SAMPEX New Goddard Data File (NGDF) Description

Version 1.2
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Document Revision History.

SAMPEX NGDF Data File Description.

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Aug 23, 2006: add single alignment bytes to EM and EP sets (§ 3.1.4 & 3.1.5) and comment to Appendix I.

Sept. 28, 2006: change definition of EL, EH, and MF sets (§ 3.1.3, 3.1.2, and 3.1.7) to adjust for spare bytes; add Appendix J, IDL read routine supplied by Glenn Hamel and Andrew Davis

Oct. 31, 2006: add references to appendices 5.1-5.4 in event description (EH, etc)

May 30, 2007: adjust titles for tables 6.5-6.9 (MAST subcommed rates)

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Much of this document is adapted from the
"SAMPEX MDF document description, v1.4, April 2005", by
Mike Lennard, Joe Mazur, Glenn Mason, and Peter Walpole

Specific formats and conversion algorithms are from the
"Telemetry Packet Description for the SAMPEX Data Processing Unit"
SAM-1-O-08105 Rev B, April 1991
Space Sciences Laboratory
The Aerospace Corporation
El Segundo, CA 90245

1.0 Using This Document.

1.1 Scope

This document describes the SAMPEX New Goddard Data File (NGDF), which is a data set containing data intended for science analysis on SAMPEX. The NGDF is a VAX unformatted file that contains data from the SAMPEX Master Date File (MDF) data set. The file name is a modification of "Goddard Data File (GDF)" which was a private data set used by Shri Kanekal (GSFC, and U of Colorado).

1.2 Finding Information Quickly

Refer to the following listings to quickly locate material in this document pertaining to a particular topic.

1.2.1 About New Goddard Data Files in General

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- The R6 structure - RS bin mid-point interpolation values
- The R7 structure - LICA 1-sec rates
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1.2.4 MAST Related Topics

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The EM structure - MAST pulse height analyzed events.
The RS structure - MAST low resolution rates (subcommed).
The HS structure - MAST analog housekeeping.

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1.2.5 PET Related Topics

§ 3.1 Structure Descriptions,
The EP structure - PET pulse height analyzed events.
The RP structure - PET high resolution rates.
The RS structure - PET low resolution rates (subcommed).
The HS structure - PET analog housekeeping.

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1.2.6 DPU Related Topics

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1.2.7 Spacecraft Related Topics

§ 3.1 Structure Descriptions,
The AS structure - Spacecraft Attitude.
The MF structure - Onboard magnetometer.
The PS structure - Position, Attitude, and Model Magnetic Field Parameters.
The SB structure - Spacecraft battery subsystem monitor.
The SP structure - Spacecraft power monitor.
The ST structure - Subsystem temperatures.

Overview of SAMPEX New Goddard Data Files (NGDFs)

2.1 What is a New Goddard Data File (NGDF) ?

A New Goddard Data File (NGDF) is a VAX unformatted file containing SAMPEX mission data for one 24 hour period from 00:00:00 to 23:59:59 UT. These data include the science data from the HILT, LICA, MAST and PET instruments, engineering data, housekeeping data, and spacecraft position data. NGDFs are created from the original SAMPEX "Master Data Files" (MDFs) which were stored in the "Tennis" format and therefore difficult to use. Specifically, the NGDFs were created simply by reading the MDFs and writing out new files. Some of the data has been unpacked in this process. Some data in the original MDFs was not used by the science team and this data was dropped when the NGDFs were created in order to keep file size to a minimum.

Over the course of the SAMPEX mission, the software used to generate the MDFs was changed a number of times. The version number used to create the original MDFs is available in the PS structure. The NGDFs were all created with a single version of the program.

Details about the MDF data set, the different versions of the program, and some of its limitations, are given in the SAMPEX MDF description, v1.4, April 2005, which is available at:
http://www.srl.caltech.edu/sampex/DataCenter/docs/MDFdescriptionV1.4.pdf

A sample program that reads the NGDF structures is in Appendix I.

This document assumes some familiarity with the SAMPEX spacecraft and the 4 science instruments: HILT, LICA, MAST, and PET. A description can be found in the special issue of *IEEE Trans. Geosci. & Remote Sens.*, vol 31, No. 3, May 1993 (see Appendix A for further details). These papers are also available at the SAMPEX Data Center web site.

2.2 Organization of a New Goddard Data File (NGDF)

NGDFs are organized into a collection of records consisting of pairs of structure identifiers followed by the corresponding structure.

2.2.1 NGDF Bin Timing

New Goddard Data Files are organized into 6-second time bins. The first time bin will have a start time-of-day of between 00 and 05 seconds depending upon the first occurrence of a low resolution rate packet. The packet time stamp is obtained from the first low resolution rate packet in the Level-0 data received from GSFC. The time, in seconds of day, is determined and extrapolated back in six second steps to the earliest possible time of the same day. This determines the first bin time. Subsequent bin times are some multiple of six seconds later than this time. The last time bin of the day will be less than or equal to 14399 seconds of the day.

As an example, assume the first low resolution rate packet has a packet time stamp of 31017627 (seconds since 00:00:00 01 Jan 92). Divide by 86400 seconds/day to get 359 days, 27 seconds elapsed. This translates to year 1992, day 360, 27 seconds of the day. The corresponding first bin time would be 31017603 (00:00:03); four 6-seconds step backs. All data with packet time stamps or event times of between 31017603 (00:00:03) and 31017608 (00:00:08) will be put into this bin. All data with packet time stamps or event times occurring before this first bin time will be discarded. The next 6- second time bin begins at time 31017609 (00:00:09), etc.

Note that in any given six second time bin all structures of the same type will appear together, in increasing time order. However, all structures in the bin are not necessarily in time order since a subsequent group of same-type structures may have members with earlier times. For more information see sections **4.3 Data Sources** and **2.3.2 NGDF Structure Ordering**.

2.2.2 NGDF Structure Ordering

Structure types do not occur in random order within any 6-sec bin. The following rules and table 2.2 define the order and frequency in which structures may appear.

1) Each bin begins with a PS structure type. The PS structure time is identical to the bin time in which it occurs. Each bin contains one and only one PS structure. An entire NGDF will contain 14400 PS structures, one every six seconds.

2) Following each PS structure should be an RS structure. RS structures may not be present due to certain spacecraft/instrument conditions. Occasionally more than one RS structure will appear in a bin. See section **3.2 Known Limitations and Problems** for more details. Additional rates added later in the mission are in two additional structures, R6 and R7 which follow the RS structure.

3) For structure types which may occur more than once per bin, all structures of the same type will appear together in increasing time order. EH, EL, EM, and EP structure types may occur in this way, as may other structure types.

4) Other than PS structures, no structure type is guaranteed to appear in any given bin.

Table 2.2 - Order of Structure Occurrences.

Structure C	Frequency	Comments
PS	1/bin	Must occur in each bin, see rule #1
RS	1/bin	See rule #2
R6	1/bin	See rule #2; data after approx 7/30/1998
R7	1/bin	See rule #2; data after approx 7/1/1997
RP	1 every 8 bins	1 structure every 48 seconds (8 bins)
RH	1/bin	See rule #2
EH	variable	See rules #3, #4
EL	variable	See rules #3, #4
EM	variable	See rules #3, #4
EP	variable	See rules #3, #4
AS	variable	Dependent on rate of spacecraft attitude change
HS	1 every 10 bins	1 structure every 60 seconds (10 bins)
ST	1 every 10 bins	1 structure every 60 seconds (10 bins)
SP	1 every 10 bins	1 structure every 60 seconds (10 bins)
SB	1 every 10 bins	1 structure every 60 seconds (10 bins)
MF	~1/bin	1 structure every ~5 seconds

2.2.3 How to read a NGDF file

See Appendix “I” for a sample VAX fortran program that reads NGDF structures.

3.0 New Goddard Data File Structure Descriptions

A New Goddard Data File (NGDF) may contain any of 16 different structure types. Each structure type contains as its first element a 2-ASCII character structure name which indicates the structure type to follow. Appendix "I" contains a sample Vax fortran program that shows a read routine for the NGDF. Table 4.1 contains an alphabetical listing of all structure ASCII identifiers and structure names.

Table 3.1 - Structure Identifiers and Structure Names

Structure identifier	Structure Name
"AS"	Spacecraft attitude
"EH"	HILT event
"EL"	LICA event
"EM"	MAST event
"EP"	PET event
"HS"	Analog housekeeping
"MF"	Onboard magnetometer measurements
"PS"	Position, attitude, and model magnetic field parameters
"RH"	HILT high resolution rates
"RP"	PET high resolution rates
"RS"	Low resolution multiplexed rates
"R6"	RS bin mid-point interpolation values
"R7"	LICA 1-sec rates
"SB"	Spacecraft battery subsystem monitor
"SP"	Spacecraft power monitor
"ST"	Subsystem temperature monitors

3.1 Structure Descriptions

The following structure descriptions describe the NGDF Structures and data types.

3.1.1 : Structure AS - SAMPEX Spacecraft Attitude

Contents:

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Real * 4	quaternion x-element
Real * 4	quaternion y-element
Real * 4	quaternion z-element
Real * 4	quaternion scalar

3.1.2 Structure: EH - HILT PHA Event

Contents: see §5.1 for additional detail

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
14 Bytes	single 14 byte HILT event
2 bytes	Spare

3.1.3 Structure: EL - LICA PHA Event

Contents: see §5.2 for additional detail

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
15 Bytes	single 15 byte LICA event
1 byte	Spare (for word alignment)

3.1.4 Structure: EM - MAST PHA Event

Contents: see §5.3 for additional detail

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Integer * 4	MAST sequence number,
Byte	event offset time
Byte	Spare byte (for alignment)
Byte	detector flag
Byte	event flag
Integer*2	Single MAST event - ADC (14)

3.1.5 Structure: EP - PET PHA Event

Contents: see §5.4 for additional detail

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Integer * 4	PET sequence number
Byte	Event offset time
Byte	Spare byte (for alignment)
Integer * 2	ADC (4)
Byte	mode flag
Byte	discriminator flag

3.1.6 Structure: HS - Analog Housekeeping

<u>See Appendix C for HS structure conversion algorithms</u>

Contents:

Data Type	Item	Comments
I*4		SAMPEX time, seconds since 01JAN92 00:00:00
Byte	1	HILT temp: vent valve
Byte	2	HILT temp: main valve
Byte	3	HILT temp: pressure regulator, internal
Byte	4	HILT temp: analog box, internal
Byte	5	HILT temp: sensor internal
Byte	6	HILT temp: digital box
Byte	7	HILT temp: digital electronics
Byte	8	HILT temp: HV converter PC
Byte	9	HILT temp: HV converter drift,
Byte	10	HILT temp: LV converter 1 analog,
Byte	11	HILT temp: LV converter 2 system
Byte	12	HILT temp: cover motor
Byte	13	HILT: -10 volt monitor
Byte	14	HILT: +5 volt monitor
Byte	15	HILT: +10 volt monitor
Byte	16	HILT: SSD bias
Byte	17	HILT: HV monitor (PC)
Byte	18	HILT: HV monitor (drift)
Byte	19	HILT: pressure monitor # 1
Byte	20	HILT: pressure monitor # 2
Byte	21	HILT: regulator valve temperature
Byte	22	HILT: +13 volt monitor/converter # 2
Byte	23	HILT: -13 volt monitor/converter # 2
Byte	24	HILT: +10 volt monitor/converter # 2
Byte	25	HILT: -10 volt monitor/converter # 2
Byte	26	HILT: +5 volt monitor/converter # 2

continued

Structure HS description continued

See Appendix C for HS structure conversion algorithms

Data Type	Item	Comments
Byte	1	LICA: +12 volt monitor
Byte	2	LICA: +6 volt monitor
Byte	3	LICA: +5 volt monitor
Byte	4	LICA: -5 volt monitor
Byte	5	LICA: -6 volt monitor
Byte	6	LICA: -12v volt monitor
Byte	7	LICA: High Voltage monitor # 1
Byte	8	LICA: High Voltage monitor # 2
Byte	9	LICA: temp # 1 (Telescope Foil end)
Byte	10	LICA: temp # 2 (Telescope Detector end)
Byte	11	LICA: temp # 3 (Electronics)
Byte	12	LICA: temp # 4 (TOF board)
Byte	13	LICA: High Voltage control monitor # 1
Byte	14	LICA: High Voltage control monitor # 2
Byte	15	LICA: High Voltage monitor # 1
Byte	16	LICA: High Voltage monitor # 2
Byte	1	MAST: matrix (thin) board thermister
Byte	2	MAST: thick board thermister
Byte	3	MAST: M1 thermister
Byte	4	MAST: D2 thermister (not M3)
Byte	5	MAST: D7 thermister
Byte	6	MAST: M1 thermister
Byte	7	MAST: D2 thermister (not M3)
Byte	8	MAST: D7 thermister
Byte	9	PET: P1RT thermister
Byte	10	PET: P8RT thermister
Byte	11	PET: ANART thermister
Byte	12	PET: P1RT thermister
Byte	13	PET: P8RT thermister
Byte	14	PET: ANART thermister
Byte	15	PET: P1RT thermister
Byte	16	PET: P8RT thermister

continued

Structure HS Description continued

See Appendix C for HS structure conversion algorithms

Data Type	Item	Comments
Byte	1	LVPS: +7.5 volt monitor
Byte	2	LVPS: +4.7 volt monitor
Byte	3	LVPS: -7.5 volt monitor
Byte	4	LVPS: -13.5 volt monitor
Byte	5	LVPS: -37.0 volt monitor
Byte	6	LVPS: ground monitor # 1
Byte	7	LVPS: ground monitor # 2
Byte	8	LVPS: ground monitor # 3
Byte	9	LVPS: ground monitor # 4
Byte	10	LVPS: +37.0 volt monitor
Byte	11	LVPS: +13.5 volt monitor
Byte	12	LVPS: +10.0 volt monitor
Byte	13	LVPS: PET monitor
Byte	14	LVPS: MAST monitor
Byte	15	LVPS: PSA current monitor
Byte	16	LVPS: variable load monitor
Byte	17	DPU: +5.0 volt monitor
Byte	18	DPU: +10.0 volt monitor
Byte	19	DPU: -10.0 volt monitor
Byte	20	DPU: +2.5 volt monitor
Byte	21	DPU: ground monitor
Byte	22	Spare, 1 byte

3.1.7 Structure: MF - Onboard Magnetometer Measurements

See Appendix C for MF structure conversion algorithms

Contents:

Date type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Integer * 2	Body-centered X-axis counts
Integer * 2	Body-centered Y-axis counts
Integer * 2	Body-centered Z-axis counts
2 bytes	Spare

3.1.8 Structure: PS - Position, Attitude, and Model Magnetic Field Parameters

Contents:

Data type	No. of Items (if>1)	Struct Item	Comments
I * 4		STIME	SAMPEX time, sec since 01JAN92 00:00:00
I * 4		ORBIT	Orbit #
I * 2		MVERS	MDF version. #
R * 4	3	GEO_POS	Geographic range, longitude, latitude
R * 4	3	GEI_POS	X,Y,Z coordinates
R * 4	3	GEI_VEL	VX,VY,VZ velocity
R * 4	3	ECD_POS	Eccentric dipole range, longitude, latitude
R * 4	9	DIR_COS	Direction cosine array
R * 4		ALTITUDE	Geographic altitude
R * 4		IDOT	Inertial dot-product.
R * 4		ECD_LOCTIM	Local time in ECD
R * 4		LSHEL	L-shell parameter
R * 4		BMAG	Model field magnitude
R * 4		MLT	Local time at magnetic equator
R * 4		INVLAT	Invariant latitude
R * 4		PITCH	Pitch angle of particle
R * 4		LOSCON1	Loss Cone 1
R * 4		LOSCON2	Loss Cone 2
R * 4	3	B_CART	Magnetic field vector, Cartesian coordinates
R * 4	3	B_SPHE	Magnetic field vector, spherical coordinates
R * 4	3	DIPOL1	Dipole moment vector
R * 4	3	DIPOL2	Dipole moment displacement vector
R * 4		DECLIN	Magnetic declination
R * 4		DIP	Magnetic dip angle
R * 4		MAGRAD	Algebraic magnetic radial distance
R * 4		MAGLAT	Algebraic magnetic latitude
R * 4	3	G_MIRROR	Geographic alt.,long.,lat. of mirror point
R * 4	4	B_EQU	Field magn. and posn. at magnetic equator
R * 4	4	BN_100	Field magn. and posn. at north 100 km point
R * 4	4	BS_100	Field magn. and posn. at south 100 km point
R * 4		CUTOFF	nominal vertical cutoff
R * 4		SAAF	SAA flag
R * 4		ZENITH	zenith angle
R * 4		AZIMUTH	azimuth angle
R * 4		ACS	ACS control mode

3.1.9 Structure: RH - HILT High Resolution Rates

The RH structure contents depend on the DPU software version in use. There were 4 different versions used. Section 6.1.1 and Appendix E contain details on the RH structure contents and applicable effective dates.

Contents:

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Byte	compressed rate*, 60 values
Byte	compressed rate*, 60 values
Byte	compressed rate*, 60 values
Byte	compressed rate*, 60 values
Byte	compressed rate*, 60 values
Byte	compressed rate*, 60 values

Notes:
1) see § 6.1 for rates assigned to each data item
2) see Appendix B for rate decompression algorithm

3.1.10 Structure: RP - PET High Resolution Rates

See §6.1.2 for description of count rate coverage in the RP structure.

Contents:

Data type	Comments
Integer * 4	time, seconds since 01JAN92 00:00:00
Byte	480 compressed P1 rates, counts in 0.05 second interval

Notes:
1) see Appendix B for rate decompression algorithm

3.1.11 Structure: RS - Low Resolution Multiplexed Rates

<u>See Appendix B for RS structure rate decompression algorithm</u>

Contents:

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Integer * 2	subcom
Integer * 2	HILT HE1 rate
Integer * 2	HILT HE2 rate
Integer * 2	HILT HZ1 rate
Integer * 2	HILT HZ2 rate
Integer * 2	HILT Subcom rate 1, subcom dependent (see §6.2.1)
Integer * 2	HILT Subcom rate 1, subcom dependent (see §6.2.1)
Integer * 2	HILT IDLE-HI rate
Integer * 2	HILT IDLE-LO rate
Integer * 2	LICA D4 Singles rate
Integer * 2	LICA D3 Singles rate
Integer * 2	LICA D2 Singles rate
Integer * 2	LICA D1 Singles rate
Integer * 2	LICA Triples rate
Integer * 2	LICA Doubles rate
Integer * 2	LICA Stop Singles rate
Integer * 2	LICA Start Singles rate
Integer * 2	LICA in-flight calibration count rate
Integer * 2	LICA Proton rate
Integer * 2	LICA Low Priority rate
Integer * 2	LICA High Priority rate

continued

Structure RS Description (continued)

Data type	Comments
Integer * 2	MAST Z1SEC rates
Integer * 2	MAST ADC OR rates
Integer * 2	MAST LIVE TIME rates
Integer * 2	MAST PEN rates
Integer * 2	MAST Z1 rates
Integer * 2	MAST Z2 rates
Integer * 2	MAST HIZR0 rates
Integer * 2	MAST HIZR1 rates
Integer * 2	MAST HIZR2 rates
Integer * 2	MAST HIZR3 rates
Integer * 2	MAST HIZR4 rates
Integer * 2	MAST HIZR5 rates
Integer * 2	MAST HIZR6 rates
Integer * 2	MAST Subcom rate 1, subcom dependent (see §6.2.1)
Integer * 2	MAST Subcom rate 2, subcom dependent (see §6.2.1)
Integer * 2	MAST Subcom rate 3, subcom dependent (see §6.2.1)
Integer * 2	MAST Subcom rate 4, subcom dependent (see §6.2.1)
Integer * 2	MAST Subcom rate 5, subcom dependent (see §6.2.1)
Integer * 2	PET PHI rates
Integer * 2	PET EHI rates
Integer * 2	PET PLO rates
Integer * 2	PET ELO rates
Integer * 2	PET EWG rates
Integer * 2	PET LIVE TIME rates
Integer * 2	PET PEN rates
Integer * 2	PET RNG rates
Integer * 2	PET Subcom rate 1, subcom dependent (see §6.2.1)
Integer * 2	PET Subcom rate 2, subcom dependent (see §6.2.1)

3.1.12 Structure: R6 - RS bin mid-point interpolation values

See Appendix F; structure R6 is present for MDF versions #30 and above

Contents:

Data type	Comments
Integer * 4	time, seconds since 01JAN92 00:00:00
Real * 4	pitch angle at midpoint of RS structure
Real * 4	zenith angle at midpoint of RS structure
Real * 4	azimuth angle at midpoint of RS structure
Real * 4	seconds between quaternions used to interpolate attitude

3.1.13 Structure: R7 - LICA 1-sec rates

See Appendix H: Structure R7 is present for MDF versions #42 and above

Contents:

Data type	Comments
Integer * 4	time, seconds since 01JAN92 00:00:00
Integer * 2	D4+D3 second #1 **
Integer * 2	D2+D1 second #1
Integer * 2	Stop second #1
Integer * 2	Start second #1
Integer * 2	Low Pri second #1
Integer * 2	High Pri second #1
Integer * 2	D4+D3 second #2
Integer * 2	D2+D1 second #2
Integer * 2	Stop second #2
Integer * 2	Start second #2
Integer * 2	Low Pri second #2
Integer * 2	High Pri second #2
Integer * 2	D4+D3 second #3
Integer * 2	D2+D1 second #3
Integer * 2	Stop second #3
Integer * 2	Start second #3
Integer * 2	Low Pri second #3
Integer * 2	High Pri second #3
Integer * 2	D4+D3 second #4
Integer * 2	D2+D1 second #4
Integer * 2	Stop second #4
Integer * 2	Start second #4
Integer * 2	Low Pri second #4
Integer * 2	High Pri second #4
Integer * 2	D4+D3 second #5
Integer * 2	D2+D1 second #5
Integer * 2	Stop second #5
Integer * 2	Start second #5
Integer * 2	Low Pri second #5
Integer * 2	High Pri second #5
Integer * 2	D4+D3 second #6
Integer * 2	D2+D1 second #6
Integer * 2	Stop second #6
Integer * 2	Start second #6
Integer * 2	Low Pri second #6
Integer * 2	High Pri second #6

3.1.14 Structure: SB - SAMPEX Spacecraft Battery Subsystem Monitor

<u>See Appendix C for SB structure conversion algorithms</u>

Contents:

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Byte	Battery state of charge
Byte	Battery under voltage status
Byte	Safe hold status
Byte	spare, 1 byte
Integer * 2	Battery current monitor
Integer * 2	Shunt current monitor
Integer * 2	Non-essential bus load current monitor
Integer * 2	Solar array A current monitor
Integer * 2	Battery voltage monitor
Integer * 2	Battery top-of-cell temperature monitor
Integer * 2	Battery base plate temperature monitor
Integer * 2	Main bus voltage monitor

3.1.15 Structure: SP - SAMPEX Spacecraft Power Monitor

See Appendix C for SP structure conversion algorithms

Format:

Data type	Comments
Integer * 4	SAMPEX time, seconds since 01JAN92 00:00:00
Byte	HILT acoustic cover power
Byte	LICA acoustic cover power
Byte	HILT pre-regulator power
Byte	LICA pre-regulator power
Byte	MAST/PET bus power
Byte	operational heater power
Byte	survival heater power
Byte	spare, 1 byte
Integer * 2	PD/PCU signal ground reference
Integer * 2	spare, 2 bytes

3.1.16 Structure: ST - Subsystem Temperature Monitor

<u>See Appendix C for ST structure conversion algorithms</u>

Format:

Data type	Comments
Integer * 4	time, seconds since 01JAN92 00:00:00
Byte	transmitter power status
Byte	spare, 1 byte
Integer * 2	lower S/C radiator plate temperature
Integer * 2	upper S/C radiator plate temperature
Integer * 2	instrument/bus separation plate temperature
Integer * 2	HILT support plate temperature
Integer * 2	HILT isobutane tank temperature
Integer * 2	HILT analog electronics temperature
Integer * 2	HILT sensor base plate temperature
Integer * 2	HILT acoustic cover temperature
Integer * 2	spare, 2 bytes
Integer * 2	LICA base plate temperature
Integer * 2	spare, 2 bytes
Integer * 2	MAST base plate temperature
Integer * 2	PET base plate temperature
Integer * 2	MAST/PET low voltage power supply temp.
Integer * 2	spare, 2 bytes
Integer * 2	DPU base plate temperature
Integer * 2	spare, 2 bytes

3.2 Known Limitations and Problems

Several problems with and limitations of the original MDF data set have been identified. These carry over to the NGDF. The following sections describe these problems.

3.2.1 Structure RS - Packet Time Stamp Error

RS structure times occur every six seconds, thus we expect one in each 6-second time bin. Due to the asynchronous relationship of the spacecraft clock and the DPU clock, there exists the possibility of a one second time jitter in the RS packet time stamp. This may result in two RS structures occurring in a 6-second time bin. The time bin either preceding or following a time bin containing two RS structures will not contain an RS structure. No attempt is made to correct this timing error.

3.2.2 Structure PS - ACS Control Mode (Coast)

The PS structure contains the ACS control mode variable. ACS control mode can take on four values: 0, 1, 2, and 3. The spacecraft attitude control system (ACS) algorithm produces an APID 11 packets as the spacecraft attitude changes. This packet contains the current control mode of the ACS which is used to update the PS structure. When the spacecraft is in full sun and the angle between the unit sun vector and the magnetic field is less than 5° or the spacecraft is in eclipse and this same angle is less than 40°, the ACS control mode takes on the value 3 (coast mode). When the ACS is in coast mode, no APID 11 packets are sent, therefore the variable ACS never assumes the value 3 in the NGDF, instead it remains at the value it had prior to the change in ACS control mode for the duration of the coast mode period. Since no APID 11 packets are sent, there will be no AS structure types in the NGDF during this period.

See Appendix F for other details about attitude determination in coast mode during 1 RPM spinning periods.

4.0 The PS Structure

The PS structure contains spacecraft position and velocity in inertial coordinates, position in geographic and magnetic coordinates, spacecraft attitude, zenith and azimuth look angles, and model magnetic field parameters. The PS structure is *always* the first structure in every 6-second NGDF bin. The SAMPEX Time Stamp is synonymous with the bin time. *Calculated parameters in the PS structure correspond to the start time of each bin.*

4.1 Models

The variable MVERS in the PS structure is the software version number for the subroutine BL_IGRF (author: M. NcNab, Aerospace Corp.) which calculates magnetic field parameters. The IGRF 1990 Model is used.

4.2 Dynamic Integration Step Size

The integration step size used in the magnetic field model numerical integration routine is dynamically adjustable as a function of the L-shell parameter in the PS structure. For L-shell values of 10 or greater the step size is 500. For L-shell values less than 10, the step size is 100. The purpose of this is to achieve good accuracy for $L < 10$ while reducing calculation time for $L \geq 10$ where the model is less accurate.

4.3 Detailed Item Descriptions

More detailed descriptions of the items in the PS structure are given in table 4.1 since most are *not* described in the SAMPEX Telemetry and Command Handbook (full reference is Appendix A).

Table 4.1 - Detailed PS Structure Item Descriptions

Item Name	No. of Items (if>1)	Description
STIME		Time (seconds since 01Jan92 00:00:00) of current 6-second NGDF bin.
ORBIT		Current orbit number. Launch into orbit 1. Orbit 2 starts at first ascending node through geographic equatorial plane.
MVERS		Software version number for MDF Generator.
GEO_POS	3	Geographic position; range (km), longitude (0° to 360°), latitude (-90° to +90°)
GEI_POS	3	X,Y,Z of spacecraft (km) in Geocentric Equatorial Inertial coordinates (identical to ECI coordinates).
GEI_VEL	3	VX,VY,VZ velocities (km/s) in GEI coordinates
ECD_POS	3	Eccentric Dipole (offset tilted dipole) range (km), longitude (0° to 360°), latitude (-90° to +90°) of spacecraft.
DIR_COS	9	9-element direction cosine array for rotating from GEI coordinates to body fixed coordinates. Z-axis in body fixed is along instrument bore sights. Order of elements is A(1,1), A(2,1), A(3,1), A(1,2), A(2,2), A(3,2), A(1,3), A(2,3), A(3,3).
ALTITUDE		Geographic altitude (km).
IDOT		Inertial dot product between unit sun vector and unit B-vector.
ECD_LOCTIM		Local time in ECD (hr).

continued

PS Structure Item Descriptions, continued

Item Name	No. of Items (if>1	Description
LSHEL		L-shell parameter
BMAG		Model field magnitude (gauss)
MLT		Local time at magnetic equator (hr) ECD
INVLAT		Invariant latitude (degrees)
PITCH		Pitch angle of particle entering on instrument center line (angle between B and spacecraft minus Z direction) (degrees)
LOSCON1		Loss cone 1/2 angle (degrees) for particles mirroring below 100 km in same hemisphere as spacecraft.
LOSCON2		Loss cone 1/2 angle (degrees) for particles mirroring below 100 km in either hemisphere.
B_CART	3	Magnetic field vector, Cartesian GEI coordinates.
B_SPHE	3	Magnetic field vector, spherical geographic coordinates (r, theta, phi).
DIPOL1	3	Dipole moment vector. Cartesian geographic coordinates.
DIPOL2	3	Dipole moment displacement vector. Cartesian geographic coordinates.
DECLIN		Magnetic declination (degrees).
DIP		Magnetic dip angle (degrees)
MAGRAD		Algebraic magnetic radial distance (km). *Note A.*
MAGLAT		Algebraic magnetic latitude (degrees) *Note A.*
G_MIRROR	3	Geographic altitude (km), longitude (degrees), latitude (degrees) of mirror point.

PS Structure Item Descriptions, continued

Item Name	No. of Items (if>1	Description
B_EQU	4	Magnitude of field (gauss) and GEO altitude (km), longitude (degrees), latitude (degrees) at magnetic equator.
BN_100	4	Magnitude of field (gauss) and GEO altitude (km), longitude (degrees), latitude (degrees) at north 100 km point. *Note B.*
BS_100	4	Magnitude of field (gauss) and GEO altitude (km), longitude (degrees), latitude (degrees) at south 100 km point. *Note B.*
CUTOFF		Nominal vertical cutoff (1980) at 20 km altitude at subsatellite location (GV). (Shea and Smart, 1983, Bangalore ICRC, Paper MG10-3).
SAAF		South Atlantic Anomaly Flag. 0=not in SAA 1=within SAA
ZENITH		Angle (0° to 180°) between zenith and spacecraft z-axis (instrument bore sight).
AZIMUTH		Direction of projection of spacecraft z-axis in plane perpendicular to radial direction. 0=east, 90=north, 180=west, 270=south
ACS		ACS control mode indicator. 0=SUNPOINT 1=MAGCAL 2=ORBIT ROTATION (normal mode) 3=COAST (see §**3.2.2 Known Limitations and Problems**)

Note A: Algebraic radius and latitude are computed using the dipole relationship between B, L, and latitude but with values for B and L generated from the IGRF model.
Note B: The 100-km points (a typical altitude for particle loss) are determined numerically, not analytically, so the computed values are step-size dependent. The altitude is included with the longitude and latitude to provide the user with a measure of how close the computed position is to the ideal.

5.0 Pulse Height Analyzed Events

Pulse height analyzed (PHA) events are found in structure types EH, EL, EM, EP (see section **3.1 Structure Descriptions**). Each structure contains one PHA event. The first item in these structures contains the *SAMPEX time*, the time assigned by the DPU to the telemetry packet from which the PHA event structure is derived. No PHA structure contains the *event time* per se. To determine the *event time*, the time at which the PHA was detected by the instrumentation, do the following:

For **HILT** and **LICA**, make the substitution:

1) Zero the LSB of hours, and the entire minutes and seconds portion of the *SAMPEX time*. (Since the LSB of hours and all minutes and seconds are less than 7200 seconds, divide *SAMPEX time* by 7200 and then multiply again by 7200. Integer math will zero out the proper fields!)

2) Convert the BCD coded time bytes (see sections **5.1 HILT,** and **5.2 LICA**) to seconds and add to the *SAMPEX time* .

For **MAST** and **PET**, add the offset time byte (see sections **5.3 MAST,** and **5.4 PET**) to the *SAMPEX time*.

Descriptions of the contents of single pulse height analyzed event structure type are shown. Refer to section **3.1 Structure Descriptions**.

5.1 HILT -- Single event contents

Each EH structure contains one 14 byte HILT PHA event. The data is packed. Table 5.1 lists the contents of the 14 bytes.

Table 5.1 HILT single event contents

byte	bit of byte	content	
0	7	HR	
0	6	10s min	
0	5	10s min	
0	4	10s min	
0	3	1s min	
0	2	1s min	
0	1	1s min	
0	0	1s min	
1	7	10s sec	
1	6	10s sec	
1	5	10s sec	
1	4	10s sec	
1	3	1s sec	
1	2	1s sec	
1	1	1s sec	
1	0	1s sec	
2	7	En PCR	msb
2	6	En PCR	
2	5	En PCR	
2	4	En PCR	
2	3	En PCR	
2	2	En PCR	
2	1	En PCR	
2	0	En PCR	
3	7	En PCR	
3	6	En PCR	
3	5	En PCR	
3	4	En PCR	lsb
3	3	Position PCR	msb
3	2	Position PCR	
3	1	Position PCR	
3	0	Position PCR	
4	7	Position PCR	
4	6	Position PCR	
4	5	Position PCR	
4	4	Position PCR	
4	3	Position PCR	
4	2	Position PCR	
4	1	Position PCR	
4	0	Position PCR	lsb
5	7	En PCF	msb
5	6	En PCF	

5	5	En PCF	
5	4	En PCF	
5	3	En PCF	
5	2	En PCF	
5	1	En PCF	
5	0	En PCF	
6	7	En PCF	
6	6	En PCF	
6	5	En PCF	
6	4	En PCF	lsb
6	3	Position PCF	msb
6	2	Position PCF	
6	1	Position PCF	
6	0	Position PCF	
7	7	Position PCF	
7	6	Position PCF	
7	5	Position PCF	
7	4	Position PCF	
7	3	Position PCF	
7	2	Position PCF	
7	1	Position PCF	
7	0	Position PCF	lsb
8	7	En Ion Ch (IK)	msb
8	6	En Ion Ch (IK)	
8	5	En Ion Ch (IK)	
8	4	En Ion Ch (IK)	
8	3	En Ion Ch (IK)	
8	2	En Ion Ch (IK)	
8	1	En Ion Ch (IK)	
8	0	En Ion Ch (IK)	
9	7	En Ion Ch (IK)	
9	6	En Ion Ch (IK)	
9	5	En Ion Ch (IK)	
9	4	En Ion Ch (IK)	lsb
9	3	En SSD	msb
9	2	En SSD	
9	1	En SSD	
9	0	En SSD	
10	7	En SSD	
10	6	En SSD	
10	5	En SSD	
10	4	En SSD	
10	3	En SSD	
10	2	En SSD	lsb
10	1	En CsI	msb
10	0	En CsI	
11	7	En CsI	
11	6	En CsI	
11	5	En CsI	
11	4	En CsI	
11	3	En CsI	
11	2	En CsI	

11	1	En CsI	
11	0	En CsI	lsb
12	7	time of drift	msb
12	6	time of drift	
12	5	time of drift	
12	4	time of drift	
12	3	time of drift	
12	2	time of drift	
12	1	time of drift	
12	0	time of drift	lsb
13	7	SSD row 1 flag	
13	6	SSD row 2 flag	
13	5	SSD row 3 flag	
13	4	SSD row 4 flag	
13	3	Event ID(HE1-N)	
13	2	Event ID(HE2-N)	
13	1	Event ID(HZ1-N)	
13	0	Event ID(HZ2-N)	lsb

Note that the table contains the HILT event time bytes. These BCD coded bytes are substituted into the packet time stamp to determine the event time.

5.2 LICA single event contents

Each EL structure contains one 15 byte LICA PHA event. The data is packed as shown in Table 5.2

Table 5.2 LICA single vent

byte	bit of byte	content	
0	7	SSD	msb
0	6	SSD	
0	5	SSD	
0	4	SSD	
0	3	SSD	
0	2	SSD	
0	1	SSD	
0	0	SSD	
1	7	SSD	
1	6	SSD	
1	5	SSD	
1	4	SSD	lsb
1	3	TOF	msb
1	2	TOF	
1	1	TOF	
1	0	TOF	
2	7	TOF	
2	6	TOF	
2	5	TOF	
2	4	TOF	
2	3	TOF	
2	2	TOF	
2	1	TOF	
2	0	TOF	lsb
3	7	Start W	msb
3	6	Start W	
3	5	Start W	
3	4	Start W	
3	3	Start W	
3	2	Start W	
3	1	Start W	
3	0	Start W	
4	7	Start W	
4	6	Start W	
4	5	Start W	
4	4	Start W	lsb
4	3	Start S	msb
4	2	Start S	
4	1	Start S	
4	0	Start S	
5	7	Start S	
5	6	Start S	

5	5	Start S	
5	4	Start S	
5	3	Start S	
5	2	Start S	
5	1	Start S	
5	0	Start S	lsb
6	7	Start Z	msb
6	6	Start Z	
6	5	Start Z	
6	4	Start Z	
6	3	Start Z	
6	2	Start Z	
6	1	Start Z	
6	0	Start Z	
7	7	Start Z	
7	6	Start Z	
7	5	Start Z	
7	4	Start Z	lsb
7	3	Stop W	msb
7	2	Stop W	
7	1	Stop W	
7	0	Stop W	
8	7	Stop W	
8	6	Stop W	
8	5	Stop W	
8	4	Stop W	
8	3	Stop W	
8	2	Stop W	
8	1	Stop W	
8	0	Stop W	lsb
9	7	Stop S	msb
9	6	Stop S	
9	5	Stop S	
9	4	Stop S	
9	3	Stop S	
9	2	Stop S	
9	1	Stop S	
9	0	Stop S	
10	7	Stop S	
10	6	Stop S	
10	5	Stop S	
10	4	Stop S	lsb
10	3	Stop Z	msb
10	2	Stop Z	
10	1	Stop Z	
10	0	Stop Z	
11	7	Stop Z	
11	6	Stop Z	
11	5	Stop Z	
11	4	Stop Z	
11	3	Stop Z	
11	2	Stop Z	

11	1	Stop Z	
11	0	Stop Z	lsb
12	7	HR	
12	6	10s min	
12	5	10s min	
12	4	10s min	
12	3	1s min	
12	2	1s min	
12	1	1s min	
12	0	1s min	
13	7	10s sec	
13	6	10s sec	
13	5	10s sec	
13	4	10s sec	
13	3	1s sec	
13	2	1s sec	
13	1	1s sec	
13	0	1s sec	
14	7	MS	
14	6	Calena	
14	5	PRI	
14	4	Calevn	
14	3	D4	
14	2	D3	
14	1	D2	
14	0	D1	

MS = Multi START flag
Calena. = In-flight Calibrator flag
PRI = Priority, 1 = high, 0 = low
Calevn. = Calibrator produced event
D1, D2, D3, D4 = Discriminator which fired

Note that the table contains the LICA event time bytes. These BCD coded bytes are substituted into the packet time stamp to determine the event time.

5.3 MAST single event contents

Each EM structure contains one MAST PHA. The contents are given in table 5.3

Table 5.3 - MAST single event

Data type	Bit No.	Comments
Integer * 4		time, seconds since 01JAN92 00:00:00
Integer * 4		Sequence No.
Byte	All	Event time tag offset (in seconds)
Byte	7	Last Det Fired bit 2
	6	Last Det Fired bit 1
	5	Last Det Fired bit 0
	4	G2 - high level guard
	3	G1 - Low level guard
	2	Sector No. bit 2
	1	Sector No. bit 1
	0	Sector No. bit 0
Byte	7	HIZ event flag
	6	PEN event flag
	5	Z2 event flag
	4	Z1 event flag
	3	CAL event flag
	2	HAZ event flag
	1	Unused
	0	Unused
Integer*2		M1X1 ADC
Integer*2		M1XS ADC
Integer*2		M2Y1 ADC
Integer*2		M2YS ADC
Integer*2		M3X1 ADC
Integer*2		M3XS ADC
Integer*2		M4Y1 ADC
Integer*2		M4YS ADS
Integer*2		D1 ADC
Integer*2		D2 ADC
Integer*2		D3 ADC
Integer*2		D4 ADC
Integer*2		D5 ADC
Integer*2		D6 ADC

5.4 PET single event contents

Each EP structure contains one PET PHA event. The contents are given in table 5.4

Table 5.4 - PET single event

Data type	Bit No.	Comments
Integer * 4		time, seconds since 01JAN92 00:00:00
Integer * 4		Sequence No.
Byte	All	Event time tag offset (in seconds)
Integer*2		P1 ADC
Integer*2		P2 ADC
Integer*2		P3 ADC
Integer*2		P47 ADC
Byte	7	Buffer No. bit 2
	6	Buffer No. bit 1
	5	Buffer No. bit 0
	4	NMode - indicated neutral mode
	3	Sector No. bit 2
	2	Sector No. bit 1
	1	Sector No. bit 0
	0	LOZMode - indicates gain state
Byte	7	P3 Discriminator flag
	6	P4 Discriminator flag
	5	P5 Discriminator flag
	4	P6 Discriminator flag
	3	P7 Discriminator flag
	2	P8 Discriminator flag
	1	AL - low level guard
	0	AH - high level guard

6.0 Rates

All rates as stored in NGDF structures are compressed values. See appendix B for rate decompression algorithms.

6.1 High Resolution Rates

The time stamp associated with the RH (HILT) and RP (PET) structures is the time at the *start* of the acquisition interval. Below are the definitions of the individual high resolution rates.

6.1.1 HILT

Each HILT high resolution rate structure contains 60 rate blocks, each of which is 1 byte in length. Each byte of a rate block is a rate compressed as described in Appendix B. Rate acquisition intervals vary in length. The first rate block acquisition interval begins at the time stamp associated with the RH structure. Subsequent rate blocks correspond to either stated number of millisecond following. Tables 6.1(a) - 6.1(d) show the individual rates. Note that in version 2.3 (Table 6.1(c)) 10 msec of every 100 msec are not accumulated for telemetry. Refer to Appendix E to determine exactly when to use each definition.

Table 6.1(a) - HILT high resolution rates - original version.

Structure RH, HILT High Resolution Rates - initial (launch) version	
Item	Rate Description
2	compressed SSD1, 60 rates, 1 every 100 milliseconds
3	compressed SSD2, 60 rates, 1 every 100 milliseconds
4	compressed SSD3, 60 rates, 1 every 100 milliseconds
5	compressed SSD4, 60 rates, 1 every 100 milliseconds
6	compressed PCRE, 60 rates, 1 every 100 milliseconds
7	compressed IK, 60 rates, 1 every 100 milliseconds

Table 6.1(b) - HILT high resolution rates - DPU patch 2.2 version

Structure RH, HILT High Resolution Rates - DPU version 2.2	
Item	Rate Description
2	compressed SSD1, 60 rates, 1 every 20 milliseconds
3	compressed SSD1, 60 rates, 1 every 20 milliseconds
4	compressed SSD1, 60 rates, 1 every 20 milliseconds
5	compressed SSD4, 60 rates, 1 every 100 milliseconds
6	compressed SSD1, 60 rates, 1 every 20 milliseconds
7	compressed SSD1, 60 rates, 1 every 20 milliseconds

Note: installed 3/25/94 19:03-21:29 -- note see DPU history table for details of patches in use; after safeholds, e.g., system would revert to earlier patches until reconfigured by ground command.

Table 6.1(c) - HILT high resolution rates - DPU patch 2.3 version

Structure RH, HILT High Resolution Rates - DPU version 2.3	
Item	Rate Description
2	compressed SSD1, 60 rates, 1st 30 milliseconds
3	compressed PCRE, 60 rates, 1st 30 milliseconds
4	compressed SSD1, 60 rates, 2nd 30 milliseconds
5	compressed PCRE, 60 rates, 2nd 30 milliseconds
6	compressed PCRE, 60 rates, 3rd 30 milliseconds
7	compressed SSD1, 60 rates, 3rd 30 milliseconds

Note: installed 8/25/94 20:08:27-21:00:44 -- note see DPU history table for details of patches in use; after safeholds, e.g., system would revert to earlier patches until reconfigured by ground command.

Table 6.1(d) - HILT high resolution rates - DPU patch 2.4 version

Structure RH, HILT High Resolution Rates - DPU version 2.4	
Item	Rate Description
2	compressed sum (SSD1-SSD4), 60 rates, 1st 20 milliseconds
3	compressed sum (SSD1-SSD4), 60 rates, 2nd 20 milliseconds
4	compressed sum (SSD1-SSD4), 60 rates, 3rd 20 milliseconds
5	compressed sum (SSD1-SSD4), 60 rates, 4th 20 milliseconds
6	compressed sum SSD4, 60 rates, 100 milliseconds
7	compressed sum (SSD1-SSD4), 60 rates, 5th 20 milliseconds

Note: installed 8/7/96 17:25 -- note see DPU history table for details of patches in use; after safeholds, e.g., system would revert to earlier patches until reconfigured by ground command.

6.1.2 PET High resolution rates

PET high resolution rates structures cover a 48 second period with 0.1 second resolution and 50% coverage for the P1 rate. The beginning of the rate accumulation period is the packet time stamp assigned by the DPU. PET high resolution rates are only sent if the count during one of the 480 0.05 second intervals is above a threshold set by command to the DPU. In addition, there is a quota on maximum memory which can be occupied by PET high resolution rates. If this quota is exceeded, no packets will be sent. Table 6.2 shows the PET high resolution rates in the RP structure.

Table 6.2 - PET High Resolution Rates

Structure RP, PET High Resolution Rates	
Byte	Rate Definition
1	P1 counts for 0.1 second interval beginning at time t
2	P1 counts for 0.1 second interval beginning at time t+0.1 seconds
.	.
.	.
479	P1 counts for 0.1 second interval beginning at time t+478*0.1 seconds
480	P1 counts for 0.1 second interval beginning at time t+479*0.1 seconds

6.2 Low Resolution Rates

Low resolution rates are multiplexed and occur every 6 seconds in the RS structure type. Refer to section **3.2 Structure Descriptions** for the RS structure definition. The time stamp associated with the RS structure is the time at the *start* of the 6 second acquisition interval. The subcom defines the multiplexed rates.

6.2.1 Subcom Descriptions

Valid subcom values are 6 through 21. Tables 6.3 - 6.11 list the multiplexed rate definitions for the HILT, MAST, and PET rate groups. The LICA instrument has no multiplexed rates.

Table 6.3 HILT Subcom rate 1: RS Structure

Subcom	Comments
6	SSD1
7	SSD2
8	SSD3
9	SSD4
10	SSD1
11	SSD2
12	SSD3
13	SSD4
14	SSD1
15	SSD2
16	SSD3
17	SSD4
18	SSD1
19	SSD2
20	SSD3
21	SSD4

Table 6.4 HILT Subcom rate 2: RS Structure

Subcom	Comments
6	Strobe
7	PCF0
8	IK0-AC
9	CSI
10	PCR0
11	NO(PC*SSD)
12	Pile-up
13	Invalid Array
14	Strobe
15	PCF0
16	IK0-AC
17	CSI
18	PCR0
19	NO(PC*SSD)
20	Pile-up
21	Invalid Array

Table 6.5 MAST Subcom rate 1 ("Subcommed rate 17"): RS Structure

Subcom	Comments
6	M1XSA
7	M1XSB
8	M2YSA
9	M2YSB
10	M3XSA
11	M3XSB
12	M4YSA
13	M4YSB
14	D1A
15	D1B
16	D2A
17	D2B
18	D3A
19	D3B
20	D4A
21	D4B

Table 6.6 MAST Subcom rate 2 ("Subcommed rate 16"): RS Structure

Subcom	Comments
6	M1X1
7	M1XS
8	M2Y1
9	M2YS
10	M3X1
11	M3XS
12	M4Y1
13	M4YS
14	D1
15	D2
16	D3
17	D4
18	D5
19	D6
20	G1
21	G2

Table 6.7 -- MAST Subcom rate 3 ("Subcommed rate 18"): RS Structure

Subcom	Comments
6	D7
7	G35L
8	G35H
9	G47L
10	G47H
11	G6L
12	G6H
13	HAZ
14	D5A
15	D5B
16	D6A
17	D6B
18	M12
19	M34
20	L
21	H

Table 6.8 -- MAST Subcom rate 4 ("Z=1 events"): RS Structure

Subcom	Comments
6	Z1R0
7	Z1R1
8	Z1R2
9	Z1R3
10	Z1R4
11	Z1R5
12	Z1R6
13	Z1R0
14	Z1R0
15	Z1R1
16	Z1R2
17	Z1R3
18	Z1R4
19	Z1R5
20	Z1R6
21	Z1R0

Table 6.9 -- MAST Subcom rate 5 ("Z=2 events"): RS Structure

Subcom	Comments
6	Z2R0
7	Z2R1
8	Z2R2
9	Z2R3
10	Z2R4
11	Z2R5
12	Z2R6
13	Z2R0
14	Z2R0
15	Z2R1
16	Z2R2
17	Z2R3
18	Z2R4
19	Z2R5
20	Z2R6
21	Z2R0

Table 6.10 -- PET Subcom rate 1: RS Structure

Subcom	Comments
6	P1ADC
7	ADC OR
8	P2ADC
9	AL
10	P3ADC
11	AH
12	P47ADC
13	HAZ
14	P1ADC
15	ADC OR
16	P2ADC
17	AL
18	P3ADC
19	AH
20	P47ADC
21	HAZ

Table 6.11 -- PET Subcom rate 2: RS Structure

Subcom	Comments
6	P4 single
7	P5 single
8	P6 single
9	P7 single
10	P8 single
11	A3L single
12	A3H single
13	A4L single
14	A4H single
15	A57L single
16	A57H single
17	A68L single
18	A68H single
19	P1A single
20	P3A single
21	P3B single

Appendices

Appendix A - Reference Documents

SAMPEX Mission Telemetry and Command Handbook
GSFC-S-740-90-968, Version 17.0, June 16, 1992
Goddard Space flight Center
Greenbelt, MD

Telemetry Packet Description for the SAMPEX Data Processing Unit
SAM-1-O-08105 Rev B, April 1991
Space Sciences Laboratory
The Aerospace Corporation
El Segundo, CA 90245

Time Code Formats
CCSDS 301.0-B-2 (Blue Book), Issue 2, April 1990
Consultative Committee for Space Data Systems
Communications and Data Systems Division (Code OS)
National Aeronautics and Space Administration
Washington, DC 20546

VAX FORTRAN Language Reference Manual
AA-D034E-TE, June 1988
Digital Equipment Corp.
Maynard, MA

SAMPEX mission overview

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DPU description

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Appendix B - Rate Decompression Algorithms

High Resolution Rates

HILT and PET high resolution rates in structures RH and RP are 16 bit values compressed to 8 bits: $E_3E_2E_1E_0M_3M_2M_1M_0$ where E bits (E3 - E0) indicate the exponent, and M bits(M3 - M0) the mantissa. To compute the decompressed value, N, apply the following algorithm.

If E < 2, N = (E*16)+M

If E ≥ 2, N = (16+M+0.5)*2^(E-1)

The maximum N which can be specified is 63,488, and the maximum error is ±3.125%.

Low Resolution Rates

Low resolution rates in structure RS are 24 bit values compressed to 12 bits: $E_4E_3E_2E_1E_0M_6M_5M_4M_3M_2M_1M_0$. To obtain the decompressed value N, extract the exponent (E4 - E0) and the mantissa (M6 - M0) and apply the following algorithm.

N = integer[(128+M)2^(E-8)]

Appendix C - Analog Conversion Algorithms

Convertible values are listed by structure item. Unless otherwise indicated, analog conversions are polynomial equations of the form:

$$A = C_0 + C_1N + C_2N^2 + \cdots + C_nN^n$$

Coefficients $C_0 \cdots C_n$ are taken from the SAMPEX Mission Telemetry and Command Handbook, "A" is the desired analog value, "N" is the integer value of the item to be converted.

Structure HS, -- HILT Analog Housekeeping portion		
Item	Name	Conversion
1	HILT vent valve temp. (°C)	A=-23.580+(N*0.50870)
2	HILT main valve temp. (°C)	A=-23.580+(N*0.50870)
3	HILT internal pressure reg. temp. (°C)	A=-23.580+(N*0.50870)
4	HILT internal analog box temp. (°C)	A=-23.580+(N*0.50870)
5	HILT internal sensor temp. (°C)	A=-23.580+(N*0.50870)
6	HILT digital box temp.(°C)	A=-23.580+(N*0.50870)
7	HILT digital electronics temp. (°C)	A=-23.580+(N*0.50870)
8	HILT HV converter PC temp. (°C)	A=-23.580+(N*0.50870)
9	HILT HV converter drift temp. (°C)	A=-23.580+(N*0.50870)
10	HILT LV converter 1 analog temp. (°C)	A=-23.580+(N*0.50870)
11	HILT LV converter 2 system temp. (°C)	A=-23.580+(N*0.50870)
12	HILT cover motor temp. (°C)	A=-23.580+(N*0.50870)
13	HILT -10 volt monitor (volts)	A=N*-5.3670e-2
14	HILT +5 volt monitor (volts)	A=N*2.6420e-2

continued

Structure HS, -- HILT Analog Housekeeping portion, continued		
Item	Name	Conversion
15	HILT +10 volt monitor (volts)	A=N*5.1130e-2
16	HILT SSD bias (volts)	A=N*1.4780
17	HILT HV PC monitor (volts)	A=N*4.6900
18	HILT HV drift monitor (volts)	A=N*-11.490
19	HILT pressure monitor # 1 (torr)	A=N*0.45180
20	HILT pressure monitor # 2 (torr)	A=N*4.0210
21	HILT regulator valve temp. (°C)	A=N*2.0740e-2
22	HILT +13 volt monitor converter #2 (volts)	A=N*6.2240e-2
23	HILT -13 volt monitor converter #2 (volts)	A=N*-6.2240e-2
24	HILT +10 volt monitor converter #2 (volts)	A=N*6.2240e-2
25	HILT -10 volt monitor converter #2 (volts)	A=N*-6.2240e-2
26	HILT +5 volt monitor converter #2 (volts)	A=N*2.5930e-2

Structure HS -- LICA Analog Housekeeping portion		
Item	Name	Conversion
1	LICA +12 volt monitor (volts)	A=N*0.13440
2	LICA +6 volt monitor (volts)	A=N*6.720e-2
3	LICA +5 volt monitor (volts)	A=N*5.4460e-2
4	LICA -5 volt monitor (volts)	A=N*-51870e-2
5	LICA -6 volt monitor (volts)	A=N*-6.2860e-2
6	LICA -12 volt monitor (volts)	A=N*-0.12570
7	LICA HV monitor #1 (volts)	A=N*41.494
8	LICA HV monitor #2 (volts)	A=N*41.494
9	LICA temperature monitor #1 (°C)	A=-60+(N*0.82990)
10	LICA temperature monitor #2 (°C)	A=-60+(N*0.82990)
11	LICA temperature monitor #3 (°C)	A=-60+(N*0.82990)
12	LICA temperature monitor #4 (°C)	A=-60+(N*0.82990)
13	LICA HV control monitor #1 (volts)	A=N*4.149e-2
14	LICA HV control monitor #2 (volts)	A=N*4.149e-2
15	LICA HV monitor #1 (volts)	A=N*41.494
16	LICA HV monitor #2 (volts)	A=N*41.494

Structure HS -- MAST/PET Analog Housekeeping portion		
Item	Name	Conversion
1	MAST matrix board thermister (°C)	$A=59.321-(N*1.1450)$ $+(N^2*1.3830e-2)$ $-(N^3*1.0370e-4)$ $+(N^4*3.7140e-7)$ $-(N^5*5.0560e-10)$
2	MAST thick board thermister (°C)	same as item 1
3	MAST M1 thermister (°C)	same as item 1
4	MAST D2 thermister (°C)	same as item 1
5	MAST D7 thermister (°C)	same as item 1
6	MAST M1 thermister (°C)	same as item 1
7	MAST D2 thermister (°C)	same as item 1
8	MAST D7 thermister (°C)	same as item 1
9	PET P1RT thermister (°C)	same as item 1
10	PET P8RT thermister (°C)	same as item 1
11	PET ANART thermister (°C)	same as item 1
12	PET P1RT thermister (°C)	same as item 1
13	PET P8RT thermister (°C)	same as item 1
14	PET ANART thermister (°C)	same as item 1
15	PET P1RT thermister (°C)	same as item 1
16	PET P8RT thermister (°C)	same as item 1

Structure HS -- LVPS/DPU Analog Housekeeping portion		
Item	Name	Conversion
1	LVPS +7.5 volt monitor (volts)	A=N*3.9210e-2
2	LVPS +4.7 volt monitor (volts)	A=N*2.4360e-2
3	LVPS -7.5 volt monitor (volts)	A=-12.881+(N*5.670e-2)
4	LVPS -13.5 volt monitor (volts)	A=-20.880+(N*7.90e-2)
5	LVPS -37.0 volt monitor (volts)	A=-52.849+(N*0.16830)
6	LVPS ground monitor #1 (volts)	A=N*2.0750e-2
7	LVPS ground monitor #2 (volts)	A=N*2.0750e-2
8	LVPS ground monitor #3 (volts)	A=N*2.0750e-2
9	LVPS ground monitor #4 (volts)	A=N*2.0750e-2
10	LVPS +37.0 volt monitor (volts)	A=N*0.19190
11	LVPS +13.5 volt monitor (volts)	A=N*7.0020e-2
12	LVPS +10.5 volt monitor (volts)	A=N*5.1970e-2
13	LVPS PET monitor (amps)	A=N*2.0750e-2
14	LVPS MAST monitor (amps)	A=N*2.0750e-2
15	LVPS PSA current monitor (amps)	A=N*3.00
16	LVPS variable load monitor (amps)	A=N*2.5930e-3
17	DPU VCC monitor (volts)	A=N*2.0750e-2
18	DPU +10 volt monitor (volts)	A=N*6.2250e-2
19	DPU -10 volt monitor (volts)	A=N*-6.2250e-2
20	DPU +2.5 volt monitor (volts)	A=N*2.0750e-2
21	DPU ground monitor (volts)	A=N*2.0750e-2

Structure MF -- On-board magnetometer measurements		
Item	Name	Conversion
1	Body centered x (mgauss)	A=700.0-(N*0.34188)
2	Body centered y (mgauss)	A=700.0-(N*0.34188)
3	Body centered z (mgauss)	A=700.0-(N*0.34188)

Note: Scale is linear from -700 mgauss to 700 mgauss, accurate to four significant digits.

Structure SB -- Battery monitor		
Item	Name	Conversion
5	Battery current monitor (amps)	A=-20.0+(N*9.76801e-3)
6	Shunt current monitor (amps)	A=5.0-(N*2.442e-3)
7	NEB current monitor (amps)	A=5.0-(N*2.442e-3)
8	Solar Array A current monitor (amps)	A=5.0-(N*2.442e-3)
9	Battery Voltage Monitor (volts)	A=35.220-(N*1.72015e-2)
10	Battery top-of-cell temp. monitor (°C)	$A=-66.181+(N*0.25209)$ $-(N^2*5.00065e-4)$ $+(N^3*5.59885e-7)$ $-(N^4*2.97226e-10)$ $+(N^5*6.05992e-14)$
11	Battery base plate temp. monitor (°C)	$A=-66.181+(N*0.25209)$ $-(N^2*5.00065e-4)$ $+(N^3*5.59885e-7)$ $-(N^4*2.97226e-10)$ $+(N^5*6.05992e-14)$
12	Main bus voltage (volts)	A=40.0-(N*1.9536e-2)

Structure ST -- S/C subsystem temperature monitor		
Item	Name	Conversion
3	Lower S/C radiator plate temp. (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)
4	Upper S/C radiator plate temp. (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)
5	Instrument/bus separation plate temp. (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)

Structure ST -- S/C subsystem temperature monitor		
Item	Name	Conversion
1	HILT support plate (°C)	$A=-37.229+(N*0.39926)$ $-(N^2*1.10348e-3)$ $+(N^3*1.82231e-6)$ $-(N^4*1.46776e-9)$ $+(N^5*4.54815e-13)$
2	HILT isobutane tank (°C)	$A=-37.229+(N*0.39926)$ $-(N^2*1.10348e-3)$ $+(N^3*1.82231e-6)$ $-(N^4*1.46776e-9)$ $+(N^5*4.54815e-13)$
3	HILT analog electronics (°C)	$A=-37.229+(N*0.39926)$ $-(N^2*1.10348e-3)$ $+(N^3*1.82231e-6)$ $-(N^4*1.46776e-9)$ $+(N^5*4.54815e-13)$
4	HILT sensor base (°C)	$A=-37.229+(N*0.39926)$ $-(N^2*1.10348e-3)$ $+(N^3*1.82231e-6)$ $-(N^4*1.46776e-9)$ $+(N^5*4.54815e-13)$
5	HILT acoustic cover (°C)	$A=-37.229+(N*0.39926)$ $-(N^2*1.10348e-3)$ $+(N^3*1.82231e-6)$ $-(N^4*1.46776e-9)$ $+(N^5*4.54815e-13)$

Structure ST -- S/C subsystem temperature monitor		
Item	Name	Conversion
9	LICA base plate (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)

Structure ST -- S/C subsystem temperature monitor portion		
Item	Name	Conversion
1	MAST base plate (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)
2	PET base plate (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)
3	MAST/PET low voltage power supply (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)

Structure ST -- S/C subsystem temperature monitor portion		
Item	Name	Conversion
1	DPU base plate (°C)	A=-37.229+(N*0.39926) -(N^2*1.10348e-3) +(N^3*1.82231e-6) -(N^4*1.46776e-9) +(N^5*4.54815e-13)

Appendix D - Acronyms and Abbreviations

Acronyms.

ACS - Attitude control system
ADC - Analog to digital converter
APID - Application ID
BCD - Binary coded decimal
DCL - Digital command language © Digital Equipment Corp.
DPU - Data processing unit
ECD - Eccentric dipole
EOF - End of file
EPV - Extended Precision Vector (S/C location)
GEI - Geocentric equatorial inertial
GEO - Geographic
HILT - Heavy ion large telescope
HK - Housekeeping
HRR - High resolution rate
HV - High voltage
IFC - In-flight calibration
IGRF - International Geophysical Reference Field
ISO - International standards organization
LICA - Low energy ion composition analyzer
LEICA - another acronym for LICA
LRR - Low resolution rate
LSB - Least significant bit
LV - Low voltage
LVPS - Low voltage power supply
MAST - Mass spectrometer telescope
MDF - Master Data File
NGDF - New Goddard Data File
MPL - Missing packet list
MS - Multi-stop
NEB - Non-essential bus
PACOR - Packet processor facility
PET - Proton-electron telescope
PHA - Pulse height analyzed
QAC - Quality and accounting capsule
SAA - South Atlantic anomaly
S/C - Spacecraft
SRL - Space Radiation Laboratory (California Institute of Technology)
SSD - Solid state detector
ToD - Time of day
ToF - Time of flight
UMSOC - University of Maryland Science Operations Center
VMS - Virtual Memory System © Digital Equipment Corp.

Abbreviations.

alt. - altitude
Calena. - Calibration enable
Calevn. - Calibration event
cmd. - command
conf. - confirmed
dec. - decimal
hr(s) - hour(s)
km. - kilometer
lat. - latitude
len. - length
long. - longitude
magn. - magnitude
param. - parameter
pkt(s) - packets(s)
posn. - position
temp. - temperature

Appendix E - SAMPEX High Resolution Rate Changes

Below is information relevant to the RH and RS structures, whose contents have been modified during the course of the mission.

In addition, the SAMPEX "event log" (Appendix G) contains events of importance which affect the interpretation of various data contained in the NGDF.

Structure RH (see § 6.1.1)

Different versions of the RH structure contents for HILT were in use for time intervals shown below. After occasional spacecraft safeholds or other reconfigurations, there were brief intervals when the DPU was operating in the original version.

DPU Version	HRR Contents Reference	Start Date	End Date
original	Table 7.1	launch	3/25/94 19:09:59
Version 2.2	Table 7.2	3/25/94 19:09:59	8/25/94 21:00:34
Version 2.3	Table 7.3	8/25/94 21:00:34	1/31/96 12:35:52
original (2.1)	Table 7.1	1/31/96 12:35:52	8/7/96 17:25
Version 2.4	Table 7.4	8/7/96 17:25	

Appendix F - Attitude determination in 1 RPM spin mode

F.1 Introduction

In its 1 RPM spin mode, SAMPEX attitude gets updated once every 6 seconds, or about every 36 degrees of rotation angle (except in coast mode). In order to more accurately report the attitude and pitch angle in the MDFs for days in the spin mode, the MDF generator was modified as described below.

These changes apply to MDF generator versions 30 and higher.

In order to correlate the rates with the attitude, the S/C attitude is determined, and then the pitch angle at the midpoint of the low resolution rate accumulation interval is calculated. Determining the attitude as close in time to when the low resolution rates are accumulated improves the correlation with 90 deg. pitch angle in the outer zone and in the anomaly. This information also looks promising for studies of precipitation.

F.2 Non-coast mode times

For times outside of coast mode intervals, the following calculations are done for each RS structure:

1. interpolate the S/C attitude at the midpoint of the low resolution rate accumulation interval using the method described by Landis Markley (memo to Doug Hamilton, 4/4/94) and implemented by Mark Looper

2. compute the magnetic field vector in the S/C frame at the midpoint of low resolution rate accumulation interval using the same IGRF model used to report mag field data in the PS structures (field routine courtesy of Mike McNab)

3. use the attitude and magnetic field to compute the pitch angle

4. report the attitude and pitch angle as a NEW structure, the R6 structure.

The last variable in the R6 is the time in seconds between the packet times of the two quaternions used to interpolate the attitude. During times when the S/C is in 1 RPM spin mode, a value of >6 seconds in the time between quaternions indicates that the satellite is in coast mode.

F.3 Coast mode

During orbit rate rotation mode, recovering the attitude in coast was difficult since we could not interpolate across a coast mode gap due to the possibility of sudden maneuvers the carried out by the S/C did in order to look at J-perp while maintaining ram avoidance. The 1 RPM spin mode in principle makes it easier to recover the attitude, since we can assume a constant rotation rate and direction through the attitude gap.

When the S/C is determined to be in 1 RPM coast mode, the attitude is calculated as follows:

a) use the most recent attitude update to find the S/C y-axis in the GEI frame (the S/C rotates about the y-axis; this axis is assumed to be stationary in the GEI frame and the rotation rate is constant)
b) in the GEI frame, rotate about the y-axis by an angle (0.1053 rad/sec)*(current RS time + 3 - latest APID-11 time) where the 'latest APID-11 time' is the time of the last quaternions before the coast mode gap
c) apply this rotation to the most recent APID-11 quaternions to get the quaternions at the current RS structure time + 3 seconds

Steps 2-4 in §F.2 are followed to find and report the pitch, zenith, & azimuth.

The rate of 0.1053 rad/sec is slightly faster than 1.00 RPM. This rate and the resulting pitch angle fit the LICA SSD peaks measured during coast modes in the SAA better than 1.00 RPM or the daily averaged rate measured from the APID 11 quaternions.

The time between APID 11 quaternions included in the new structure R6 indicates which method was used to compute the attitude.

Appendix G - SAMPEX "Event" Table

This table contains times of "events" of importance to determining the status of the instrument or spacecraft. Items not included are:

- routine instrument calibrations run on or near the start of each month
- MOST instrument power cycling
- brief turn-ons of HILT for gas pressure checks.

This list is based on examination of command logs through 7/3/94 (day 184), and from inputs from the POCC since that time.

Table G.1 -- Spacecraft Events

Time	Event
08/12/92	NEB off due to DPU reboots
09/19/92	Spacecraft safehold
03/31/93	NEB current noisy due to M/P LVPS instability during 12 hour MAST turnoff
04/07/93	NEB current noisy due to M/P LVPS instability during 12 hour MAST turnoff
9/12/93 11:23:55	Spacecraft clock jump back 2 sec; corrected at 23:48:16
12/15/93	MAST/PET LVPS out of limits
12/22/93	NEB and MAST/PET LVPS noisy all day
2/9/94 01:46:49	Spacecraft clock jumps back 3 sec; corrected at 15:32:06
5/26/94 13:46:28	Spacecraft pointing algorithm modified to point perpendicular to field for B<0.3 gauss, parallel to field at other times subject to pointing and ram avoidance. If a warm restart occurs, will revert to old program until new one loaded and activated.
6/1/94 18:41:01	RPP warm restart, revert to old pointing program
6/2/94 14:52:07	modified pointing algorithm re-activated
8/10/94 15:40:17	RPP warm restart, revert to old pointing program
8/10/94 22:40	modified pointing algorithm re-activated
4/1/95 17:39:30	S/C clock stepback by 5 sec (time approx)
4/1/95 23:38:20 23:41:23 23:43:25:	S/C clock adjusts made to correct 5-sec stepback
4/30/95 12:22:51	RPP warm restart, revert to old pointing program
5/1/95 13:07:01	modified pointing algorithm re-activated
10/24/95 13:41	S/C enters analog safehold, revert to old pointing program
10/26/95 19:55	safehold recovery: MAST & PET command words modified to pre-safehold values
10/27/95 18:26	safehold recovery: modified pointing algorithm re-activated

continued

Spacecraft Event Table, continued

Time	Event
1/1/96 0:00	S/C clock moved back 1 sec to stay in synch with UT
1/30/96 20:05	Memory dwell tables & ACS patch loaded for "spinup"
2/1/96 15:07:12	S/C pointing commanded to 1 RPM mode
2/1/96 19:15	S/C pointing to normal mode (spin down requires ~2 hrs after this command sent)
2/13/96 13:45:32	S/C pointing commanded to 1 RPM mode
2/14/96 19:30	S/C commanded back to normal mode (bad ACS patch)
2/14/96 20:30:50	S/C pointing commanded to 1 RPM mode
2/16/96 18:00:00	S/C commanded back to normal mode
3/5/96 15:25:08	S/C pointing commanded to 1 RPM mode
3/8/96 17:45:00	S/C commanded back to normal mode
5/8/96 13:33:00	S/C pointing commanded to 1 RPM mode
8/19/96 ??:??	S/C commanded to safehold after signal acq. problem
8/22/96 09:53	S/C commanded to ORR (original) pointing mode
8/24/96 03:57	S/C commanded to modified ORR mode
8/26/96 08:53	S/C pointing commanded to 1 RPM mode
11/6/97 23:10:56	S/C commanded to prior spin program (looks towards zenith over poles; perp to B for B<0.3 gauss) for solar flare event study
11/17/97 13:26:20	S/C pointing commanded to 1 RPM mode -- for ACR intercalibration with ACE
12/18/97 13:08:01	S/C commanded to prior spin program (looks towards zenith over poles; perp to B for B<0.3 gauss) (took ~4 hours to achieve new mode)
1/13/98	switchover from GSFC FDF to UMd FDCL daily EPVs
1/14/98 12:45	S/C pointing commanded to 1 RPM mode est 2 hrs to achieve transition (short shadows)
4/21/98 15:08:01	S/C commanded to prior spin program (looks towards zenith over poles; perp to B for B<0.3 gauss) for solar flare event study
4/28/98 16:08:45	S/C pointing commanded to 1 RPM mode; est 2 hrs to achieve transition (short shadows)
5/7/98 14:05:09	S/C commanded to 1 RPO spin program for SEP charge studies, Space Station cutoff support

continued

Spacecraft Event Table, continued

Time	Event
12/05/99 ~14:40	Spacecraft safehold due to watchdog time out
12/09/99 18:30	S/C reconfiguration from safehold completed
12/17/99 20:10	S/C to 1 RPM spin mode in support of L D Balloon
12/25/99 20:20	Spacecraft safehold
12/28/99 23:30	S/C reconfiguration from safehold completed; 1 RPM
2/2/00 20:05	S/C to 1 RPO mode after completion of balloon flight
5/13/00 (134) 03:22:13	S/C clock noticed 4.122 seconds off (spacecraft behind); gradual adjustment back to specifications
5/17/00 (138) 17:05:45	S/C clock readjust back to within limits completed MDF position data not affected by these jumps 6/5
1/16/02 (016) 14:29:31	RPP warm restart, revert to old ORR pointing program
1/17/02 (017) 18:45	S/C back to 1 RPO mode after restart (modified pgm)

Data losses due to overflow of memory partition in solid state recorder (SSR):

Time Range	Partition	Data Loss
1/9/93 22:06:05 - 22:18:09	ACS	12 min, 4 sec
1/17/93 20:21:56 - 20:31:21	ACS	9 min, 25 sec
3/7/93 14:38:18 - 14:46:04	ACS	7 min, 46 sec
9/29/94 19:21:05 - 20:51:37	ACS	90 min, 32 sec
10/20/94 15:07:53 - 16:08:00	DPU	60 min, 07 sec
10/31/94 15:38:35 - 16:15:37	ACS	37 min, 02 sec
10/5/95 17:55:48 - 18:36:06	ACS	40 min, 18 sec
12/17/95 07:45:36 - 14:38:39	ACS	6 hrs, 53 min, 3 sec
8/18/96 ??:??:??	ACS/DPU due to tracking loss	
8/25/96 10:03:04 - 10:25:45	ACS	22 min 41 sec
10/29/96 13:36:40 - 15:39:29	ACS	2 hrs, 2 min, 49 sec

Other data losses:

Time Range	Partition	Data Loss
12/17/96 18:04 - 12/18/96 01:30	Science	loss of 55% of a blind dump due to Wallops problem
4/27/97 08:47 - 11:16	Science	loss of 82% of a blind dump due to Wallops problem
5/2/97 00:11 - 05:35	Science	loss of 46% of a blind dump due to Wallops problem
6/3/97 19:25 - 21:32	Science	loss of 10% of a blind dump due to Wallops problem
1/15/98 00:24	Science	loss of 14% of a blind dump due to Wallops problem
6/27/98 01:41 - 19:02 (day 178)	Science	loss due to antenna point error at Poker Flats during blind dump
7/21/98 2 hr 6 min lost between 10:48-22:33	Science	error at Wallops due to misconfigured equipment
11/17/98 14:30 - 11/18/98 01:00	Science	Instruments off for Leonid Meteor Shower
12/19/98 45% of dump lost	Science	loss due to dropout during blind playback at Wallops
1/17/99 35% of 12-hr dump lost	Science	blind playback at Wallops, reason for loss unknown
1/28/99 10% of 12-hr dump lost	Science	brief dropout during blind pass
3/7/99 53% of 12-hr dump lost	Science	Instr subcom VC2 data loss; 53% of period 98/066/04:59-16:43 due to dropout at Wallops
6/26/99 56% of 12-hr dump lost	Science	VC2 data loss due to drop- out (low elevation Wallops pass)
7/9/99 50% of 12-hr dump lost	Science	low elevation Wallops pass

continued

Time Range	Partition	Data Loss
8/20/99 ~90% of 12-hr dump lost	Science	VC2 data lost from 99/231/18:45 to 99/232/05:41 due to switch error at Wallops
9/15/99 13:19 to 9/16/99 03:20	Science	no tracking due to Hurricane Floyd closedown of Wallops
9/16/99 16:28 to 9/17/99 01:47	Science	no tracking due to Hurricane Floyd closedown of Wallops
10/1/99 16:12 - 10/2/99 01:33	Science	low elevation Wallops pass
11/17/99 16:00 - 11/18/99 16:00	Science	Instruments off for Leonids
11/24/99 03:10-15:33 90% of VC 2 lost	Science	loss of lock at Wallops
1/9/00 20:46 - 1/10/00 02:13 data in VC 2 lost	Science	loss of lock at Wallops
1/27/00 16:53 - 1/28/00 08:43 47% of VC 2 lost	Science	loss of lock at Wallops
2/2/00 18:56 - 2/3/00-02:23 57% of VC 2 lost	Science	loss of lock at Wallops
2/26/00 14:06 - 2/27/00 04:04 loss of unknown % of VC 2	Science	Wallops LEO-T prob
3/17/00 01:47 - 3/17/00 11:51 loss	Science	Wallops equipment prob
4/4/00 22:55:02 - 4/5/00 04:15:05 loss of science data	Science	Wallops equipment prob
7/15/00 08:32:27 - 09:08:35 (day 197)	Science	loss of 36 min data due to filling of science data partition in large SEP event
11/5/00 03:44 to 16:04 (day 310)	Science	loss of 12h 20m of data due to Wallops antenna slewing off S/C
11/29/00 01:46 to 10:55 (day 334)	Science	loss of 9h 9m of data due to Wallops antenna lost contact w S/C
12/31/00 20:07:31 - 01/01/01 10:03:02	Science	Loss of ~25% of frames during this period due to signal interference at Wallops

continued

Time Range	Partition	Data Loss
5/22/01 13:05:00 - 5/22/01 14:50:00 (day 142)	Science	Loss of 1 hr 45 m data due to power failure at Wallops during pass
6/21/01 09:26 to 21:05 (day 172)	Science	Loss of 11.5 hours of data due to failure with Wallops TOTS antenna
7/18/01 17:32 to 7/19/01 05:48 (days 199-200)	Science	Loss of ~18% of data due to problem with Wallops antenna
8/02/01 14:47 to 8/03/01 03:04 (days 214-215)	Science	loss of ~12 hrs of data due to problem w Wallops antenna
8/10/01 02:30 to 10:40 (day 222)	Science	loss of 8 hr 10 min of data due to problem w Poker Flat Antenna
8/16/01 13:42 to 8/18/01 01:58 (day 228-9)	Science	loss of 12 hr 16 min of data due to problem w Wallops Antenna
8/21/01 13:18 to 8/22/01 01:34 (day 233-4)	Science	loss of 14% of science data due to problem w Wallops downlink converter
8/22/01 11:36 to 8/23/01 01:29 (day 234-5)	Science	loss of 33% of science data due to problem w Wallops downlink converter
8/28/01 23:25 to 8/29/01 11:01 (day 240-41)	Science	loss of about 11 1/2 hours data due to Wallops LEO-t antenna
9/14/01 09:43 to 9/14/01 21:58 (day 257)	Science	loss of 12 hr 15 min due to problem w Wallops antenna
9/26/01 08:29:56	Science	14.5 min lost due to VC2 overfill during intense SEP event
10/20/01 17:01 to 10/21/01 04:40 (day 294-5)	Science	loss of 11 hrs 40 min due to Wallops 5m antenna problem, with combiner
11/01/01 14:08 to 11/02/01 01:44 (day 305-6)	Science	loss of 11.5 hrs data due to Wallops power outage
11/06/01 14:06 to 20:10:00 (310)	Science	6 hrs 4 min lost due to operator error and 1 hr loss due to overflow

continued

Time Range	Partition	Data Loss
01/15/02 05:55 to 15:54 (015)	Science	loss of 10 hrs data due to CRC errors caused by Wallops problem
01/26/02 14:13 to 01/27/02 02:28 (026-027)	Science	loss of 36% of data due to CRC errors caused by Wallops problem
01/27/02 02:28 to 01/27/02 14:03	Science	loss of 100% of data (11.5 hrs) due to CRC error caused by Wallops ground system
3/01/02 13:11 to 22:23 (day 060)	Science	loss of 9 hr 12 min due to problem w Wallops antenna
3/30/02 18:34 to 4/1/02 06:09 (day 90-91)	Science	loss of 14.4% of VC2 data due to frame error losses at Wallops
4/08/02 21:54 to 4/09/02 04:35 (day 98-99)	Science	loss of 6 hr 40 min of VC2 data due to computer crash at Wallops
5/18/02 11:47 to 23:23	Science	loss of 12% of VC2 due to excessive Wallops CRC errors
10/08/02 01:22:42 to 02:30:10	Science	ACS data missing
10/28/02 00:10 to 12:23 (day 301)	Science	12 hrs 13 min lost due to tracking problem in TOTS antenna
11/11/02 23:16 to 11/12/02 06:43 (days 315/6)	Science	loss of 7 hrs 27 minutes due to late AOS at Wallops
11/15/02 22:09 to 11/16/02 05:34 (days 319/20)	Science	loss of 7 hrs 25 minutes due to late AOS at Wallops
12/31/02 15:23 to 01/01/02 03:33	Science	loss of 13 hr 10 min loss due to TOTS antenna problem
01/18/03 01:37 to 13:09	Science	loss of 12% of data due to CRC frame errors (1 hr 22 min)
01/18/03 13:09 to 01/19/03 01:19	Science	loss of all data due to antenna problems (12 hr 29 min)
02/07/03 22:22 to 02/08/03 09:53	Science	loss of 43% data due to antenna problems (4 hr 57 min)

continued

Time Range	Partition	Data Loss
03/31/03 15:23 to 04/01/03 02:54	Science	loss of 14% of data due to antenna problems (1 hr 32 min)
04/04/03 01:55 to 15:39	Science	loss of 40% of data due to antenna problems (5 hr 29 minutes)
04/17/03 00:48 to 12:15	Science	loss of 15% of data due to frame errors (1 hr 49 minutes)
05/11/03 09:41 to 21:12	Science	loss of 23% of data due to antenna problems (2 hrs 39 minutes)
05/29/03 06:47 to 18:16	Science	loss of 28% of data due to antenna problems (3 hrs 10 minutes)
06/05/03 05:58 to 17:27	Science	loss of 31% of data due to antenna problems (3 hrs 36 minutes)
07/01/03 03:18 to 14:50	Science	loss of 16% of data due to antenna problems (1 hr 48 minutes)
07/30/03 09:25 to 23:10	Science	loss of 100% of data due to operator error (13 hr 45 minutes)
09/25/03 13:55 to 09/26 01:23	Science	loss of 62% of data due to procedure problem (7 hr 6 minutes)
11/14/03 08:06 to 19:37	Science	loss of 12% of data due to acquisition delay (1 hr 23 min)
12/3/03 15:55 to 12/4 05:38	Science	loss of 31% of data due to CRC problems (4 hr 15 min)
1/13/04 10:35 to 22:43	Science	loss of 100% of data due to operator error (12 hr 8 min)
3/19/04 04:32 - 3/19/04 18:30 (days 79-80)	Science	loss of 100% of data (13 hr 58 min) due to problem at Poker, which was covering for Wallops during maintenance
4/5/04 11:26 - 22:54 (day 096)	Science	loss if 100% of data (11 hr 28 min) due to operator error at Wallops

continued

Time Range	Partition	Data Loss
5/18/04 04:44 - 16:11 (day 139)	Science	loss of 100% of data due to command encoder failure at Wallops
5/19/04 05:53 - 17:22 (day 140)	Science	loss of 100% of data due to command encoder failure at Wallops

Table G.2 -- LICA events

note: LICA individual high voltage spikes, and "noon" turnoffs are NOT included in this list; they are in the data file LICA_bad_hv.dat on www page.

LICA Event Table

Time	Event
7/10/92 12:20:56	LICA first in-calibrate data MCP HV steps 155/155
7/22/92 8:49:12	LICA out of calibrate until 9/29/92
9/27/92 20:28	LICA back in calibration at HV steps 165/165
11/16/92	LICA daily "turn-offs" begin
11/25/92	LICA daily turn-offs scheduled for 12:00-12:15 GMT
11/10/93 0:30:00	LICA START MCP bias adjusted up to step 175
12/20/93 23:17	LICA START MCP bias to step 180
1/21/94 18:46	LICA proton "slant" disabled
5/4/94 12:17	LICA START MCP bias to step 185
9/27/94 20:29:23	LICA START MCP bias to 191; STOP MCP bias to 169
11/11/94 12:15	LICA START MCP bias to 192; STOP MCP bias unchanged
12/27/94 12:15	LICA START MCP bias to 193; STOP MCP bias unchanged
2/10/95 12:15	LICA START MCP bias to 194; STOP MCP bias unchanged
3/27/95 12:18:14	LICA START MCP bias to 195; STOP MCP bias unchanged
5/11/95 12:15	LICA START MCP bias to 196; STOP MCP bias unchanged
6/26/95 12:15	LICA START MCP bias to 197; STOP MCP bias unchanged
8/9/95 12:15	LICA START MCP bias to 198; STOP MCP bias unchanged
9/22/95 12:18:14	LICA START MCP bias to 199; STOP MCP bias unchanged
11/7/95 12:15	LICA START MCP bias to 200; STOP MCP bias unchanged
12/22/95 12:18:14	LICA START MCP bias to 201; STOP MCP bias unchanged
2/5/96 12:18:14	LICA START MCP bias to 202; STOP MCP bias unchanged
3/21/96 12:18:14	LICA START MCP bias to 203; STOP MCP bias unchanged

continued

LICA Event Table, continued

Time	Event
5/3/96 12:18:14	LICA START MCP bias to 204; STOP MCP bias unchanged
6/19/96 12:18:14	LICA START MCP bias to 205; STOP MCP bias unchanged
8/2/96 12:18:14	LICA START MCP bias to 206; STOP MCP bias unchanged
8/2/96 12:00:00 - 16:58:12	LICA off due to RTS sequencing error
8/21/96 12:18	LICA on & HV on after S/C safehold
9/17/96 12:18:14	LICA START MCP bias to 207; STOP MCP bias unchanged
11/1/96 12:18:14	LICA START MCP bias to 208; STOP MCP bias unchanged
12/16/96 12:18:14	LICA START MCP bias to 209; STOP MCP bias unchanged
1/30/97 12:18:14	LICA START MCP bias to 210; STOP MCP bias unchanged
3/16/97 12:18:14	LICA START MCP bias to 211; STOP MCP bias unchanged
4/30/97 12:18:14	LICA START MCP bias to 212; STOP MCP bias unchanged
6/14/97 12:18:14	LICA START MCP bias to 213; STOP MCP bias unchanged
7/29/97 12:18:14	LICA START MCP bias to 214; STOP MCP bias unchanged
9/12/97 12:18:14	LICA START MCP bias to 215; STOP MCP bias unchanged
10/28/97 12:15:10	LICA START MCP bias to 216; STOP MCP bias unchanged
12/11/97 12:18:14	LICA START MCP bias to 217; STOP MCP bias unchanged
1/27/98 12:18:14	LICA START MCP bias to 218; STOP MCP bias 169
3/11/98 12:18:14	LICA START MCP bias to 219; STOP MCP bias 169
6/23/98 12:15	LICA START MCP bias to 210 [sic]; STOP MCP bias 169
2/16/99 12:15	LICA START MCP bias to 215; STOP MCP bias to 172
5/12/99 12:15	LICA START MCP bias to 216; STOP MCP bias 172
8/10/99 12:15	LICA START MCP bias to 217; STOP MCP bias 172
11/10/99 12:15	LICA START MCP bias to 218; STOP MCP bias 172
12/05/99 ~14:40	Spacecraft safehold due to watchdog time out
12/09/99 18:30	S/C reconfiguration from safehold completed

continued

LICA Event Table, continued

Time	Event
12/25/99 20:20	Spacecraft safehold
12/28/99 23:30	S/C reconfiguration from safehold completed; 1 RPM
02/08/00 12:15	LICA START MCP bias to 219; STOP MCP bias 172
05/09/00 12:15	LICA START MCP bias to 220; STOP MCP bias 172
08/03/00 12:15	LICA START MCP bias to 221; STOP MCP bias 172
11/02/00 12:15	LICA START MCP bias to 222; STOP MCP bias 172
01/31/01 12:15	LICA START MCP bias to 223; STOP MCP bias 172
04/11/01 12:18:14	LICA START MCP bias to 233; STOP MCP bias 175
09/25/01 12:15	LICA START MCP bias to 236; STOP MCP bias 175
05/29/02 12:15	LICA START MCP bias to 240; STOP MCP bias 178
07/02/02 12:18:14	LICA START MCP bias to 243; STOP MCP bias 180
07/09/02 12:18:14	LICA START MCP bias to 246; STOP MCP bias 180
09/09/02 12:18	SEDS monitor table setting changed to reset LICA after 1 high HV reading (old limit was 3 successive readings)
02/26/03 06:48	LICA START MCP bias to 249; STOP MCP bias 180
11/18/03 02:25	LICA START MCP bias to 251; STOP MCP bias 185

Table G.3 -- HILT events

HILT Event Table

Time	Event
7/13/92 22:20:54	HILT hi res rate threshold set = 6
8/19/92	HILT door opens; HILT in-calibrate operations begin
10/6/92 18:11:09-	HILT cover cycled
11/1/92 18:12:25	HILT 1-sec quotas changed
11/6/92 20:47:52	HILT flow regulator valve opened
11/12/92 20:17:33	HILT flow regulator valve closed
10/7/92 18:07-	HILT cover cycled
12/23/92 14:49:10-14:51:44	HILT cover cycled
2/3/93 21:54:31-21:57:38	HILT cover cycled
3/11/93 21:34:37-21:37:03	HILT cover cycled
5/24/93 17:24:40-17:29:32	HILT cover cycled
7/3/93 12:56:33-12:59:14	HILT cover cycled
8/11/93 17:29:29	HILT cover closed for meteor shower
8/12/93 03:38:02	HILT cover opened-(took 2-3 hrs to open fully)
10/12/93 20:20:58-20:25:16	HILT cover cycled
12/14/93 11:23:42-11:26:18	HILT cover cycled
2/11/94 03:21:51-	HILT cover cycled
2/21/94 14:10-17:30	HILT gas off for leak test
3/1/94 20:50:42	HILT gas off for conservation
3/11/94 19:12:40	HILT off--turned on briefly every 3 days to check gas
3/25/94 19:03:20-21:29:49	HILT HRR packet changed (DPU patch 2.2) 20 ms for SSD1, 100 ms on HSSD4, (no HSSD2, HSSD3, HPCIK, HPCRE) Threshold: HSSD4 > 6 cts/ 100 ms
4/14/94 18:13:30	HILT cover cycled
5/17/94 13:58:29	HILT gas turned back on; calibrated operation began at ......
6/17/94 18:20:11	HILT SSD voltage & gas regulation disabled
7/19/94 23:58	HILT in calibrate operation begins (gas repressurized, and all detector bias in place)

continued

HILT Event Table, continued

Time	Event
8/25/94 20:08:27-21:00:44	HILT HRR packet changed (DPU patch 2.3) 30 ms for HSSD1, HPCRE (no HSSD2,3,4; HPCIK) Threshold: HPCRE > 6 cts / 30 ms
11/15/94 13:40:02	HILT cover cycled
1/3/95 16:51:55	HILT off--turned on briefly every few days to check gas
1/23/95 20:56:43	HILT in calibrate operation begins (gas repressurized, and all detector bias in place)
2/7/95 15:03:04	HILT cover cycled (open at 15:05:53)
2/9/95 22:17:30	HILT gas off for conservation/ power off on 2/10
3/17/95 12:53:16	HILT in calibrate operation begins (gas repressurized, and all detector bias in place)
3/24/95 07:17:07 - 19:17:31	HILT XILINX anomaly / reset / restart
4/11/95 17:11:28 - 17:14:17	HILT cover cycled
6/23/95 07:25:41 - 07:28:36	HILT cover cycled
7/31/95 21:19:21	HILT HV/gas off for conservation; pwr off 8/1
11/12/95 13:04:36	HILT in calibrate operation begins (gas repressurized, and all detector bias in place)
11/15/95 21:49:29	HILT High Voltages disabled due to pressure regulator temp out of range
2/22/96 14:44:01 - 16:47:02	HILT cover cycled (instr bias off)
3/4/96 18:02:58	HILT switched to high energy mode
4/22/96 13:11:21 - 13:14:13	HILT cover cycled
6/1/96 19:19:06	HILT switched out of high en mode inadvertently
6/2/96 01:16:29	HILT high energy mode resumed
8/2/96 01:01:24 - 01:04:05	HILT cover cycled
8/8/96 12:38	disable HILT sub com word for high res rates (test)
8/9/96 12:48 re-enabled	HILT sub com word
8/22/96 07:28	HILT on in high energy mode after S/C safehold
8/28/96 09:11	HILT HRR subcom disabled EXCEPT for 5 min around Wallops Daily Support pass; subcom to be enabled from AOS - 3 min to AOS + 2 min
9/27/96 17:20:55 - 17:23:44	HILT cover cycled

continued

HILT Event Table, continued

Time	Event
12/6/96 13:00:28 - 13:02:57	HILT cover cycled
2/2/97 02:09:07 - 02:11:56	HILT cover cycled
3/31/97 15:23:33 - 02:26:00	HILT cover cycled
5/29/97 12:33:22 - 12:36:02	HILT cover cycled
8/6/97 22:29:47 - 22:33:00	HILT cover cycled
9/20/97 16:11:32 - 16:14:47	HILT cover cycled
12/5/97 16:00:02 - 16:05:02	HILT cover cycled
1/28/98 18:01:06 - 18:04:28	HILT cover cycled
3/27/98 15:07:22 - 15:09:54	HILT cover cycled
5/28/98 18:09:44 - 18:12:02	HILT cover cycled
7/29/98 14:46:33 - 14:49:52	HILT cover cycled
9/23/98 13:40:15 - 13:43:08	HILT cover cycled
12/2/98 16:32:43 - 16:35:11	HILT cover cycled
1/27/99 20:20:50 - 20:24:06	HILT cover cycled
3/24/99 12:10:08 - 12:13:45	HILT cover cycled
5/19/99 17:34:57 - 17:37:53	HILT cover cycled
7/21/99 21:03:58 - 21:08:48	HILT cover cycled
9/10/99 12:54:56 - 12:57:30	HILT cover cycled
11/10/99 17:44:21 - 17:46:31	HILT cover cycled
12/05/99 ~14:40	Spacecraft safehold due to watchdog time out
12/09/99 18:30	S/C reconfiguration from safehold completed
12/25/99 20:20	Spacecraft safehold
12/28/99 23:30	S/C reconfiguration from safehold completed; 1 RPM
1/11/00 17:26:48 - 17:29:22	HILT cover cycled
3/15/00 (075) 13:25:56 - 13:28:29	HILT cover cycled
5/24/00 (145) 15:42:36 - 15:47:28	HILT cover cycled
7/19/00 (201) 19:08:52 - 19-11:26	HILT cover cycled
9/20/00 (264) 13:17:00 - 13-21:19	HILT cover cycled
11/15/00 (320) 15:56:05 - 16:01:06	HILT cover cycled
01/17/01 (017) 18:00:49 - 18:05:11	HILT cover cycled
05/16/01 (136) 15:06:45 - 18:27:12	HILT cover cycled (T1 line problem)
05/18/01 (138) 15:00:13 - 15:05:01	HILT cover cycled
07/18/01 (199) 17:34:32 - 17:39:02	HILT cover cycled
09/26/01 (269) 19:24:31 - 19:28:09	HILT cover cycled
11/28/01 (269) 17:22:05 - 17:26:57	HILT cover cycled
01/29/02 (029) 13:46:35 - 13:52:04	HILT cover cycled
03/19/02 (078) 20:50:31 - 20:54:51	HILT cover cycled
05/14/02 (134) 12:42:58 - 12:48:36	HILT cover cycled

continued

HILT Event Table, continued

Time	Event
07/09/02 (190) 16:31:16 - 16:35:47	HILT cover cycled
09/10/02 (253) 20:02:34 - 20:07:39	HILT cover cycled
11/12/02 (316) 17:56:38 - 18:01:46	HILT cover cycled
01/14/03 (014) 12:48:51 - 11:52:34	HILT cover cycled
03/12/03 (071) 18:43:35 - 18:49:33	HILT cover cycled
05/08/03 (128) 17:10:49 - 17-15:22	HILT cover cycled
07/09/03 (190) 13:40:15 - 13-44:19	HILT cover cycled
09/10/03 (253) 16:12:43 - 16:17:16	HILT cover cycled
11/21/03 (325) 18:36:40 - 18:40:23	HILT cover cycled
01/14/04 (014) 14:51:55 - 14:54:16	HILT cover cycled
03/12/04 (072) 14:56:53 - 15:01:09	HILT cover cycled
05/10/04 (131) 17:59:02 - 18:03:04	HILT cover cycled

Table G.4 -- MAST events

Note: MAST/PET routine power cyclings are NOT included below

MAST Event Table

Time	Event
7/5/92 11:32:07	MAST initial power on cmd word 2 initially set to FFFEAF5E
08/12/92 09:13	MAST off due to NEB shutdown (DPU reboot problem)
08/13/92 18:36	MAST on after NEB shutdown
09/02/92	MAST/PET power cycles begin
9/25/92 19:26:17	MAST cmd word 2 to FFFEAF7E Removed M4 from event coincidence requirement
11/12/92 20:19:51	Reinstated M4 requirement in event coincidence
5/5/93 02:13:47	Removed M4 from event coincidence requirement
10/02/93	MAST/PET LVPS 7.5 V reached upper yellow limit (7.57 V)
12/15/93	MAST/PET LVPS out of limits
12/19/93 10:45	adjust MAST/PET DPU memory quotas
12/22/93	NEB and MAST/PET LVPS noisy all day
2/8/94	MAST/PET power cycling from noon Tues-non Wed begins
4/1/94 20:56:57	MAST cmd to allow "hazard" events (wrd 1 C03A9FF8)
4/27/94 05:20:25	MAST cmd wrd 2 changed from FF FE AF 7E to FF FE EF 7E Removed M1 from the coincidence eqn for event storage.
5/5/94 04:59:48	MAST cmd wrd 2 changed from FF FE EF 7E to FF FE AF 7E (back to its default state)
5/17/94 02:06:47	MAST cmd wrd 2 changed from FF FE AF 7E to FF FE EF 7E (removes M1 from coincidence equation)
6/19/94 20:19	MAST **D4** is steadily noisy at around 10^4 cts/s after approximately this time
7/19/94 03:50:10	MAST command word 6 changed from 00 0f ff f8 to 00 0d ff f8 (disables the D4 ADC)

continued

MAST Event Table, continued

Time	Event
6/9/95 16:31:21	MAST command word 1 changed from c0 3a 9f f8 to c0 3f 0f f8 (modifies logic for Z2 rate and HIZ equation; enable HAZ event veto)
6/9/95 16:32:16	MAST command word 5 changed from 00 7f 58 68 to 00 6f 58 68 (disable D6L guard discr.)
6/13/95 12:19	MAST command word 1 changed from c0 3f 0f f8 to c0 3f 1f f8 (correct error in HAZ enable in command on 6/9/95 16:31:21)
7/1/95 18:37:42	MAST Command Word 1 Set To Default State (C0 3A 9F F8) out of ATS (after instrument calibrate sequence)
7/2/95 15:38:19	MAST Command Word 1 changed from C0 3A 9F F8 to C0 3F 1F F8
7/20/85 19:10:04	MAST Command Word 5 changed from 00 6f 58 68 to 00 7f 58 68 (enable D6L guard discr.)
10/24/95 13:41	MAST off due to analog safehold
10/26/95 19:55	MAST on and command state configured
8/20/96 ??:??	MAST power on after S/C safehold
8/23/96 02:27:35	MAST command words 1,2 updated after safehold
8/23/96 02:27:35	MAST command word 6 changed from 00 0F FF F8 to 00 0D FF F8 (disables D4 ADC)
9/1/96 07:13:10	MAST CALIBRATE sequence modified so that D4 ADC is also disabled during calibrate mode
11/7/97 14:54:24	MAST command word 6 to be changed from 00 0D FF F8 to 00 0D FF 38 (disables ADCs for M1 detector)
8/14-9/4/98	MAST/PET instrument power cycling near equator suspended for test purposes
9/15/98 13:42	Enable M-1 for 24 hour test
9/16/98 13:50	Disable M-1 after testing it for 24 hrs
9/17/98 13:57	Enable D-4 for 24 hour test per
9/18/98 14:05	Disable D-4 after testing it for 24 hour test
9/21/98 14:28	Attempt to re-enable M1 "permanently" (Mistakenly applied command event to Word2, resulting in garbled data)
9/22/98 02:51	Corrected the change made earlier at 264-14:28z to this word, by changing it to the settings requested by Jay Cummings (02:51z)
9/22/98 02:53	"Permanently" re-enabled M-1
3/25/99 13:54:47	MAST command word 1 (c2) changed from FF FE AF 5E to FF FE EF 5E (remove M-1 trigger requirement to pulse-height-analyze events)

continued

MAST Event Table, continued

Time	Event
12/05/99 ~14:40	Spacecraft safehold due to watchdog time out
12/09/99 18:30	S/C reconfiguration from safehold completed
12/25/99 20:20	Spacecraft safehold
12/28/99 23:30	S/C reconfiguration from safehold completed; 1 RPM
3/1/00 21:51	D7 fails (zero output); D7 and PEN rates = 0 after this time; HIZR6, HIZSUM, Z1R6, and Z2R6 rates all increase due to loss of anti-coincidence condition.

Table G.5 -- PET events

Note: MAST/PET routine power cyclings are NOT included below

PET Event Table

Time	Event
7/5/92 11:32:07	PET initial power on
7/7/92	Intermittent P3 crosstalk to guard begins
7/7/92 22:47:41	set PET HRR threshold to 6
7/11/92	PET ADC P4-7 fails
7/24/92 21:10:00	PET HRR threshold set to 8
08/12/92 09:13	PET off due to NEB shutdown (DPU reboot problem)
08/13/92 18:36	PET on after NEB shutdown
09/02/92	MAST/PET power cycle
12/2/92 17:28:16	PET command word 2 changed from 04F8FA3E to 04F8FB2E Substitute high guard for low guard anticoincidence
12/19/92 10:45	adjust MAST/PET DPU memory quotas
12/22/92 23:54:02	PET command word 2 changed from 04F8FB2E to 04F8FB7E Remove guard anticoincidence
1/23/93 2:46:27	PET command word 2 changed from 04F8FB7E to 04F8FB2E Reinstate high guard anticoincidence
03/31/93	LVPS noisy during 12 hour MAST turnoff. PET data no good
04/07/93	LVPS noisy during 12 hour MAST turnoff. PET data no good
5/18/93 19:39:26	increase PET HRR memory allocation to allow 100% coverage
7/10/93 21:41:36	set PET HRR threshold to 2
7/12/93 20:27:50	set PET HRR threshold to 1
9/23/93 19:38:22	PET command word 2 changed from 04F8FB2E to 0DF9FB3E Allow all P1 triggers to cause PHA events
10/02/93	MAST/PET LVPS 7.5 V reached upper yellow limit (7.57 V)
10/7/93 09:16:01	Changed PET 1-sec throttle to 10 events/sec
12/15/93	MAST/PET LVPS out of limits
12/22/93	NEB and MAST/PET LVPS noisy all day -PET data bad?

continued

PET Event Table, continued

Time	Event
2/8/94	MAST/PET power cycling from noon Tues-non Wed begins
3/5/94 23:03:12	PET cmd wrd 2 to 04F8FB3E Reinstate requirement for at least 2 detector triggers (No P1 only events)
10/24/95 13:41	PET off due to analog safehold
10/26/95 19:55	PET on and command state configured
8/20/96 ??:??	PET power on after S/C safehold
8/23/96 02:19	PET command words 2 updated after safehold
8/14-9/4/98	MAST/PET instrument power cycling near equator suspended for test purposes
9/21-22/98	see MAST log for garbled data period
1/14/99 22:01	PET cmd word 2 changed from 04 F8 FB 3E to 04 F8 FB 5E. This change allows PHA events in which the guards are triggered to be stored in the RNG buffer.
9/28/99 17:37	PET cmd word 2 changed from 04 f8 fb 5e to 04 f8 fb 68
12/05/99 ~14:40	Spacecraft safehold due to watchdog time out
12/09/99 18:30	S/C reconfiguration from safehold completed
12/25/99 20:20	Spacecraft safehold
12/28/99 23:30	S/C reconfiguration from safehold completed; 1 RPM

Table G.6 -- DPU events

<u>SEE APPENDIX M FOR MORE DETAILED DESCRIPTION OF DPU PATCHES</u>

(see also list of data loss times above due to SSR overflows)

DPU Event Table

Time	Event
7/4/92 21:22:20	DPU initial power on
08/12/92 09:13	NEB shutdown (DPU reboot problem)
08/13/92 18:36	MAST/PET on after NEB shutdown
2/21/94	New DPU Bootlist to RPP RAM
3/25/94 19:09:59	HILT HRR packet changed to mostly D1 (DPU mod)
8/25/94 21:00:34	HILT HRR packet changed to SSD1 & PCRE
5/31/94 20:18	DPU Time Command Error Count increments from 0 to 1
10/25/95 19:45	DPU reboot during patch load (safehold recovery)
10/26/95 16:50	DPU reconfiguration complete (safehold recovery)
1/31/96 12:35:52	DPU version 2.1 installed; thresh = 1; mostly D1
3/8/96 19:21:16	HILT 1-second quotas reduced from 5 to 1 for both HE1 and HE2
8/7/96 17:25	DPU patch version 2.4 loaded
8/20/96 ??:??	DPU power on (no patches!) after S/C safehold
8/23/96 10:01	DPU patch version 2.4 loaded after safehold
4/22/97 13:42:20	DPU set to version 4.0 (test of 1-s LICA rates in RS) note: rates garbled for ~4 min associated with transition to patch 4.0
4/22/97 22:12:50	DPU set back to version 3.9
10/9/97 17:06:45	DPU set to version 4.0 (1-s LICA rates in RS) note: rates garbled for ~4 min prior to this time associated with transition to new patch
10/9/97 17:06:45	DPU set to version 4.0 (1-s LICA rates in RS) note: rates garbled for ~4 min prior to this time associated with transition to new patch
3/16/98 00:00:00	DPU quotas / reallocations existing values: (units: 256 bytes; realloc every orbit) HILT LICA MAST PET Hilt HRR Pet HRR quota: 1877 3691 2953 1806 540 226 reall: 5 10 12 3 2 0
3/16/98 15:13:31	DPU quotas / reallocations adjusted to increase HRR HILT LICA MAST PET Hilt HRR Pet HRR quota: 1877 2851 2953 1806 1380 226 reall: 5 12 12 3 0 0

continued

DPU Event Table (continued)

Time	Event
12/05/99 ~14:40	Spacecraft safehold due to watchdog time out
12/09/99 18:30	S/C reconfiguration from safehold completed
12/25/99 20:20	Spacecraft safehold
12/28/99 23:30	S/C reconfiguration from safehold completed; 1 RPM

Appendix H - LICA rates at 1-second resolution

H.1 Introduction

The LICA instrument sends its singles rates to the SAMPEX DPU every second, where they are accumulated and reported as 6-second sums in the low resolution rate packets. In order to extract more information from these rates, DPU patch 4.0 (implemented on 10/9/97) appended the individual 1-second readouts for selected LICA rates to the existing low resolution rate packets, increasing their size from 90 to 144 bytes. This improved the time resolution of LICA by a factor of 6, and allowed more detailed studies of the pitch angle distributions of trapped and precipitating ions.

MDF generator versions 42 and above include the LICA 1-second rates in an additional structure: R7

H.2 The R7 Structure

The LICA 1-second rates are in the R7 structure, which is in data for MDF generator versions ≥ 42.

The 36 items are the 6 LICA rates read out 6 successive times:

D4+D3	readout # 1 + (n-1)*6
D2+D1	readout # 2 + (n-1)*6
Stop	readout # 3 + (n-1)*6
Start	readout # 4 + (n-1)*6
Low Pri	readout # 5 + (n-1)*6
High Pri	readout # 6 + (n-1)*6

where n is an index that labels the individual 1-second intervals that make up this low resolution rate packet: n=1, 2, 3, 4, 5, 6.

Appendix I -- Sample fortran program to read NGDF structures

Below is an example of VAX fortran code that reads an NGDF. The use of the term "set" in the structure definitions refers to the old "Tennis" format (see MDF Document for details).

Note: in the EP and EM structures ((§ 3.1.4 & 3.1.5)) there are single alignment bytes in the data files. These bytes can be specified in the VAX structure or not with no effect on operation.

From: shrikanth.kanekal@lasp.colorado.edu
Subject: **NGDF structures**
Date: August 8, 2006 5:03:28 PM EDT

```
C
C
         PROGRAM NGDF_TEST
C
C      READ GDF'S TO TEST THEM
C
      IMPLICIT NONE
C
C      RS SET STRUCTURE          17-JAN-95 S.K
C
      STRUCTURE  /SETRS/
                INTEGER*4 STIME
                INTEGER*2 SUBCOM_RS,

    &                    HILT_HE1,
    &                    HILT_HE2,
    &                    HILT_HZ1,
    &                    HILT_HZ2,
    &                    HILT_MUX1,
    &                    HILT_MUX2,
    &                    HILT_IDL1,
    &                    HILT_IDL2,

    &                    LICA_L4,
    &                    LICA_L3,
    &                    LICA_L2,
    &                    LICA_L1,
    &                    LICA_TRPL,
    &                    LICA_DOBL,
    &                    LICA_STOP,
    &                    LICA_STRT,
    &                    LICA_IFC,
```

```
     &                  LICA_PRTN,
     &                  LICA_LOWP,
     &                  LICA_HIP,

     &                  MAST_Z1SEC,
     &                  MAST_ADC,
     &                  MAST_LIVE,
     &                  MAST_PEN,
     &                  MAST_Z1,
     &                  MAST_Z2,
     &                  MAST_HIZR0,
     &                  MAST_HIZR1,
     &                  MAST_HIZR2,
     &                  MAST_HIZR3,
     &                  MAST_HIZR4,
     &                  MAST_HIZR5,
     &                  MAST_HIZR6,
     &                  MAST_RAT17,
     &                  MAST_RAT16,
     &                  MAST_RAT18,
     &                  MAST_Z1RX,
     &                  MAST_Z2RX,

     &                  PET_PHI,
     &                  PET_EHI,
     &                  PET_PLO,
     &                  PET_ELO,
     &                  PET_EWG,
     &                  PET_LIVE,
     &                  PET_PEN,
     &                  PET_RNG,
     &                  PET_MUX1,
     &                  PET_MUX2

      END STRUCTURE

      RECORD /SETRS/ RS
c
c  LICA additions R6 and R7
c
      STRUCTURE  /SET1/
              INTEGER*4 STIME

              REAL*4    PITCH,
     &                  ZENITH,
     &                  AZIMUTH,
     &                  Q_SCND
```

```
      END STRUCTURE

      RECORD /SET1/ R6

      STRUCTURE  /SET2/
              INTEGER*4 STIME

              INTEGER*2 LICA_1SEC(6,6)

      END STRUCTURE

      RECORD /SET2/ R7
C
C      PS SET STRUCTURE
C
      STRUCTURE /SETPS/
       INTEGER*4    STIME,
   &                ORBIT
       INTEGER*2    MVERS
         REAL*4    GEO_POS(3),
   &                GEI_POS(3),
   &                GEI_VEL(3),
   &                ECD_POS(3),
   &                DIR_COS(9),
   &                ALTITUDE,
   &                IDOT,
   &                ECD_LOCTIM,
   &                LSHEL,
   &                BMAG,
   &                MLT,
   &                INVLAT,
   &                PITCH,
   &                LOSCON1,
   &                LOSCON2,
   &                B_CART(3),
   &                B_SPHE(3),
   &                DIPOL1(3),
   &                DIPOL2(3),
   &                DECLIN,
   &                DIP,
   &                MAGRAD,
   &                MAGLAT,
   &                G_MIRROR(3),
   &                BEQU(4),
   &                BN100(4),
   &                BS100(4),
```

```
    &              CUTOFF,
    &              SAAF,
    &              ZENITH,
    &              AZIMUTH,
    &              ACS
      END STRUCTURE

      RECORD /SETPS/ PS
C
C     RP SET STRUCTURE 17-JAN-95 S.K
C
      STRUCTURE  /SETRP/
               INTEGER*4 STIME

                 BYTE   PET_HIRES(480)

      END STRUCTURE

      RECORD /SETRP/ RP

C
C     EP SET STRUCTURE 17-JAN-95 S.K
C
      STRUCTURE  /SETEP/
               INTEGER*4 STIME
               INTEGER*4 SEQ_NO
                 BYTE   OFFSET_TIME
               INTEGER*2 ADC(4)
                 BYTE   MODE_FLag,
    &                   DISC_FLAG
      END STRUCTURE

      RECORD /SETEP/ EP
C
C   RH SET STRUCTURE 17-JAN-95 S.K
C
      STRUCTURE  /SETRH/
               INTEGER*4 STIME

                 BYTE   SSD1(60),
    &                   SSD2(60),
    &                   SSD3(60),
    &                   SSD4(60),
    &                   PCRE(60),
    &                   IK(60)
      END STRUCTURE
```

```
      RECORD /SETRH/ RH

      STRUCTURE  /SETEL/
            INTEGER*4 STIME
              BYTE   LICA_EVT(15)
      END STRUCTURE

      RECORD /SETEL/ EL

      STRUCTURE  /SETEM/
            INTEGER*4 STIME
            INTEGER*4 SEQ_NO
              BYTE   OFFSET_TIME,
     &                  DET_FLAG,
     &                  EVT_FLAG
            integer*2 MAST_EVT(14)
      END STRUCTURE

      RECORD /SETEM/ EM

      STRUCTURE  /SETEH/
            INTEGER*4 STIME

              BYTE   HILT_EVT(14)
      END STRUCTURE

      RECORD /SETEH/ EH

      STRUCTURE  /SETas/
            INTEGER*4 STIME
              REAL*4 QUATER_X,
     &                  QUATER_Y,
     &                  QUATER_Z,
     &                  QUATER_S
      END STRUCTURE

      RECORD /SETas/ AS

      STRUCTURE  /SETMF/
            INTEGER*4 STIME

            INTEGER*2 COUNT_X,
     &                  COUNT_Y,
     &                  COUNT_Z
      END STRUCTURE

      RECORD /SETMF/ MF
```

```
      STRUCTURE  /SETHS/
              INTEGER*4 STIME
                 BYTE HILT(26),
     &                  LEICA(16),
     &                  MAST_PET(16),
     &                  GAME5(22)
      END STRUCTURE

      RECORD /SETHS/ HS
      STRUCTURE  /SETSB/
              INTEGER*4 STIME
              BYTE      CHARGE_STATE,
     &                  UNDER_VOLTAGE,
     &                  SAFE_HOLD,
     &                  SPARE
              INTEGER*2 BATT_CURR_MON,
     &                  SHNT_CURR_MON,
     &                  BUSN_CURR_MON,
     &                  SLRA_CURR_MON,
     &                  BATT_VOLT_MON,
     &                  BATT_TOP_TEMP_MON,
     &                  BATT_BASE_TEMP_MON,
     &                  MNBS_VOLT_MON
      END STRUCTURE

      RECORD /SETSB/ SB

      STRUCTURE  /SETSP/
              INTEGER*4 STIME
              BYTE      HILT_APWR,
     &                  LEICA_APWR,
     &                  HILT_PPWR,
     &                  LEICA_PPWR,
     &                  MAST_PET_BPWR,
     &                  OPHTR_PWR,
     &                  SRHTR_PWR,
     &                  SPARE
              INTEGER*2 PD_PCU_REF,
     &                  SPAREW
      END STRUCTURE

      RECORD /SETSP/ SP

      STRUCTURE  /SETST/
              INTEGER*4 STIME
                 BYTE TP_STAT,
```

```
    &                   SPARE
                  INTEGER*2 LO_SCTEMP,
    &                   HI_SCTEMP,
    &                   INST_BUS_TEMP,
    &                   HILT(6),
    &                   LEICA(2),
    &                   MAST_PET(4),
    &                   DPU(2)
      END STRUCTURE

      RECORD /SETST/ ST

C
=================================================================
=========
C
      INTEGER*4
INP,NUMPS,NUMRS,NUMRH,NUMEP,NUMRP,NUMOT,NUMR6,NUMR7
      INTEGER*4    NUMEH,NUMEL,NUMEM,NUMAS,NUMMF
      INTEGER*4    NUMHS,NUMSB,NUMSP,NUMST
      INTEGER*4    OUTP

      CHARACTER*2  SET_NAME
      CHARACTER*32 FIN
      CHARACTER*14 FOUT

      DATA      INP/10/,OUTP/11/
      DATA      FIN  /'$GDF:[AERO.ARCHIVE]NGDF04182.H00'/

      DATA      FOUT /'NGDF04182.TEST'/
C
      OPEN(UNIT=INP,FILE=FIN,
    &     STATUS='OLD',FORM='UNFORMATTED',
    &     DISP='KEEP',READONLY)

      OPEN(UNIT=OUTP,FILE=FOUT,STATUS='NEW',
    &      FORM='FORMATTED',DISP='KEEP')

 100    READ(UNIT=INP,END=997,ERR=998)SET_NAME

       IF(SET_NAME .EQ . 'PS') THEN
         READ(UNIT=INP,END=997,ERR=998)PS
         NUMPS = NUMPS + 1
       ELSE IF(SET_NAME .EQ . 'RS')THEN
         READ(UNIT=INP,END=997,ERR=998)RS
         NUMRS = NUMRS + 1
       ELSE IF(SET_NAME .EQ . 'R6')THEN
```

```
            READ(UNIT=INP,END=997,ERR=998)R6
            NUMR6 = NUMR6 + 1
         ELSE IF(SET_NAME .EQ . 'R7')THEN
           READ(UNIT=INP,END=997,ERR=998)R7
           NUMR7 = NUMR7 + 1
C             WRITE(OUTP,*)R7.STIME,R7.LICA_1SEC(1,1),
C     &       R7.LICA_1SEC(1,2),R7.LICA_1SEC(1,3),R7.LICA_1SEC(1,4),
C     &       R7.LICA_1SEC(1,5),R7.LICA_1SEC(1,6)
         ELSE IF(SET_NAME .EQ . 'RP')THEN
           READ(UNIT=INP,END=997,ERR=998)RP
           NUMRP = NUMRP + 1
         ELSE IF(SET_NAME .EQ . 'EP')THEN
           READ(UNIT=INP,END=997,ERR=998)EP
           NUMEP = NUMEP + 1
         ELSE IF(SET_NAME .EQ . 'RH')THEN
           READ(UNIT=INP,END=997,ERR=998)RH
           NUMRH = NUMRH + 1
         ELSE IF(SET_NAME .EQ . 'EH')THEN
           READ(UNIT=INP,END=997,ERR=998)EH
           NUMEH = NUMEH + 1
         ELSE IF(SET_NAME .EQ . 'EL')THEN
           READ(UNIT=INP,END=997,ERR=998)EL
           NUMEL = NUMEL + 1
         ELSE IF(SET_NAME .EQ . 'EM')THEN
           READ(UNIT=INP,END=997,ERR=998)EM
           NUMEM = NUMEM + 1
         ELSE IF(SET_NAME .EQ . 'AS')THEN
           READ(UNIT=INP,END=997,ERR=998)AS
           NUMAS = NUMAS + 1
         ELSE IF(SET_NAME .EQ. 'MF')THEN
           READ(UNIT=INP,END=997,ERR=998)MF
           NUMMF = NUMMF + 1

         ELSEIF(SET_NAME .EQ. 'HS')THEN
           READ(UNIT=INP,END=997,ERR=998)HS
           NUMHS = NUMHS + 1
           WRITE(OUTP,*)' SET HS ',HS.STIME
           WRITE(OUTP,*)HS
         ELSE IF(SET_NAME  .EQ. 'SB')THEN
           READ(UNIT=INP,END=997,ERR=998)SB
           NUMSB = NUMSB + 1
           WRITE(OUTP,*)' SET SB ',SB.STIME
           WRITE(OUTP,*)SB
         ELSE IF(SET_NAME   .EQ. 'SP')THEN
           READ(UNIT=INP,END=997,ERR=998)SP
           NUMSP = NUMSP + 1
           WRITE(OUTP,*)' SET SP ',SP.STIME
```

```
        WRITE(OUTP,*)SP

      ELSE IF(SET_NAME.EQ. 'ST')THEN
        READ(UNIT=INP,END=997,ERR=998)ST
        NUMST = NUMST + 1
        WRITE(OUTP,*)' SET ST ',ST.STIME
        WRITE(OUTP,*)ST
      ELSE
       READ(UNIT=INP,END=997,ERR=998)
       NUMOT = NUMOT + 1
      END IF

      GO TO 100

997   CONTINUE

      WRITE(6,*)' ====================================== '
      WRITE(6,*)'      INPUT FILE   ',FIN
      WRITE(6,*)
      WRITE(6,*)' NUMBER PS ',NUMPS
      WRITE(6,*)' NUMBER RS ',NUMRS
      WRITE(6,*)' NUMBER R6 ',NUMR6
      WRITE(6,*)' NUMBER R7 ',NUMR7
      WRITE(6,*)' NUMBER RP ',NUMRP
      WRITE(6,*)' NUMBER EP ',NUMEP
      WRITE(6,*)' NUMBER EH ',NUMEH
      WRITE(6,*)' NUMBER EL ',NUMEL
      WRITE(6,*)' NUMBER EM ',NUMEM
      WRITE(6,*)' NUMBER RS ',NUMRH
      WRITE(6,*)' NUMBER AS ',NUMAS
      WRITE(6,*)' NUMBER MF ',NUMMF
      WRITE(6,*)' NUMBER HS ',NUMHS
      WRITE(6,*)' NUMBER SB ',NUMSB
      WRITE(6,*)' NUMBER SP ',NUMSP
      WRITE(6,*)' NUMBER ST ',NUMST
      WRITE(6,*)' NUMBER OT ',NUMOT

      STOP

998   WRITE(6,*)'ERROR READING SET ',SET_NAME

999   STOP
      END
```

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Appendix J -- Sample IDL program to read NGDF structures

Below is an IDL code that reads an NGDF.

```
; $Id$
; Author: Glenn Hamell, Andrew Davis
; NAME: read_ngdf.pro
;
; CALLING SEQUENCE:  read_ngdf <input_filename>
;
; PURPOSE:
;    Reads each record of an NGDF file, outputs some stats.
;
; INPUT:
;      Command line:
;           Full path to input file
;
; OUTPUT: some simple stats on number of sets found

;
; RETURN:
;
;
; MODIFICATION HISTORY:
; =====================
; 2006Sep27-Andrew Davis Created, from Glenn Hamell's XDR
generation program
;
;################################################;

;============  RDNXTDELIMITER  ===================

FUNCTION rdNxtDelimiter, fin, s1, s2

s1=0B
s2=0B
WHILE( NOT EOF( fin )) DO BEGIN
    READU, fin, s1
    IF( EOF( fin )) THEN BEGIN
        BREAK
    ENDIF
    READU, fin, s2

    IF(( s1 EQ '03'X ) AND ( s2 EQ '00'X )) THEN BEGIN
        RETURN, 0                  ; normal return
    ENDIF
ENDWHILE
RETURN, -1                         ; return when EOF found
END
```

```
;- - - - - - - - end rdNxtDelimiter - - - - - - - - - - -


; = = = = = = = =  rd_2bytes  = = = = = = = = = = =

FUNCTION rd_2bytes, fin, s1, s2
  s1 = 0B
  s2 = 0B
  READU, fin, s1, s2
 RETURN, 0
END
;- - - - - - - -  end rd_2bytes  - - - - - - - - - - -



;
***********************************************************
***********
;+
; NAME: Setup_GDF_rcds
;
; PURPOSE:
;       Define the structure for all record sets as sub-
structures.
;
; MODIFICATION HISTORY:
; Created: Glenn R. Hamell, 09 August 2000.
; 2000 Aug 10 - GRHamell - Added an alignment byte to EM
struct definition.
; 2000-12-01 - ALabrador - EP struct - Changed ADC from
intarr to uintarr (unsigned)
; 2000-12-04 - ALabrador - EP struct - Changed ADC back to
intarr, added alignment
;         byte, as per Rick Leske's recommendation.
; 2006-08-28 - ADavis - added HS, SB, SP, ST sets.
; 2006-09-27 - ADavis - added alignment byte at end of EL
struct, and two spare
;         bytes at end of EH and MF structs.
;-
;
***********************************************************
******************
FUNCTION Setup_GDF_rcds

tmp = {  $

rsset :
{rssetstruct,STIME:0l,SUBCOM_RS:0,HILT_HE1:0,HILT_HE2:0, $
     HILT_HZ1:0,HILT_HZ2:0,HILT_MUX1:0,HILT_MUX2:0,HILT_IDL
1:0, $
```

```
     HILT_IDL2:0,LICA_L4:0,LICA_L3:0,LICA_L2:0,LICA_L1:0,LI
CA_TRPL:0, $
     LICA_DOBL:0,LICA_STOP:0,LICA_STRT:0,LICA_IFC:0,LICA_PR
TN:0, $
     LICA_LOWP:0,LICA_HIP:0,MAST_Z1SEC:0,MAST_ADC:0,MAST_LI
VE:0, $
     MAST_PEN:0,MAST_Z1:0,MAST_Z2:0,MAST_HIZR0:0,MAST_HIZR1
:0, $
     MAST_HIZR2:0,
MAST_HIZR3:0,MAST_HIZR4:0,MAST_HIZR5:0,MAST_HIZR6:0, $
     MAST_RAT17:0,MAST_RAT16:0,MAST_RAT18:0,MAST_Z1RX:0,MAS
T_Z2RX:0, $
     PET_PHI:0,PET_EHI:0,PET_PLO:0,PET_ELO:0,PET_EWG:0,PET_
LIVE:0, $
     PET_PEN:0,PET_RNG:0,PET_MUX1:0,PET_MUX2:0} $
,r6set :
{r6setstruct,STIME:0l,PITCH:0.,ZENITH:0.,AZIMUTH:0.,Q_SCND:
0.} $
,r7set : {r7setstruct,STIME:0l,LICA_1SEC:intarr(6,6)} $
,psset :
{pssetstruct,STIME:0l,ORBIT:0l,MVERS:0,dum:0,GEO_POS:fltarr
(3), $
     GEI_POS:fltarr(3),GEI_VEL:fltarr(3),ECD_POS:fltarr(3),
$
     DIR_COS:fltarr(9),ALTITUDE:0.,IDOT:0.,ECD_LOCTIM:0.,LS
HEL:0., $
     BMAG:0.,MLT:0.,INVLAT:0.,PITCH:0.,LOSCON1:0.,LOSCON2:0
., $
     B_CART:fltarr(3),B_SPHE:fltarr(3),DIPOL1:fltarr(3),DIP
OL2:fltarr(3), $
     DECLIN:0.,DIP:0.,MAGRAD:0.,MAGLAT:0.,G_MIRROR:fltarr(3
), $
     BEQU:fltarr(4),BN100:fltarr(4),BS100:fltarr(4),CUTOFF:
0.,SAAF:0., $
     ZENITH:0.,AZIMUTH:0.,ACS:0.} $
,rpset : {rpsetstruct,STIME:0l,PET_HIRES:bytarr(480)} $
,epset :
{epsetstruct,STIME:0l,SEQ_NO:0l,OFFSET_TIME:0b,spare:0b, $
     ADC:intarr(4),MODE_FLAG:0b,DISC_FLAG:0b} $
,rhset :
{rhsetstruct,STIME:0l,SSD1:bytarr(60),SSD2:bytarr(60), $
     SSD3:bytarr(60),SSD4:bytarr(60),PCRE:bytarr(60),IK:byt
arr(60)} $
,ehset : {ehsetstruct,STIME:0l,HILT_EVT:bytarr(14),
spare1:0b, spare2:0b} $
,elset : {elsetstruct,STIME:0l,LICA_EVT:bytarr(15),
spare:0b} $
,emset :
{emsetstruct,STIME:0l,SEQ_NO:0l,OFFSET_TIME:0b,DET_FLAG:0b,
$
     EVT_FLAG:0b,Alignment:0b,MAST_EVT:intarr(14)} $
```

```
,asset :
{assetstruct,STIME:0l,QUATER_X:0.,QUATER_Y:0.,QUATER_Z:0.,Q
UATER_S:0.} $
,mfset :
{mfsetstruct,STIME:0l,COUNT_X:0,COUNT_Y:0,COUNT_Z:0,spare1:
0b, spare2:0b} $
,dsset :
{dssetstruct,STIME:0l,HILT_XILNX:0,VALVE_HV:0,SEC_QUOTA:0,
$
     HILT_EVTQ:0,LICA_EVTQ:0,MAST_EVTQ:0,PET_EVTQ:0,HILT_HR
SQ:0, $
     PET_HRSQ:0,DPU_COMCNT:0,DPU_CERCNT:0,DPU_TIMCNT:0,DPU_
TERCNT:0, $
     PROM_CHKSM:0,HILT_DSTAT:0b,HILT_ISTAT:0b,HILT_PGCNT:0b
,HILT_PAGE1:0b, $
     HILT_PAGE2:0b,HILT_PAGE3:0b,HILT_PAGE4:0b,HILT_PAGE5:0
b, $
     HILT_PAGE6:0b,HILT_PAGE7:0b,WDOG_ERCNT:0b,XILN_ERCNT:0
b, $
     XINT_PLCNT:0b,XPWR_PLCNT:0b,LICA_STAT1:0b,LICA_STAT2:0
b, $
     FIX_VAL:0b,CAL_BIT6:0b,MAST_STAT:0b,PET_STAT:0b,LVPS_S
TAT:0b, $
     DPU_STAT:0b,DPU_VERSION:0b,DPU_RAM_PGCNT:0b,DPU_RAM_PA
GE1:0b, $
     DPU_RAM_PAGE2:0b,DPU_RAM_PAGE3:0b,DPU_RAM_PAGE4:0b,DPU
_RAM_PAGE5:0b, $
     DPU_RAM_PAGE6:0b,DPU_RAM_PAGE7:0b,ANALOG_OSC:0b,MAST_C
OM1:bytarr(5), $
     MAST_COM2:bytarr(5),MAST_COM3:bytarr(5),MAST_COM4:byta
rr(5), $
     MAST_COM5:bytarr(5),MAST_COM6:bytarr(5),PET_COM1:bytar
r(5), $
     PET_COM2:bytarr(5),PET_COM3:bytarr(5),CONFIG:0b} $
,hsset :
{hssetstruct,STIME:0l,HILT:bytarr(26),LEICA:bytarr(16), $
     MAST_PET:bytarr(16),GAME5:bytarr(22)} $
,sbset :
{sbsetstruct,STIME:0l,CHARGE_STATE:0b,UNDER_VOLTAGE:0b,SAFE
_HOLD:0b, $

     SPARE:0b,BATT_CURR_MON:0,SHNT_CURR_MON:0,BUSN_CURR_MON
:0, $
     SLRA_CURR_MON:0,BATT_VOLT_MON:0,BATT_TOP_TEMP_MON:0, $
     BATT_BASE_TEMP_MON:0,MNBS_VOLT_MON:0} $
,spset :
{spsetstruct,STIME:0l,HILT_APWR:0b,LEICA_APWR:0b,HILT_PPWR:
0b, $

     LEICA_PPWR:0b,MAST_PET_BPWR:0b,OPHTR_PWR:0b,SRHTR_PWR:
0b,SPARE:0b, $
```

```
     PD_PCU_REF:0,SPAREW:0} $
,stset :
{stsetstruct,STIME:0l,TP_STAT:0b,SPARE:0b,LO_SCTEMP:0,HI_SC
TEMP:0, $

     INST_BUS_TEMP:0,HILT:intarr(6),LEICA:intarr(2),MAST_PE
T:intarr(4), $
     DPU:intarr(2)} $
      }

RETURN, tmp

END


; MAIN PROGRAM
PRO read_ngdf, filein

; OPEN INPUT FILE
OPENR, fin,  filein,  /GET_LUN, /VAX_FLOAT

s1 = 0B        ; Prepare for detecting 2-byte delimiter
s2 = 0B

; Establish NGDF data set structures
gdf = Setup_GDF_rcds()

rsset = gdf.rsset
r6set = gdf.r6set
r7set = gdf.r7set
psset = gdf.psset
rpset = gdf.rpset
epset = gdf.epset
rhset = gdf.rhset
elset = gdf.elset
emset = gdf.emset
ehset = gdf.ehset
asset = gdf.asset
mfset = gdf.mfset
dsset = gdf.dsset
hsset = gdf.hsset
sbset = gdf.sbset
spset = gdf.spset
stset = gdf.stset

nps = 0
nunknown = 0

; PROCESS EACH RECORD

WHILE( NOT EOF( fin ) ) DO BEGIN
```

```
    ; Read data set ID of next record

    ; Read past next delimiter or until EOF is encountered
    IF( rdNxtDelimiter( fin, s1, s2 ) NE 0 ) THEN BREAK

    IF( EOF( fin ) ) THEN BREAK     ; if EOF found, exit
the WHILE loop

    s1='x'
    s2='x'
    rtn=rd_2bytes( fin, s1, s2 )      ; next 2bytes should
be a data set ID
    sname = STRING( s1 ) + STRING( s2 )

    ;  Make certain the next two bytes are also a delimiter
    IF( EOF( fin ) ) THEN BREAK
    rtn = rd_2bytes( fin, s1, s2 )
    IF(( s1 NE 3B ) OR ( s2 NE 0B )) THEN BEGIN
        CONTINUE
    ENDIF

    ; READ SET, and maybe do something useful...

    CASE STRUPCASE( sname ) OF
       'PS': BEGIN
        readu,  fin,  psset
        nps = nps + 1
           END
       'RS': BEGIN
        readu,  fin,  rsset
           END
       'R6': BEGIN
        readu,  fin,  r6set
           END
       'R7': BEGIN
        readu,  fin,  r7set
           END
       'RH': BEGIN
        readu,  fin,  rhset
           END
       'EP': BEGIN
        readu,  fin,  epset
           END
       'RP': BEGIN
        readu,  fin,  rpset
          END
       'EH': BEGIN
        readu,  fin,  ehset
           END
       'EL': BEGIN
        readu,  fin,  elset
```

```
           END
       'EM': BEGIN
        readu,  fin,  emset
           END
       'AS': BEGIN
        readu,  fin,  asset
        print, asset.STIME, asset.QUATER_S
           END
       'MF': BEGIN
        readu,  fin,  mfset
           END
       'DS': BEGIN
        readu,  fin,  dsset
           END
       'HS': BEGIN
        readu,  fin,  hsset
           END
       'SB': BEGIN
        readu,  fin,  sbset
           END
       'SP': BEGIN
        readu,  fin,  spset
           END
       'ST': BEGIN
        readu,  fin,  stset
           END
       ELSE: BEGIN
           nunknown = nunknown + 1
       END
   ENDCASE

ENDWHILE      ;  end loop (PROCESSING NEXT RCRD TILL EOF)

print, "Number of PS sets found:", nps
print, "Number of unknown sets found:", nunknown

CLOSE, /ALL

EXIT

END
;------  end  main  ------------------------;
```