DYNAMICS EXPLORER-2
VECTOR ELECTRIC FIELD INSTRUMENT
DATA REFINEMENT SYSTEM

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ABSTRACT

This document describes the Vector Electric Field Instrument (VEFI) Data Refinement System (DRS) which processes the telemetry data from the VEFI which is on board the Dynamics Explorer-2 spacecraft. The algorithm necessary for the computation of the geophysical quantities which are stored in the final repository of science data, the Mission Analysis Files (MAFs), were provided by the Principal Investigator and are described herein. The software components and the operation of the VEFI DRS are also described.

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SECTION 1 - INTRODUCTION

The Dynamics Explorer satellites were launched on August 3, 1981. The low-orbit spacecraft, DE-2, which re-entered the Earth's atmosphere in February 1983, contained a Vector Electric Field Instrument (VEFI) to measure the electric field in the Earth's ionosphere. Although the VEFI employed a triaxial direct probe method of measurement, one antenna, the Z-antenna perpendicular to the orbit plane (spin axis) failed to deploy and remained useless for the duration of the mission.

The VEFI Data Refinement System (DRS) decommutates and refines the quantities measured by the VEFI and stores the results in the Mission Analysis Files (MAFs), the final repository of the science data. The VEFI DRS operates on the DE Science Data Processing System (SDPS) computer, the Sigma-9 computer, located in Building 23 at the Goddard Space Flight Center. This volume contains a complete specification of the telemetry data which is input to the DRS, the MAFs which are output from the DRS, and the algorithms used for computing the geophysical quantities which are retained in the MAF data base. The algorithms are based on information received from the Principal Investigator.

Included in this volume (Section 6), are operating instructions for the DRS.

SECTION 2 - INPUTS TO THE VEFI DRS

2.1 TELEMETRY (TM) DATA

2.1.1 TM DATA ORGANIZATION

Spacecraft telemetry is organized into minor frames containing 128 8-bit words. A major frame consists of 128 minor frames. Since telemetry is transmitted at a rate of 16 kilobits per second, a major frame of data takes 8 seconds. A telemetry word may be used exclusively by an experiment, shared by more than one experiment or reserved for spacecraft data. A word dedicated to an experiment may be commutated. That is, it may contain different data depending on the location of the minor frame within the major frame, or upon the mode of the instrument as specified in other telemetry words. VEFI telemetry minor frame words 54-55, 62-63 and 70-71 are not commutated, while VEFI telemetry minor frame words 75, 76, 77, and 126-127 are commutated. See Appendix A for the assignment of telemetry words in a minor frame. See Table 2.1 for VEFI minor frame word contents.

TABLE 2.1. VEFI TELEMETRY LOCATIONS

MINOR FRAME WORD #	CONTENT
54-55	Differential Voltage measured along the X-axis, ΔX
62-63	Differential Voltage measured along the Y-axis, ΔY
70-71	Differential Voltage measured along the Z-axis, ΔZ
75	Spectrometer A reading in counts for one of eight channels*
76	Spectrometer B reading in counts for one of eight channels*
77	Spectrometer C reading in counts for one of eight channels*
126-127	Programmable: either an additional ΔX, ΔY or ΔZ or a Common Mode Voltage (CMX, CMY or CMZ)

**The content depends on the mode of the spectrometer.*

2.1.2 TELEMETRY DATA ACCESS

Telemetry data is accessed via the TMREAD subroutine which resides in the Data Management Facility (DMF) library. Reference 2 contains a detailed description of TMREAD. Specifics of the VEFI DRS usage of TMREAD are as follows: A single major frame of TM data is requested at a time. Since major frame synchronization is specified, the major frame containing the requested time is returned. TMREAD stores each eight-bit TM word in the right-most byte of a data element with leading bits, zero-filled. A negative returned value indicates fill data for the minor frame.

In the discussion which follows, the bits of each TM word are referenced from left to right by the numbers 1 to 8.

2.1.2.1 Power On/Off Status

The VEFI power on/off status is accessed from the 4-second spacecraft subcom word, minor frame word 65. If bit 5 of the 25th minor frame is one, the VEFI is on.

2.1.2.2 DC TM Data Extraction

The differential voltages measured along the X, Y, and Z axes are accessed from minor frame telemetry words 54-55, 62-63, and 70-71, respectively. A 14-bit value is extracted from each pair of words. The most significant 8 bits of each value are accessed from words 54, 62 and 70, while the least significant 6 bits are accessed from words 55, 63 and 71. Within the 8-bit telemetry words (55, 63 and 71), the left-most 6 bits are accessed. The residual two right-most bits of words 55, 63 and 71 specify spectrometer modes, gain, antenna, etc. (See Section 2.1.2.3 for a complete specification.)

Minor frame words 126-127 may contain an additional differential voltage measured along the X, Y, or Z axis. The contents of words 126-127 is determined as follows:

TABLE 2.2. PROGRAMMABLE MINOR FRAME WORDS 126-127

CONTENTS OF MINOR FRAME #1

WORDS 126-127	WORD 71 BIT 8	WORD 127 BIT 7	WORD 127 BIT 8
CM + Z	0	0	0
CM – Z	0	0	1
CM + Y	0	1	0
CM – Y	0	1	1
CM + X	1	0	0
ΔX	1	0	1
ΔY	1	1	0
ΔZ	1	1	1

If words 126-127 contain a differential voltage, it is accessed in the same manner as the other differential voltages. The 14-bit value extracted from words 54-55, 62-63, 70-71 and 126-127 is converted to a voltage as follows:

$$V = (N - 2^{13})\ (2.442)\ \text{mV}$$

$$N = \sum_{n=0}^{13} 2^n\, b_n$$

where V = voltage and b = bit # (1 or 0). If words 126-127 contain a Common Mode voltage, the 14-bit value extracted is converted to a voltage as follows:

$$V = (N - 2^{13})\ (3.663)\ \text{mV}$$

$$N = \sum_{n=0}^{13} 2^n\, b_n$$

where V = voltage and b = bit # (1 or 0).

2.1.2.3 AC TM Data Extraction

The spectrometer output for the three VEFI spectrometers (See Appendix F for a chart of the Spectrometer Frequencies for VEFI) is accessed from minor frame telemetry words 75, 76, and 77. An eight-bit value is extracted from each word. Because each of the spectrometers operates in one of several different modes, the contents of the minor frame telemetry words differ according to mode.

Spectrometers A and B operate in one of three modes: peak, average, or alternating mode:

- For peak mode, all readings are peaks;
- For average mode, all readings are averages;
- For alternating mode, peaks for channels 1 to 8 are followed by averages for channels 1 to 8.

Table 2.3 illustrates this for the first 16 minor frames of a major frame. The pattern repeats for each subsequent set of 16 minor frames.

TABLE 2.3. CONTENTS OF MINOR FRAME WORD 75 OR 76
ACCORDING TO MODE OF SPECTROMETER A OR B, RESPECTIVELY

CONTENTS ACCORDING TO MODE

MINOR FRAME #	PEAK	AVERAGE	ALTERNATING
1	Channel 1 Peak	Channel 1 Average	Channel 1 Peak
2	Channel 2 Peak	Channel 2 Average	Channel 2 Peak
3	Channel 3 Peak	Channel 3 Average	Channel 3 Peak
4	Channel 4 Peak	Channel 4 Average	Channel 4 Peak
5	Channel 5 Peak	Channel 5 Average	Channel 5 Peak
6	Channel 6 Peak	Channel 6 Average	Channel 6 Peak
7	Channel 7 Peak	Channel 7 Average	Channel 7 Peak
8	Channel 8 Peak	Channel 8 Average	Channel 8 Peak
9	Channel 1 Peak	Channel 1 Average	Channel 1 Average
10	Channel 2 Peak	Channel 2 Average	Channel 2 Average
11	Channel 3 Peak	Channel 3 Average	Channel 3 Average
12	Channel 4 Peak	Channel 4 Average	Channel 4 Average
13	Channel 5 Peak	Channel 5 Average	Channel 5 Average
14	Channel 6 Peak	Channel 6 Average	Channel 6 Average
15	Channel 7 Peak	Channel 7 Average	Channel 7 Average
16	Channel 8 Peak	Channel 8 Average	Channel 8 Average

The mode of Spectrometer A is obtained from minor frame word 55, bit 8 (the right-most bit) for minor frame #5 and minor frame # 6 as follows:

Mode of Spectrometer A	Contents of Word 55, bit 8 Minor Frame # 5	6
Peak	1	X
Average	0	1
Alternating	0	0

The mode of Spectrometer B is obtained from minor frame word 55, bit 8 for minor frame #7 and minor frame #8 as follows:

Mode of Spectrometer B	Contents of Word 55, bit 8 Minor Frame # 7	8
Peak	1	X
Average	0	1
Alternating	0	0

Spectrometer C operates in one of four modes: Option 1, 2, 3 or 4. The contents of minor frame word 77 for the first 16 minor frames within a major frame and for each subsequent set of 16 minor frames is shown in Table 2.4.

TABLE 2.4. CONTENTS OF MINOR FRAME WORD 77 ACCORDING TO MODE OF SPECTROMETER C

CONTENTS ACCORDING TO MODE

MINOR FRAME #	OPTION 1	OPTION 2	OPTION 3	OPTION 4
1	X Peak	X Peak	X Peak	X Peak
2	Y Peak	Y Peak	Y Peak	Y Peak
3	Z Peak	Common Mode +Z	Z Peak	Z Peak
4	Channel 1	Channel 1	Channel 1	Channel 1
5	Channel 2	Channel 2	Channel 2	X Peak
6	Channel 3	Channel 3	Channel 3	Y Peak
7	Channel 4	Channel 4	Channel 4	Z Peak
8	Channel 2	Common Mode +X	Common Mode +X	Channel 2
9	X Peak	Common Mode –X	Common Mode –X	X Peak
10	Y Peak	Common Mode +Y	Common Mode +Y	Y Peak
11	Z Peak	Common Mode -Y	Common Mode -Y	Z Peak
12	Channel 1	Channel 1	Common Mode +Z	Channel 3
13	Channel 2	Channel 2	Common Mode –Z	X Peak
14	Channel 3	Channel 3	ΔX	Y Peak
15	Channel 4	Channel 4	ΔY	Z Peak
16	Channel 2	Common Mode –Z	ΔZ	Channel 4

Minor frame word 63, bit 7 for minor frame 1 and 2 specifies the mode of Spectrometer C:

Mode of Spectrometer C	Contents of Word 63, bit 7 Minor Frame # 1	2
Option 1	0	0
Option 2	1	0
Option 3	0	1
Option 4	1	1

The meaning of the value extracted from words 75, 76, and 77 depends on the gain of the spectrometer, as well as the mode. The gain for each of the three spectrometers may be determined from minor frame words 55 and 63 as illustrated in Table 2.5.

TABLE 2.5. SPECTROMETER A, B, C GAIN

SPECTROMETER A GAIN	CONTENTS OF WORD 63, BIT 8 MINOR FRAME #2
LOW	0
HIGH (21.4)	1

SPECTROMETER B GAIN	CONTENTS OF WORD 55, BIT 7 MINOR FRAME #8
LOW	0
HIGH (21.6)	1

SPECTROMETER C GAIN	CONTENTS OF WORD 63, BIT 7 MINOR FRAME #3
LOW	0
HIGH (21.1)	1

The axis to be analyzed by each filter bank as well as the mode and gain are selectable by ground command. Table 2.6 illustrates how the antenna which was selected is determined for each spectrometer.

TABLE 2.6. SPECTROMETER A, B, C ANTENNAS

SPECTROMETER A INPUT (ANTENNA)	CONTENTS OF WORD 63, BIT 8 MINOR FRAME # 3	4
X	0	0
Y	1	0
–	0	1
Z	1	1

SPECTROMETER B INPUT (ANTENNA)	CONTENTS OF WORD 63, BIT 8 MINOR FRAME # 5	6
X	0	0
Y	1	0
–	0	1
Z	1	1

SPECTROMETER C INPUT (ANTENNA)	CONTENTS OF WORD 63, BIT 8 MINOR FRAME # 7	8
X	0	0
Y	1	0
–	0	1
Z	1	1

For all of the VEFI AC readings extracted from minor frame words 75, 76 and 77, an initial conversion from counts to volts is performed. Because the 8-bit spacecraft word can contain a maximum count of 255 which corresponds to a maximum of 5.1 volts, the number of volts represented by a reading in counts is calculated as follows:

$$V = c/50$$

where V = volts and c = counts.

2.1.2.4 The Four- and Eight-Second Instrument Subcom Words

Minor frame word 67 is the four-second Instrument Subcom word. VEFI common mode voltage readings may be extracted from word 67 as follows:

Minor Frame #	Contents of Word 67
10, 42	CM+X
11, 43	CM–X
18, 50	CM+Y
19, 51	CM–Y
20, 52	CM+Z
21, 53	CM–Z

Minor frame word 68 is the eight-second Instrument Subcom word. Eight distinct VEFI readings may be extracted from word 68. They are as follows:

Minor Frame #	Contents of Word 68
33	+X PreTemp
34	-X PreTemp
35	+Y PreTemp
36	-Y PreTemp
37	+Z PreTemp
38	-Z PreTemp
39	Elec Temp
40	13V Mon

All of the Instrument Subcom word values are changed first from counts to volts (See formula in Section 2.1.2.3).

2.1.2.5 Internal Calibration

The instrument performance is verified by an internal calibration sequence. This occurs once or twice per orbit and lasts a duration of either 32 or 64 seconds according to preceding ground command(s). Internal calibration (CAL) mode is determined by the processing program by the examination of minor frame word 71, bit 7 for any minor frame:

- '1' indicates CAL mode on;
- '0' indicates off.

The VEFI DRS accesses the CAL bit for the first and last minor frames of a major frame and flags the entire major frame for a later bypass of the potential integration.

2.2 ORBIT/ATTITUDE DATA

Orbit/Attitude (O/A) data is accessed via the OAREAD subroutine which resides in the DMF library. (See reference 2 for a detailed description of OAREAD.) Specifics of the VEFI usage of OAREAD is as follows: OAREAD is called at the beginning of the processing to determine the availability of O/A data for the pass to be processed, and to obtain information which is related to the pass, for retention in the directory entry of each output Mission Analysis File (MAF). The O/A parameters (see appendix B for a complete list) accessed for this purpose are shown in Table 2.7.

TABLE 2.7 O/A PARAMATERS

MAP NUMBER	DESCRIPTION
1	Predicted/definitive orbit flag = 0, definitive = 1, predicted
13	Orbit number
32	Height above spheroid (km)
33	Geodetic latitude (degrees)
38	Local magnetic time (hours)
40	Invariant latitude
23,24	X, Y positions of GEI satellite position vector (km)

OAREAD is also called once per 64 seconds of telemetry during the DC data refinement processing. The O/A parameters required for this processing are shown in Table 2.8.

TABLE 2.8. O/A PARAMETERS - DC PROCESSING

MAP NUMBER	DESCRIPTION
7	Right ascension of ascending node (degrees)
17-19	GEI vector toward Sun (unit vector)
23-25	GEI satellite position vector (km)
26-28	GEI satellite velocity vector (km/sec)
32	Height above spheroid (km)
33	Geodetic latitude (degrees)
41	Magnetic field strength (Gauss)
42-44	GEI magnetic field vector (Gauss)
59-67	3x3 rotation matrix for SP/C to GEI transformation

2.3 RUN-TIME PARAMETERS

The VEFI DRS requires as input a start date, start time, end date and end time at the initiation of each processing run. In general, the start/stop dates and times specify a telemetry (TM) segment; however, two or more consecutive TM segments may be processed in one run if the start date and time reflects the beginning of the first (earliest) pass and the end date and time reflects the end of the last (latest) pass.

One other parameter may optionally be specified: a contact potential used in the DC processing. The default contact potential values are as follows:

```
Ecx = -4.9
Ecy = -4.3
Ecz =  0.0
```

The contact potential values were determined by the Principal Investigator (PI).

2.4 RUN-TIME OPTIONS

The VEFI DRS may operate in a number of modes, depending on the selection of various processing options at execution time. DC data extraction, processing, and the creation of one or more DC MAFs may be selected. AC data extraction, processing and AC MAF creation may be selected. DC and AC processing may occur in separate runs independent of each other, or both may occur in the same run, thereby reducing the number of times the TM data must be accessed. There are several different types of DC MAFs which may be output from the DRS processing. The user may choose to generate more than one type of DC MAF in one run. In general, all or any combination of VEFI MAFs may be generated in one run; however, the creation of both the DC averaged data MAF (the DCA MAF) and the DC high resolution refined data MAF (the DCHR MAF) is prohibited within one run.

The other options selectable at run-time are all related to the DC data processing. The user may select any of the following DC options:

- **Magnetic Field Values**. Theoretical **B** values only may be selected. Measured **B** value selection may be implemented in the future.
- **Contact potential modification**. New values may be input, as specified by the PI.
- **Theoretical E_Z calculation**. The user may select the calculation of a theoretical E_Z based on the assumption that **E•B**=0. The PI specifies any pass for which this option is to be selected.
- **Antenna orthogonalization**. An orthogonalization matrix as specified by the PI may be applied to each electric field vector to compensate for the non-orthogonality of the antennas.
- **Extra programmable electric field value bypass**. The extra reading obtained from minor frame words 126-127 was discovered to be erroneous toward the end of 1981; therefore, this option enables the user to bypass its access and inclusion in the processing.

SECTION 3 - VEFI DRS PROCESSING

3.1 VEFI DC DATA

3.1.1 RAW DATA

The VEFI DC data, once extracted from the TM minor frame and converted from counts to millivolts, is converted to the geophysical units as follows:

```
Ex = – Vx/dx
Ey = – Vy/dy
Ez = – Vz/dz
```

where Vx, Vy and Vz are electric field values in millivolts measured along the X, Y and Z axes, respectively, and dx, dy and dz are the distances (baselines) for each antenna (21.4 meters each).

The electric field values, Ex, Ey and Ez are the values (in geophysical units) which are considered to be the "raw" data and which comprise the VEFI raw data MAF if the option was selected for the creation of one. Because of the failure of the Z antenna to deploy, the Ez value is set to 0 by the VEFI DRS.

3.1.2 DC DATA AVERAGING

VEFI raw data is averaged over 1/2 second intervals if the DC averaged data MAF processing option was selected. Thus, for one major frame (8 seconds of TM data), sixteen 1/2 second averages are calculated.

3.1.3 DC ELECTRIC FIELD ALGORITHM

The DC electric field algorithm consists of a subtraction from the raw data values (in spacecraft electric field coordinates) of the following:

- contact potentials
- corotation electric field
- **V**×**B** electric field

The result is the ambient electric field which is then transformed from spacecraft electric field coordinates (SCE) to spacecraft coordinates (SPC); from SPC to geocentric equatorial inertial coordinates (GEI), from GEI to topographic coordinates (TOP) and from TOP to local magnetic coordinates (LMG). (See Appendix D of Reference 9 for coordinate system acronym conventions.)

The values in SPC, TOP, and LMG are retained in the DC MAFs.

3.1.4 TRANFORMATION MATRICES

A number of transformations and the matrices which, when applied to a vector perform those transformations, are an integral part of the VEFI DC electric field algorithm. The matrices will, for notational convenience, be named as follows:

MATRIX	**TRANSFORMATION**
S	SPC TO GEI
G	GEI TO TOP
$\mathbf{M_T}$	TOP TO LMG (based on theoretical **B**)
R	SCE to SPC
C	ORTHOGONALIZATION

3.1.4.1 The R matrix: SCE to SPC transformation

The **R** matrix which transforms a vector from SCE to SPC coordinates, is a 45° rotation matrix, defined as follows:

$$\mathbf{R} = \begin{pmatrix} \cos 45º & \cos 45º & 0 \\ -\sin 45º & \sin 45º & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

3.1.4.2 The S Matrix: SPC to GEI transformation

This matrix which transforms a vector from SPC to GEI is accessed from the O/A data.

3.1.4.3 The G Matrix: GEI to TOP transformation

The **G** matrix which transforms a vector from GEI to TOP, is based on the ascension and declination and calculated as follows:

$$\mathbf{G} = \begin{pmatrix} -\sin\delta\cos\alpha & -\sin\delta\sin\alpha & \cos\delta \\ -\sin\alpha & \cos\alpha & 0 \\ -\cos\delta\cos\alpha & -\cos\delta\sin\alpha & -\sin\delta \end{pmatrix}$$

where α = satellite right ascension and δ = satellite declination (=satellite geographic latitude). See Reference 8.

3.1.4.4 The M Matrix: TOP to LMG transformation

The GEI theoretical magnetic field vector B is accessed from the O/A data and transformed to TOP coordinates:

$$\mathbf{B}_{TOP} = \mathbf{G}\ \mathbf{B}_{GEI}$$

Expressed by components:

$$\mathbf{B}_{TOP} = (B_X, B_Y, B_Z)_{TOP}$$

The magnetic field topographic coordinate system uses theoretical **B** and has its Z axis along **B**. The Y axis is perpendicular to **B** and in an Easterly direction.

Two vectors are defined in topographic:

$$\hat{A} = \left(\frac{-B_y}{\sqrt{B_x^2 + B_y^2}}, \frac{B_x}{\sqrt{B_x^2 + B_y^2}}, 0\right)$$

$$\hat{B} = \left(\frac{B_x}{|\boldsymbol{B}|}, \frac{B_y}{|\boldsymbol{B}|}, \frac{B_z}{|\boldsymbol{B}|}\right)$$

In the magnetic field topographic coordinate system:

$$\hat{A} = \hat{Y}$$
$$\hat{B} = \hat{Z}$$

Using procedures specified in Reference 4:

$$\mathbf{M_T} = (\hat{A}, \hat{A}\times\hat{B}, \hat{A}\times(\hat{A}\times\hat{B}))_{LMGT}\ (\hat{A}, \hat{A}\times\hat{B}, \hat{A}\times(\hat{A}\times\hat{B}))_{TOP}$$

$$= \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix} (\hat{A}, \hat{A}\times\hat{B}, \hat{A}\times(\hat{A}\times\hat{B}))$$

$$\mathbf{M_T} = (\hat{A}\times\hat{B}, \hat{A}, -\hat{A}\times(\hat{A}\times\hat{B})) = (\hat{A}\times\hat{B}, \hat{A}, \hat{B})$$

Note that the coordinate system flips in the X and Y direction as each pole is crossed.

$$\mathbf{A}_{LMGT} = \mathbf{M}_T \mathbf{A}_{TOP}$$

3.1.4.5 The C Matrix: orthogonalization

The **C** matrix is a matrix provided by the PI which is to compensate for the non-orthogonality of the antennas. Two such matrices have been used. They are identified by an ID number which is retained in the MAFs created using the associated matrix.

Orthogonalization Matrix, ID =1:

$$\mathbf{C} = \begin{pmatrix} 0.999999 & 0 & -3.4906\times10^{-4} \\ 0 & 0.999978 & -6.6322\times10^{-3} \\ 0 & 0 & 1.00000 \end{pmatrix}$$

Orthogonalization Matrix, ID =2 (Implemented February 22, 1982)

$$\mathbf{C} = \begin{pmatrix} 1.00000 & 0 & 0.00087 \\ 0 & 0.99996 & 0.00890 \\ 0 & 0 & 1.00000 \end{pmatrix}$$

3.1.5 COROTATION ELECTRIC FIELD CALCULATION

$$(\mathbf{V}_{COR})_{GEI} = (\omega\times\mathbf{r})$$

$$(\mathbf{V})_{SPC} = \mathbf{S}^{-1}\,(\mathbf{V}_{COR})_{GEI}$$

$$(\mathbf{E}_{COR})_{SPC} = (\mathbf{V}_{COR})_{GEI} \times (\mathbf{B}_T)_{SPC}\ 10^{-3}\ \text{mV/m}$$

where

$\mathbf{V}_{COR}$ is the corotation velocity

$\mathbf{B}_T$ is the theoretical magnetic field vector

$\mathbf{E}_{COR}$ is the corotation electric field

To calculate ($\omega\times\mathbf{r}$) the Earth's rotation:

ROT = $2\pi/86400$

The cross product, with the position vector accessed from the O/A data, is as follows in GEI:

V_X = P_Y * ROT

V_Y = –ROT * P_X

V_Z = 0

This vector is then transformed to SPC coordinates. The cross product with the theoretical magnetic field vector is calculated and the result is transformed to SCE coordinates.

3.1.6 V×B ELECTRIC FIELD CALCULATION

The spacecraft velocity vector and the theoretical magnetic field vector (both in GEI coordinates) are accessed from the O/A data previously obtained via OAREAD. Both vectors are transformed to SPC coordinates using the despin matrix which was previously accessed from the O/A data and stored in the /MATRIX/ named common area.

The cross product is expressed as follows:

$$(\mathbf{E}_{VXB})_{SPC} = (\mathbf{V})_{SPC} \times (\mathbf{B}_T)_{SPC}\ 10^2 \text{ mV/m}$$

where $(\mathbf{B}_T)_{SPC}$ is in Gauss. **V×B** is determined by the following equations:

$$Exs = (Vys*Bzs - Bys*Vzs)\ 10^2$$
$$Eys = (Vzs*Bxs - Bzs*Vxs)\ 10^2$$
$$Ezs = (Vxs*Bys - Bxs*Vys)\ 10^2$$

where

Exs represents the calculated x component of the cross product
Eys represents the calculated y component of the cross product
Ezs represents the calculated z component of the cross product

Vxs represents the x component of the velocity vector in SPC coordinates
Vys represents the y component of the velocity vector in SPC coordinates
Vzs represents the z component of the velocity vector in SPC coordinates

Bxs represents the x component of the theoretical magnetic field vector in SPC coordinates
Bys represents the y component of the theoretical magnetic field vector in SPC coordinates
Bzs represents the z component of the theoretical magnetic field vector in SPC coordinates.

The result, $(\mathbf{E}_{VXB})_{SPC}$ is transformed to SCE coordinates.
The orthogonalization matrix (See Section 3.1.4.5) is then applied to the resultant vector, $(\mathbf{E}_{VXB})_{SCE}$.

3.1.7 POTENTIAL INTEGRATION ALONG THE ORBIT PATH

The potential is integrated along the orbit path as follows:

$$V = -\int \boldsymbol{E} \bullet dx$$

where

V = integrated potential
E = electric field value, after corotation and **V×B** subtractions, in SPC coordinates, measured along the X-axis
dx = the distance the satellite has travelled along the orbit path

For each 1/2 sec, the product

$$V = -(E_x)_{SPC}\ \Delta x\ 10^{-3}$$

is calculated. Δx is determined by accessing the satellite position vector (P_X, P_Y, P_Z) from the O/A data for two consecutive data points at 1/2 second intervals, and calculating

$$\Delta x^2 = (P_{x2}-P_{x1})^2 + (P_{y2}-P_{y1})^2 + (P_{z2}-P_{z1})^2$$

where

(P_{x1},P_{y1},P_{z1}) refers to the position vector corresponding to the satellite position at the start of the 1/2 sec, interval over which E_x was averaged.

(P_{x2},P_{y2},P_{z2}) corresponds to the position at the end of the 1/2 sec interval

$(E_x)_{SPC}$ is in mV/m,

Δx is in km.

The potential in kV, is the running sum of the V's.

The potential integration is bypassed during the DC data processing if a flag, previously set, indicates that the internal calibration took place during the 8 second TM major frame.

3.1.8 THEORETICAL Z-COMPONENT

If the user selected this option at run-time, the following calculation is made for either DC averaged data processing or for DC high resolution data processing:

$$E_{Z(T)} = (-E_X*B_X - E_Y*B_Y)/B_Z$$

where

all components	are in SPC coordinates and
E_X, E_Y	are the electric field X and Y components
B_X, B_Y, B_Z	are the magnetic field components

Any MAF generated with a theoretical Z component is readily identified by a unique key: DCHR Z, DCA Z

3.1.9 HIGH RESOLUTION DC DATA PROCESSING

High resolution DC data processing is nearly identical to the 1/2 averaged DC data processing except for a few considerations

1) The potential integration is performed only on the ½ second averaged data.
2) Since O/A data cannot be accessed at precisely 1/16 second intervals, the O/A data is interpolated for all values· within each 1/2 second interval. OAREAD is called once per 64 seconds of TM data with a time increment of 1/2 second. A spline interpolation routine is called once per 8 seconds of TM for interpolating the O/A parameters.

3.2 VEFI AC DATA

The VEFI AC data, once extracted from the TM minor frame and converted from counts to volts (see section 2.1.2.3), is converted, in general, to a logarithmic scale.

3.2.1 SPECTROMETER A AND B

Tables 3.1 and 3.2 define the amplitude responses for Spectrometers A and B. Based on these values, the constants a, b, for the exponential function

$$y = a \cdot e^{bx}$$

were determined according to spectrometer, channel, and peak or average. See Tables 3.5 and 3.6 for the values of the constants for Spectrometers A and B. Solving the equation for Y results in the pre-amp voltage.

The amplitude response is then divided by the baseline: 21.4 meters. If the spectrometer is in high gain, the value is multiplied by 1000 and divided by a gain factor which is 21.4 for Spectrometer A and 21.6 for Spectrometer B. Grey scale values are assigned based on the values illustrated in Table 3.7. The grey scale value assigned to the high gain voltage is assigned to the value retained in the AC MAF divided by a factor of 1000.

Any Spectrometer A or B value which is either fill or, after conversion to a logarithmic scale, is less than 0.4 for high gain or 0.008 for low gain, is reset to 0.4 and 0.008, respectively.

3.2.2 SPECTROMETER C

For the conversion of the spectrometer C channel output to a logarithmic scale, Table 3.3 or Table 3.4 is used according to the gain of the spectrometer.

Interpolation is performed using the appropriate table. The result is divided by the baseline, 21.4 meters. If the spectrometer is in high gain, the value is multiplied by 1000. Grey scale values are assigned according to Table 3.7.

If the Spectrometer C value is fill or exceeds a minimum value, the value is reset to the minimum. These values are:

Channel	1	2	3	4
low gain	0.0233645	0.0373832	0.0140187	0.186916
high gain	1.16822	1.86916	0.467290	2.33645

3.2.3 DC PEAKS

DC peak values, in volts, are multiplied by 4 and divided by the baseline, 21.4.

Table 3.1. Spectrometer A Amplitude Response (T=+9 ºC)

Pre-amp	Low Gain (Volts DC)															
Vin	Ch1-5.7		Ch2-11.3		Ch3-22.6		Ch4-45.3		Ch5-90.5		Ch6-181		Ch7-362		Ch8-724	
(mv RMS)	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg
200.00	5.03	5.00	5.03	4.99	4.93	4.94	4.98	4.97	4.98	4.98	5.12	5.03	5.10	5.03	5.04	5.01
100.24	4.61	4.63	4.61	4.62	4.53	4.53	4.57	4.59	4.58	4.58	4.66	4.66	4.66	4.66	4.60	4.61
50.24	4.21	4.22	4.20	4.20	4.11	4.12	4.16	4.16	4.16	4.17	4.21	4.21	4.22	4.22	4.17	4.18
25.18	3.80	3.80	3.79	3.79	3.69	3.71	3.74	3.74	3.74	3.74	3.77	3.77	3.79	3.79	3.73	3.74
12.62	3.39	3.40	3.37	3.37	3.27	3.28	3.31	3.32	3.31	3.32	3.33	3.31	3.36	3.36	3.31	3.31
6.32	2.98	2.99	2.94	2.95	2.84	2.85	2.89	2.89	2.89	2.89	2.90	2.90	2.93	2.93	2.89	2.89
3.17	2.55	2.57	2.52	2.52	2.41	2.42	2.47	2.47	2.47	2.47	2.48	2.48	2.51	2.51	2.46	2.46
1.59	2.12	2.14	2.09	2.09	1.99	1.99	2.04	2.04	2.04	2.03	2.05	2.04	2.09	2.08	2.03	2.03
0.80	1.70	1.72	1.66	1.67	1.55	1.56	1.62	1.62	1.61	1.60	1.62	1.61	1.66	1.65	1.60	1.59
0.40	1.26	1.30	1.23	1.23	1.12	1.13	1.19	1.18	1.19	1.16	1.19	1.18	1.24	1.21	1.18	1.14
0.20	0.82	0.88	0.78	0.78	0.66	0.68	0.77	0.76	0.75	0.70	0.78	0.73	0.81	0.76	0.71	0.68
0.14	0.58	0.68	0.55	0.55	0.42	0.45	0.57	0.54	0.53	0.46	0.54	0.52	0.59	0.53	0.47	0.44
0.10	0.33	0.47	0.30	0.33	0.17	0.23	0.35	0.34	0.31	0.21	0.32	0.29	0.38	0.31	0.22	0.20

High Gain V_{in} = Low Gain V_{in} /21.4

Table 3.2. Spectrometer B Amplitude Response (T=+9 ºC)

Pre-amp	Low Gain (Volts DC)															
Vin	Ch1-5.7		Ch2-22.6		Ch3-53.7		Ch4-90.5		Ch5-215		Ch6-304		Ch7-430		Ch8-724	
(mv RMS)	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg	Pk	Avg
200.00	5.01	4.99	4.91	4.91	4.80	4.80	4.93	4.93	4.79	4.79	4.78	4.78	4.80	4.81	5.02	4.99
100.24	4.61	4.62	4.51	4.51	4.38	4.39	4.53	4.54	4.35	4.36	4.33	4.35	4.36	4.37	4.58	4.58
50.24	4.21	4.22	4.11	4.12	3.96	3.96	4.13	4.13	3.93	3.93	3.91	3.91	3.93	3.94	4.15	4.15
25.18	3.80	3.81	3.70	3.70	3.53	3.53	3.71	3.72	3.50	3.50	3.48	3.49	3.50	3.51	3.71	3.72
12.62	3.39	3.40	3.28	3.28	3.10	3.10	3.29	3.29	3.08	3.08	3.06	3.06	3.08	3.08	3.29	3.29
6.32	2.98	2.99	2.85	2.85	2.68	2.68	2.87	2.88	2.65	2.65	2.63	2.63	2.65	2.66	2.86	2.86
3.17	2.56	2.58	2.42	2.43	2.24	2.25	2.45	2.45	2.22	2.22	2.20	2.21*	2.23	2.23	2.43	2.43
1.59	2.13	2.15	1.99	1.99	1.81	1.83	2.02	2.02	1.80	1.79	1.78	1.78	1.81	1.79	2.01	2.00
0.80	1.70	1.73	1.57	1.58	1.38	1.40	1.59	1.59	1.37	1.36	1.35	1.35	1.38	1.35	1.58	1.57
0.40	1.27	1.30	1.14	1.14	0.92	0.99	1.15	1.15	0.94	0.93	0.92	0.92	0.95	0.89	1.14	1.13
0.20	0.82	0.89	0.69	0.70	0.44	0.59	0.73	0.71	0.49	0.49	0.46	0.49	0.50	0.40	0.70	0.68
0.14	0.58	0.67	0.47	0.48	0.18	0.38	0.46	0.48	0.25	0.28	0.24	0.29	0.30	0.14	0.46	0.45
0.10	0.34	0.45	0.24	0.26	-0-	0.21	0.19	0.24	0.03	0.08	-0-	0.09	0.08	-0-	0.23	0.22

High Gain V_{in} = Low Gain V_{in} /21.6

Table 3.3. Spectrometer C Low Gain Amplitude Response (T=+9 ºC)

Pre-amp Vin	Low Gain (Volts DC)			
(mv RMS)	Ch1-2.04k	Ch2-8.09k	Ch3-32k	Ch4-200k
200.00	4.99	4.99	4.96	4.76
100.24	4.54	4.54	4.51	4.34
50.24	4.10	4.10	4.08	3.88
25.18	3.67	3.66	3.64	3.37
12.62	3.22	3.20	3.20	2.76
8.93	2.99	2.96	2.98	2.35
6.32	2.77	2.72	2.75	1.75
5.64	2.69	2.63	2.68	1.47
5.02	2.61	2.55	2.60	1.12
4.48	2.53	2.46	2.52	0.59
3.99	2.45	2.37	2.44	-0-
3.17	2.28	2.18	2.29	
2.24	2.02	1.85	2.03	
1.59	1.73	1.43	1.78	
1.12	1.39	0.74	1.50	
1.00		0.26		
0.80	0.94	-0-	1.18	
0.63	0.49		0.94	
0.56	0.11		0.81	
0.50	-0-		0.65	
0.40			0.28	
0.30			-0-	

Table 3.4. Spectrometer C High Gain Amplitude Response (T=+9 ºC)

Pre-amp Vin	High Gain (Volts DC)			Pre-amp Vin	
(mv RMS)	Ch1-2.04k	Ch2-8.09k	Ch3-32k	(mv RMS)	Ch4-200k
11.241			5.03	25.179	5.04
10.024	5.01	5.01	4.96	20.000	4.91
8.934	4.94	4.93	4.89	14.159	4.69
5.024	4.57	4.57	4.52	10.024	4.48
2.518	4.13	4.13	4.09	5.024	4.02
1.262	3.69	3.69	3.65	2.SU	3.57
0.632	3.26	3.23	3.21	1.262	3.04
0.317	2.80	2.76	2.76	0.632	2.46
0.159	2.32	2.23	2.30	0.317	1.73
0.080	1.78	1.51	1.80	0.159	0.93
0.056	1.46	0.93	1.54	0.080	0.37
0.050		0.61		0.071	0.29
0.045		0.01		0.056	0.09
0.040	1.05	-0-	1.28	-0-	-0-
0.036	0.88		1.19		
0.032	0.65		1.10		
0.028	0.36		1.03		
0.025	-o-		0.95		
0.020			0.82		
0.016			0.72		
0.011			0.61		
-0-			0.52		
-0-			-0-		

TABLE 3.5. CONSTANTS FOR THE CONVERSION OF SPECTROMETER A DC VOLTS TO PRE-AMP VOLTS

CHANNEL	1		2	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.05270	0.04519	0.05647	0.05520
b	1.62638	1.66528	1.61447	1.62243
r^2	0.99962	0.99988	0.99976	0.99971

CHANNEL	3		4	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.06916	0.06596	0.05608	0.05734
b	1.60162	1.61085	1.63748	1.63112
r^2	0.99968	0.99985	0.99997	0.99994

CHANNEL	5		6	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.05862	0.06486	0.05994	0.06155
b	1.62486	1.59669	1.59489	1.59605
r^2	0.99994	0.99964	0.99991	0.99992

CHANNEL	7		8	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.05443	0.06308	0.06475	0.06744
b	1.61576	1.58097	1.59244	1.58247
r^2	0.99997	0.99877	0.99980	0.99975

TABLE 3.6. CONSTANTS FOR THE CONVERSION OF SPECTROMETER B DC VOLTS TO PRE-AMP VOLTS

CHANNEL	1		2	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.05192	0.04519	0.06396	0.06262
b	1.63118	1.66526	1.62395	1.62797
r^2	0.99955	0.99980	0.99979	0.99978

CHANNEL	3		4	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.09655	0.07749	0.06407	0.06298
b	1.57774	1.61244	1.61461	1.61651
r^2	0.99965	0.99383	0.99947	0.99977

CHANNEL	5		6	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.09115	0.08916	0.09463	0.08900
b	1.60427	1.61074	1.60190	1.61758
r^2	0.99992	0.99999	0.99991	0.99997

CHANNEL	7		8	
MODE	PEAK	AVERAGE	PEAK	AVERAGE
a	0.08705	0.10100	0.06605	0.06714
b	1.61531	1.5701 4	1.59678	1.59463
r^2	0.99998	0.99958	0.99993	0.99991

TABLE 3.7. GREY SCALE ASSIGNMENT VALUES

Value in mV/m	Grey Scale Value
n < 0.002	1
0.002 < n < 0.005	2
0.005 < n < 0.01	3
0.01 < n < 0.02	4
0.02 < n < 0.05	5
0.05 < n < 0.1	6
0.1 < n < 0.2	7
0.2 < n < 0.5	8
0.5 < n < 1.0	9
1.0 < n < 2.0	10
2.0 < n < 5.0	11
5.0 < n	12

SECTION 4 - OUTPUTS FROM THE VEFI DRS

4.1 MISSION ANALYSIS FILES (MAFs)

The prime output of the VEFI DRS is the VEFI MAFs which contain data resulting from the processing of the telemetry data. The MAF database is the final repository for the DE science data. The MAF database specifications are described in Reference 2. VEFI specific MAFs are discussed in the sections which follow. The formats of all VEFI MAFs comprise Appendix C.

4.1.1 THE MAF KEY

The MAF key which is assigned at MAF creation time, during the VEFI DRS processing, is based on a standard key format:

DIRECTORY ENTRY KEY PACKET

Word*	Item	Internal Type	Format	Values
1	File Type	Character	Left Justified Blank filled	D-data file, E-explanatory
2	Start date	Integer	YYDDD	
3	Start time of day	Integer	Milliseconds	0-86399999
4	Stop date	Integer	YYDDD	
5	Stop time of day	Integer	Milliseconds	0-86399999
6	Satellite	Character	Left justified, Blank filled	'A'-'E'
7	Instrument	Character	Left justified, Blank filled	(Table 2-3)
8	Content	Character	User defined	
9	Content			

VEFI MAF keys are readily identified by an instrument ID of VEFI. VEFI MAF types are distinguished from each other by the user-defined portion of the key:

```
'DCA      ‘ or 'DCA Z ’
'DCHR     ‘ or 'DCHR Z’
‘DCHRSCE ‘
'AC       ‘
```

The date(s) and time(s) of each MAF key is determined by the dates and times input to the VEFI DRS by the user.

4.1.1.1 The DC Averaged Data MAF

```
Key:            'DCA      ‘
Data Type:      Constant Increment Abscissa
Abscissa Type:  Time
Vector Type:    Fixed
```

4.1.1.2 The DC High Resolution Data MAF

```
Key:            'DCHR     ‘
Data Type:      Constant Increment Abscissa
Abscissa Type:  Time
Vector Type:    Fixed
```

4.1.1.3 The DC Raw Data MAF

```
Key:            'DCHRSCE ‘
Data Type:      Constant Increment Abscissa
Abscissa Type:  Time
Vector Type:    Fixed
```

4.1.1.4 The AC Data MAF

```
Key:            'AC       ‘
Data Type:      Constant Increment Abscissa
Abscissa Type:  Time
Vector Type:    Fixed Variable
```

4.1.2 TIME ADJUSTMENTS FOR MAF VECTORS

The abscissa (time) associated with each MAF vector is adjusted from the time of the major frame according to the time of the readout. The adjustments for the DC and AC times are as follows:

For DC MAF vectors (DCA and DCHR MAFs):

```
-2.929688 (-6/128*62.5)
```

For AC MAF vectors:

```
+36.62109 (75/128*62.5)
```

4.2 LINE PRINTER OUTPUT

The VEFI DRS generates output which is intended for a print device. This output provides a record of the processing run for analysis by the DE production staff and/or by VEFI account personnel.

4.2.1 PROCESSING LOG

Information which summarizes the processing run is output to a logical unit which, for production purposes is set to the line printer, but may be set to a file or to the user console or other device. This information includes:

Start and stop dates and times of the pass; a summary of the processing options selected; an entry for each record (vector) written with the time (abscissa) associated with each vector; a processing summary which provides run statistics. The processing summary includes the total number of TM major frames accessed, the number of TM frames that consisted of fill data, the number of TM frames for which the VEFI power was off, and the number of MAF records for each type of MAF.

4.2.2 ERROR LOG

Output pertaining to any error conditions which were detected during VEFI DRS processing are output to the same logical unit as the processing log output. In general, this output specifies the subroutine in which the error occurred, and some information indicative of the type of error which occurred. See Appendix C for a complete list of DRS error messages.

SECTION 5 - DRS SUBROUTINES

5.1 MODULE DEPENDENCY DIAGRAMS

The charts on the pages which follow illustrate the module dependencies for the VEFI DRS. See Figures 5.1, 5.2, and 5.3. The table which follows, Table 1, provides a brief description of the purpose of each DRS subroutine.

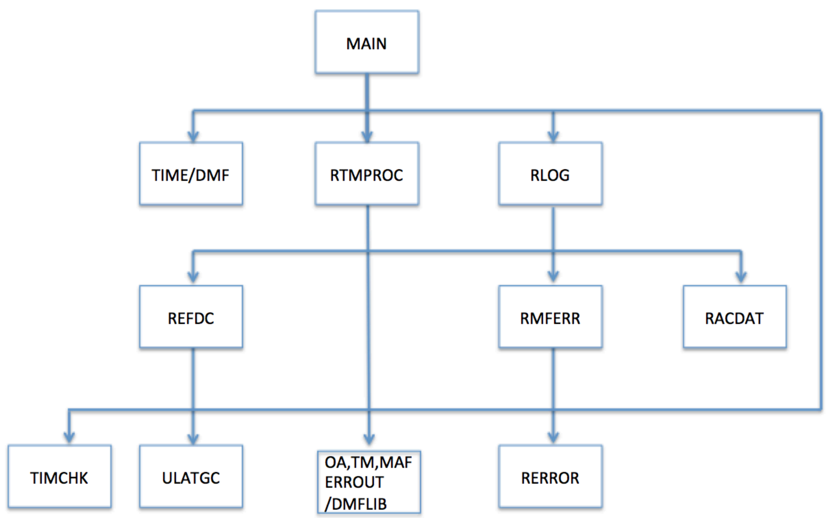


Figure 5.1 Module Dependency Diagram for MAIN program.

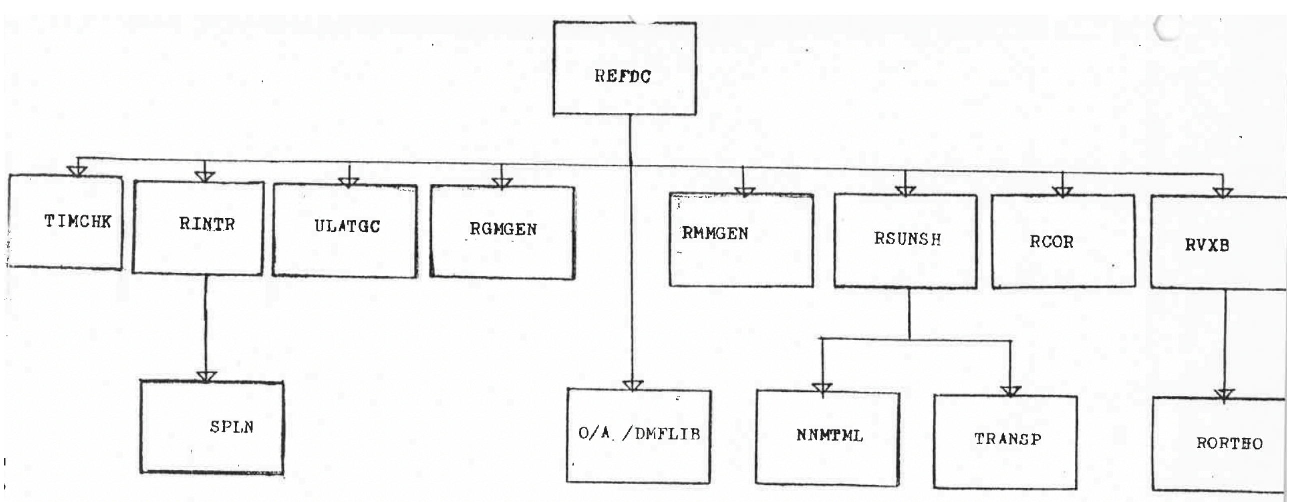


Figure 5.2 Module Dependency Diagram for subroutine REFDC.

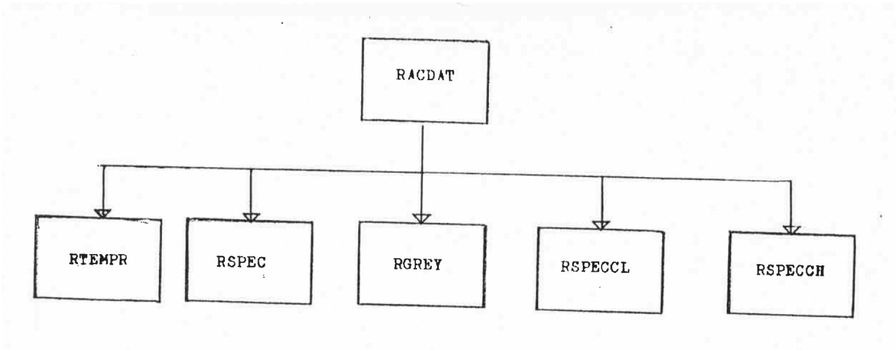


Figure 5.3 Module Dependency Diagram for subroutine RACDAT

TABLE 5.1 LIST OF VEFI DRS SUBROUTINES

SUBROUTINE	FILE NAME	PURPOSE
NNMTML	F4:NNM1ML	Transforms a vector according to the matrix provided
RACDAT	F4:RACDAT	Processes the AC TM data, producing the AC MAF vector
RCOR	F4:RCOR	Calculates the corotation electric field
RDATA	F4:RDATA	Block data for the initialization of /RCTL/ named common
REFDC	F4:REFDC	Refines the DC electric field values; formats the DCHR and DCA MAF vectors
RERROR	F4:RERROR	Writes error messages requested by number to F:108; also writes out a user buffer to F:108
RGMGEN	F4:RGMGEN	Generates the GEI to TOP matrix
RGREY	F4:RGREY	Converts AC millivolts to a grey scale value, and positions value in bits of output word
RINTR	F7:RINTR	Interfaces with spline subroutine, SPLN(R)
RLOG	F4:RLOG	Writes error message from user buffer to F:108
RMAIN	F4:RMAIN	Main control routine: reads control parameters, performs initialization
RMFERR	F4:RMFERR	Checks for and handles errors returned from MAF calls
RMMGEN	F4:RMMGEN	Generates top to LMG matrix
RORTHO	F4:RORTHO	Transforms vector using orthogonalization matrix
RSPEC	F4:RSPEC	Converts spectrometer A and B volts to a logarithmic scale
RSPECCH	F4:RSPECCH	Converts spectrometer C volts (high gain) to a logarithmic scale
RSPECCL	F4:RSPECCL	Converts spectrometer C volts (low gain) to a logarithmic scale
RSUNSH	F4:RSUNSH	Determines if any axis is within 5° of the sun vector and flags it in the output flag word
RTEMPR	F4:RTEMPR	Converts volts to temperature
RTMPROC	F4:RTMPROC	Main TM data refinement processing: reads TM, averages DC data, writes MAFs
RVXB	F4:RVXB	Calculates VxB in SPC; transforms to SCE
SPLN(R)	F7:SPLINE	Performs a cubic spline interpolation of O/A data
TIMCHK	F7:KTIMCH	Checks to determine if the ms of day has exceeded *a* day, and resets date and ms of day to next day
TRANSP	F4:TRANSP	Transposes a matrix
ULATGC	F7:ULATGC	Calculates geodetic latitude

5.2 FILE NAMING CONVENTIONS

Each filename consists of a 2-character prefix, followed by a : (colon), and the subroutine name. The naming conventions used are that source modules begin with F, object modules with B (binary) and load modules with L. The second character of the prefix is a number which designates a database. The 4 designates the TM database and identifies most subroutines as part of a system which processes TM data. A ‘7’ denotes 'other'.

5.3 COMPILING VEFI DRS SUBROUTINES

To compile:

```
!FORT4 filename OVER filename
```

e.g., `FORT4 F4:RMAIN OVER B4:RMAIN`

NOTE: For F4:RTMPROC, the ‘X’ option must be specified. Otherwise, the MAF I/O will not occur, however, the run will appear successful.

For a number of other subroutines, write statements will be compiled if the ‘X’ option is specified. Various debug information will be printed in this case. Subroutines in this category include: RSPECCL, RSPECCH, RSPEC, RGREY.

5.4 LINKING THE VEFI DRS

To link the VEFI DRS, creating the load module L4:RDSYS:

```
!LYNX J4:RML
```

The contents of J4:RML are as follows:

```
FILE: J4:RML

¡LYNX B4:RMAIN,;
 B7:INTR,B7:SPLINE,;
 B4:RDATA,B4:RERROR,B4:RLOG,B4:RTMPROC,B4:REFDC,;
 B4:RGMGEN,B4:RMMGEN,B4:RCOR,B4:RORTHO,B4:RVXB,B4:RACDAT,B7:ULATGC,;
 B4:RSUNSH,B4:NNMTML,B4:TRANSP,B4:RSPEC,B4:RTEMPR,B4:RGREY,;
 B4:RSPECCH,B4:RSPECCL,B4:RMFERR,;
 B7:KTIMCH OVER L4:RDSYSC(P2);U:LIB.DMFLIB;DMFLIB.LIBRARY
```

SECTION 6 - VEFI DRS OPERATING INSTRUCTIONS

6.1 VEFI DRS EXECUTION

The VEFI DRS load module, L4:RDSYS.VEFI may be executed in online or batch mode.

6.1.1 ONLINE EXECUTION

To initiate L4:RDSYS in the online interactive mode, the following device assignments are required, followed by the START command:

```
SET F:105 UC
SET F:106 UC
SET F:108 LP
SET F:201 /MAFA.VEFI
SET F:202 /MAFH.VEFI
SET.F:203 /MAFC.VEFI
SET F:204 /MAFR.VEFI
SET L4:RDSYS
```

After L4:RDSYS begins execution, the user will be prompted for the start date, start time, end date, and end time for the pass or subset of the pass *or* consecutive passes to be processed.

```
!S L4:RDSYS
VEFI DATA REDUCTION PROCESSING
     ENTER STARTDATE, STARTTIME. ENDDATE, ENDTIME.
     DATES ARE YYDDD FORMAT. TIMES ARE IN MS. OF DAY.
     PLEASE SEPARATE ALL FIELDS WITH COMMAS.
```

The user may respond to the remainder of the prompts with a 'Y' for yes, an 'N' for no. A 'standard' run is the normal production mode and is defined as follows:

```
!S L4:RDSYS
 VEFI DATA REDUCTION PROCESSING
      ENTER STARTDATE, STARTTIME, ENDDATE, ENDTIME.
      DATES ARE YYDDD FORMAT. TIMES ARE IN MS. OF DAY.
      PLEASE SEPARATE ALL FIELDS WITH COMMAS.
?82018,22778176,82018,24866148
      ENTER Y IF THIS IS A STANDARD RUN;
      ENTER N IF THIS IS A NON-STANDARD RUN
?Y

 DE-B VEFI PROCESSING ON 14:34 SEP 29,'83
      START DATE:82018;START TIME: 22778176
      STOP DATE:82018;STOP TIME: 24866148

 THE FOLLOWING RUN OPTIONS WERE SELECTED
     DC DATA WILL BE PROCESSED
        THE AVERAGED DATA MAF WILL BE CREATED
        THEORETICAL MAGNETIC FIELD VALUES USED
        CONTACT POTENTIAL VALUES ARE
        CX= -4.90, CY= -4.30, CZ= .00
        ANTENNAS WILL BE ORTHOGONALIZED
        EXTRA DELTA X,Y, OR Z WILL BE BYPASSED

     AC DATA WILL BE PROCESSED
        PLEASE VERIFY ALL PROCESSING OPTIONS.
        ENTER Y TO PROCEED, N TO REENTER, OR Q TO QUIT
```

After the user has responded to all processing option queries, a summary of the option selected is output to the UC. The operator may then enter 'Y 'to proceed, 'N' to re-specify all options, or Q to quit.

Once the user responds 'Y', the processing of TM begins. If the 1M selected is not online, the user will be asked to verify that a TM promotion is desired. The response to the system message must be 'YES' in order to proceed. When the TM is online, a relatively long wait will ensue for the user until, at the end of the job, a message is output:

```
DE-B VEFI PROCESSING COMPLETED
*STOP* 0
```

6.2 ONLINE INITIATION VIA THE 'BATCH' COMMAND

The same processing run may be submitted as a batch job by the command:

```
!BATCH VEFIRDSYS,'START'=82018,22778176','STOP'=' 82018,24866148'
```

This results in the following device assignments and START command. Note that the options selected are included in the input data stream, and that the VEFI DRS JCL ends at the first !EOD.

```
FILE: VEFIRDSYS
!JOB VEFI,ZBKLB,7
!LIMIT (COR,72),(TIME,3),(ACCOUNT),(RERUN)
!SET F:106 LP
!SET F:108 LP
!SET F:201 /MAFA
!SET F:202 /MAFH
!SET F:203 /MAFC
!SET F:204 /MAFR
!RUN (LMN,L4:RDSYS,VEFI)
!PMDE
!DATA
START,STOP
N
N
Y
Y
!EOD
!RUN (LMN,L5:BTMPRM,VEFI)
!PMDE
!DATA
START,STOP
!EOD
```

A non-standard run is anything other than the standard run. Some examples of non-standard runs are included.

AC

```
!S L4:RDSYS
 VEFI DATA REDUCTION PROCESSING
      ENTER STARTDATE, STARTTIME, ENDDATE, ENDTIME.
      DATES ARE YYDDD FORMAT. TIMES ARE IN MS. OF DAY.
      PLEASE SEPARATE ALL FIELDS WITH COMMAS.
?82018,22778176,82018,24866148
      ENTER Y IF THIS IS A STANDARD RUN;
      ENTER N IF THIS IS A NON-STANDARD RUN;
?N
      ENTER Y IF DC PROCESSING IS TO RE EXECUTED; OTHERWISE ENTER N
?N
      ENTER Y IF AC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?Y
DE-B VEFI PROCESSING ON 14:36 SEP 29, 83
 START DATE:82018;START TIME: 22778176
 STOP DATE:82018;STOP TIME: 24866148

 THE FOLLOWING RUN OPTIONS WERE SELECTED
```

```
   AC DATA WILL BE PROCESSED
       PLEASE VERIFY ALL PROCESSING OPTIONS.
       ENTER Y TO PROCEED, N TO REENTER, OR Q TO QUIT
?Q
*STOP* 0
```

High Resolution DC

```
!S L4:RDSYS
 VEFI DATA REDUCTION PROCESSING
      ENTER STARTDATE, STARTTIME, ENDDATE, ENDTIME.
      DATES ARE YYDDD FORMAT. TIMES ARE IN MS. OF DAY.
      PLEASE SEPARATE ALL FIELDS WITH COMMAS.
?83025,46241417,83025,46361417
      ENTER Y IF THIS IS A STANDARD RUN;
      ENTER N IF THIS IS A NON-STANDARD RUN;
?N
      ENTER Y IF DC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?Y
      ENTER Y IF RAW DATA FILE IS TO BE CREATED; OTHERWISE ENTER N
?N
      ENTER Y IF HIGH RESOLUTION MAF IS TO BE CREATED; OTHERWISE ENTER N
?Y
      ENTER Y IF AVERAGED DATA MAF IS TO BE CREATED; OTHERWISEE ENTER N
?N
      ENTER Y IF MEASURED MAGNETIC FIELD IS TO BE USED; OTHERWISE ENTER N
?N
      ENTER Y IF CONTACT POTENTIAL IS TO BE MODIFIED; OTHERWISE ENTER N
?N
      ENTER Y IF THEORETICAL EZ IS TO BE CALCUL ATED; OTHERWISE ENTER N
?N
      ENTER Y IF ANTENNAS ARE TO BE ORTHOGONALIZED; OTHERWISE ENTER N
?Y
      ENTER Y IF EXTRA DELTA X,Y,OR Z TO BE BYPASSED; OTHERWISE ENTER N
?Y
      ENTER Y IF AC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?N

 DE-B VEFI PROCESSING ON 15:28 SEP 29,'83
      START DATE:83025;START TIME: 46241417
      STOP DATE:83025;STOP TIME: 46361417

 THE FOLLOWING RUN OPTIONS WERE SELECTED
      DC DATA WILL BE PROCESSED
          THE HIGH RESOLUTION MAF WILL BE CREATED
          THEORETICAL MAGNETIC FIELD VALUES USED
          CONTACT POTENTIAL VALUES ARE
          CX= -4.90, CY= -4.30, CZ= .00
          ANTENNAS WILL BE ORTHOGONALIZED
          EXTRA DELTA X, Y, OR Z WILL BE BYPASSED

      PLEASE VERIFY ALL PROCESSING OPTIONS.
      ENTER Y TO PROCEED, N TO REENTER. OR Q TO QUIT
```

RAW DATA

```
!S L4:RDSYS
 VEFI DATA REDUCTION PROCESSING
      ENTER STARTDATE, STARTTIME, ENDDATE, ENDTIME.
      DATES ARE YYDDD FORMAT. TIMES ARE IN MS. OF DAY.
      PLEASE SEPARATE ALL FIELDS WITH COMMAS.
?83025,46241417,83025,46361417
      ENTER Y IF THIS IS A STANDARD RUN;
      ENTER N IF THIS IS A NON-STANDARD RUN;
?N
      ENTER Y IF DC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?Y
      ENTER Y IF RAW DATA FILE IS TO BE CREATED; OTHERWISE ENTER N
?Y
      ENTER Y IF HIGH RESOLUTION MAF IS TO BE CREATED; OTHERWISE ENTER N
?N
      ENTER Y IF AVERAGED DATA MAF IS TO BE CREATED; OTHERWISEE ENTER N
?N
      ENTER Y IF MEASURED MAGNETIC FIELD IS TO BE USED; OTHERWISE ENTER N
?N
      ENTER Y IF CONTACT POTENTIAL IS TO BE MODIFIED; OTHERWISE ENTER N
?N
      ENTER Y IF THEORETICAL EZ IS TO BE CALCUL ATED; OTHERWISE ENTER N
?N
      ENTER Y IF ANTENNAS ARE TO BE ORTHOGONALIZED; OTHERWISE ENTER N
?N
      ENTER Y IF EXTRA DELTA X,Y,OR Z TO BE BYPASSED; OTHERWISE ENTER N
?N
      ENTER Y IF AC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?N

 DE-B VEFI PROCESSING ON 15:39 SEP 29,'83
      START DATE:83025;START TIME: 46241417
      STOP DATE:83025;STOP TIME: 46361417

 THE FOLLOWING RUN OPTIONS WERE SELECTED
      DC DATA WILL BE PROCESSED
            THE RAW DATA FILE WILL BE CREATED
            THEORETICAL MAGNETIC FIELD VALUES USED
            CONTACT POTENTIAL VALUES ARE
            CX= -4.90, CY= -4.30, CZ= .00
     PLEASE VERIFY ALL PROCESSING OPTIONS.
      ENTER Y TO PROCEED, N TO REENTER. OR Q TO QUIT
```

AVERAGED DC DATA

```
!S L4:RDSYS
 VEFI DATA REDUCTION PROCESSING
      ENTER STARTDATE, STARTTIME, ENDDATE, ENDTIME.
      DATES ARE YYDDD FORMAT. TIMES ARE IN MS. OF DAY.
      PLEASE SEPARATE ALL FIELDS WITH COMMAS.
?83025,46241417,83025,46825432
      ENTER Y IF THIS IS A STANDARD RUN;
      ENTER N IF THIS IS A NON-STANDARD RUN;
?N
      ENTER Y IF DC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?Y
      ENTER Y IF RAW DATA FILE IS TO BE CREATED; OTHERWISE ENTER N
?N
      ENTER Y IF HIGH RESOLUTION MAF IS TO BE CREATED; OTHERWISE ENTER N
?N
      ENTER Y IF AVERAGED DATA MAF IS TO BE CREATED; OTHERWISEE ENTER N
?Y
      ENTER Y IF MEASURED MAGNETIC FIELD IS TO BE USED; OTHERWISE ENTER N
?N
      ENTER Y IF CONTACT POTENTIAL IS TO BE MODIFIED; OTHERWISE ENTER N
?N
      ENTER Y IF THEORETICAL EZ IS TO BE CALCUL ATED; OTHERWISE ENTER N
?Y
      ENTER Y IF ANTENNAS ARE TO BE ORTHOGONALIZED; OTHERWISE ENTER N
?Y
      ENTER Y IF EXTRA DELTA X,Y,OR Z TO BE BYPASSED; OTHERWISE ENTER N
?Y
      ENTER Y IF AC PROCESSING IS TO BE EXECUTED; OTHERWISE ENTER N
?N

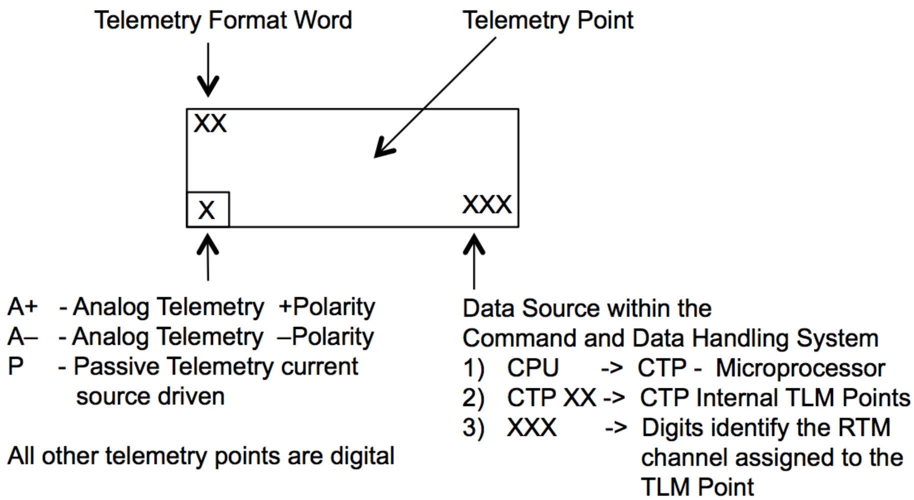
 DE-B VEFI PROCESSING ON 15:25 SEP 29,'83
      START DATE:83025;START TIME: 46241417
      STOP DATE:83025;STOP TIME: 46825432

 THE FOLLOWING RUN OPTIONS WERE SELECTED
      DC DATA WILL BE PROCESSED
             THE AVERAGED DATA MAF WILL BE CREATED
             THEORETICAL MAGNETIC FIELD VALUES USED
             CONTACT POTENTIAL VALUES ARE
              CX= -4.90, CY= -4.30, CZ= .00
             THEORETICAL EZ WILL BE CALCULATED
             EXTRA DELTA X,Y, OR Z WILL BE BYPASSED
 PLEASE VERIFY ALL PROCESSING OPTIONS.
 ENTER Y TO PROCEED, N TO REENTER. OR Q TO QUIT
```

APPENDIX A - TELEMETRY FORMATS

This appendix shows the assignment of telemetry words in a minor frame and the allocation of 4-second and a-second subcom words.

The Tables on the following pages are formatted according to the figure below:



Notes:

1. Data rate: 16,300kps
2. Minor frame period: 62.5msec/minor frame
3. Major frame period: 8 sec/major frame

1 24-BIT STRC	2 24-BIT STRC	3 24-BIT STRC	4 2-bit S/C IO 6-bit FRAME STATUS	5	6	7 FPI	8 LANG
9 WATS	10 WATS	11 SPARE 4-WORD SUBCOM->	12	13 S/C ATT 4-WORD SUBCOM->	14	15 LAPI	16 WATS A
17 NAC	18 NAC	19 RPA A	20 RPA A	21 RPA	22 LAPI	23 LAPI	24 LAPI
25 RPA A	26 IDM A	27 IDM A	28 LAPI	29 LAPI	30 LAPI	31 LAPI	32 LAPI(2)
33 FPI	34 FPI	35 FPI	36 SPARE	37 S/C SUBCOM CTA	38 LANG(2)	39 LANG A	40 LANG A
41 WATS	42 WATS	43 LAPI	44 LAPI	45 LAPI	46 LAPI	47 LAPI	48 LAPI
49 NAC	50 NAC	51 LAPI	52 RPA A	53 RPA	54 VEFI	55 VEFI	56 MAG
57 RPA A	58 IDM A	59 IDM A	60 IDM	61 LAPI	62 VEFI	63 VEFI	64 LAPI(2)
65 4-SEC SC SUBCOM	66 8-SEC SC SUBCOM	67 4-SEC SC SUBCOM	68 8-SEC SC SUBCOM	69 MAG	70 VEFI	71 VEFI	72 LANG A
73 WATS	74 WATS	75 VEFI A	76 VEFI A	77 VEFI A	78 LAPI	79 MAG	80 MAG
81 NAC	82 NAC	83 NAC A	84 RPA A	85 RPA	86 LAPI	87 LAPI	88 LAPI
89 RPA A	90 IDM A	91 IDM A	92 LAPI	93 LAPI	94 LAPI	95 LAPI	96 LAPI(2)
97 FPI	98 FPI	99 FPI	100 SPARE	101 MAG	102 LANG(2)	103 LANG A	104 LANG A
105 WATS	106 WATS	107 WATS	108 LAPI	109 LAPI	110 LAPI	111 LAPI	112 MAG
113 NAC	114 NAC	115 NAC	116 RPA A	117 RPA	118 LAPI	119 LAPI	120 LAPI
121 RPA A	122 IDM A	123 IDM A	124 IDM	125 LAPI	126 VEFI	127 VEFI	128 LAPI(2)

Figure A-1. DE-2 Mission Data Minor Frame Telemetry Format

1 RPA A+ 44	2 RPA A+ 51	3 RPA A+ 60	4 RPA A+ 67	5 RPA A+ 75	6 LANG 9	7 LANG 9	8 LAPI 22
9 S/C TIME CODE CTP19	10 VEFI A+ 42	11 VEFI A+ 33	12 MAG 19	13 MAG 19	14 LANG 9	15 LANG 9	16 37
17 MAG 26	18 VEFI A+ 58	19 VEFI A+ 49	20 VEFI A+ 121	21 VEFI A+ 65	22 LANG 9	23 LANG 9	24 LAPI 22
25 LAPI 22	26 LAPI 22	27 LAPI 22	28 LAPI A+ 107	29 LANG 9	30 LANG 9	31 RPA 33	32 RPA A+ 35
33 RPA A+ 44	34 RPA A+ 51	35 RPA A+ 60	36 RPA A+ 67	37 RPA A+ 75	38 LANG 9	39 LANG 9	40 LAPI 22
41 A+ 85	42 VEFI A+ 42	43 VEFI A+ 33	44 LAPI A+ 120	45 86	46 LANG 9	47 LANG 9	48 37
49 A+ 87	50 VEFI A+ 58	51 VEFI A+ 49	52 VEFI A+ 121	53 VEFI A+ 65	54 LANG 9	55 LANG 9	56 LAPI 22
57 FPI A+ 122	58 FPI A+ 59	59 FPI A+ 66	60 FPI A+ 73	61 LANG 9	62 LANG 9	63 RPA 33	64 RPA A+ 35

Figure A-2. DE-2 4-Sec Instrument Subcom - Minor Frame Word 67

1 RPA 43	2 RPA 44	3 RPA 45	4 RPA 83	5 RPA A+ 101	6 A+ 101	7 A+ 102	8 LAPI A+ 52
9 IDM A+ 123	10 IDM A+ 123	11 LAPI A+ 71	12 MAG A+ 1	13 MAG A+ 41	14 MAG A+ 57	15 A+ 100	16 LAPI 11
17 A+ 103	18 IDM A+ 45	19 IDM A+ 36	20 A+ 37	21 A+ 38	22 A+ 39	23 A+ 40	24 LAPI A+ 61
25 A+ 53	26 A+ 54	27 A+ 55	28 A+ 56	29 A+ 62	30 A+ 63	31 LAPI A+ 84	32 LAPI 11
33 VEFI A+ 112	34 VEFI A+ 116	35 VEFI A+ 113	36 VEFI A+ 117	37 VEFI A+ 114	38 VEFI A+ 118	39 VEFI A+ 115	40 VEFI A+ 119
41 IDM A+ 123	42 IDM A+ 123	43 IDM 28	44 LANG 32	45 LANG A+ 64	46 LANG A+ 72	47 LANG A+ 80	48 LANG 11
49 A+ 68	50 A+ 69	51 A+ 70	52 A+ 92	53 A+ 93	54 A+ 94	55 A+ 95	56 LAPI A+ 71
57 LAPI 11	58 LAPI A+ 71	59 LAPI 11	60 A+ 124	61 A+ 125	62 A+ 126	63 A+ 127	64 LAPI 11
65 LAPI A+ 71	66 LAPI 11	67 LAPI A+ 71	68 LAPI 11	69 LAPI 11	70 LAPI 11	71 LAPI 11	72 LAPI A+ 71
73 IDM A+ 123	74 IDM A+ 123	75 IDM 47	76 A+ 76	77 A+ 77	78 LAPI 11	79 A+ 78	80 LAPI 11
81 FPI 10	82 FPI 10	83 FPI 10	84 FPI A+ 50	85 FPI A+ 81	86 FPI A+ 89	87 FPI A+ 97	88 LAPI A+ 71
89 FPI A+ 105	90 FPI A+ 34	91 FPI A+ 43	92 FPI 10	93 A+ 62	94 A+ 63	95 A+ 47	96 LAPI 11
97 16	98 16	99 16	100 16	101 16	102 16	103 16	104 LAPI A+ 71
105 IDM A+ 123	106 IDM A+ 123	107 IDM 39	108 16	109 A+ 106	110 A+ 46	111 A+ 46	112 LAPI 11
113 A+ 46	114 A+ 46	115 A+ 46	116 A+ 46	117 A+ 46	118 A+ 46	119 17	120 LAPI A+ 71
121 17	122 17	123 17	124 17	125 17	126 17	127 17	128 LAPI 11

Figure A-3. DE-2 8-Sec Instrument Subcom - Minor Frame Word 68

APPENDIX B - AVAILABLE ORBIT/ATTITUDE INFORMATION

This appendix lists the OA parameters available on the system. Access to these parameters is via call to the DMF library routine OAREAO. Detailed definition of these parameters can be found in Ref. 3.

Map Number	Description
2	Period
3	Inclination
4	Eccentricity
5	Semi-major axis
6	Argument of Perigee
7	Right ascension of ascending node
8-10	GEI vector normal to orbit plane (in the direction PxV)
11	Apogee height
12	Perigee height
13	Orbit number
14	Time from perigee
15	Sun light/darkness flag
16	Greenwich sidereal time
17-19	GEI vector toward the Sun
20-22	GEI vector from satellite toward Moon
23-25	GEI satellite position vector
26-28	GEI satellite velocity vector
29-31	GEI satellite velocity relative to rotating atmosphere
32	Height above spheroid
33	Geodetic latitude of subsatellite point
34	East longitude of satellite
35	Minimum ray height
36	Minimum ray latitude
37	Local apparent solar time
38	Local magnetic time
39	McIlwain's shell parameter
40	Invariant latitude
41	Magnetic field strength
42-44	GEI magnetic field vector
45-47	Polar components of magnetic field
48	Geocentric magnetic inclination
49-51	GEI coordinates of ingress (north)
52-54	GEI coordinates of egress (south)
55-56	Geodetic latitude and longitude of ingress point
57-58	Geodetic latitude and longitude of egress point
59-67	3x3 rotation matrix for transformation from spacecraft coordinates to GEI coordinates
68-70	GEI coordinates of spacecraft angular momentum vector
71	Phase angle of spin-measured from velocity vector to x-axis of spacecraft
72	Spin rate with respect to nadir
73	Coning angle (between L and spacecraft z axis)
74	Coning rate
75	Coning phase
76	Solar zenith angle

APPENDIX C - VEFI MAF FORMATS

1. Optional Key Packet (User-Defined Words) for all VEFI MAFS

Word #	Type*	Contents
1	F	Orbit #
2	F	Begin GEI Latitude of Pass
3	F	End GEI Latitude of Pass
4	F	Begin Invariant Latitude of Pass
5	F	End Invariant Latitude of Pass
6	F	Begin M.L.T. of Pass
7	F	End M.L.T. of Pass
8	B	Flags: Bit # (numbered from left to right, 0-31) 0-1 orbit size: 0 = 1/4 1 = 1/2 2 = full 2 spare 3 satellite direction: 0 = latitude decreasing 1 = latitude increasing 4- 6 spare 7 microfiche processing complete (0=No, 1 =Yes) 8- 9 spare 10 measured B=l, theoretical B=O 11 0 = no orthogonalization 1 = antennas orthogonalized 12-15 orthogonalization matrix ID 16-23 spare 24-31 # points/record (vector)
9	F	Ecx, X-component of contact potential
10	F	Ecy, Y-component of contact potential
11	F	Ecz, Z-component of contact potential
12	F	Baseline, X
13	F	Baseline, Y
14	F	Baseline, Z
15	B	spare
16	B	spare
17	B	spare
18	B	spare
19	I	Date Processed
20	F	Time resolution/data point

*Type: F = floating point
B = binary
I = integer

2. Averaged Data MAF

Record Format: 128 data points/record (vector)
1/2 sec/data point
11 words/data point

Word #	Type*	Contents
1- 128	B	Flags: Bit #(numbered from left to right, 0-31) 0 1 => all fill 0 => not all fill 1 fill qualifier: 1 => from processing; 0 => TM fill 2-3 spare 4 Extra-resolution, X: 1 = Yes,0 = No 5 Extra-resolution, Y: 1 = Yes,0 = No 6 Extra-resolution, Z: 1 = Yes,0 = No 7 non-standard # of pts in X avg. 1 = Yes; 0 = No 8 non-standard # of pts in Y avg. 1 = Yes; 0 = No 9 non-standard # of pts in Z avg. 1 = Yes; 0 = No 10 sun/shadow, X 0 = sun; 1 = shadow 11 sun/shadow, Y 0 = sun; 1 = shadow 12 sun/shadow, Z 0 = sun; 1 = shadow 13-15 spare
129– 256	F	Ex in S/C coordinates (1/2 sec. avg)
257– 384	F	Ey in S/C coordinates (1/2 sec. avg)
385- 512	F	Ez in S/C coordinates (1/2 sec. avg)
513- 640	F	Ex in TOPO coordinates
641- 768	F	Ey in TOPO coordinates
769- 896	F	Ez in TOPO coordinates
897-1024	F	Ex in LMG coordinates
1025-1152	F	Ey in LMG coordinates
1153-1280	F	Ez in LMG coordinates
1281-1408	F	Potential, integrated along X-axis

3. High-resolution Data MAF

Record Format: 128 data points/record (vector)
1/16 sec/data point
13 words/data point

Word #	Type*	Contents
1- 128	B	Flags: Bit #(numbered from left to right, 0-31) 0 1 => all fill 0 => not all fill 1 fill qualifier: 1 => from processing; 0 => TM fill 2-3 spare 4 Extra reading, X: 1 = Yes,0 = No 5 Extra reading, Y: 1 = Yes,0 = No 6 Extra reading, Z: 1 = Yes,0 = No 7 Common Mode, 1 = Yes; 0 = No 8 Common Mode, 1 = Yes; 0 = No 9 Common Mode, 1 = Yes; 0 = No 10 sun/shadow flag, X 0 = sun; 1 = shadow 11 sun/shadow flag, Y 0 = sun; 1 = shadow 12 sun/shadow flag, Z 0 = sun; 1 = shadow 13-31 spare
129– 256	F	Ex in S/C coordinates (1/16 sec)
257– 384	F	Ey in S/C coordinates (1/16 sec)
385- 512	F	Ez in S/C coordinates (1/16 sec)
513- 640	F	Ex in TOPO coordinates
641- 768	F	Ey in TOPO coordinates
769- 896	F	Ez in TOPO coordinates
897-1024	F	Ex in LMG coordinates
1025-1152	F	Ey in LMG coordinates
1153-1280	F	Ez in LMG coordinates
1281-1408	F	Ex,y, or z in S/C <u>or</u> CMX,CMY,CMZ
1409-1536	F	Ex,y, or z in TOP <u>or</u> spare
1536-1664	F	Ex,y, or z in LMG <u>or</u> spare

4. Raw Data MAF

Record Format: 128 data points/record (vector)
1/16 sec/data point
3 words/data point

Word #	Type*	Contents
1- 128	F	Ex in spacecraft electric field coordinates
129– 256	F	Ey in spacecraft electric field coordinates
257– 384	F	Ez in spacecraft electric field coordinates

5. AC Data MAF

Word #	Type*	Contents
1	B	Flags: Bit # (numbered from left to right, 0-31) 0 Spec A gain: 0 = Low; 1 = High 1 Spec B gain: 0 = Low; 1 = High 2 Spec C gain: 0 = Low; 1 = High 3-4 Spec A axis: 00 = X; 10 = Y; 11 = Z 5-6 Spec B axis: 00 = X; 10 = Y; 11 = Z 7-8 Spec C axis: 00 = X; 10 = Y; 11 = Z 9-10 Spec A Mode: 00 = Alternating; 10 = Averages; 11 = Peak 11-12 Spec B Mode: 00 = Alternating; 10 = Averages; 11 = Peak 13-14 Spec C Mode: 00 = Alternating; 10 = Averages; 11 = Peak 15-17 Word 126-127 identifier 18-30 spare 31 Mode, gain or axis is fill: 1 => fill; 0 => not fill
2	F	CM+X (1st reading from 4 sec. Instrument Subcom)
3	F	CM-X (1st reading from 4 sec. Instrument Subcom)
4	F	CM+Y (1st reading from 4 sec. Instrument Subcom)
5	F	CM-Y (1st reading from 4 sec. Instrument Subcom)
6	F	CM+Z (1st reading from 4 sec. Instrument Subcom)
7	F	CM-Z (1st reading from 4 sec. Instrument Subcom)
8	F	Temperature (Elec.)
9	F	+Z Pre-Temp
10	F	-Z Pre-Temp
11-26	B	Flags: Bit # 0 1=>fill; 0=>not fill 1 =>fill from processing 2 Spec C Z peak 1 = fill; 0 = not fill 3 Spec C Ch 3 1 = fill; 0 = not fill 4 Spec C Ch 4 1 = fill; 0 = not fill 5-31 spare
27-42	F	Spectrometer A Channel 1 Peak or Average
43-58	F	Spectrometer A Channel 2 Peak or Average
59-74	F	Spectrometer A Channel 3 Peak or Average
75-90	F	Spectrometer A Channel 4 Peak or Average
91-106	F	Spectrometer A Channel 5 Peak or Average
107-122	F	Spectrometer A Channel 6 Peak or Average
123-138	F	Spectrometer A Channel 7 Peak or Average
139-154	F	Spectrometer A Channel 8 Peak or Average
155-170	F	Spectrometer B Channel 1 Peak or Average
171-186	F	Spectrometer B Channel 2 Peak or Average
189-202	F	Spectrometer B Channel 3 Peak or Average
203-218	F	Spectrometer B Channel 4 Peal or Average
219-234	F	Spectrometer B Channel 5 Peak or Average
235-250	F	Spectrometer B Channel 6 Peak or Average
251-266	F	Spectrometer B Channel 7 Peak or Average
267-282	F	Spectrometer B Channel 8 Peak or Average
283-298	F	Spectrometer C Channel 1*
299-314	F	Spectrometer C Channel 2*
315-330	F	Spectrometer C Channel 3*
331-346	F	Spectrometer C Channel 4*

347-362	F	Spectrometer C x Peak
363-378	F	Spectrometer C y Peak
379-394	F	Spectrometer C z Peak*
395-410	B	Gray Scale Values Bits: 0-3 Spectrometer A Channel 1 4-7 Spectrometer A Channel 2 8-11 Spectrometer A Channel 3 12-15 Spectrometer A Channel 4 16-19 Spectrometer A Channel 5 20-23 Spectrometer A Channel 6 24-27 Spectrometer A Channel 7 28-31 Spectrometer A Channel 8
411-426	B	Gray Scale Values Bits: 0-3 Spectrometer B Channel 1 4-7 Spectrometer B Channel 2 8-11 Spectrometer B Channel 3 12-15 Spectrometer B Channel 4 16-19 Spectrometer B Channel 5 20-23 Spectrometer B Channel 6 24-27 Spectrometer B Channel 7 28-31 Spectrometer B Channel 8
427-442	B	Gray Scale Values Bits: 0-3 Spectrometer C Channel 1 4-7 Spectrometer C Channel 2 8-11 Spectrometer C Channel 3 12-15 Spectrometer C Channel 4 16-31 Spare

*may be fill for some options

APPENDIX D - VEFI DRS ERROR MESSAGES

The VEFI DRS issues a number of error messages, written to F:108. Each message contains the name of the subroutine which detected an error, followed by an explanation of the error. The error messages are as follows:

MESSAGE #	MODULE	EXPLANATION
1	RTMPROC:	O/A DATA MISSING - START TIME OF PASS
2	RTMPROC:	O/A DATA MISSING - END TIME OF PASS
3	RTMPROC:	TM DATA NOT AVAILABLE FOR PASS
4	REFDC:	O/A DATA MISSING IN PASS
5	RTMPROC:	UNDOCUMENTED MAF ERROR RETURN
6	RTMPROC:	PROCEESS TERMINATED DUE TO PRIOR ERROR
7	RTMPROC:	ERROUT UNABLE TO FORMAT MAF ERROR CODE
8	RTMPROC:	NO PROCESSING SELECTED
9	RTMPROC:	ERROUT UNABLE TO FORMAT TM ERROR CODE
10	RTMPROC:	TMREAD ERROR CODE
11	RTMPROC:	OAREAD ERROR RETURN J N PRESCAN
12	RTMPROC:	ATT MISSING OR B FIELD IS 0
13	REFDC:	O/A DATA MISSING FOR PASS
20	RGFREY:	INVALID CHANNEL
21	RSPEC:	INVALID CHANNEL
22	RSPEC:	INVALID SPECTROMETER ID
23	RSPECCL/H:	INVALID CHANNEL
24	RSPECCL/H:	INVALID ARGUMENT
25	RTEMPR:	INVALID ARGUMENT

Messages 1-13 are issued when specific run-related error conditions are detected during processing.
Messages 20-25 are internal and will occur only if the load module has regressed.

APPENDIX E - SAMPLE RUN

The following is an example of a standard VEFI DRS batch processing run which created a DCA MAF of 1/2 second averaged data, and an AC MAF of 1/16 second resolution. The contact potentials used were the default values.

The processing run was initiated on-line. The off-line output is shown as well as the on-line commands and responses which initiated the run.

```
DE-B VEFI PROCESSING ON 18:06 SEP 27,'83
     START DATE:82018;START TIME: 22778176
     STOP DATE:82018;STOP TIME: 24866148
  THE FOLLOWING RUN OPTIONS WERE SELECTED
     DC DATA WILL BE PROCESSED
        THE AVERAGED DATA MAF WILL BE CREATED
        THEORETICAL MAGNETIC FIELD VALUES USED
        CONTACT POTENTIAL VALUES ARE
        CX= -4.90, CY= -4.30, CZ=    .00
        ANTENNAS WILL BE ORTHOGONALIZED
        EXTRA DELTA X,Y, OR Z WILL BE BYPASSED
     AC DATA WILL BE PROCESSED
TM FILL OR INSTRUMENT OFF OCCURRED AT 22810175
TM FILL OR INSTRUMENT OFF OCCURRED AT 22818175
TM FILL OR INSTRUMENT OFF OCCURRED AT 22826175
TM FILL OR INSTRUMENT OFF OCCURRED AT 22834175
TM FILL OR INSTRUMENT OFF OCCURRED AT 22842175
TM FILL OR INSTRUMENT OFF OCCURRED AT 22850174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22858174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22866174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22874174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22882174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22890174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22898174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22906174
TM FILL OR INSTRUMENT OFF OCCURRED AT 22914174
AC DATA MAF DATE =82018            TIME =22922208
AC DATA MAF DATE =82018            TIME =22930208
AC DATA MAF DATE =82018            TIME =22938208
AC DATA MAF DATE =82018            TIME =22946208
AC DATA MAF DATE =82018            TIME =22954208
AC DATA MAF DATE =82018            TIME =22962208
AC DATA MAF DATE =82018            TIME =22970208
AC DATA MAF DATE =82018            TIME =22978208
AVERAGED DATA MAF DATE=82018             TIME=22922490
AC DATA MAF DATE =82018            TIME =22986208
AC DATA MAF DATE =82018            TIME =22994207
AC DATA MAF DATE =82018            TIME =23002207
AC DATA MAF DATE =82018            TIME =23010207
AC DATA MAF DATE =82018            TIME =23018207
AC DATA MAF DATE =82018            TIME =23026207
AC DATA MAF DATE =82018            TIME =23034207
AC DATA MAF DATE =82018            TIME =23042207
AVERAGED DATA MAF DATE=82018             TIME=22986490
AC DATA MAF DATE =82018            TIME =23050207
AC DATA MAF DATE =82018            TIME =23058207
AC DATA MAF DATE =82018            TIME =23066206
AC DATA MAF DATE =82018            TIME =23074206
AC DATA MAF DATE =82018            TIME =23082206
AC DATA MAF DATE =82018            TIME =23090206
AC DATA MAF DATE =82018            TIME =23098206
AC DATA MAF DATE =82018            TIME =23106206
AVERAGED DATA MAF DATE=82018             TIME=23050419
AC DATA MAF DATE =82018            TIME =23114206
AC DATA MAF DATE =82018            TIME =23122206
AC DATA MAF DATE =82018            TIME =23130206
AC DATA MAF DATE =82018            TIME =23138205
AC DATA MAF DATE =82018            TIME =23146205
AC DATA MAF DATE =82018            TIME =23154205
AC DATA MAF DATE =82018            TIME =23162205
AC DATA MAF DATE =82018            TIME =23170205
AVERAGED DATA MAF DATE=82018             TIME=23114418
AC DATA MAF DATE =82018            TIME =23178205
```

```
AC DATA MAF DATE =82018          TIME =23194205
AC DATA MAF DATE =82018          TIME =23202205
AC DATA MAF DATE =82018          TIME =23210204
AC DATA MAF DATE =82018          TIME =23218204
AC DATA MAF DATE =82018          TIME =23226204
AC DATA MAF DATE =82018          TIME =23234204
AVERAGED DATA MAF DATE=82018          TIME=23178417
AC DATA MAF DATE =82018          TIME =23242204
AC DATA MAF DATE =82018          TIME =23250204
AC DATA MAF DATE =82018          TIME =23258204
AC DATA MAF DATE =82018          TIME =23266204
AC DATA MAF DATE =82018          TIME =23274204
AC DATA MAF DATE =82018          TIME =23282203
AC DATA MAF DATE =82018          TIME =23290203
AC DATA MAF DATE =82018          TIME =23298203
AVERAGED DATA MAF DATE=82018          TIME=23242416
AC DATA MAF DATE =82018          TIME =23306203
AC DATA MAF DATE =82018          TIME =23314203
AC DATA MAF DATE =82018          TIME =23322203
AC DATA MAF DATE =82018          TIME =23330203
AC DATA MAF DATE =82018          TIME =23338203
AC DATA MAF DATE =82018          TIME =23346203
AC DATA MAF DATE =82018          TIME =23354202
AC DATA MAF DATE =82018          TIME =23362202
AVERAGED DATA MAF DATE=82018          TIME=23306415
AC DATA MAF DATE =82018          TIME =23370202
AC DATA MAF DATE =82018          TIME =23378202
AC DATA MAF DATE =82018          TIME =23386202
AC DATA MAF DATE =82018          TIME =23394202
AC DATA MAF DATE =82018          TIME =23402202
AC DATA MAF DATE =82018          TIME =23410202
AC DATA MAF DATE =82018          TIME =23418202
AC DATA MAF DATE =82018          TIME =23426201
AVERAGED DATA MAF DATE=82018          TIME=23370414
AC DATA MAF DATE =82018          TIME =23434201
AC DATA MAF DATE =82018          TIME =23442201
AC DATA MAF DATE =82018          TIME =23450201
AC DATA MAF DATE =82018          TIME =23458201
AC DATA MAF DATE =82018          TIME =23466201
AC DATA MAF DATE =82018          TIME =23474201
AC DATA MAF DATE =82018          TIME =23482201
AC DATA MAF DATE =82018          TIME =23490201
AVERAGED DATA MAF DATE=82018          TIME=23434413
AC DATA MAF DATE =82018          TIME =23498200
AC DATA MAF DATE =82018          TIME =23506200
AC DATA MAF DATE =82018          TIME =23514200
AC DATA MAF DATE =82018          TIME =23522200
AC DATA MAF DATE =82018          TIME =23530200
AC DATA MAF DATE =82018          TIME =23538200
AC DATA MAF DATE =82018          TIME =23546200
AC DATA MAF DATE =82018          TIME =23554200
AVERAGED DATA MAF DATE=82018          TIME=23498412
AC DATA MAF DATE =82018          TIME =23562200
AC DATA MAF DATE =82018          TIME =23570199
AC DATA MAF DATE =82018          TIME =23578199
AC DATA MAF DATE =82018          TIME =23586199
AC DATA MAF DATE =82018          TIME =23594199
AC DATA MAF DATE =82018          TIME =23602199
AC DATA MAF DATE =82018          TIME =23610199
AC DATA MAF DATE =82018          TIME =23618199
AVERAGED DATA MAF DATE=82018          TIME=23562412
AC DATA MAF DATE =82018          TIME =23626199
AC DATA MAF DATE =82018          TIME =23634199
```

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AC DATA MAF DATE =82018          TIME =23650198
AC DATA MAF DATE =82018          TIME =23658198
AC DATA MAF DATE =82018          TIME =23666198
AC DATA MAF DATE =82018          TIME =23674198
AC DATA MAF DATE =82018          TIME =23682198
AVERAGED DATA MAF DATE=82018          TIME=23626411
AC DATA MAF DATE =82018          TIME =23690198
AC DATA MAF DATE =82018          TIME =23698198
AC DATA MAF DATE =82018          TIME =23706198
AC DATA MAF DATE =82018          TIME =23714197
AC DATA MAF DATE =82018          TIME =23722197
AC DATA MAF DATE =82018          TIME =23730197
AC DATA MAF DATE =82018          TIME =23738197
AC DATA MAF DATE =82018          TIME =23746197
AVERAGED DATA MAF DATE=82018          TIME=23690410
AC DATA MAF DATE =82018          TIME =23754197
AC DATA MAF DATE =82018          TIME =23762197
AC DATA MAF DATE =82018          TIME =23770197
AC DATA MAF DATE =82018          TIME =23778197
AC DATA MAF DATE =82018          TIME =23786196
AC DATA MAF DATE =82018          TIME =23794196
AC DATA MAF DATE =82018          TIME =23802196
AC DATA MAF DATE =82018          TIME =23810196
AVERAGED DATA MAF DATE=82018          TIME=23754409
AC DATA MAF DATE =82018          TIME =23818196
AC DATA MAF DATE =82018          TIME =23826196
AC DATA MAF DATE =82018          TIME =23834196
AC DATA MAF DATE =82018          TIME =23842196
AC DATA MAF DATE =82018          TIME =23850196
AC DATA MAF DATE =82018          TIME =23858195
AC DATA MAF DATE =82018          TIME =23866195
AC DATA MAF DATE =82018          TIME =23874195
AVERAGED DATA MAF DATE=82018          TIME=23818408
AC DATA MAF DATE =82018          TIME =23882195
AC DATA MAF DATE =82018          TIME =23890195
AC DATA MAF DATE =82018          TIME =23898195
AC DATA MAF DATE =82018          TIME =23906195
AC DATA MAF DATE =82018          TIME =23914195
AC DATA MAF DATE =82018          TIME =23922195
AC DATA MAF DATE =82018          TIME =23930194
AC DATA MAF DATE =82018          TIME =23938194
AVERAGED DATA MAF DATE=82018          TIME=23882407
AC DATA MAF DATE =82018          TIME =23946194
AC DATA MAF DATE =82018          TIME =23954194
AC DATA MAF DATE =82018          TIME =23962194
AC DATA MAF DATE =82018          TIME =23970194
AC DATA MAF DATE =82018          TIME =23978194
AC DATA MAF DATE =82018          TIME =23986194
AC DATA MAF DATE =82018          TIME =23994194
AC DATA MAF DATE =82018          TIME =24002193
AVERAGED DATA MAF DATE=82018          TIME=23946406
AC DATA MAF DATE =82018          TIME =24010193
AC DATA MAF DATE =82018          TIME =24018193
AC DATA MAF DATE =82018          TIME =24026193
AC DATA MAF DATE =82018          TIME =24034193
AC DATA MAF DATE =82018          TIME =24042193
AC DATA MAF DATE =82018          TIME =24050193
AC DATA MAF DATE =82018          TIME =24058193
AC DATA MAF DATE =82018          TIME =24066193
AVERAGED DATA MAF DATE=82018          TIME=24010405
AC DATA MAF DATE =82018          TIME =24074192
AC DATA MAF DATE =82018          TIME =24082192
AC DATA MAF DATE =82018          TIME =24090192
[illegible]
```

```
AC DATA MAF DATE =82018          TIME =24106192
AC DATA MAF DATE =82018          TIME =24114192
AC DATA MAF DATE =82018          TIME =24122192
AC DATA MAF DATE =82018          TIME =24130192
AVERAGED DATA MAF DATE=82018          TIME=24074404
AC DATA MAF DATE =82018          TIME =24138192
AC DATA MAF DATE =82018          TIME =24146191
AC DATA MAF DATE =82018          TIME =24154191
AC DATA MAF DATE =82018          TIME =24162191
AC DATA MAF DATE =82018          TIME =24170191
AC DATA MAF DATE =82018          TIME =24178191
AC DATA MAF DATE =82018          TIME =24186191
AC DATA MAF DATE =82018          TIME =24194191
AVERAGED DATA MAF DATE=82018          TIME=24138404
AC DATA MAF DATE =82018          TIME =24202191
AC DATA MAF DATE =82018          TIME =24210191
AC DATA MAF DATE =82018          TIME =24218190
AC DATA MAF DATE =82018          TIME =24226190
AC DATA MAF DATE =82018          TIME =24234190
AC DATA MAF DATE =82018          TIME =24242190
AC DATA MAF DATE =82018          TIME =24250190
AC DATA MAF DATE =82018          TIME =24258190
AVERAGED DATA MAF DATE=82018          TIME=24202403
AC DATA MAF DATE =82018          TIME =24266190
AC DATA MAF DATE =82018          TIME =24274190
AC DATA MAF DATE =82018          TIME =24282190
AC DATA MAF DATE =82018          TIME =24290189
AC DATA MAF DATE =82018          TIME =24298189
AC DATA MAF DATE =82018          TIME =24306189
AC DATA MAF DATE =82018          TIME =24314189
AC DATA MAF DATE =82018          TIME =24322189
AVERAGED DATA MAF DATE=82018          TIME=24266402
AC DATA MAF DATE =82018          TIME =24330189
AC DATA MAF DATE =82018          TIME =24338189
AC DATA MAF DATE =82018          TIME =24346189
AC DATA MAF DATE =82018          TIME =24354189
AC DATA MAF DATE =82018          TIME =24362188
AC DATA MAF DATE =82018          TIME =24370188
AC DATA MAF DATE =82018          TIME =24378188
AC DATA MAF DATE =82018          TIME =24386188
AVERAGED DATA MAF DATE=82018          TIME=24330401
AC DATA MAF DATE =82018          TIME =24394188
AC DATA MAF DATE =82018          TIME =24402188
AC DATA MAF DATE =82018          TIME =24410188
AC DATA MAF DATE =82018          TIME =24418188
AC DATA MAF DATE =82018          TIME =24426188
AC DATA MAF DATE =82018          TIME =24434187
AC DATA MAF DATE =82018          TIME =24442187
AC DATA MAF DATE =82018          TIME =24450187
AVERAGED DATA MAF DATE=82018          TIME=24394400
AC DATA MAF DATE =82018          TIME =24458187
AC DATA MAF DATE =82018          TIME =24466187
AC DATA MAF DATE =82018          TIME =24474187
AC DATA MAF DATE =82018          TIME =24482187
AC DATA MAF DATE =82018          TIME =24490187
AC DATA MAF DATE =82018          TIME =24498187
AC DATA MAF DATE =82018          TIME =24506186
AC DATA MAF DATE =82018          TIME =24514186
AVERAGED DATA MAF DATE=82018          TIME=24458399
AC DATA MAF DATE =82018          TIME =24522186
AC DATA MAF DATE =82018          TIME =24530186
AC DATA MAF DATE =82018          TIME =24538186
AC DATA MAF DATE =82018          TIME =24546186
```

```
AC DATA MAF DATE =82018            TIME =24562186
AC DATA MAF DATE =82018            TIME =24570186
AC DATA MAF DATE =82018            TIME =24578185
AVERAGED DATA MAF DATE=82018          TIME=24522398
AC DATA MAF DATE =82018            TIME =24586185
AC DATA MAF DATE =82018            TIME =24594185
AC DATA MAF DATE =82018            TIME =24602185
AC DATA MAF DATE =82018            TIME =24610185
AC DATA MAF DATE =82018            TIME =24618185
AC DATA MAF DATE =82018            TIME =24626185
AC DATA MAF DATE =82018            TIME =24634185
AC DATA MAF DATE =82018            TIME =24642185
AVERAGED DATA MAF DATE=82018          TIME=24586397
AC DATA MAF DATE =82018            TIME =24650184
AC DATA MAF DATE =82018            TIME =24658184
AC DATA MAF DATE =82018            TIME =24666184
AC DATA MAF DATE =82018            TIME =24674184
AC DATA MAF DATE =82018            TIME =24682184
AC DATA MAF DATE =82018            TIME =24690184
AC DATA MAF DATE =82018            TIME =24698184
AC DATA MAF DATE =82018            TIME =24706184
AVERAGED DATA MAF DATE=82018          TIME=24650396
AC DATA MAF DATE =82018            TIME =24714184
TM FILL ER INSTRUMENT OFF OCCURRED AT 24722148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24730148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24738148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24746148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24754148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24762148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24770148
AVERAGED DATA MAF DATE=82018          TIME=24714396
TM FILL ER INSTRUMENT OFF OCCURRED AT 24778148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24786148
TM FILL ER INSTRUMENT OFF OCCURRED AT 24794147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24802147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24810147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24818147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24826147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24834147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24842147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24850147
TM FILL ER INSTRUMENT OFF OCCURRED AT 24858147
D 82018 22778176 82018 24866148 B VEFI DCA
D 82018 22778176 82018 24866148 B VEFI AC
DE-B VEFI PROCESSING COMPLETED
PROCESSING SUMMARY:
    TOT FR =  257
    FR FILL =    1
    FR OFF =   32
    RD MAF RECS =    0
    HR MAF RECS =    0
    DC AVG MAF RECS =   29
    AC MAF RECS =  225
```

APPENDIX F - ORIGINAL TM SPECIFICATIONS

This appendix contains the original specification of the VEFI Telemetry locations and details regarding the contents of these locations. This specification was provided by the Principal Investigator.

VEFI DE-B

Telemetry Locations	
Minor Frame Format	
Word #	
54-55	Diff Volt ΔX
62-63	Diff Volt ΔY
70-71	Diff Volt ΔZ
75	Spec A (Pk, Avg, Alt) - 8 Channels
76	Spec B (Pk, Avg, Alt) - 8 Channels
77	Spec C (Opt 1,2,3,4) - 4 Channels
126-127	Prog (CM X,Y,Z-ΔX,Y,Z)

Word 67 - 4 Sec Instrument Subcom	
Sub Word	
10,42	CM+X
11,45	CM-X
18,50	CM+Y
19,51	CM-Y
20,52	CM+Z
21,53	CM-Z

Word 68 - 8 Sec Instrument Subcom	
Sub Word	
33	+ X Pre Temp
34	- X Pre Temp
35	+ Y Pre Temp
36	- Y Pre Temp
37	+ Z Pre Temp
38	- Z Pre Temp
39	Elec. Temp
40	13V Mon

Word 65 - 4 Sec S/C Subcom
Sub Word
25-bit 5 VEFI Pwr ON-OFF
1 = ON
0 = OFF

Diff Voltages - Words 54-55[1], 62-63[2], 70-71[3], 126-127[4]														
					ΔX	ΔY		ΔZ		PROG				
	14 bit A/D converter, offset binary coded													
	Words 54,62,70,126								Words 55, 63, 71, 127					
Output	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	MSB1							LSB8	MSB1					
+VFS	1	1	1	1	1	1	1	1	1	1	1	1	1	1
+1LSB	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
-1LSB	0	1	1	1	1	1	1	1	1	1	1	1	1	1
-VFS	0	0	0	0	0	0	0	0	0	0	0	0	0	0

$V = (N - 2^{13})\ (2.442)$ mV

where $N = \sum_{n=0}^{13} 2^n b_n$, V = voltage, and b = bit # (1 or 0)

$|-V_{FS}| = |+V_{FS}| + 1$ LSB

* XPk,YPk,ZPk – word 77 (Opt. i-4)
X,Y, Pk = **V**x4

Spec C Spectrometer Modes

VEFI DE-B

FR#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
OPT1	XPk	YPk	ZPk	Chl	Ch2	Ch3	Ch4	Ch2	XPk	YPk	ZPk	Chl	Ch2	Chl	Ch4	Ch2
OPT2	XPk	YPk	CM+Z	Chl	Ch2	Ch3	Ch4	CM+X	CM-X	CM+Y	CM-Y	Chl	Ch2	Ch3	Ch4	CM-Z
OPT3	XPk	YPk	ZPk	Chl	Ch2	Ch3	Ch4	CM+X	CM-X	CM+Y	CM-Y	CM+Z	CM-Z	ΔX	ΔY	ΔZ
OPT4	XPk	YPk	ZPk	Chl	XPk	YPk	ZPk	Ch2	XPk	YPk	ZPk	Ch3	XPk	YPk	ZPk	Ch4

Spec C Mode	CRJl7	CRKl8	Spec A Mode	CRE13	CRF14	Spec B Mode	CRGl5	CRH16
OPT 1	0	0	Peak	1	x	Peak	1	x
OPT 2	1	0	Avg	0	1	Avg	0	1
OPT 3	0	1	Alt.	0	0	Alt.	0	0
OPT 4	1	1						

Spec C Input	CRY31	CRZ32	Spec A Input	CRU27	CRU28	Spec B Input	CRW29	CRX30
X	0	0	X	0	0	X	0	0
Y	1	0	Y	1	0	Y	1	0
*	0	1	*	0	1	*	0	1
Z	1	1	Z	1	1	Z	1	1

Spec C GAIN	CRL19		Spec A GAIN	CRL26		Spec B GAIN	CRAB8	
LOW	0	.	LOW	0	.	LOW	0	.
HIGH	1	(21.1)	HIGH	1	(21.4)	HIGH	1	(21.6)

FR#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A,B Peak	Ch1Pk	Ch2Pk	Ch3Pk	Ch4Pk	Ch5Pk	Ch6Pk	Ch7Pk	ChBPk	CHlPk	Ch2Pk	Ch3Pk	Ch4Pk	Ch5Pk	Ch6Pk	Ch7Pk	ChBPk
A,B Avg	1 Avg	2 Avg	3 Avg	4 Avg	5 Avg	6 Avg	7 Avg	8 Avg	1 Avg	2 Ave	3 Avg	4 Avg	5 Avg	6 Avg	7 Avg	8 Avg
A,B Alt	1 Pk	2 Pk	3 Pk	4 Pk	5 Pk	6 Pk	7 Pk	8 Pk	1 Avg	2 Avg	3 Avg	4 Avg	5 Avg	6 Avg	7 Avg	8 Avg

Command Verification

VEFI DEB

MINOR FRAME	1	2	3	4	5	6	7	8	
Diqital Status Bits									
Dl	CalEna	Pwr on Reset	CB3	CB4	CB5	CB6	CRAA7	CRAB8	Wrd 55, Bit 7
D2	CRA9	CRB10	CRC11	CRD12	CRD13	CRF14	CRG15	CRH16	Wrd 55, Bit 8 (LSB)
D3	CRJl7	CRKl8	CRL19	CRM20	CRN21	CRP22	CRQ23	CRR24	Wrd 63, Bit 7
D4	CRS25	CRT26	CRU27	CRV28	CRW29	CRX30	CRY31	CRZ32	Wrd 63, Bit 8 (LSB)
D5	1=Cal, 0=Sig								Wrd 71, Bit 7
D6	M22								Wrd 71, Bit 8 (LSB)
D7	M21								Wrd 127, Bit 7
D8	M20								Wrd 127, Bit 8 (LSB)

(126-127)			
Word 4 Ident.	M22	M21	M20
CM + Z	0	0	0
CM - Z	0	0	1
CM + Y	0	1	0
CM - Y	0	1	1
CM + X	1	0	0
X	1	0	1
Y	1	1	0
Z	1	1	1
Cal Mode	Dl, FR1	1 = Ena,	0 = Inh (Pulse Cmd Ver)
	CRD12	1 = Inh,	0 = Ena
Cal Dur	CRBl0	1 = 64 sec,	0 = 32 sec
Cal Per	CRC11	1 = l per orbit,	0 = 2 per orbit
Imme	CRA9	1 = On,	0 = Off
Pwron reset	Dl, FR2	1 = Off,	0 = On

CB Commanding Bit	CR CMD Reg	Function			
1->6	- -				
7	AA				
8	AB	Spec B Gain	1 = High	0 = Low	
9	A	Imme Cal	1 = Cal		
10	B	Cal Duration	1 = 64 sec	0 = 32 sec	
11	c	Cal Per	1 = 2.28	0 = 1.14 hr.	Cal starts 17.07 min after Pwr On.
12	D	Nml Cal Ena	1 = Inh	0 = Ena	
13	E	Spec A Mode	1 = Pk	0 = CB14	
14	F		1 = Avg	0 = Alt	
15	G	Spec B Mode	1 = Pk	0 = CB16	
16	H		1 = Avg	0 = Alt	
17	J	Ana 3 Sel	1 = "1"		0=Opt1, 1=Opt2
18	K	Spec C	1 = "2"		2=Opt3, 3=Opt4
19	L	Spec C Gain	1 = High	0 = Low	
20	M	MUX 2 Cntrl	1 = Alt	0 = Fixed	
21	N	Word 4 Mode	1 = "1"		Fixed Mode Sel
22	P	(126-127)	1 = "2"		
23	Q	-||-	1 = "4"		
24	R			0 = Alt4	Alt Mode Sel
25	S			0 = Alt8	
26	T	Spec A Gain	1 = High	0 = Low	
27	U	Spec A Sel	1 = "1"		0 = ΔX, 1 = ΔY, 3 = ΔZ
28	V	MUX3	1 = "2"		
29	W	Spec B Sel	1 = "1"		0 = ΔX, 1 = ΔY, 3 = ΔZ
30	X	MUX4	1 = "2"		
31	Y	Spec C Sel	1 = "1"		0 = ACΔX, 1 = ACΔY,3 = ACΔZ
32	Z	MUX5	1 = "2"		

VEFI DE-B   Antenna Telemetry Locations

Word 66 - 8 sec Spacecraft Subcom			
Sub Word			
81	+X ant position		
83	-X ant position		
85	+Y ant position		
87	-Y ant position		
89	+Z ant position		
91	-Z ant position		

Word 65 - 4 sec Spacecraft Subcom			
Sub Word	bit#		
23	1	+X ant disp on/off	
23	2	+Y ant disp on/off	
23	3	+Z ant disp on/off	
23	4	-X ant disp on/off	
23	5	-Y ant disp on/off	
23	6	-Z ant disp on/off	
24	1	+X ant dep/retr	0 = deploy, 1 = retract
24	2	+Y ant dep/retr	
24	3	+Z ant dep/retr	
24	4	-X ant dep/retr	
24	5	-Y ant dep/retr	
24	6	-Z ant dep/retr	
41	1	+X limit SW	0 = full deploy/retract 1 = partial dep/retr
41	2	+Y limit SW	
41	3	+Z limit SW	
41	4	-X limit SW	
41	5	-Y limit SW	
41	6	-Z limit SW	

CM Voltages - Words (126-127)

$V = (N - 2^{13})\ (3.663)\ mV$ $N = \sum_{n=0}^{13} 2^n b_n$ b = bit # (1 or 0).

CH Voltages - 4 sec Instrument Subcom and Word 77 (Opt 2 & Opt 3)

CM Volt = (V-2.50)x12

Diff Voltages - Word 77 (Opt 3)

ΔX,Y,Z = (V-2.50)x8

Temperature - Preamps and Electronics - 8 sec Instrument Subcom

R(KΩ) = 20V /(5.00-V)

R(kΩ) -> Temp (°C) (See Resistance vs Temp Chart)

Temp	V
-20	3.99
-15	3.76
-10	3.52
-5	3.26
0	2.98
+5	2.70
10	2.42
15	2.16
20	1,90
25	1.66
30	1,46
35	1.26
40	1.10
45	0,94
50	0,82
55	0,70

VEFI DE-B

SPECTROMETER FREQUENCIES
(Hz) (Hz) (kHz)

Ch#	SpecA	fc	SpecB	fc	SpecC	fc
1	4 - 8	5.7	4 - 8	5.7	1.02 - 4.09	2.04
2	8 - 16	11.3	16 - 32	22.6	4.09 - 16.0	8.09
3	16 - 32	22.6	45 – 64	53.7	16.0 - 64.0	32.0
4	32 - 64	45.3	64 - 128	90.5	128.0 - 512	256.0
5	64 - 128	90.5	181 - 256	215		
6	128 - 256	181	256 - 361	304		
7	256 - 512	362	361 - 512	430		
8	812 - 1024	724	512 - 1024	724		

RESISTANCE VERSUS TEMPERATURE —80° to +150°C

TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES	TEMP°C	RES
— 80	3558K	— 50	441 3K	— 20	78 91K	+ 10	18 79K	+ 40	5592	+ 70	1990	+ 100	816 8	+ 130	376 4
79	3296K	49	414 5K	19	74 91K	11	17 98K	41	5389	71	1928	101	794 6	131	367 4
78	3055K	48	389 4K	18	71 13K	12	17.22K	42	5193	72	1868	102	773.1	132	358 7
77	2833K	47	366 0K	17	67.57K	13	16.49K	43	5006	73	1810	103	752 3	133	350 3
76	2620K	46	344 1K	16	64 20K	14	15 79K	44	4827	74	1754	104	732 1	134	342 0
75	2440K	45	323 7K	15	61 02K	15	15 13K	45	4655	75	1700	105	712 6	135	334.0
74	2266K	44	304 6K	14	58 01K	16	14 50K	46	4489	76	1648	106	693 6	136	326 3
73	2106K	43	286 7K	13	55.17K	17	13 90K	47	4331	77	1598	107	675 3	137	318 7
72	1957K	42	270 0K	12	52 48K	18	13 33K	48	4179	78	1549	108	657 5	138	311 3
71	1821K	41	254 4K	11	49 94K	19	12.79K	49	4033	79	1503	109	640.3	139	304.2
— 70	1694K	— 40	239 8K	— 10	47 54K	+ 20	12.26K	50	3893	+ 80	1458	+ 110	623 5	+ 140	297 2
69	1577K	39	226 0K	9	45 27K	21	11.77K	51	3758	81	1414	111	607.3	141	290 4
68	1469K	38	213 2K	8	43.11K	22	11 29K	52	3629	82	1372	112	591 6	142	283.8
67	1369K	37	201 1K	7	41 07K	23	10 84K	53	3504	83	1332	113	576 4	143	277.4
66	1276K	36	189 8K	6	39 14K	24	10 41K	54	3385	84	1293	114	561 6	144	271.2
65	1190K	35	179 2K	5	37.31K	25	10.00K	55	3270	85	1255	115	547.3	145	265.1
64	1111K	34	169 3K	4	35 57K	26	9605	56	3160	86	1218	116	533 4	146	259.2
63	1037K	33	160 0K	3	33.93K	27	9227	57	3054	87	1183	117	519 9	147	253.4
62	968.4K	32	151 2K	2	32 37K	28	8867	58	2952	88	1149	118	506 8	148	247 8
61	904 9K	31	143.0K	— 1	30 89K	29	8523	59	2854	89	1116	119	494 1	149	242.3
— 60	845 9K	— 30	135 2K	0	29.49K	+ 30	8194	+ 60	2760	+ 90	1084	+ 120	481.8	+ 150	237.0
59	791.1K	29	127.9K	+ 1	28.15K	31	7880	61	2669	91	1053	121	469.8		
58	740.2K	28	121.1K	2	26.89K	32	7579	62	2582	92	1023	122	458.2		
57	692 8K	27	114.6K	3	25 69K	33	7291	63	2497	93	994.2	123	446.9		
56	648.8K	26	108.6K	4	24.55K	34	7016	64	2417	94	966.3	124	435.9		
55	607.8K	25	102.9K	5	23.46K	35	6752	65	2339	95	939.3	125	425.3		
54	569.6K	24	97.49K	6	22.43K	36	6500	66	2264	96	913.2	126	414.9		
53	534.1K	23	92.43K	7	21.45K	37	6258	67	2191	97	887.9	127	404.9		
52	501.0K	22	87.66K	8	20.52K	38	6026	68	2122	98	863.4	128	395.1		
51	470.1K	21	83.16K	9	19.63K	39	5805	69	2055	99	839.7	129	385.6		

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