Suprathermal Ion Telescope
Interface Control Document
for the
Solar Energetic Particle
Central Electronics

SIT-SEP_Central ICD

Revision A

March 19, 2003

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Table of Contents:

1. Scope and Revision History

This document describes electrical hardware interfaces and timing protocols for commands, data, discrete and power signals between the SIT 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 SIT-SEP_Central interface see the reference document 2.2.
For details on pyro-related aspects of the SIT-S/C interface see the reference document 2.3.

The interfaces are conducted via external shielded harness that is 18 cm (7") long and terminated on both sides by an MDM 51-pin connector, as shown in Appendix 8.1. Pin redundancy is not mandatory, yet highly desirable.

Rev.	Date	Description
-	11/10/02	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 SIT . . . 3.1 – 3.2.1
B. Command responses from SIT to SEP_Central . . 3.3 – 3.4.1
C. Frame sync pulses from SEP_Central to SIT . . 3.5 – 3.6.1
D. Reset pulses from SEP_Central to SIT . . . 3.7 – 3.8.1
E. Boot code from SEP_Central to SIT . . . 3.9

A. Transfer of commands from SEP_Central to SIT

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

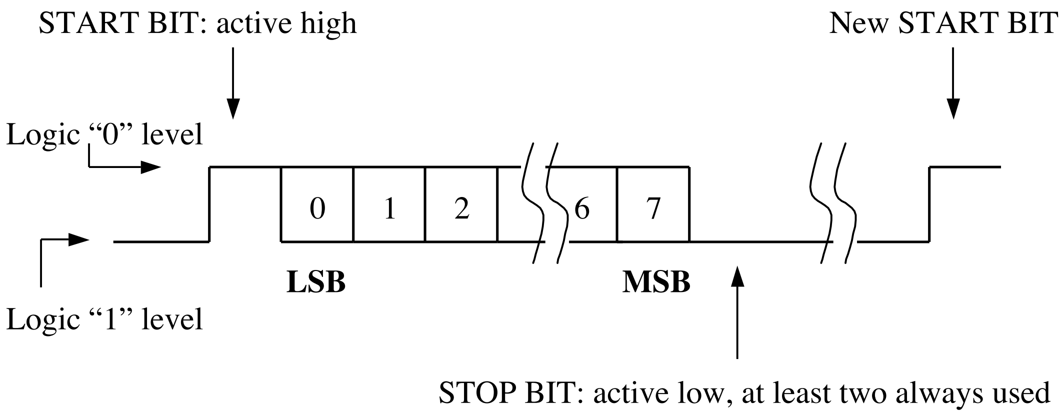


Figure 1 - Serial Data/Command Protocol
(Signal polarity shown at interface connector pins)

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 SIT 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 SIT CMD IN*. This 0 to +5 V digital signal is used to transfer commands from SEP_Central to SIT. SEP_Central shall generate this signal. Its return line is SIT MSTR RTN, which is tied to the signal ground (local chassis) on the SEP_Central side, while on the SIT 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 SIT to SEP_Central

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

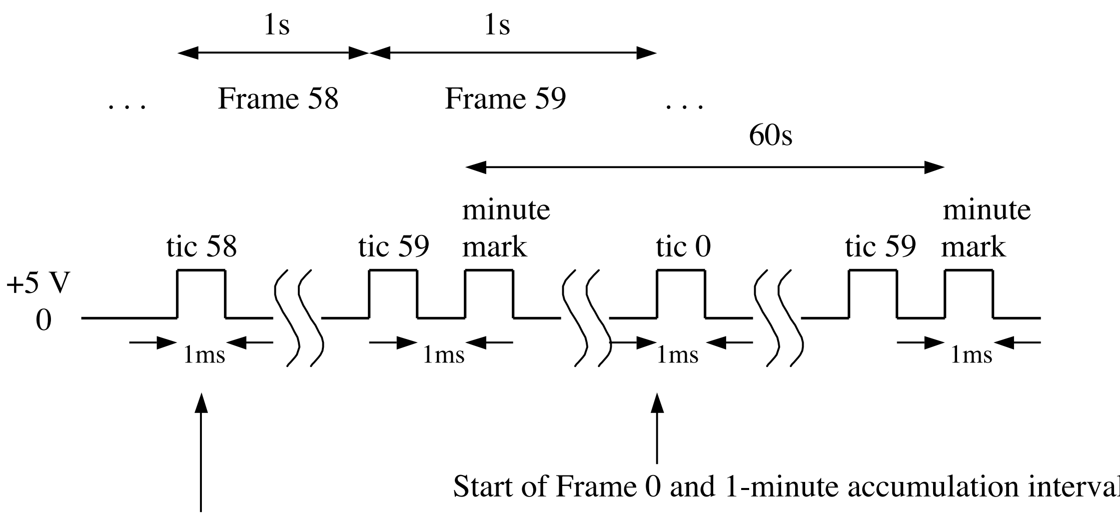
Note: In case of extremely long command responses (e.g., command table dump or memory dump) SIT shall throttle the transfer rate of command responses so that SEP_Central buffer is not saturated.

3.4 Signal Description.

3.4.1 SIT CMD OUT*. This 0 to +5 V digital signal is used to transfer command responses from SIT to SEP_Central. SIT shall generate this signal. Its return line is SIT SUB RTN, which is tied to the signal ground (local chassis) on the SIT 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 SIT

3.5 Protocol. Transfer of frame sync pulses from SEP_Central to SIT 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)

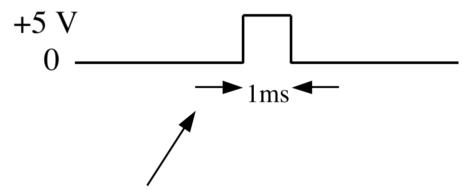
Note: Tic 0 follows the 1-minute mark by ~1 second and marks the beginning of Frame 0 as well as the beginning of 1-minute accumulation interval for SIT.

3.6 Signal Description.

3.6.1 SIT FRAME SYNC. This 0 to +5 V digital signal is used to transfer a frame-synchronizing signal from SEP_Central to SIT. SEP_Central shall generate this signal. Its return line is SIT MSTR RTN, which is tied to the signal ground (local chassis) on the SEP_Central side, while on the SIT 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 SIT

3.7 Protocol. Transfer of reset pulses from SEP_Central to SIT 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 SIT RESET. This 0 to +5 V digital signal is used to transfer a reset signal from SEP_Central to SIT in order to reset the SIT Minimum Instruction Set Computer (MISC). SEP_Central shall generate this signal. Its return line is SIT MSTR RTN, which is tied to the signal ground (local chassis) on the SEP_Central side, while on the SIT 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 SIT

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 SIT to SEP_Central. All SIT 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 SIT DATA OUT*. This 0 to +5 V digital signal is used to transfer data from SIT to SEP_Central. SIT shall generate this signal. Its return line is SIT SUB RTN, which is tied to the signal ground (local chassis) on the SIT 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 SIT 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.

SIT 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: 01100010 (Part of 11-bit APID, e.g., 262 hex = 010 0110 0010.)
- 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.)

SIT 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. SIT 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 SIT packets.
SIT 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. SIT data packets shall carry an 11-bit APID (Application Process Identifier) in the hex range 262-26B (inclusive), or 610–619 decimal. In order to fill in the required Primary Header information (bytes # 2-3) SIT 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 SIT and distributed among its various packet types, shown below with their rate allocations (note that rates do not include packet headers):

- SIT science data (rates, events, etc.)	12 packet/min (417.6 bit/s)
- SIT HK data (6 Fixed, 30 Dribbled bytes)	1 packet/min (4.8 bit/s)
- SIT beacon data (24 bytes)	1 packet/min (3.2 bit/s)

4.3.4 Transfer Schedule. Using the protocols in Figures 1 and 2 above, data packet transfer from SIT 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. SIT 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. SIT 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. SIT shall transmit at least one packet to SEP_Central within the initial 200-ms window following tic 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, 34, 37, 40, 43, 46, 49, 52, 55 and 58.

Given the baud rate of 57.6 kbaud it takes ~52 ms to send one data packet. SIT may send more than one packet during the 200-ms window or send a "dummy", zero-filled, packet instead. SIT 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 SIT data packets to the IDPU. SIT 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.

SIT data packets received by SEP_Central during a given accumulation minute (N) shall contain SIT 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 (SIT), 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. SIT 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 SIT, as well as the number of SIT packets passed on by the SEP_Central shall be commandable. This would allow SIT 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 SIT 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. In the harness they shall be routed as a twisted quad.

5.2 Signal Description.

5.2.1 SIT S/C TEMP and SIT S/C TEMP RTN. These are a pair of signals that connect to a spacecraft-monitored thermistor in the SIT 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 SIT sensor.

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

6.2.2 SIT +13A. This line provides analog power at +13 V, primarily used in the HVPS. Its maximum current draw during the steady-state operation shall not exceed 15 mA.

6.2.3 SIT -13A. This line provides analog power at -13 V, primarily used in the HVPS. Its maximum current draw during the steady-state operation shall not exceed 2 mA.

6.2.4 SIT +6A. This line provides analog power at +6 V, primarily used in the energy electronics. Its maximum current draw during the steady-state operation shall not exceed 10 mA.

6.2.5 SIT -6A. This line provides analog power at -6 V, primarily used in the energy electronics. Its maximum current draw during the steady-state operation shall not exceed 10 mA.

6.2.6 SIT +2.6D. This line provides digital power at +2.6 V, primarily used in the time of flight electronics and the core supply of Actel gate array. Its maximum current draw during the steady-state operation shall not exceed 25 mA. Temporary peak load shall not exceed 36 mA.

6.2.7 SIT +3.4D. This line provides digital power at +3.4 V, primarily used in the time of flight electronics, 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 30 mA. Temporary peak load shall not exceed 44 mA.

6.2.8 SIT +5.1D. This line provides digital power at +5.1 V, primarily used in the time of flight electronics and interface circuits. Its maximum current draw during the steady-state operation shall not exceed 12 mA.

6.2.9 SIT -5.2D. This line provides digital power at -5.2 V, primarily used in the time of flight electronics. Its maximum current draw during the steady-state operation shall not exceed 110 mA.

6.2.10 SIT +5.1A. This line provides analog power at +5.1 V, primarily used in the time of flight electronics. Its maximum current draw during the steady-state operation shall not exceed 50 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 SIT BIAS. This signal is used on a single solid-state detector. Its nominal value shall be set for flight in the range of 150-200 V, and its current limit set to 20 uA, allowing the detector to draw its maximum leakage current (assumed for the end of detector life and at 40 ºC).

7. Heaters

SIT operational and survival heater power is supplied by the STEREO spacecraft, with SEP_Central only providing a connection between the spacecraft and the SIT sensor. SIT 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 SIT sensor.

7.1 Protocol. SEP_Central and SIT shall route the signals listed below in a way that wires and traces are kept close together on the harness and PCBs to minimize the introduction of electric noise. In the harness they shall be routed as a twisted shielded 8-wire cable within the main shield. 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:

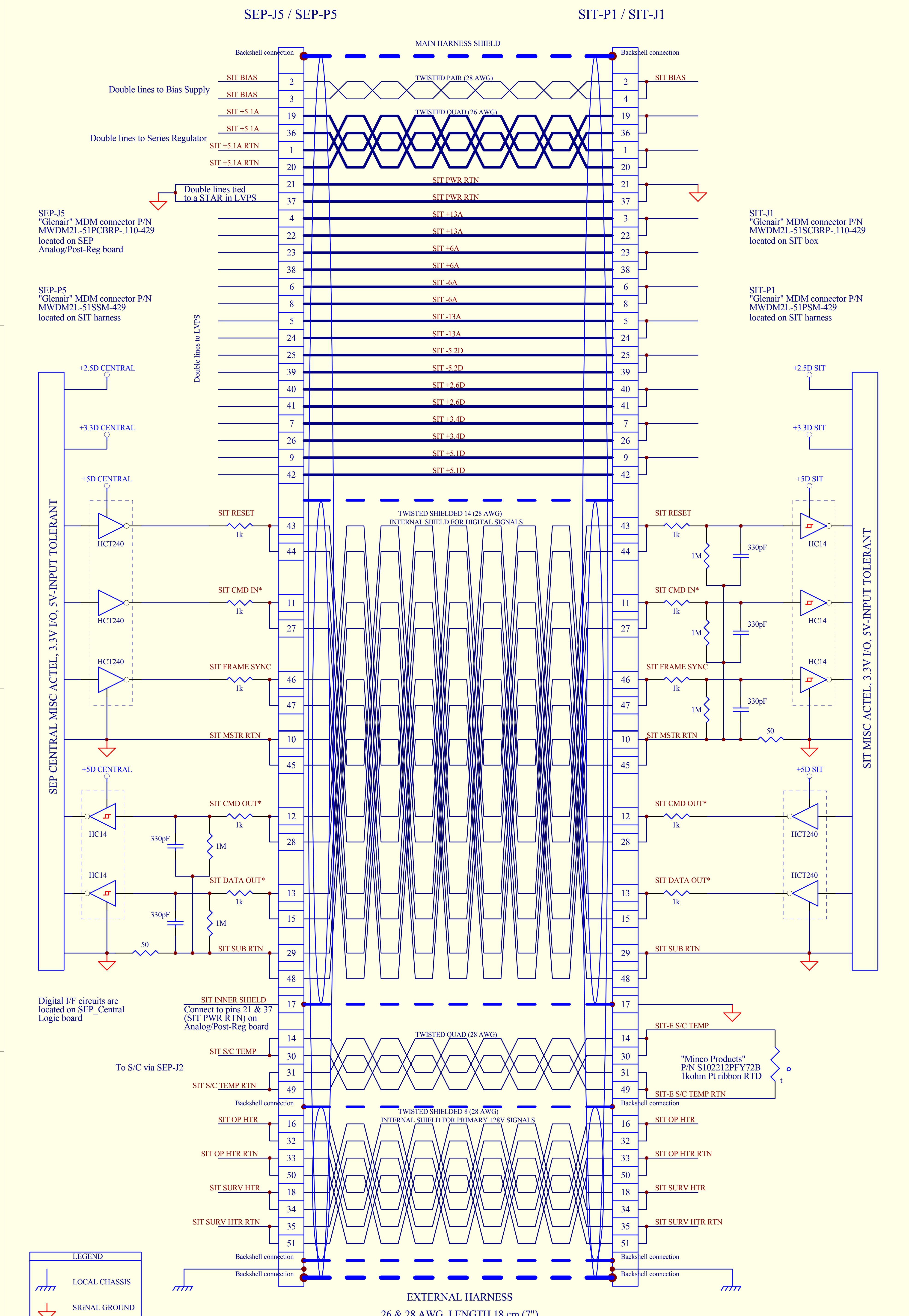
7.1.1 SIT operational heater shall be sized for a 75% duty cycle at 30.5 V.

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

7.2 Signal Description.

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

7.2.2 SIT SURV HTR and SIT SURV HTR RTN. These are a pair of signals that supply nominal +28 VDC power to the SIT 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 SIT sensor shall control SIT SURV HTR signal whenever SEP is powered off.



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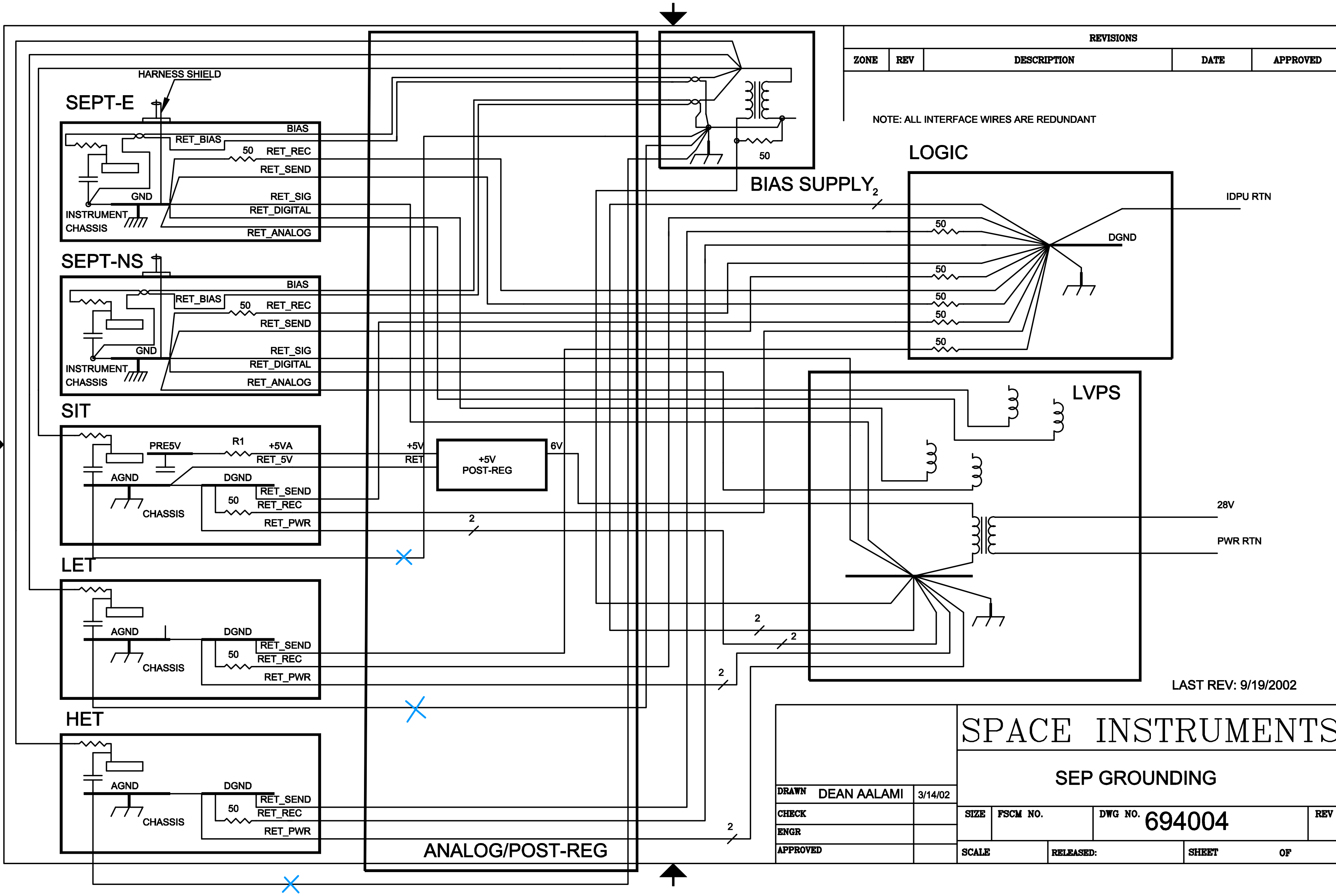
Revision:	
Date: 14-Mar-2003	Sheet 1 of 1
File: C:\Protel\Stereo\ICD\SEP ICD.Ddb - Documents\SIT	

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



REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

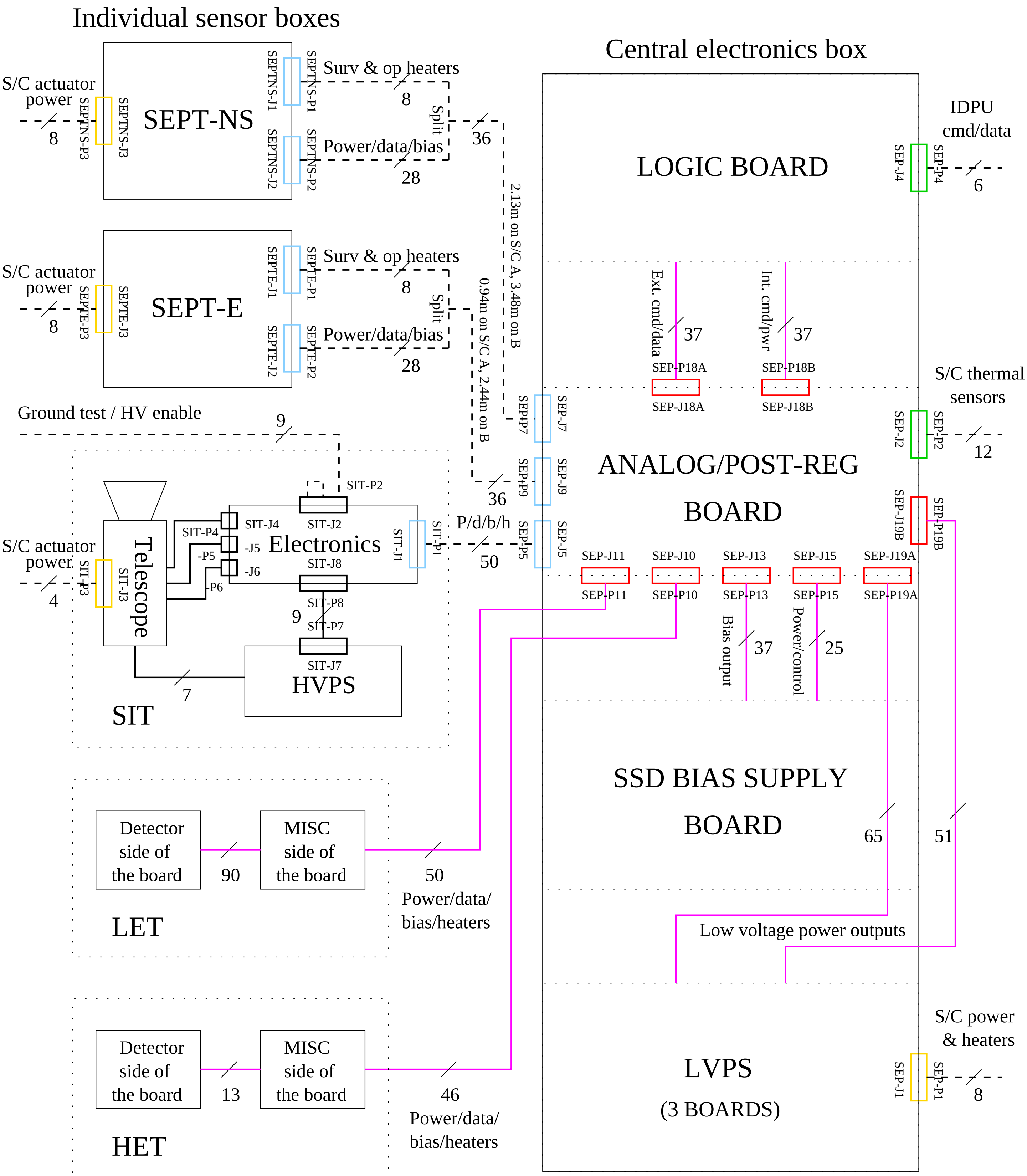
NOTE: ALL INTERFACE WIRES ARE REDUNDANT

SPACE INSTRUMENTS

SEP GROUNDING

DRAWN	DEAN AALAMI	3/14/02
CHECK		
ENGR		
APPROVED		

SIZE	FSCM NO.	DWG NO. 694004	REV
SCALE	RELEASED:	SHEET	OF



SEP Harness Diagram

BK 12/4/02

Legend:

D connector pair	Yellow
HD connector pair	Green
Nanonics conn. pair	Red
MDM connector pair	Light blue
Ext. (28 or 26 AWG, shielded)	Dashed line
Int. harness (rigi-flex, no shield)	Magenta line
Internal harness (no shield)	Solid line
Connector type TBD	Black box

TELEMETRY PACKET

Primary Packet Header								Secondary Packet Header		App Data
Version Number	Packet Identification Field				Packet Sequence Control		Packet Data Length	Spacecraft Time		
	Type Indicator	Secondary Header Flag	Application Process ID		Grouping Flag	Source Sequence Count		Seconds since Epoch	Subsecs since Epoch	
			Subsystem Identifier	Data Format ID						
"00"	"0"	"1"	0 C&DH 2 G&C 4 IMPACT 6 PLASTIC 8 SECCHI 10 SWAVES	See ApID table	01=First 00=Cont 10=Last 11=no grp	decimal 0 to 16,383	# bytes minus 1, decimal 265	Rollover in 2094	4 msec count	
3 bits	1 bits	1 bits	4 bits	7 bits	2 bits	14 bits	16 bits	32 bits	8 bits	2088 bits
48 bits								40 bits		261 bytes
2176 bits 272 bytes										

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**		

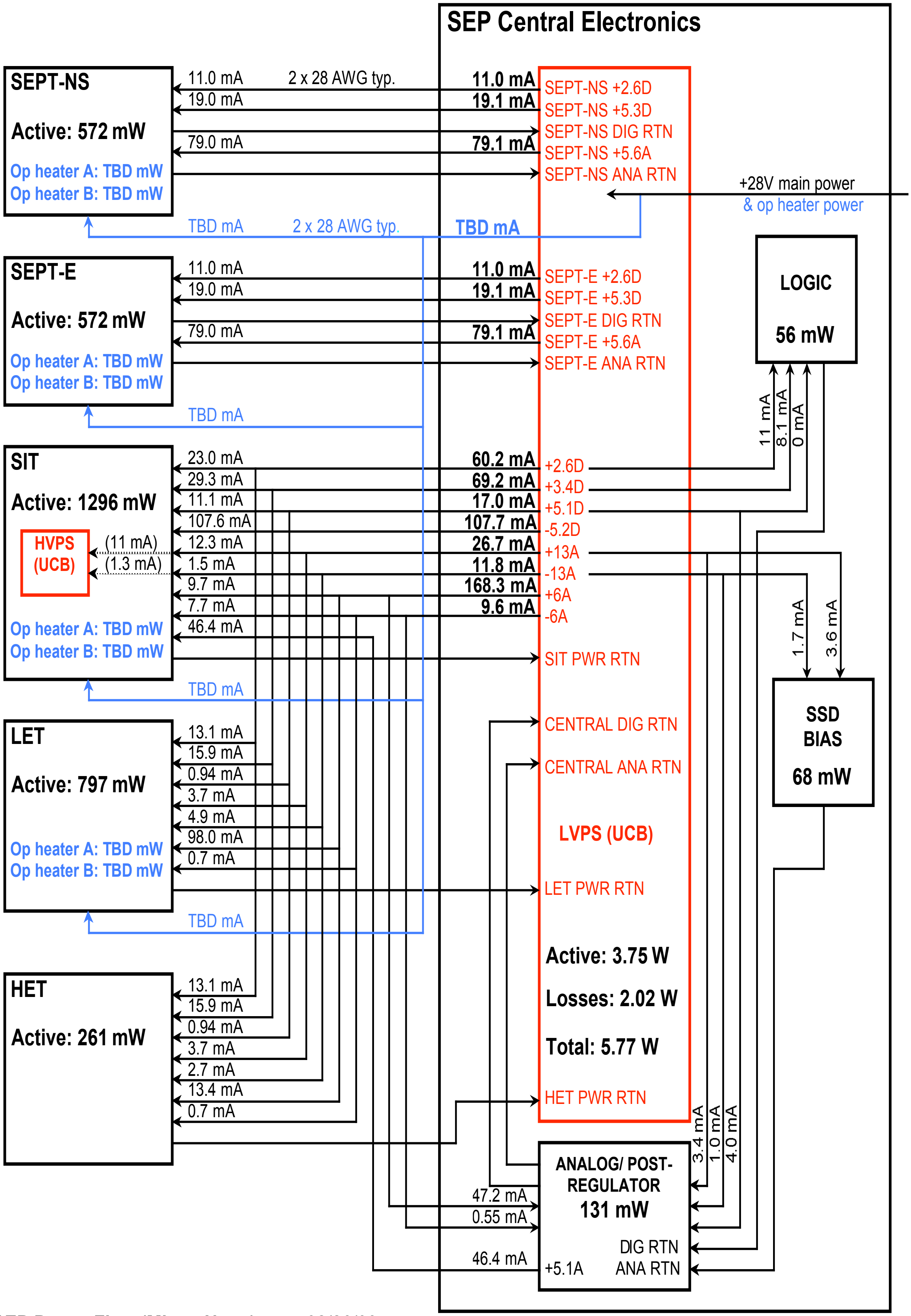
SEP Detector Leakage Current Table 7/8/01

Positive supply: 300 V

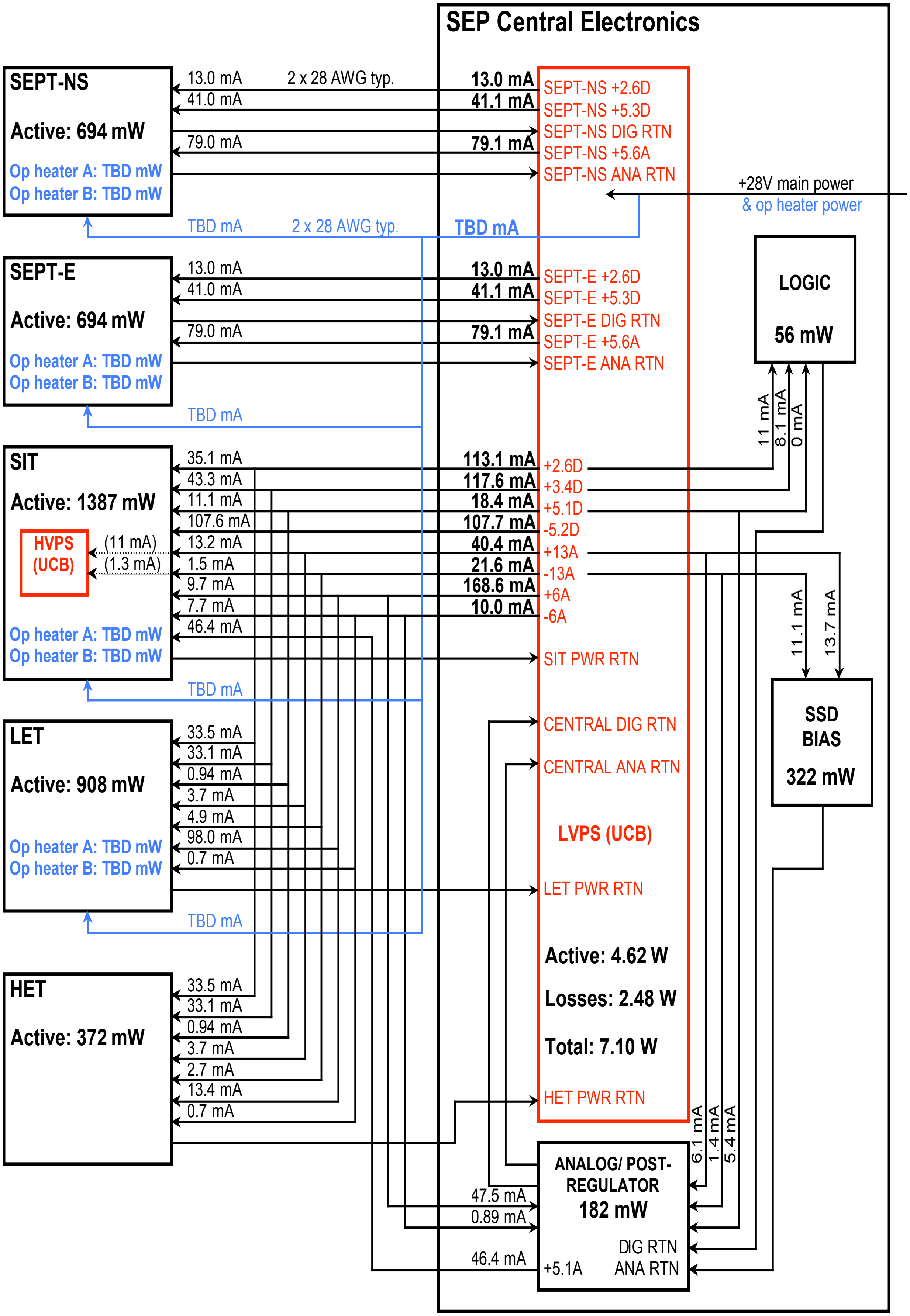
Item No.	Name	Thick (um)	Area (cm^2)	Max volts	Max curr (uA) 20	Factor temp 40	Factor time	Max curr no rad dam (uA)	Damage Coeff (uA/cm^3)	Delta rad (uA)	Max curr (uA)
1	L1A1	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
2	L1A2	20	2.00	30	1	7.25	2	14.49	100	0.40	14.89
3	L1A3	20	2.00	30	1	7.25	2	14.49	100	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