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

8

9

10 Record Type Indicator = 0

### 3.2.10.5 Observation Corrections Record #N (N=1)

Buffer	REV	
Part.	NO.	Description

-----

1

2

3

4

5

6

7

8

9

10 Record Type Indicator = N,000,000

### 3.2.10.6 Location Data Record

Buffer	REV	
Part.	NO.	Description

-----

1

2

3

4

5

6 Camera ID # (integer)

7  
8  
9

10 1.6 Record Type Indicator = 7,000,000

### 3.2.11 DELTA-DOR DATA

#### 3.2.11.1 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.ppxsss) (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 (bbbb) 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.ppxsss see page 2-34

#### 3.2.11.2 Block Header Record #N (N=1)

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

1

2	Eight (8) character alphanumeric name for station #1
3	
4	
5	
6	Date and time from TDF(YMMDDHHMMSS.) (N=1 only)
7	Station ID for site #1 (integer)
8	Satellite ID # (integer) (N=1, only)
9	Prepro Word #1
10	-8,000,000

### 3.2.11.3 Block Header Record #N (N=2)

Buffer Part.	REV NO.	Description
-----		
1		
2		Eight (8) character alphanumeric name for station #2
3		Eight (8) character alphanumeric name for quasar
4		
5		
6		
7		Station ID for site #2 (integer)
8		Quasar ID # (integer)
9		Prepro Word #2
10		-7,000,000

### 3.2.11.4 Observation Record

Buffer Part.	REV NO.	Description
-----		
1		Observation
2		

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

4

5 Sum of time corrections

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

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

8

9

10 Record Type Indicator = 0

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

Buffer Part.	REV NO.	Description
1		Meteorological Data for Station #N
2		SIC Center of Gravity Correction (N=1 only)
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 for Station #N
7		Cable calibration correction for station #N
8		Relativity Correction for station #N
9		Water vapor radiometer correction for Station #N.
10		Record Type Indicator = N,000,000

### 3.2.12 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 (deconstruct 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

```

22 for station N tracking user satellite (N=2,3).  
 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  
23  
24

Observations are in True of Reference.  
Observations are NOT Radial PCE data.

**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

```

### 3.2.13 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 $(T3 \rightarrow S3 \rightarrow S1 \rightarrow S2 \rightarrow T2) - (T3 \rightarrow S3 \rightarrow P1T1 \rightarrow S2 \rightarrow T2)$
84	SINGLY DIFFERENCED FOUR-WAY SAT&TARGET DOPPLERS $(T3 \rightarrow S3 \rightarrow S1 \rightarrow S2 \rightarrow T2) + SF2S * (T2 \rightarrow S2 \rightarrow T2) - (T3 \rightarrow S3 \rightarrow P1T1 \rightarrow S2 \rightarrow T2) - SF2T * (T2 \rightarrow S2 \rightarrow T2)$
85	DOUBLY DIFFERENCED ONE-WAY RANGES $[(S2 \rightarrow T1) - (S3 \rightarrow T1)] - [(S2 \rightarrow S1) - (S3 \rightarrow S1)]$
86	DOUBLY DIFFERENCED ONE-WAY DOPPLERS $[(S2 \rightarrow S1) - (S3 \rightarrow S1)] - [(S2 \rightarrow T1) - (S3 \rightarrow T1)]$
87	DOUBLY DIFFERENCED ONE-WAY RANGES $[(S1 \rightarrow T1) - (S2 \rightarrow T1)] - [(S1 \rightarrow T2) - (S2 \rightarrow T2)]$
88	DOUBLY DIFFERENCED ONE-WAY DOPPLERS $[(S1 \rightarrow T1) - (S2 \rightarrow T1)] - [(S1 \rightarrow T2) - (S2 \rightarrow T2)]$
89	DOUBLY DIFFERENCED ONE- AND TWO-WAY RANGES $[(S2 \rightarrow S1 \rightarrow T2) - (S2 \rightarrow T2)] - [(S3 \rightarrow S1 \rightarrow T3) - (S3 \rightarrow T3)]$
90	DOUBLY DIFFERENCED ONE- AND TWO-WAY DOPPLERS $[(S2 \rightarrow S1 \rightarrow T2) - (S2 \rightarrow T2)] - [(S3 \rightarrow S1 \rightarrow T3) - (S3 \rightarrow T3)]$
91	DOUBLY DIFFERENCED ONE- AND THREE-WAY RANGES $[(P1T1 \rightarrow S2 \rightarrow T2) - (P1T1 \rightarrow T2)] - [(P1T1 \rightarrow S3 \rightarrow T3) - (P1T1 \rightarrow T3)]$
92	DOUBLY DIFFERENCED ONE- AND THREE-WAY DOPPLERS $(P1T1 \rightarrow S2 \rightarrow T2) - (P1T1 \rightarrow T2) - [(P1T1 \rightarrow S3 \rightarrow T3) - (P1T1 \rightarrow T3)]$
93	DOUBLY DIFFERENCED TWO- AND THREE-WAY RANGES $(S1 \rightarrow S2 \rightarrow T2) - (T1 \rightarrow S2 \rightarrow T2) - [(S1 \rightarrow S3 \rightarrow T3) - (T1 \rightarrow S3 \rightarrow T3)]$
94	DOUBLY DIFFERENCED TWO- AND THREE-WAY DOPPLERS $(S1 \rightarrow S2 \rightarrow T2) - (T1 \rightarrow S2 \rightarrow T2) - [(S1 \rightarrow S3 \rightarrow T3) - (T1 \rightarrow S3 \rightarrow T3)]$
95	DOUBLY DIFFERENCED FOUR-WAY RANGES $[(T3 \rightarrow S3 \rightarrow S1 \rightarrow S2 \rightarrow T2) - (T3 \rightarrow S3 \rightarrow S1 \rightarrow S3 \rightarrow T3)] - [(T3 \rightarrow S3 \rightarrow T1 \rightarrow S2 \rightarrow T2) - (T3 \rightarrow S3 \rightarrow T1 \rightarrow S3 \rightarrow T3)]$
96	DOUBLY DIFFERENCED FOUR-WAY DOPPLERS $[(T3 \rightarrow S3 \rightarrow S1 \rightarrow S2 \rightarrow T2) + SF2S * (T2 \rightarrow S2 \rightarrow T2) - (T3 \rightarrow S3 \rightarrow S1 \rightarrow S3 \rightarrow T3) - SF3S * (T3 \rightarrow S3 \rightarrow T3)] - [(T3 \rightarrow S3 \rightarrow T1 \rightarrow S2 \rightarrow T2) + SF2T * (T2 \rightarrow S2 \rightarrow T2) - (T3 \rightarrow S3 \rightarrow T1 \rightarrow S3 \rightarrow T3) - SF3T * (T3 \rightarrow S3 \rightarrow T3)]$
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

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

P<sub>n</sub> REFERS TO THE PLANET ON WHICH THE TRACKING STATION T<sub>n</sub> EXISTS. AN IMPLICIT REFERENCE TO PLANETARY BODIES IS MADE SIMPLY BY SPECIFICATION OF THE TRACKING STATION T<sub>n</sub>. 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 P<sub>n</sub> 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 P<sub>n</sub> TO BE OF AN INTER-PLANETARY NATURE.

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

Q<sub>n</sub> REFERS TO THE QUASAR WHICH IS DEFINED ON BLOCK HEADER RECORD NUMBER "n" OF THE GEODYN-II BINARY TRACKING DATA FORMAT.

### 3.2.14 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 (N index).	0
18-20	I3	Order of C and S coefficients (M index).	0
25-44	D20.8	A priori (or starting) value of C coefficient.	0.
45-59	D15.3	A priori (or starting) value of S coefficient.	0.

**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	0

```

= 1 values normalized
= 2 values ignored

```

```

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           0.
          S coefficient.

```

### 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 referring 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 is available in this run.	50

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:	0300
		Mercury	0100
		Venus	0200
		Earth	0300
		Earth's Moon	0301
		Mars	0400
		Jupiter	0500
		Saturn	0600
		Uranus	0700
		Neptune	0800
		Pluto	0900
		Sun	9999

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 of the planet.	0.
-------	-------	---	----

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 automatically 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. =1 X-Y East-West =2 X-Y North-South =3 Azimuth-Elevation =4 Hour Angle-Declination	3	
21-35	D15.6	Antenna axis displacement in meters.	0.	M
36-50	D15.6	Nominal received wavelength in microns. ( 0. indicates nominal wavelength will be used from observation file as supplied by the Tracking Data Formatter Program.)	0.	M*1.0D-6
51-65	D15.6	Turn around factor (TRF). (TRF=Wavelength trans./wavelength rec.)	1.	

**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 -)XXXXXXXX.XXX meters
36-50  D15.6   Second coordinate:         0.
          DDMSS.SSS
          (+ or -)XXXXXXXX.XXX meters
51-65  D15.6   Third coordinate:          0.
          (+ or -) XXXXXXXX.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 data (YYMMDD) P
37-40	I*4	End date for magnetic A data (YYMMDD) P
41-44	I*4	Start date for magnetic K data (YYMMDD) P
45-48	I*4	End date for magnetic K date (YYMMDD)

p

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 values per record
		p
69-72	I*4	Number of magnetic flux K values per record
		p

#### 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 values per day (always = 1 )
		p
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 ,Y pairs in file P P
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 ,Y ) of pole data at P P 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 YYYY

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 YYYY
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 YYYY

#### 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 YYYY
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 YYYY
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 YYYY

## 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 ) times p 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 ) times p 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 ) times p 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 ) times p 100 for the next month



191-192          I\*2          Year and month of magnetic flux data  
   in form YYYY.

### 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 SUPPLEMENTARY PLANETARY EPHEMERIS DATA FILE

### 3.8.1 INTRODUCTION

The supplementary planetary ephemeris has been designed to complement the JPL planetary ephemeris in various ways. New celestial bodies not included in the JPL planetary ephemeris may be introduced to GEODYN and used for force modeelling computations or as center of gravity bodies. The supplementary planetary ephemeris has been designed to supply information for up to 10 extra celestial bodies.

The information provided for the celestial bodies is position and velocity in the form of Chebyshev coefficients. However, it is quite flexible in terms of reference coordinate system, length of validity for the coefficients and links to the JPL ephemeris. The supplementary planetary ephemeris does not conform to the 32 day buffer concept of the JPL ephemeris. Each celestial body here may have a different length of validity. The only restriction is that information for all the celestial bodies must start and end at the same time. The supplementary planetary ephemeris is a binary file, read by GEODYN IIS on the input unit 3.

### 3.8.2 BINARY FILE DESCRIPTION

The supplementary planetary ephemeris contains a Master Header Record, one Header Record per celestial body featured, and Data Records.

#### Master Header Record

Word	Type	Description
1	R*8	Number of words in the record.
2	R*8	Start time (MJD). Same for all celestial bodies in the supplementary planetary ephemeris.
3	R*8	Stop time (MJD). Same for all celestial bodies in the supplementary planetary ephemeris.
4	R*8	Number of celestial bodies for which information is provided.

#### Header Record

One per Celestial Body

Word	Type	Description
1	R*8	Number of words in the record.
2	R*8	Celestial body ID (JPL provided).
3	R*8	Length of validity for one group of coefficients (in days)
4	R*8	Number of coefficients within the length of validity (IDEG).
5	R*8	Number of groups of coefficients for this body (IGRP).

6 R\*8 Time system for the Chebyshev coefficients.  
1 = ET  
2 = UTC

7 R\*8 Coordinate system for the Chebyshev coefficients.  
00000 = Solar System Barycentric  
abbbb =

a = 1 JPL Ephemeris  
a = 2 Supplementary Ephemeris

bbbb Geodyn planet index.  
(i.e. 0300 for the Earth or  
0001 for the first celestial  
body in the supplementary  
planetary ephemeris)

Example: 10300 - The coordinate system  
for the coefficients is earth  
centered for the earth positions  
derived from the JPL ephemeris.

NOTE: ONLY the option 00000 works in  
GEODYN now. ie. Solar System  
Barycentric system for input coef.

8 R\*8 GM of the celestial body. If the GM is not  
supplied here it may be introduced by the  
GEODYN CBODY option.

9 R\*8 Semi-major axis of the celestial body.  
(Also CBODY option)

10 R\*8 Inverse polar flattening of the celestial  
body. (Also CBODY option)

11 R\*8 Inverse equatorial flattening of the  
celestial body. (Also CBODY option)

### Data Record

There are IGRP (see Header Record) data records with the following information.

Word	Type	Description
1	R*8	Number of words in the record.
2	R*8	Begin time for the length of validity (MJD).
3	R*8	Begin time for the length of validity (MJD).
4 - IDEG+3	R*8	Coefficients in the order x,y,z,xdot,ydot,zdot. IDEG = Word 3 from the Header Record.

## 3.9 GEODYN EXTERNAL ATTITUDE FILE

### 3.9.1 INTRODUCTION

The implementation of the external attitude capability is designed to give the user the ability to apply external attitude information to both the computation of nonconservative forces on the satellite, and antenna offset measurement corrections. This capability may be used with multiple arc and multiple satellite runs.

The external attitude is provided to GEODYN in the form of quaternions. Linear interpolation is used to find quaternions at integration and measurement times. If there are interpolation problems (ie. the quaternion magnitude is not equal to one) GEODYN will print a warning. The presence of an external attitude file during a GEODYN run directs GIIS to load the quaternion information needed for the satellites and times of the run.

Application of the external attitude to measurement corrections is specified on the OFFSET and SATPAR cards. Application of the external attitude to the force model is specified on the SATPAR card. PANEL cards must be present in order to apply the external attitude to nonconservative force model computations. Most of the external attitude control is provided in the external attitude file itself.

An antenna identification scheme which uses the metric data format allows the user to identify different antenna with the same frequency. This scheme may be used in place of the scheme which links an antenna with a particular frequency. Antenna offset measurements may be single or multiple link. Refer to the OFFSET card in Volume 3 for information on selection of identification schemes and multiple links.

### 3.9.2 BINARY FILE DESCRIPTION

The External Attitude 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: EXAT##, where ## is the number of the arc for which this external attitude file applies. For a single arc run, the filename must be EXAT01. Refer to the Volume 3 SATPAR and OFFSET cards for more details on the application of external attitude information.

#### DEFINITIONS :

SBF --> Spacecraft Body Fixed Frame  
J2000 --> J2000 Earth Equator and Equinox Frame  
MVP --> Movable Panel Frame  
MVA --> Movable Antenna Frame

"Movable" is with respect to the SBF frame.

All times in this file are TDT or TDB.

#### 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	No. of: panels+antenna separate quaternion sets/movable panels represented/movable antenna represented	QQQPPAAA**

Note: A set of quaternions is all of the quaternion data records (in ascending time order) for a particular satellite and movable panel and/or movable antenna, or spacecraft body fixed to J2000 quaternions. Satellite quaternion sets can be in any order. However, for simplicity, it is advised to group all of the quaternion sets for a particular satellite together.

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

\*\*Note: QQQ is the total \# of separate movable panels + antenna quaternion sets for this satellite (excludes SBF to J2000 quaternion set which is mandatory for each satellite represented in the file). PPP is the number of movable panels represented for this satellite. AAA is the number of moveable antenna represented for this satellite. One quaternion set may represent the attitude for up to two movable panels and one movable antenna.

### 3) QUATERNION SET HEADER RECORD

This header record must precede the quaternion data records for a particular set of quaternions.

WORD	DESCRIPTION	
1	Record Indicator	-8888888.00
2	Satellite ID	
3	Panel Number*	MMMNNN
4	Antenna-Link Number***	
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: MMM is 1st panel number and NNN is 2nd panel number. These panel numbers correspond to those on the PANEL card. There can be up to two panels and one antenna assigned to a particular quaternion set.

\*\*Note: Quaternion satellite information must match that on the satellite information header record.

\*\*\*Note: Antenna-Link number is used to specify both the antenna and link number(see table below).

Antenna-Link #  
Antenna #  
Link #

1  
1  
2

2  
2  
2

3  
3  
2

4  
4  
2

5  
1  
3

6  
2  
3

7  
3  
3

8  
4  
3

If panel number = 0 and Antenna number = 0, SBF --> J2000 (mandatory)  
" " " 0 and " " = 0, MVP --> SBF (force model)  
" " " = 0 and " " 0, MVA --> SBF (measurement model)  
" " " 0 and " " 0, MVP/MVA --> SBF (both force &  
measurement models)

To use link3 for measurement model, one needs two sets of quaternions for both link2 and link3, where the Antenna-Link # is showm above. To use link3 for force model, one should specify the panel numbers in the set header records. Note the panel number should be the same for link2 and link3. The Antenna-Link

number is used to differentiate the links.

#### 4) DATA RECORDS

These records apply to a particular quaternion set and must follow (in time ascending order) the quaternion set header record.

WORD	DESCRIPTION
1	Not used at present time
2	Not used at present time
3	q1 [note 3]                    sin(/2)n1
4	q2                                sin(/2)n2
5	q3                                sin(/2)n3
6	q4                                cos(/2)
7	Not used at present time
8	Not used at present time
9	Not used at present time

- Notes:
- 1) All quaternion sets(SBF to J2000, or MVP to SBF, or MVA to SBF) for a particular satellite ID must have the same interval, as well as the same start and stop times.
  - 2) Quaternion information must include 10 Integration steps before & after the EPOCH of the satellite in the GEODYN run.
  - 3) q1 = -9999999.000 indicates quaternion information is missing for this time point. GEODYN will use the internal attitude module if selected.
  - 4) A panel or antenna must not have a designation number of 0.
  - 5) GEODYN'S quaternion definition is Eulerion. Therefore, the scalar argument is defined as positive. Also, the quaternions should be provided without any discontinuities to provide for proper interpolation.

### 3.9.3 IMPLEMENTATION OF EXTERNAL ATTITUDE CAPABILITIES

- Construct an EXAT## file as described in the previous section. All quaternion information sets for a particular satellite must start and stop at least 10 integration steps before and after the EPOCH start and stop times for this particular satellite.
- Select the external attitude modeling for a particular satellite in the run by putting a 9 in column 12 of the SATPAR card.
- For force model application, make sure any movable panels selected with the PANEL cards have the matching number label in word 3 of the quaternion header record.
- For measurement model application, use an OFFSET1 and OFFSET2 card for multiple link offsets. Make certain external attitude modeling is selected by putting a 9 in column 8 of the OFFSET1 card. Also, an antenna number must be put in column 17 of the OFFSET1 card (an integer 1 to 4). Finally, the movable antenna frame to J2000 quaternion information must be present in the EXAT## file. Word 4 of the quaternion set header record for this movable antenna must contain the same antenna number as that in column 17 of the OFFSET1 card. The first link of the offset is in the SBF frame and the second link is in a movable frame that is rotated to SBF by the movable antenna quaternion information. The SATPAR card must also request external attitude for the particular satellite as described above.
- For single link measurement model application, use a single OFFSET card requesting external attitude with a 9 in column 8. A movable antenna quaternion information set, for this antenna number (column 17), must not be present in the EXAT## file. Even if this quaternion set has -9999999 in word 3 of the data records.

- To use an internal model as a backup for the external attitude modeling when quaternion information is not available, simply request the appropriate internal model in column 11 of the SATPAR card. Do not forget to select external attitude modeling with a 9 in column 12. During force model computations, the internal model will be used for the entire attitude modeling if a -9999999 is present on either of the interpolation boundaries for the SBF to J2000 quaternion. The internal model will be used for a particular movable panel only if a -9999999 is present on the interpolation boundaries of the movable panel to SBF quaternion. During measurement model computations if a -9999999 is present in either the satellite or antenna quaternion information for any measurement within the block, the entire block will be evaluated with the internal model.

### 3.10 GEODYN EXTERNAL ACCELERATION FILE

#### 3.10.1 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.

#### 3.10.2 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)	SSSS.SSSS
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	

## 3.11 GEODYN EXTERNAL THERMAL ACCELERATION FILE

### 3.11.1 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.

### 3.11.2 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.

### 3.12 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 SLFSDH cards to 1, otherwise 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.

### 3.13 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 Orrora1

## 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

### 3.14 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 coefficients 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.

### 3.15 OPTICAL DATA AUXILLARY FILE

The Optical data auxillary file is needed for both normal and rapid integration of optical (image) data. It is an ASCII file that consists of lines of records that contains the measurement type, modified Julian day seconds and fraction of day of image 1 and modified Julian day seconds and fraction of day of image 2. It is input in IIE on unit 55.

#### 3.15.1 FORMAT

Columns	Format	Description
-----	-----	-----
1-25	G25.16	Measurement Type (always 33)
26-50	G25.16	Modified Julian Day seconds of first image (UTC)
51-75	G25.16	Fraction of day in seconds of first image (UTC)
76-100	G25.16	Modified Julian Day seconds of second image (UTC)
101-125	G25.16	Fraction of day in seconds of second image (UTC)

### 3.16 ATMOSPHERIC LOADING FILE

The atmospheric loading file is a binary file that can be input to GEODYN IIS on unit 24. Please see APLOAD card description in Volume 3 for the details on the file format.



## 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 facility 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	

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 Parallax Refraction
8	Obs #2 Parallax 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 -----
------------------------------	----------------------

1	Latitude of Landmark	
2	Longitude of Landmark	
3	Height of Landmark	
4	B Angle	
5	X Coordinate of Landmark in Meters	
6	Y Coordinate of Landmark in Meters	Target Body Centered
7	Z Coordinate of Landmark in Meters	Fixed Coordinates
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) [NOTE 2]
9	Switches indicating which of first 40 possible words are present [NOTE 1]
10	Switches indicating which of second 40 possible words are present [NOTE 1]
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 or simple  
interval; Spline if word 60>0, Simple interval otherwise)

If spline:  
Index to the first parameter in the string for station 1  
North gradient in the configuration.

If simple interval: [NOTE 3]  
Index to the North gradient parameter 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 or simple  
interval; Spline if word 62>0, Simple interval otherwise)

If spline:  
Index to the first parameter in the string for station 2  
North gradient in the configuration.

If simple interval: [NOTE 3]  
Index to the North gradient parameter 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 or simple  
interval; Spline if word 64>0, Simple interval otherwise)

If spline:  
Index to the first parameter in the string for station 1  
East gradient the configuration.

If simple interval: [NOTE 3]  
Index to the East gradient parameter 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 or simple

interval; Spline if word 66>0, Simple interval otherwise)

If spline:

Index to the first parameter in the string for station 2  
East gradient in the configuration.

If simple interval: [NOTE 3]

Index to the East gradient parameter 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 1]: 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 2]: Record types are limited to 8.

[NOTE 3]: Since IIE version 2106.p02

## 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 Seconds (MJDS=(JD-2430000.5D0)*86400+ISEC).	ET
16	R*8	Fractional seconds of Start Time.	ET
17	R*8	Trajectory Stop Date & Time in Modified Julian Day Seconds (MJDS=(JD-2430000.5D0)*86400+ISEC).	ET
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-> 200	R*8	Spares.	
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)	ITRF to ICRS(J2000) 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	<p>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.</p> <p>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.</p> <p>Measurements other than differenced ranges and Dopplers will have non-zero indexes some or all of the first five words.</p> <p>Singly differenced ranges and Dopplers will have non-zero indexes in some or all of the first ten words.</p> <p>Doubly differenced ranges and Dopplers will have non-zero indexes in some or all words.</p> <p>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.</p>

## 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 ->2NM	R*8	Cosine of right ascension of greenwich at each observation time.
2NM+1 ->3NM	R*8	Sine of right ascension of greenwich at each observation time.
3NM+1 ->4NM	R*8	Inertial X coordinate of station location at each observation time.
4NM+1 ->5NM	R*8	Inertial Y coordinate of station location at each observation time.
5NM+1 ->6NM	R*8	Inertial Z coordinate of station location at each observation time.

6NM+1 ->7NM	R*8	Inertial X velocity of station location at each observation time.
7NM+1 ->8NM	R*8	Inertial Y velocity of station location at each observation time.
8NM+1 ->9NM	R*8	Inertial Z velocity of station location at each observation 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 ->2NM	R*8	Inertial X coordinates of satellite position. True of date, center of integration coordinates.
2NM+1 ->3NM	R*8	Inertial Y coordinates of satellite position. True of date, center of integration coordinates.
3NM+1 ->4NM	R*8	Inertial Z coordinates of satellite position. True of date, center of integration coordinates.
4NM+1 ->5NM	R*8	True of date satellite latitude wrt center of integration.
5NM+1 ->6NM	R*8	True of date satellite longitude wrt center of integration.
6NM+1 ->7NM	R*8	True of date satellite height above the ellipsoid 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 ->2NM	R*8	Inertial X coordinates of satellite position. 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-> 2NM	R*8	Observation residuals.	
2NM+1 ->3NM	R*8	Observation editing sigmas.	
3NM+1 ->4NM	R*8	Observation time derivatives.	
4NM+1 ->5NM	R*8	Right Ascension of Greenwich.	
5NM+1 ->6NM	R*8	Elevation angle from first link.	
6NM+1 ->7NM	R*8	Elevation angle from second link.	
7NM+1 ->8NM	R*8	Elevation angle from third link.	
8NM+1 ->9NM	R*8	Elevation angle from fourth link.	
9NM+1 ->10NM	R*8	Elevation angle from fifth link.	
10NM+1 ->11NM	R*8	Elevation angle from sixth link.	
11NM+1	R*8	Elevation angle from seventh link.	



->12NM

12NM+1 R\*8 Elevation angle from eighth 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 TYPE	RECORD DESCRIPTION
1	<p>HEADER RECORD</p> <p>Contains speed of light, creation date, number of parameters and other general information (30 Words).</p>
2	<p>PARAMETER GROUP IDENTIFIERS</p> <p>Fifteen digit numbers used to identify the different groups of estimated parameters (e.g. drag,tides,etc.)</p>

- 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
100002000000000.	Drag parameters
100004000000000.	Solar radiation parameters
100008000000000.	General acceleration parameters
200000000000000.	Arc geopotential parameters
300000000000000.	Thermal Drag parameters
300020000000000.	Panel area parameters
300030000000000.	Panel secular reflectivity parameters
300040000000000.	Panel diffuse reflectivity parameters
300050000000000.	Panel emmissivity parameters
300060000000000.	Panel temperature A parameters
300070000000000.	Panel temperature C parameters
300080000000000.	Panel time D parameters
300090000000000.	Panel time F parameters
300100000000000.	Panel theta x parameters
399999000000000.	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  
 11000000000000. Station coordinates  
 110000000001000. Global geometric model FANTOM parameters  
 110000000002000. Global force model FANTOM parameters  
 1100000000010000. Lense-Thirring parameters

```

1200000000000000.      Sea Surface topography parameters
1201000000000000.      Sea Surface topography using Proudman Functions
1300000000000000.      Station velocities
1300100000000000.      Station L2
1300200000000000.      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 RECORD	NUMBER OF PARAMETERS	DESCRIPTION
0.	6	Number of satellite epoch elements
1000020000000000.	1	Drag parameters
1000040000000000.	1	Solar radiation parameters
5000000000000000.	10	Global geopotential parameters
8500000000000000.	6	Polar motion and ut1
9000000000000000.	1	Common measurement biases
1000000000000000.	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 TYPE	RECORD DESCRIPTION
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 EMATRIX card)

2 Negative of the E-Matrix number (E-Matrix number is the positive number input in columns 25-44 of the EMATRIX 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.

```

9000000000000000.	GM
9000010000000000.	Planetary ephemeris correction parameters
9000020000000000.	Semi-major axis
9000030000000000.	Polar flattening
9000040000000000.	Equatorial flattening
9000100000000000.	Planetary moon
9001000000000000.	Speed of light
9001100000000000.	Ephemeris correction for central body
9001200000000000.	Ephemeris correction for tracking body
9100000000000000.	Solid earth tidal displacement
9200000000000000.	Ocean loading parameters
9500000000000000.	Polar motion and UT1
9600000000000000.	Polar motion and UT1 Rate parameters
9700000000000000.	VLBI parameters
9800000000000000.	Planet orientation parameters
1000000000000000.	Common measurement biases
110000000001000.	Global geometric model FANTOM parameters
110000000002000.	Global force model FANTOM parameters.
110000000010000.	Lense-Thirring parameters.
1100010000000000.	Station coordinates
1200000000000000.	Sea surface topography parameters.
1201000000000000.	Sea surface topography using Proudman Functions.
1300000000000000.	Station velocities.
1300100000000000.	Station L2.
1300200000000000.	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
10000000000000.	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 (20000000000000.)
$3N+3$	YYMMDDHHMMSS.SS of reference time associated with the TIEOUT option.

3N+4	TIEOUT output time in elapsed 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	Ossnnfcdddddd.	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																																
		<table border="1"> <thead> <tr> <th>\f</th> <th>0</th> <th>1</th> <th>2</th> </tr> </thead> <tbody> <tr> <td>c\</td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>X</td> <td>a</td> <td>a</td> </tr> <tr> <td>2</td> <td>Y</td> <td>e</td> <td>eCOS(W+N)</td> </tr> <tr> <td>3</td> <td>Z</td> <td>i</td> <td>eSIN(W+N)</td> </tr> <tr> <td>4</td> <td>X</td> <td>N</td> <td>SIN(i/2)SIN(N)</td> </tr> <tr> <td>5</td> <td>Y</td> <td>W</td> <td>SIN(i/2)COS(N)</td> </tr> <tr> <td>6</td> <td>Z</td> <td>M</td> <td>M+W+N</td> </tr> </tbody> </table>	\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
\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																															
	dddddd	INTERNATIONAL SATELLITE ID																																



WORD	LABEL	DESCRIPTION
1	1ssnptfcmmmm.	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  mmmm - 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	2bbbbjnnnnmmmm.	ARC 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  
 0001 <---  
 0002 | Celestial bodies supplied  
 0003 | by the supplementary  
 0004 | planetary ephemeris.  
 0005 |  
 0006 |  
 0007 |  
 0008 |  
 0009 |  
 0010 <---

j - COEFFICIENT TYPE

- 1 - COEFFICIENT OF COSINE (C)
- 2 - COEFFICIENT OF SINE (S)

nnnn - DEGREE

mmmm - ORDER

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	3ssnn0000000000.	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	4mmnnnnnnnnss.	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

4800ssssttttt.

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	500bccccccdmn	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	501bbbbbbcdmm	ARC ATTITUDE PARAMETERS  bbbbbbb - SATELLITE ID  c - ANGLE INDEX  1 - ROLL 2 - PITCH 3 - YAW  d - component  1 - CONSTANT





WORD	LABEL	DESCRIPTION
1	507000000000aa	Finite Burn Parameters  aa - parameter number in advanced order (1-25 for one group 1-50 for two groups )

WORD	LABEL	DESCRIPTION
1	599ssnptfcmm	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	6bbbbjknnnmml.	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
0001 <---
0002 | Celestial bodies supplied
0003 | by the supplementary
0004 | planetary ephemeris.
0005 |
0006 |
0007 |
0008 |
0009 |
0010 <---

```

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
k > 0		mmm - ORDER
		_1 - NUMBER OF PERIOD
		-
		nnn - DEGREE
		_mmml - ORDER
		k = 0
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 7tcdnmmMKHJJB. 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
	t>5>0	MKH - MKH EXPANSION ARGUMENTS OF THE DEMOS NUMBER M=0,1,2 K=0,1,2 H=0,1,2 JJ - J EXPANSION ARGUMENT OF DEMOS NUMBER + 10 JJ=J+10, -10<J<10 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. ccccc - GRID NUMBER. bbbbb - IS THE PARAMETER NUMBER UNIQUE IDENTIFIER FROM USER INPUT
2	ccccccceeeeeee.	ccccc - IS THE COLATITUDE OF THE CENTER OF THE AREA REPRESENTED BY THE PARAMETER. MEASURED IN UNITS OF 0.0001 DEGREES FROM NORTH POLE. eeeee - IS THE LONGITUDE OF THE CENTER OF THE AREA REPRESENTED BY THE PARAMETER. MEASURED IN UNITS OF 0.0001 DEGREES.



c - EPHEMERIS ERROR COMPONENT

- 1 - X
- 2 - Y
- 3 - Z

WORD	LABEL	DESCRIPTION
1	90001p0bbb0000.	PLANETARY MOON PARAMETERS
		p - PARAMETER TYPE
		0 - GM
		bbb - PLANETARY BODY
		0100 MERCURY
		0200 VENUS
		0300 EARTH
		0301 EARTH'S MOON
		0400 MARS
		0500 JUPITER
		0600 SATURN
		0700 URANUS
		0800 NEPTUNE
		0900 PLUTO
		9999 SUN

WORD	LABEL	DESCRIPTION
1	9001000000000000.	SPEED OF LIGHT.

WORD	LABEL	DESCRIPTION
1	9001mbbbbf000	EPHEMERIS CORRECTIONS
		m - Indicator of central vs tracking body
		1 - Central body
		2 - Tracking body
		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
		0001 <---
		0002   Celestial bodies supplied
		0003   by the supplementary
		0004   planetary ephemeris.
		0005
		0006

0007 |  
 0008 |  
 0009 |  
 0010 <---

f - FORM OF THE ELEMENTS

- 1 - KEPLERIAN
- 2 - BROUWER-CLEMENCE SET III

WORD LABEL DESCRIPTION  
 -----

c - COMPONENT, SUCH THAT

f	1	2			
c					
1	<i>Delta a</i>	1#1			
2	<i>Delta e</i>	<i>Delta e</i>			
3	<i>Delta i</i>	2#2			
4	<i>Delta N</i>	<i>Delta p</i>			
5	<i>Delta W</i>	<i>Delta q</i>			
6	<i>Delta M</i>	<i>e Delta w</i>			

2 YYYYYMDDHHMMSS Epoch for correction to osculating elements

WORD LABEL DESCRIPTION  
 -----

1 9tcnmm000000. 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	9abbbbcdddddd	<p>GEOMETRIC DISPLACEMENT AT TIDAL FREQUENCIES.  OCEAN LOADING(OL) or CENTER of MASS(COM) or  EARTH ORIENTATION PARAMETERS(EOP)  GEOMETRIC DISPLACEMENT AT TIDAL FREQUENCIES</p> <p>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</p> <p>bbbb -  1= COM  2= EOP  3-9999 = OCEAN LOADING SITE #</p> <p>c - Coefficients  1= A COEF  2= B COEF</p> <p>d - Doodson # 1-8999990 (as input on OLOAD card)</p>

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.	<p>POLAR MOTION AND UT1 PARAMETERS.</p> <p>tttttttttt - (*)</p> <p>c - COMPONENT  1 - delta X  2 - delta Y  3 - delta UT1</p>





- 1 - RA
- 2 - RA Dot
- 3 - DEC
- 4 - DEC Dot
- 5 - ROT (P.M.)
- 6 - ROT DOT (P.M. Dot)

WORD	LABEL	DESCRIPTION
1	10mmmmmmmmmmss.	GLOBAL 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.
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".

WORD	LABEL	DESCRIPTION
1	11aaaaaaaaabcmn	GLOBAL PHANTOM PARAMETERS  a - aaaaaaaaa = 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	11aaaaaaaaabcdef	Lense-Thirring and Yukawa-type force model  aaaaaaaaa = 00000000  b = 1  c = 1 Mu parameter for the Lense-Thirring model 2 Alpha parameter for the Yukawa-type force model
2	Satellite ID	
3	0	
1	11aaaaaaaaabcdef	Second Body Gravitational and Shape Parameters  aaaaaaaaa = 00000000  b = 2 C coeff cdef = Degree and order od the C coefficients b = 3 S coeff cdef = Degree and order od the C coefficients b = 4 gm b = 5 a semimajor axis
1	11aaaaaaaaabcdef	Relativity PPN parameters  aaaaaaaaa = 00000000  b = 6 f = 1 GAMMA f = 2 BETA
1	11aaaaaaaaabcdef	SUN J2  aaaaaaaaa = 00000000  b = 7
1	11aaaaaaaaabcdef	SUN GM  aaaaaaaaa = 00000000  b = 8

1 11aaaaaaaaabcdef PLANETARY FORCE PARAMETERS  
 aaaaaaaaa = 00000000  
 bc = 91  
 def= Model ID

1 11aaaaaaaaabcdef PLANETARY SURFACE PARAMETERS  
 aaaaaaaaa = 00000000  
 bc = 92  
 def= Model ID

1 11aaaaaaaaabccdef ANTENNA TRANSPONDER DELAY  
 aaaaaaaaa = 00000000  
 b=1  
 cc=00  
 def=antenna number

WORD LABEL DESCRIPTION  
 -----

1 11nnnnnnnnbbbsc. TRACKING STATION COORDINATES AND PLANETARY TARGET  
 STATION COORDINATES.

nnnnnnnn - STATION NUMBER

bbb - PLANETARY BODY

- 100 MERCURY
- 200 VENUS
- 300 EARTH
- 301 EARTH'S MOON
- 400 MARS
- 500 JUPITER
- 600 SATURN
- 700 URANUS
- 800 NEPTUNE
- 900 PLUTO
- 999 SUN
- 001 <---
- 002 | Celestial bodies supplied
- 003 | by the supplementary
- 004 | planetary ephemeris.
- 005 |
- 006 |
- 007 |
- 008 |
- 009 |
- 010 <---

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
- 12 <---
- 22 | Celestial bodies supplied
- 32 | by the supplementary
- 42 | planetary ephemeris.
- 52 |
- 62 |
- 72 |
- 82 |
- 92 |
- 13 <---

WORD LABEL DESCRIPTION  
 -----

j - COEFFICIENT TYPE

For a=0 |<sup>-</sup> 1 - COEFFICIENT OF COSINE (C)  
 |<sub>-</sub> 2 - COEFFICIENT OF SINE (S)

For a=1 |<sup>-</sup> 0 - CONSTANT COEFFICIENT  
 | 1 - COEFFICIENT OF COSWT  
 |<sub>-</sub> 2 - COEFFICIENT OF SINWT

k - PARAMETER TYPE

	J=1	J=2			
K=0	<i>barc</i>	<i>bars</i>			
K=1	<i>dotc</i>	<i>dots</i>			
K=2	<i>a<sub>ci</sub></i>	<i>a<sub>si</sub></i>			
K=3	<i>b<sub>ci</sub></i>	<i>b<sub>si</sub></i>			

WORD LABEL DESCRIPTION  
 -----

s - SEQUENCE NUMBER FOR PERIODIC FREQUENCY

For a = 0 |<sup>-</sup> nnn - DEGREE  
 | mmm - ORDER

For a = 1 |<sup>-</sup> nnnmmm - INTEGER THAT SPECIFIES THE POSITION OF  
 | THE ADJUSTED COEFFICIENT IN THE STREAM  
 |<sub>-</sub> 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	13aabnnnnnnnsc.	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																								
		<table border="1"> <thead> <tr> <th>\c</th> <th>1</th> <th>2</th> <th>3</th> </tr> </thead> <tbody> <tr> <td>s\</td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>LAT</td> <td>LON</td> <td>HEIGHT</td> </tr> <tr> <td>2</td> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>3</td> <td>SAD</td> <td>LON</td> <td>Z</td> </tr> <tr> <td>4</td> <td>LAT</td> <td>LON</td> <td>RADIUS</td> </tr> </tbody> </table>	\c	1	2	3	s\				1	LAT	LON	HEIGHT	2	X	Y	Z	3	SAD	LON	Z	4	LAT	LON	RADIUS
\c	1	2	3																							
s\																										
1	LAT	LON	HEIGHT																							
2	X	Y	Z																							
3	SAD	LON	Z																							
4	LAT	LON	RADIUS																							
		b=0																								
2	yymmddhhmss.	REFERENCE TIME FOR STATION VELOCITIES APPLICATION																								

WORD	LABEL	DESCRIPTION
1	14tttttttttttc.	NUTATION PARAMETERS
		tttttttttttt - MIDPOINT OF THE DPSI/EPST CORRECTIONS IN YYMDDHHMSS
		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 YYMDDHHMSS.
3	tttttttttttt.	STOP TIME OF THE DPSI/EPST CORRECTION TIME INTERVAL IN YYMDDHHMSS.

WORD	LABEL	DESCRIPTION
1	15tttttttttttttc.	CENTER OF MASS-CENTER OF GRAVITY COEFFICIENTS  tttttttttttt - 000000000000  c - PARAMETER IDENTIFIER 1 - X component 2 - Y component 3 - Z component
2	tttttttttttt.	000000000000.
3	tttttttttttt.	000000000000.

## 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 TYPE	RECORD DESCRIPTION
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 Partial in MJDS ET.
6	Fraction of ET Seconds of Start Time.
7	Stop of Latest Force Model Partial 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 Partial (Initial Step Size for Variable Step Integration).
6	Integration Order for Force Model Partial.
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. $MJDS = (JD - 2430000.5D0) * 86400 + (\text{Time of Day in ET Seconds})$
10	Fraction of ET Seconds of Epoch Time.
11	UTC Start Date of Force Model Partial for this S/C (YYMMDD).
12	UTC Start Time of Force Model Partial (HHMMSS.SSSS).
13	Start of Force Model Partial for this Satellite in MJDS ET.
14	Fraction of ET Seconds of Start Time.
15	UTC Stop Date of Force Model Partial for this S/C (YYMMDD).
16	UTC Stop Time of Force Model Partial (HHMMSS.SSSS).
17	Stop of Force Model Partial 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

```

9000000000000000.      GM
9000100000000000.      Planetary Moon parameters
9500000000000001.      Dynamic polar motion (X)
9500000000000002.      Dynamic polar motion (Y)
9500000000000003.      Dynamic polar motion (UT1)
9700000000000000.      Planet orientation parameters
1100000000000000.      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 ( $N_i$ ). Please note that  $N_i$  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 ( $N_i$ ). $N_i$ 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 = $(3N_i+1)$ - where $N_i$ is the number of force model parameters for the "i"th satellite.
$2 \rightarrow 3N_i+1$	Parameter labels - each parameter label consists of three words. The first $N_i$ words output correspond to the first word for each parameter label, the next $N_i$ words correspond to the second word for each parameter label, and the next $N_i$ words correspond to the third word for each parameter label.

3Ni+2                    2000000000000000. 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.  $X, Y, Z, \dot{X}, \dot{Y}, \dot{Z}$  for each of the force model parameters.

Length for this type of record =  $N_i+12$  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 =  $\max(N_i)+12$  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.

RECORD	WORD 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.

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)
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)	Time F (seconds) for plates 1 -> NUMPNL

R\*8

13+Numpnl (Numpnl) Theta X (radians) for plates 1 -> Numpnl  
R\*8

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) R*8	Satellite model number as on SATPAR.
4	(NSAT) R*8	Number of panels per SAT (Numpnl)

#### 5.7.4 DATA RECORD GROUP FORMAT

These groups are written out at each satellite integration time.

RECORD	WORD 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/s<sup>2</sup>).

                         1) Along Track  
                          2) Cross Track  
                          3) Radial

                         Drag Acceleration (m/s<sup>2</sup>).

                         4) Along Track  
                          5) Cross Track  
                          6) Radial

6            6R\*8            Albedo Acceleration (m/s<sup>2</sup>).

                         1) Along Track  
                          2) Cross Track  
                          3) Radial



Thermal Imbalance Acceleration (m/s<sup>2</sup>).

- 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.

RECORD -----	WORD TYPE ----	DESCRIPTION -----
1	8R*8	BLANKS
2	1R*8	BLANK
3	8R*8	1) Integration step time(UTC) YYYYDD 2) Integration step time(UTC) HHMM 3) Integration step time(UTC) SECONDS 4-8) BLANK
4	6R*8	Solar Radiation Acceleration (m/s <sup>2</sup> ).  1) Along Track 2) Cross Track 3) Radial  Drag Acceleration (m/s <sup>2</sup> ).  4) Along Track 5) Cross Track 6) Radial
5	6R*8	Albedo Acceleration (m/s <sup>2</sup> ).  1) Along Track 2) Cross Track 3) Radial  Thermal Imbalance Acceleration (m/s <sup>2</sup> ).  4) Along Track 5) Cross Track 6) Radial

## 5.8 RV FILE FORMAT

An RV file is a satellite ephemeris file which is output by GEODYN specifically for use by the DELTA analysis and graphics program. The RV file is a binary file with 22 8-byte floating point numbers in each record as follows:

WORD	TYPE	DESCRIPTION
1	R*8	DAYS ET FROM JAN 0.0 OF REF YEAR
2	R*8	EPOCH TIME UTC YYMMDD
3	R*8	EPOCH TIME UTC HHMM
4	R*8	EPOCH TIME UTC SECONDS
5	R*8	ITOD X (M)
6	R*8	ITOD Y
7	R*8	ITOD Z
8	R*8	ITOD X-DOT (M/S)
9	R*8	ITOD Y-DOT
10	R*8	ITOD Z-DOT
11	R*8	SATL. LATITUDE (DEG)
12	R*8	SATL. E. LONGIT (DEG)
13	R*8	SATL. ALTITUDE (M)
14	R*8	PECF X (M)
15	R*8	PECF Y
16	R*8	PECF Z
17	R*8	PECF X-DOT (M/S)
18	R*8	PECF Y-DOT
19	R*8	PECF Z-DOT
20	R*8	POLAR MOTION X (MAS)
21	R*8	POLAR MOTION Y (MAS)
22	R*8	GREENWICH HOUR ANGLE (DEG)

-----  
 Total = 176 bytes

## 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

29 R\*8 | laser reference frame ->

30 R\*8 | local vertical/local horizontal  
reference frame.

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)
```