Document No. STEREO-CIT-009.A

Low Energy Telescope
Interface Control Document
for the
Solar Energetic Particle
Central Electronics

LET-SEP_Central ICD

Revision A

March 19, 2003

Prepared by Branislav Kecman

Approval signatures:

_____

Alan Cummings, LET Project Manager Date

_____

Mark Wiedenbeck, LET Co-Investigator Date

_____

Dean Aalami, Bias Supply Designer Date

_____

Peter Berg, SEP LVPS Designer Date

_____

Dave Curtis, IMPACT Project Manager Date

_____

John Hawk, SEP Thermal Engineer Date

_____

Allan Labrador, LET Science Format Developer Date

_____

Walter Cook, LET/SEP System Engineer Date

_____

Andrew Davis, LET/SEP_Central Software Developer Date

_____

Branislav Kecman, LET/SEP_Central Cog. Engineer Date

Table of Contents:

Section and Title	Page
1. Scope and Revision History	4
2. Applicable Documents	4
3. Command Interface	4
A. Transfer of commands from SEP_Central to LET	5
B. Transfer of command responses from LET to SEP_Central	6
C. Transfer of frame sync pulses from SEP_Central to LET	7
D. Transfer of reset pulses from SEP_Central to LET	8
E. Transfer of boot code from SEP_Central to LET	8
4. Data Interface	9
5. Discrete Signal Interface	11
6. Power Interface	12
7. Heaters	14
8. Appendices	
8.1 LET-SEP_Central I/F Schematic . . .	15
8.2 SEP Grounding Diagram	16
8.3 SEP Harness Diagram	17
8.4 CCSDS Telemetry Packet Format . . .	18
8.5 SEP Detector Leakage Current Table . . .	19
8.6 SEP Power Flow Diagram	21

1. Scope and Revision History

This document describes electrical hardware interfaces and timing protocols for commands, data, discrete and power signals between the LET sensor and SEP central electronics (SEP_Central) as part of the SEP/IMPACT suite aboard each of the two STEREO spacecraft.
For details on software-related aspects of the LET-SEP_Central interface see the reference document 2.2.

The interfaces are conducted via internal unshielded rigid-flex harness that is 20 cm (8") long and terminated on the SEP_Central side by a Nanonics 51-pin, 2-row dualobe plug connector, as shown in Appendix 8.1. Pin redundancy is not mandatory, yet highly desirable.

Rev.	Date	Description
-	10/25/02	Initial release
A	03/19/03	Update Power Interface and Apendices (I/F schematic, harness and power flow diagrams)

2. Applicable Documents

2.1 STEREO Mission Operations Center (MOC) to Payload Operations Center (POC) and to STEREO Science Center (SSC) Interface Control Document (ICD)
APL Drawing No. 7381-9045, Rev. A
http://sprg.ssl.berkeley.edu/impact/dwc/ICD/MOC-POC ICD 07-10-2002.pdf

2.2 SEP Commanding and Users Manual Document No. STEREO-CIT-007.A
ftp://mussel.srl.caltech.edu/pub/stereo/docs/SEP_CommandingUserManual_A.pdf

2.3 Interface Control Document (ICD) for the IMPACT Investigation
APL Drawing No. 7381-9012, Rev. B, available at APL STEREO website

2.4 IMPACT LVPS Requirements, Rev. C
http://sprg.ssl.berkeley.edu/impact/dwc/ICD/LVPSRequirements_C.pdf

3. Command Interface

The Command Interface shall be used to transfer the following:

A. Commands from SEP_Central to LET . . . 3.1 – 3.2.1
B. Command responses from LET to SEP_Central . . 3.3 – 3.4.1
C. Frame sync pulses from SEP_Central to LET . . 3.5 – 3.6.1
D. Reset pulses from SEP_Central to LET . . . 3.7 – 3.8.1
E. Boot code from SEP_Central to LET . . . 3.9

A. Transfer of commands from SEP_Central to LET

3.1 Protocol. Transfer of commands from SEP_Central to LET shall take place according to the Serial Data/Command Protocol shown in Figure 1 below.

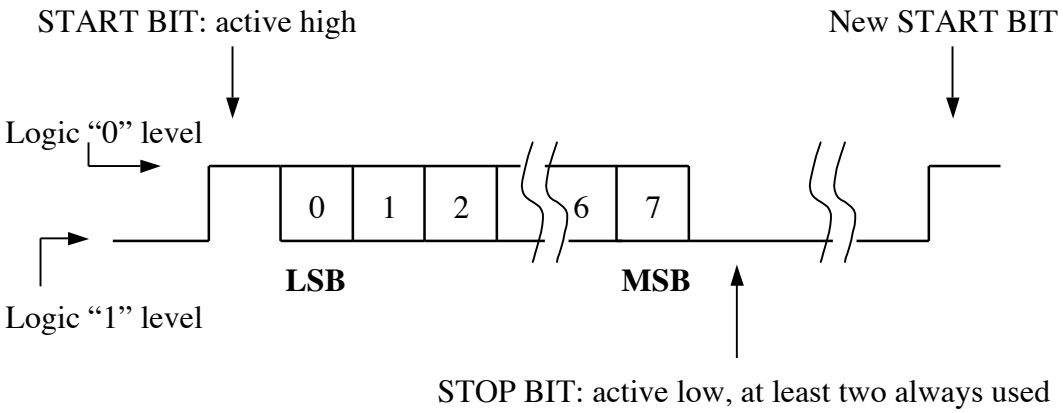


Figure 1 - Serial Data/Command Protocol
(Signal polarity shown at interface connector pins)

Note: Nominal baud rate = 57.6 kbaud
High baud rate was chosen to allow boot code transfer in a reasonably short time.

Actual rate on LET side = 57.97101 kbaud - generated from 32 MHz / (8*69)

Actual rate on SEP_Central side = 57.14286 kbaud - from 16 MHz / (8*35)

Difference in actual baud rates shall be within 2 %. In this case it is less than 1.5 %.

3.2 Signal Description.

3.2.1 LET CMD IN*. This 0 to +5 V digital signal is used to transfer commands from SEP_Central to LET. SEP_Central shall generate this signal. Its return line is LET MSTR RTN, which is tied to the signal ground (local chassis) on the SEP_Central side, while on the LET side it is separated from the local signal ground (local chassis) by 50 Ω. See Appendix 8.1 for details of the I/F schematic.

B. Transfer of command responses from LET to SEP_Central

3.3 Protocol. Transfer of command responses from LET to SEP_Central shall take place according to the Serial Data/Command Protocol described in Figure 1 and Section 3.1.

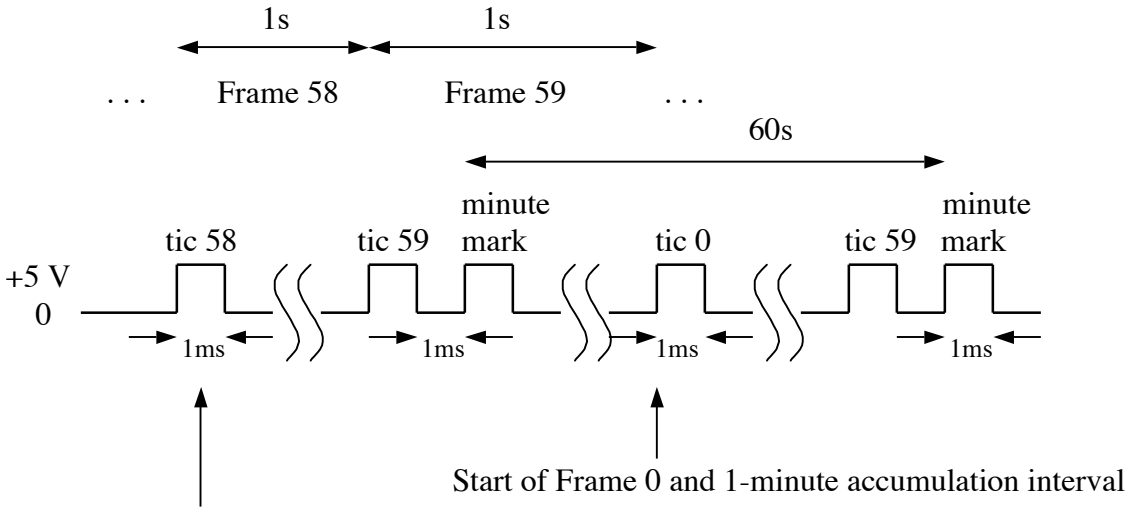
Note: In case of extremely long command responses (e.g., command table dump or memory dump) LET shall throttle the transfer rate of command responses so that SEP_Central buffer is not saturated.

3.4 Signal Description.

3.4.1 LET CMD OUT*. This 0 to +5 V digital signal is used to transfer command responses from LET to SEP_Central. LET shall generate this signal. Its return line is LET SUB RTN, which is tied to the signal ground (local chassis) on the LET side, while on the SEP_Central side it is separated from the local signal ground (local chassis) by 50 Ω. See Appendix 8.1 for details of the I/F schematic.

C. Transfer of frame sync pulses from SEP_Central to LET

3.5 Protocol. Transfer of frame sync pulses from SEP_Central to LET shall take place according to the Frame Sync Protocol shown in Figure 2 below.



FRAME SYNC: active high, 1s period, nominally 1ms long; double-pulsed every 60s to provide the 1-minute mark

Figure 2 – Frame Sync Protocol
(Signal polarity shown at interface connector pins)

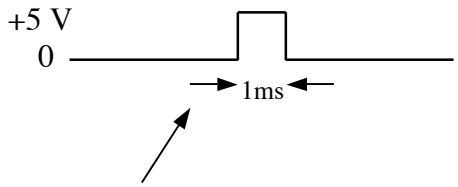
Note: Tic 0 follows the 1-minute mark by ~1 second and marks the beginning of Frame 0 as well as the beginning of 1-minute accumulation interval for LET.

3.6 Signal Description.

3.6.1 LET FRAME SYNC. This 0 to +5 V digital signal is used to transfer a frame-synchronizing signal from SEP_Central to LET. SEP_Central shall generate this signal. Its return line is LET MSTR RTN, which is tied to the signal ground (local chassis) on the SEP_Central side, while on the LET side it is separated from the local signal ground (local chassis) by 50 Ω. See Appendix 8.1 for details of the I/F schematic.

D. Transfer of reset pulses from SEP_Central to LET

3.7 Protocol. Transfer of reset pulses from SEP_Central to LET shall take place according to the Reset Pulse Protocol shown in Figure 3 below.



RESET PULSE: active high, nominally 1ms long, non-periodic

Figure 3 – Reset Pulse Protocol
(Signal polarity shown at interface connector pins)

3.8 Signal Description.

3.8.1 LET RESET. This 0 to +5 V digital signal is used to transfer a reset signal from SEP_Central to LET in order to reset the LET Minimum Instruction Set Computer (MISC). SEP_Central shall generate this signal. Its return line is LET MSTR RTN, which is tied to the signal ground (local chassis) on the SEP_Central side, while on the LET side it is separated from the local signal ground (local chassis) by 50 Ω. See Appendix 8.1 for details of the I/F schematic.

E. Transfer of boot code from SEP_Central to LET

3.9 Protocol. Transfer of boot code shall take place according to the Serial Data/Command Protocol described in Figure 1 and Section 3.1.
For more details on this topic see the reference document 2.2.

4. Data Interface

The Data Interface is used for transfer of information from LET to SEP_Central. All LET data types (science, housekeeping and beacon) shall be formatted into CCSDS telemetry packets in order to be transferred over this interface.

4.1 Protocol. Transfer of data shall take place according to the Serial Data/Command Protocol described in Figure 1 and Section 3.1.

Note: Nominal baud rate = 57.6 kbaud
High baud rate was chosen to allow data packet transfer in a reasonably short time.

4.2 Signal Description.

4.2.1 LET DATA OUT*. This 0 to +5 V digital signal is used to transfer data from LET to SEP_Central. LET shall generate this signal. Its return line is LET SUB RTN, which is tied to the signal ground (local chassis) on the LET side, while on the SEP_Central side it is separated from the local signal ground (local chassis) by 50 Ω. See Appendix 8.1 for details of the I/F schematic.

4.3 CCSDS Packet.

4.3.1 Format Overview. Data transfer from LET to SEP_Central shall be carried out in the form of a standard 272-byte CCSDS telemetry packet that consists of the following:

- 6-byte Primary Packet Header (byte # 0-5, inclusive)
- 5-byte Secondary Packet Header (byte # 6-10, inclusive)
- 261-byte Application Data (byte # 11-271, inclusive)

For a detailed CCSDS telemetry packet format description see Appendix 8.4 or the reference document 2.1, and for details on the data location within the 261 bytes of Application Data see the reference document 2.2.

LET shall transfer its data to SEP_Central in the form of complete packets with the content of the Primary Packet Header defined as follows:

- Byte 0: 00001010 (MSB on the left. The 3 LSB's are part of APID below.)
- Byte 1: 01000100 (Part of 11-bit APID, e.g., 244 hex = 010 0100 0100.)
- Byte 2: 11xxxxxx ("No grouping" flag and Src. Seq. Ct. below.)
- Byte 3: xxxxxxxx (Source Sequence Count, total of 14 bits.)
- Byte 4: 00000001 (Packet Data Length, including Secondary Header,)
- Byte 5: 00001001 (but w/o Primary Header, in # of bytes–1, i.e., 265.)

LET shall zero-fill the Secondary Packet Header (byte # 6-10, inclusive), as this part of the packet shall be filled in by SEP_Central. The header contains 5 bytes of S/C time (4+1, i.e., truncated in the sub-seconds field from 2 bytes down to 1).

4.3.2 Checksum. The Checksum Byte is byte # 271, the last byte of the CCSDS packet. LET shall calculate checksum for its data packets and set the Checksum Byte such that the arithmetic sum of all 272 bytes in the packet, modulo 256, equals zero. SEP_Central shall verify checksums upon receiving LET packets. LET science packet gets the final checksum from SEP Central when S/C time is assigned to the Secondary Packet Header.
SEP Central shall combine HK data from all sensors to form a new SEP HK packet and shall calculate its checksum.
SEP Central shall combine beacon data from all sensors to form a SEP beacon data block and shall calculate its checksum. IMPACT IDPU shall assign the final checksum upon assembly of the IMPACT beacon packet.

4.3.3 APID and Rate Allocation. LET data packets shall carry an 11-bit APID (Application Process Identifier) in the hex range 244-24D (inclusive), or 580–589 decimal. In order to fill in the required Primary Header information (bytes # 2-3) LET shall implement a separate 14-bit Source Sequence Counter for each unique APID it selects to use (including the one for zero-filled packets). The APIDs shall be designated by LET and distributed among its various packet types, shown below with their rate allocations (note that rates do not include packet headers):

- LET science data (rates, events, etc.) 16 packet/min (556.8 bit/s)
- LET HK data (72 Fixed, 30 Dribbled bytes) 1 packet/min (13.6 bit/s)
- LET beacon data (46 bytes) 1 packet/min (6.1 bit/s)

4.3.4 Transfer Schedule. Using the protocols in Figures 1 and 2 above, data packet transfer from LET to SEP_Central shall be based on a once-per-second pulse (frame sync) where the beginning of each 1-minute period is marked by a double pulse. SEP_Central shall generate the frame sync pulses and ensure that the 1-minute marks are synchronized to the UT minute intervals. LET shall make use of its internal timers and interrupts tied to the frame sync pulses to schedule data packet transfers. Frames of each minute shall be numbered 0-59. Beginning of frame 0 shall coincide with tic 0 immediately following the 1-minute mark. LET basic data accumulation interval shall be 1 minute long, beginning at tic 0.

SEP_Central collects data from three MISC-equipped sensors (LET/HET/SIT) in an alternating cyclical manner during the first 200 ms of each frame dedicated to a packet transfer from that particular sensor. Thus every sensor has a total of 20 dedicated data-transmission frames in every minute. LET shall transmit at least one packet to SEP_Central within the initial 200-ms window following tic 2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 35, 38, 41, 44, 47, 50, 53, 56 and 59.

Given the baud rate of 57.6 kbaud it takes ~52 ms to send one data packet. LET may send more than one packet during the 200-ms window or send a "dummy", zero-filled, packet instead. LET data packets shall be transmitted over the entire 1-minute cycle (the regularity of packets helps in ground testing, e.g., with an oscilloscope triggering on the frame sync one can quickly verify the data content). SEP_Central shall not forward the zero-filled LET data packets to the IDPU. LET shall assign a unique APID to its zero-filled packets so that SEP_Central can recognize them. For more details on this topic see the reference document 2.2.

LET data packets received by SEP_Central during a given accumulation minute (N) shall contain LET data collected during the prior minute (N-1) and shall be transmitted to the IMPACT IDPU during the following minute (N+1). SEP_Central shall fill-in the UT portion of all packets received during minute (N) with the UT code associated with tic 0 of minute (N-1). In other words, the UT code of a packet shall refer to the beginning of the minute during which its data was accumulated.

4.4 Special Data Modes.

4.4.1 Accelerator Testing Mode. SEP_Central shall pay attention to just one sensor (LET), which can then use nearly 57.6 kbaud bandwidth of the serial data line. The data format from the sensor can be anything in this mode, or it could be in the form of multiple packets/second. LET shall throttle the transfer rate to a maximum value that is TBD, but close to the limit imposed by the 57.6 kbaud rate.

4.4.2 Variable Packet Rate. The number of packets/minute generated by LET, as well as the number of LET packets passed on by the SEP_Central shall be commandable. This would allow LET to make use of available bandwidth should any other SEP sensor become disabled.

5. Discrete Signal Interface

5.1 Protocol. SEP_Central shall provide a pair of connections between the LET sensor and the Spacecraft Thermal connector (SEP-J2) for the signals listed below. The two signals of the pair and their redundant lines shall be routed close together to avoid introduction of electric noise.

5.2 Signal Description.

5.2.1 LET S/C TEMP and LET S/C TEMP RTN. These are a pair of signals that connect to a spacecraft-monitored thermistor in the LET sensor (a modified "Minco Products" model S17624, flight P/N S102212PFY72B, 1 kohm Pt ribbon RTD sensor, +/- 100 °C). The thermistor is nominally powered by the S/C, with SEP_Central only providing a connection between the S/C and LET sensor.

Selection of the thermistor location in LET shall be coordinated with the SEP Thermal Engineer and in accordance with the reference document 2.3.

6. Power Interface

These signals are generated in SEP_Central and used to provide power to the LET sensor.

6.1 LVPS Protocol. SEP LVPS outputs listed below shall be shared among the SEP subsystems (LET/HET/SIT/SEP_Central) and regulated to +/- 5 % (half load to full load). High frequency (LVPS-generated) ripple on the secondary outputs shall be less than 10 mV peak-to-peak at full load, as per reference document 2.4.

6.2 Signal Description.

6.2.1 LET PWR RTN. This line provides a return path for all analog and digital power signals from LET to SEP_Central. It is connected to the local chassis in both LET and SEP LVPS, therefore serving as a signal ground to which all analog and digital voltages are referenced.

6.2.2 LET +13A. This line provides analog power at +13 V, primarily used in the local +5 V series regulator. Its maximum current draw during the steady-state operation shall not exceed 4 mA.

6.2.3 LET -13A. This line provides analog power at -13 V, primarily used in the –5 V reference generator. Its maximum current draw during the steady-state operation shall not exceed 5 mA.

6.2.4 LET +6A. This line provides analog power at +6 V, primarily used in the local +5 V series regulator. Its maximum current draw during the steady-state operation shall not exceed 100 mA.

6.2.5 LET -6A. This line provides analog power at -6 V, used in HK ADC. Its maximum current draw during the steady-state operation shall not exceed 1 mA.

6.2.6 LET +2.6D. This line provides digital power at +2.6 V, primarily used for core supply of Actel gate array. Its maximum current draw during the steady-state operation shall not exceed 14 mA. Temporary peak load shall not exceed 34 mA.

6.2.7 LET +3.4D. This line provides digital power at +3.4 V, primarily used for I/O supply of Actel gate array, SRAM and 32 MHz clock oscillator. Its maximum current draw during the steady-state operation shall not exceed 16 mA. Temporary peak load shall not exceed 34 mA.

6.2.8 LET +5.1D. This line provides digital power at +5.1 V, primarily used in the heater control and interface circuits: HC14 and HCT240. Its maximum current draw during the steady-state operation shall not exceed 1 mA.

6.3 SSD Bias Supply Protocol. Positive bias supply outputs (used on LET/HET/SIT) are controlled by a single switch located in SEP_Central and shall be turned on/off simultaneously for all three sensors. For information on the detector leakage current assumptions see Appendix 8.5.

6.4 Signal Description.

6.4.1 LET L1 BIAS. This signal is shared between ten L1 detectors. Its nominal value shall be set for flight in the range of 2-30 V. Inside LET the current limit shall be set to 281 uA, allowing the bias supply output to droop 10 % from the nominal value while one short-circuited worst-case detector in the group (L1) draws 10 x its maximum leakage current (assumed for the end of detector life and at 40 ºC), 148 uA, while the other nine L1 detectors draw their maximum leakage currents and continue normal operation.

6.4.2 LET L2 BIAS. This signal is shared between two L2 detectors. Its nominal value shall be set for flight in the range of 5-50 V. Inside LET the current limit shall be set to 102 uA, allowing the bias supply output to droop 10 % from the nominal value while one short-circuited worst-case detector in the group (L2) draws 10 x its maximum leakage current (assumed for the end of detector life and at 40 ºC), 93 uA, while the other L2 detector draws its maximum leakage current and continues normal operation.

6.4.3 LET L3 BIAS. This signal is shared between LET L3 and HET H1-6 detectors. Its nominal value shall be set for flight in the range of 50-250 V that is suitable to both LET and HET detectors. Inside LET/HET the current limit shall be set to 470 uA, allowing the bias supply output to droop 10 % from the nominal value while one short-circuited worst-case detector in the group (L3) draws 10 x its maximum leakage current (assumed for the end of detector life and at 40 ºC), 305 uA, while the other LET/HET detectors draw their maximum leakage currents and continue normal operation.

7. Heaters

LET operational and survival heater power is supplied by the STEREO spacecraft, with SEP_Central only providing a connection between the spacecraft and the LET sensor. LET shall monitor its thermal environment and control its operational heater accordingly. SEP Thermal Engineer shall actively participate in selection of the operational and survival heater type and their location in the LET sensor.

7.1 Protocol. SEP_Central and LET shall route the signals listed below in a way that traces are kept close together on the harness and PCBs to minimize the introduction of electric noise. These signals carry a nominal +28 VDC voltage fed from S/C buss capable of supplying 28 +7/-6 VDC. Per RFA 62 Response to STEREO S/C PDR, in order to prevent this large voltage variation (+22 V to +35 V) from affecting the design peak power of the heaters, the following design guidelines shall be followed:

7.1.1 LET operational heater shall be sized for a 75% duty cycle at 30.5 V.

7.1.2 LET survival heater shall be sized for a 100% duty cycle at 25 V.

7.2 Signal Description.

7.2.1 LET OP HTR and LET OP HTR RTN. These are a pair of signals that supply nominal +28 VDC power to the LET operational heater when SEP power is turned on. They are fed from the same S/C power buss as the main SEP power. LET OP HTR signal shall be pulsed on and off by a heater switch located inside LET and controlled by the LET MISC.

7.2.2 LET SURV HTR and LET SURV HTR RTN. These are a pair of signals that supply nominal +28 VDC power to the LET survival heater when SEP power is turned off. They are fed from a separate S/C power buss that turns on when the main SEP power is turned off. A thermostat in the LET sensor shall control LET SURV HTR signal whenever SEP is powered off.

SEP-J11 / SEP-P11

RIGID-FLEX

SEP-J11
"Nanonics" connector P/N
STM051M6SN located on
Analog/Post-Reg board

SEP-P11
"Nanonics" connector P/N
STM051C6N located on
LET rigid-flex harness

Connectorless rigid-flex joint
located on LET board

Double lines to Bias Supply

Double lines tied
to a STAR in LVPS

Double lines to LVPS

1	LET L3 BIAS	
2	LET L3 BIAS	
3	LET L2 BIAS	
4	LET L2 BIAS	
5	LET L1 BIAS	
6	LET L1 BIAS	
7	LET PWR RTN	
8	LET PWR RTN	
9	LET PWR RTN	
10	LET PWR RTN	
11	LET +13A	
12	LET +13A	
13	LET +6A	
14	LET +6A	
15	LET -6A	
16	LET -6A	
17	LET -13A	
18	LET -13A	
19	LET +2.6D	
20	LET +2.6D	
21	LET +3.4D	
22	LET +3.4D	
23	LET +5.1D	
24	LET +5.1D	
25	Spare	
26	LET RESET	LET RESET
27	LET RESET	
28	LET CMD IN*	LET CMD IN*
29	LET CMD IN*	
30	LET FRAME SYNC	LET FRAME SYNC
31	LET FRAME SYNC	
32	LET MSTR RTN	LET MSTR RTN
33	LET MSTR RTN	
34	LET CMD OUT*	LET CMD OUT*
35	LET CMD OUT*	
36	LET DATA OUT*	LET DATA OUT*
37	LET DATA OUT*	
38	LET SUB RTN	LET SUB RTN
39	LET SUB RTN	
40	LET S/C TEMP	LET S/C TEMP
41	LET S/C TEMP	
42	LET S/C TEMP RTN	LET S/C TEMP RTN
43	LET S/C TEMP RTN	
44	LET OP HTR	LET OP HTR
45	LET OP HTR	
46	LET OP HTR RTN	LET OP HTR RTN
47	LET OP HTR RTN	
48	LET SURV HTR	LET SURV HTR
49	LET SURV HTR	
50	LET SURV HTR RTN	LET SURV HTR RTN
51	LET SURV HTR RTN	

+2.5D CENTRAL
+3.3D CENTRAL
+5D CENTRAL
HCT240
HC14
1k
330pF
1M
50
+2.5D LET
+3.3D LET
+5D LET

SEP CENTRAL MISC ACTEL, 3.3V I/O, 5V-INPUT TOLERANT

LET MISC ACTEL, 3.3V I/O, 5V-INPUT TOLERANT

Digital I/F circuits are
located on SEP_Central
Logic board

To S/C via SEP-J2

"Minco Products"
P/N S102212PFY72B
1kohm Pt ribbon RTD

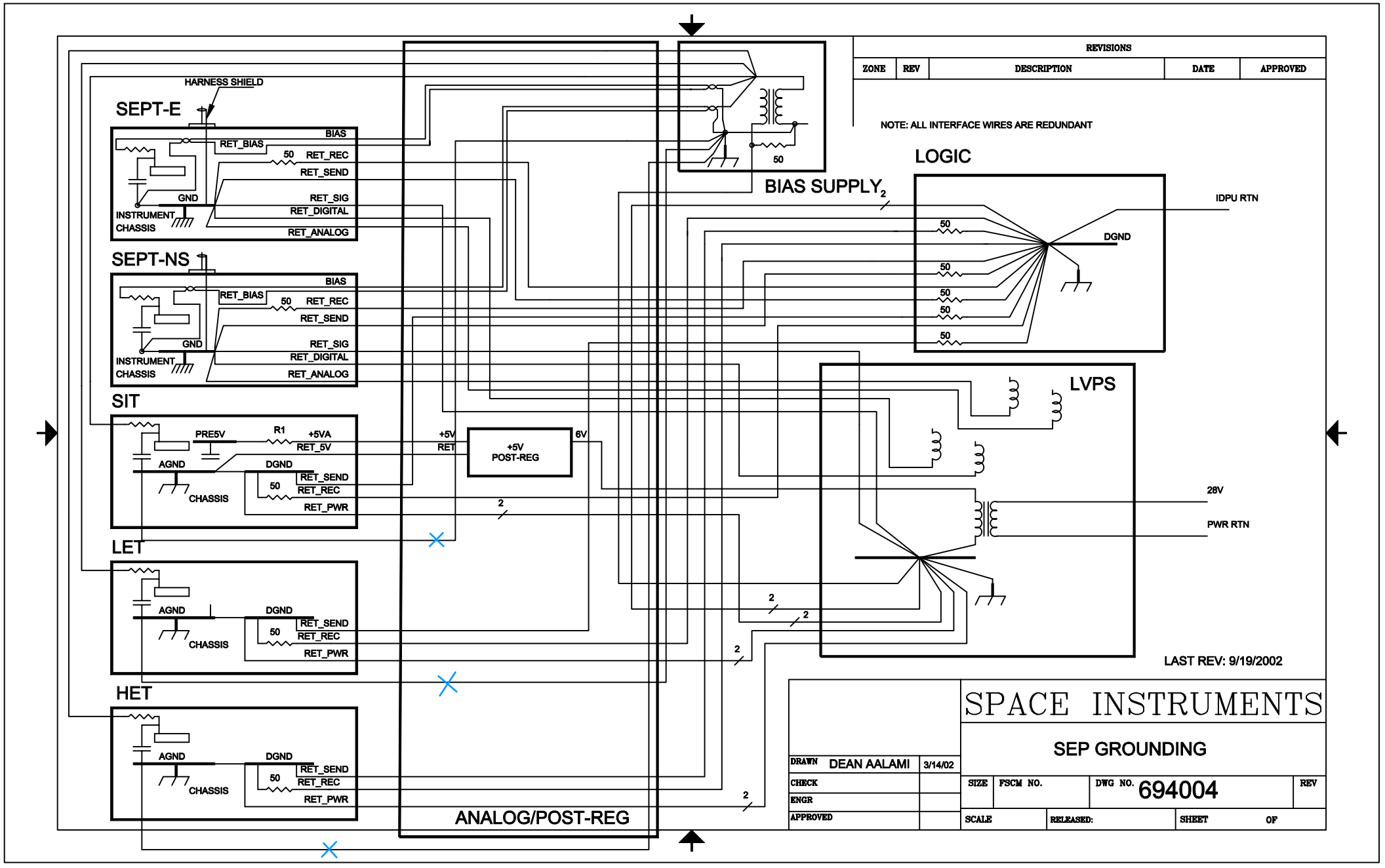
INTERNAL HARNESS

RIGI-FLEX CIRCUIT, LENGTH 20 cm (8")

LEGEND
SIGNAL GROUND

Title	LET-SEP_Central I/F Schematic		
Size:	Number: 100009	Revision:	
Date: 14-Mar-2003		Sheet 1 of 1	
File: C:\Protel\Stereo\ICD\SEP ICD.Ddb - Documents\LET			

California Institute of Technology
Space Radiation Laboratory
1201 E. California Blvd.
MC 220-47
Pasadena, CA 91125


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
NOTE: ALL INTERFACE WIRES ARE REDUNDANT
HARNESS SHIELD
SEPT-E
BIAS
RET_BIAS
50
RET_REC
RET_SEND
GND
RET_SIG
RET_DIGITAL
INSTRUMENT CHASSIS
RET_ANALOG
SEPT-NS
BIAS
RET_BIAS
50
RET_REC
RET_SEND
GND
RET_SIG
RET_DIGITAL
INSTRUMENT CHASSIS
RET_ANALOG
SIT
PRE5V
R1
+5VA
RET_5V
AGND
DGND
RET_SEND
50
RET_REC
CHASSIS
RET_PWR
LET
AGND
DGND
RET_SEND
50
RET_REC
CHASSIS
RET_PWR
HET
AGND
DGND
RET_SEND
50
RET_REC
CHASSIS
RET_PWR
+5V
RET
+5V POST-REG
6V
2
ANALOG/POST-REG
50
BIAS SUPPLY2
LOGIC
IDPU RTN
50
DGND
50
50
50
50
LVPS
28V
PWR RTN
2
2
2
2
LAST REV: 9/19/2002
SPACE INSTRUMENTS
SEP GROUNDING
DRAWN
DEAN AALAMI
3/14/02
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SIZE
FSCM NO.
DWG NO.
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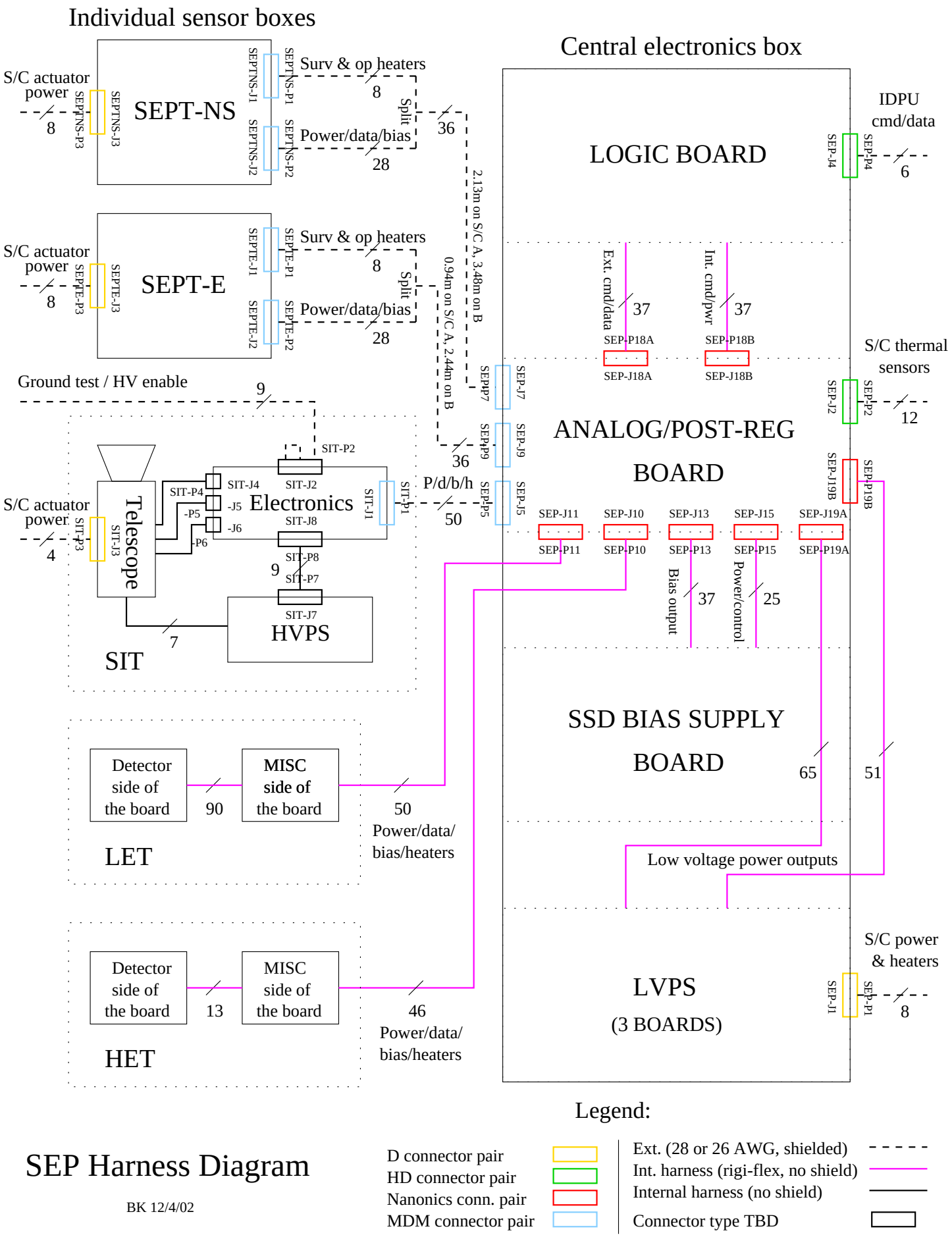
REV
SCALE
RELEASED:
SHEET
OF



SEP Harness Diagram

BK 12/4/02

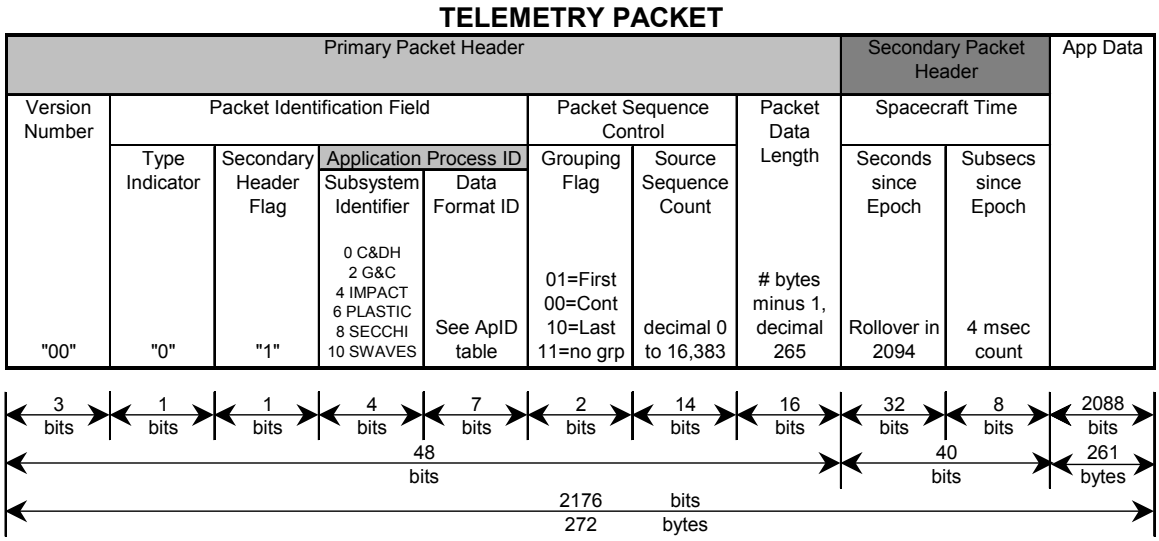


Figure 11. CCSDS Telemetry Packet Data Structure Diagram

Table 15. CCSDS Telemetry Packet Format

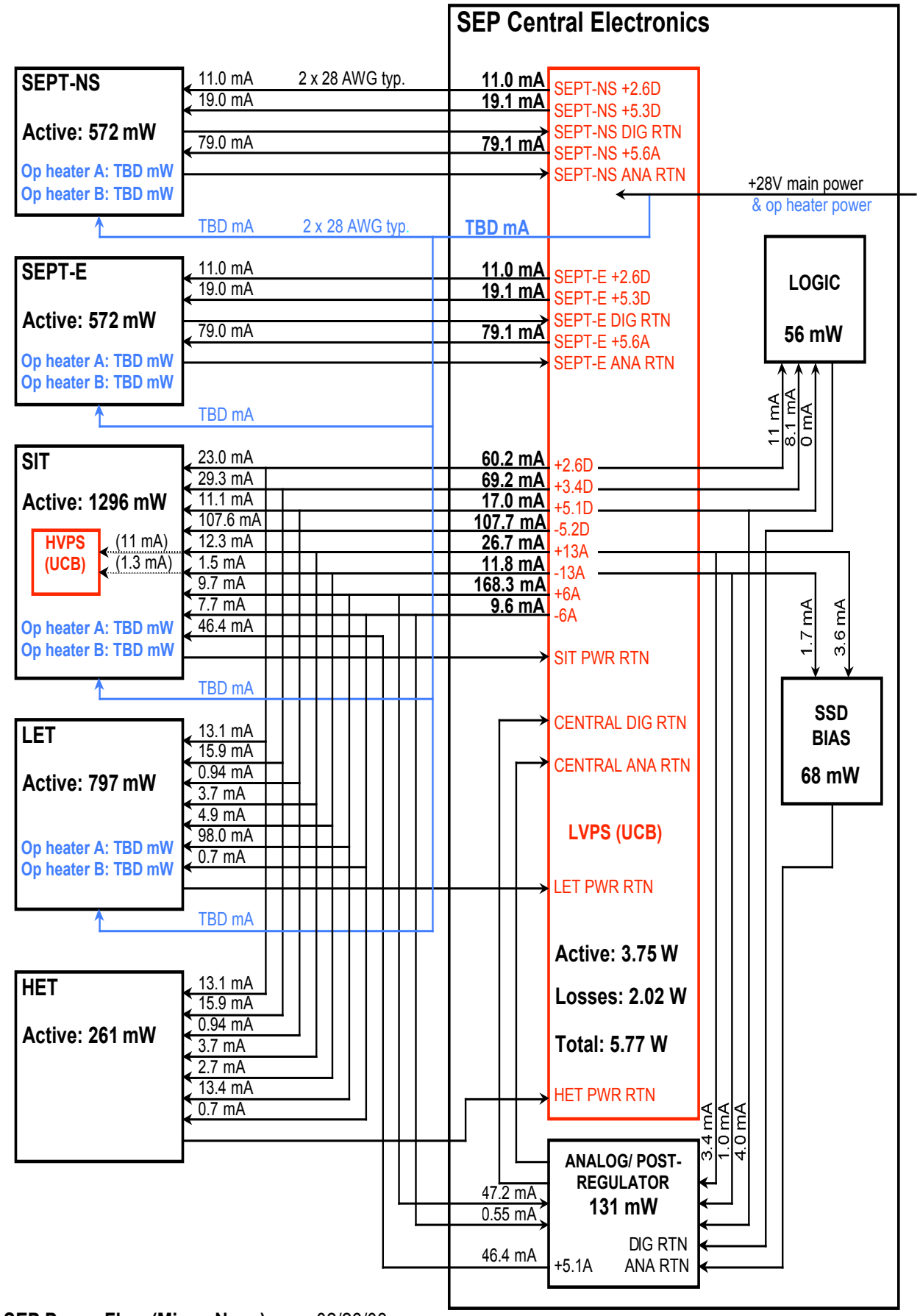
CCSDS Telemetry Packet				
Contents	Size (bits)	Size (bytes)	Type	Units/Range
PRIMARY PACKET HEADER				
Version Number	3	0.375	Binary	"00"
PACKET IDENTIFICATION FIELD				
Type Indicator	1	0.125	Binary	"0" designates a telemetry packet
Secondary Header Flag	1	0.125	Binary	0 = No secondary header 1 = Secondary Header Present
APPLICATION PROCESS IDENTIFIER				
Subsystem ID	4	0.500	Binary	0 = 0000 = C&DH 2 = 0010 = G&C 4 = 0100 = IMPACT 6 = 0110 = PLASTIC 8 = 1000 = SECCHI 10 = 1010 = SWAVES
Data Format ID	7	0.875	Binary	See ApID table
PACKET SEQUENCE CONTROL				
Grouping Flag	2	0.250	Binary	01 = First Packet 00 = Cont. Packet 10 = Last Packet 11 = No grouping
Source Sequence Count	14	1.750	Binary	Decimal range = 0 to 16,383 To ensure delivery order, increment this counter
Packet Data Length	16	2.000	Binary	Number of bytes in Secondary Header Fields + Application Data Field **minus 1, For STEREO = (261 + 5) - 1 = decimal 265 = binary 00000000 10001001**
SECONDARY PACKET HEADER				
SPACECRAFT TIME				
Seconds since Epoch	32	4.000	Binary	Seconds since Epoch Jan 01, 1958 00:00:00 UTC, Rollover in 2094
Subseconds	8	1.000	Binary	Subseconds (1/256)
Application Data	2088	261	Variable	Telemetry application data
TOTAL SIZE (bits & BYTES)	**2176**	**272**		

Positive supply: 300 V

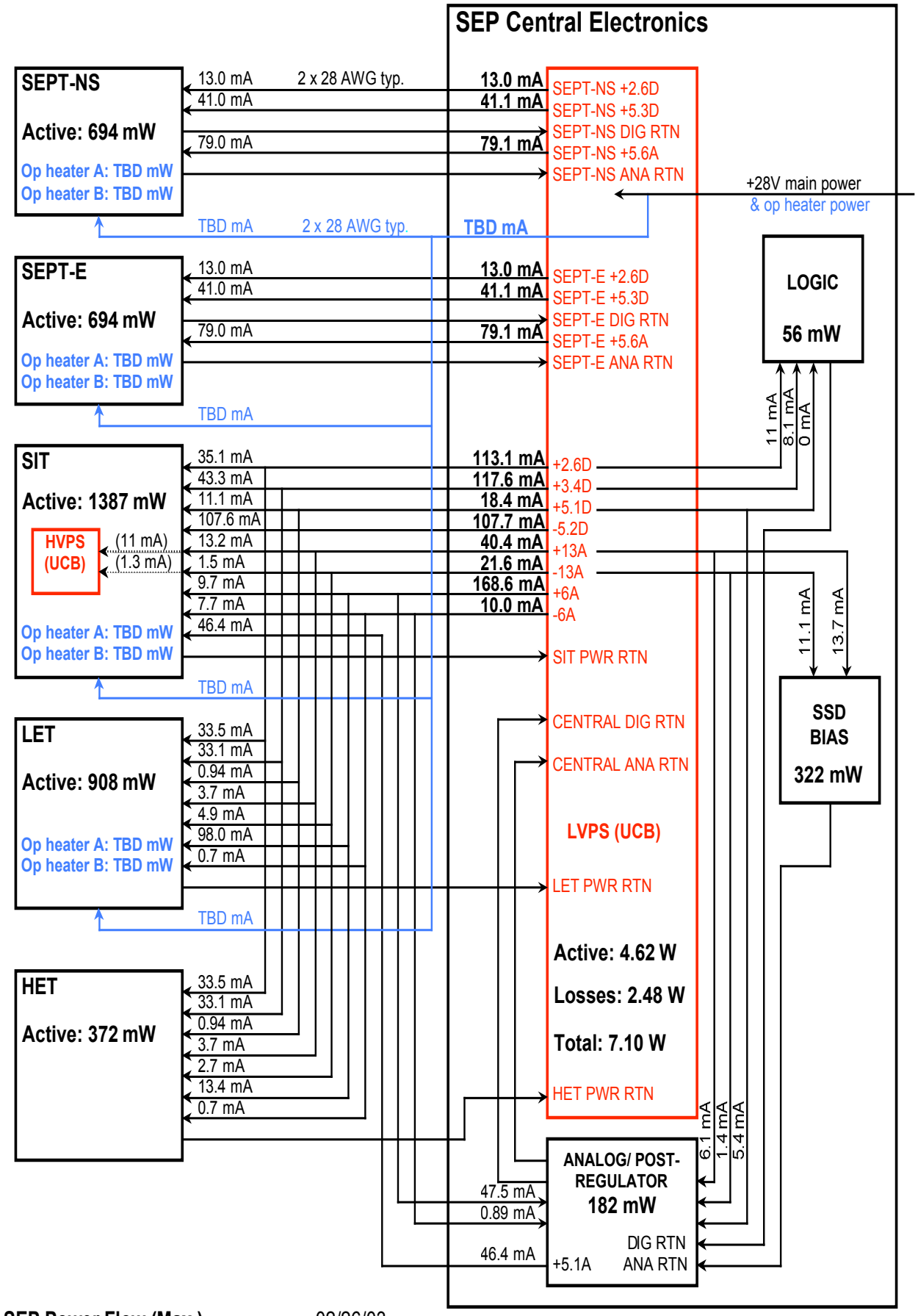
Item No.	Name	Thick (um)	Area (cm^2)	Max volts	Max curr (uA) 20	Factor temp 40	Factor time	Max curr no rad dam (uA)	Damage Coeff (uA/cm^3)	Delta rad (uA)	Max curr (uA)
1	L1A1	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
2	L1A2	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
3	L1A3	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
4	L1A4	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
5	L1A5	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
6	L2A	50	10.24	50	0.5	7.25	2	7.25	40	2.05	9.29
7	L3A	1000	15.00	250	2	7.25	2	28.98	1	1.50	30.48
8	L3B	1000	15.00	250	2	7.25	2	28.98	1	1.50	30.48
9	L2B	50	10.24	50	0.5	7.25	2	7.25	40	2.05	9.29
10	L1B1	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
11	L1B2	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
12	L1B3	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
13	L1B4	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
14	L1B5	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
15	H1	1000	3.14	250	1	7.25	2	14.49	1	0.31	14.81
16	H2	1000	3.14	250	1	7.25	2	14.49	0.1	0.03	14.52
17	H3A	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
18	H3B	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
19	H4A	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
20	H4B	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
21	H5A	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
22	H5B	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
23	H6	1000	12.57	250	1	7.25	2	14.49	0.1	0.13	14.62
24	SIT	500	6.1	160	1	7.25	2	14.49	3	0.92	15.41
Totals positive supply					25.00			362.29		13.24	375.53 uA
			Power (mW)		7.50			108.69			112.66 mW

Negative supply: 100 V

Item No.	Name	Thick (um)	Area (cm^2)	Max volts	Max curr (uA) 20	Factor temp 40	Factor time	Max curr no rad dam (uA)	Damage Coeff (uA/cm^3)	Delta rad (uA)	Max curr (uA)	
1	D0	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
2	D1	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
3	D2	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
4	D3	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
5	D4	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
6	D5	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
7	D6	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
8	D7	300	0.53	80	0.06	7.25	2	0.87	200	3.18	4.05	
9	G0	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
10	G1	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
11	G2	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
12	G3	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
13	G4	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
14	G5	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
15	G6	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
16	G7	300	0.58	80	0.06	7.25	2	0.87	200	3.48	4.35	
Totals negative supply					0.96			13.91		53.28	67.19	uA
			Power (mW)		0.10			1.39			6.72	mW
Totals both supplies					25.96			376.20		66.52	442.72	uA
			Power (mW)		7.60			110.08			119.38	mW



SEP Power Flow (Min. = Nom.) 02/26/03



SEP Power Flow (Max.) 02/26/03