GRAVITY PROBE-B

PROCEDURE FOR SCIENCE MISSION DEWAR

CERTIFICATION OF THE TEMPERATURE MONITOR AND ALARM

To be performed at Vandenberg Air Force Base building 1610/MST

THIS DOCUMENT CONTAINS NON HAZARDOUS OPERATIONS

P1021

October 29, 2002

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REVISION RECORD

REVISION	ECO	PAGES	DATE

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List of Abbreviations and Acronyms

AG-x	Gauge x of Gas Module auxiliary section	MT	Main Tank
AMI	American Magnetics Inc.	MTVC	Main Tank Vent Cap
ATC	Advanced Technology Center	MTVC-G	Main Tank Vent Cap pressure gauge
APR-x	Pressure regulator x of Gas Module	MTVC-RV	Main Tank Vent Cap relief valve
AV-x	Valve x of Gas Module auxiliary section	MTVC-V	Main Tank Vent Cap valve
CG-x	Gauge x of portable helium pressurization source	NBP	Normal boiling point
CPR-x	Pressure regulator x of portable helium pressurization source	ONR	Office of Naval Research
CV-x	Valve x of portable helium pressurization source	PFCG	Fill Cap assembly pressure Gauge
CN [xx]	Data acquisition channel number	PFM	Pump equipment Flow Meter
DAS	Data Acquisition System	PG-x	Gauge x of Pump equipment
EFM	Exhaust gas Flow Meter	PM	Pump Module
EG-x	Gauge x of Gas Module exhaust section	psi	pounds per square inch
EH-x	Vent line heat exchanger in Gas Module	psig	pounds per square inch gauge
EM	Electrical Module	PTD	Payload Test Director
ERV-x	Relief valve of Gas Module exhaust section	PV-x	Valve x of the Pump equipment
EV-x	Valve number x of Gas Module exhaust section	QA	Quality Assurance
FCV	Fill Cap Valve	RAV-x	Remote Actuated Valve-x
FIST	Full Integrated System Test	RGA	Residual Gas Analyzer
GHe	Gaseous Helium	SMD	Science Mission Dewar
GM	Gas Module	STV	SMD Thruster vent Valve
GP-B	Gravity Probe-B	SU	Stanford University
GSE	Ground Support Equipment	SV-x	SMD Valve number x
GT	Guard Tank	TG-x	Gauge x of Utility Turbo System
GTVC	Guard Tank Vent Cap	TV-x	Valve x of Utility Turbo System
GTVC-G	Guard Tank Vent Cap pressure gauge	UTS	Utility Turbo System
GTVC-RV	Guard Tank Vent Cap relief valve	Vac	Vacuum
GTVC-V	Guard Tank Vent Cap valve	VCP-x	Vent cap pressure gauge
GTV-G	Guard Tank vent pressure gauge	VCRV-x	Vent cap relief valve
GTV-RV	Guard Tank vent relief valve	VCV-x	Vent cap valve
GTV-V	Guard Tank vent valve	VDC	Volts Direct Current
KFxx	Quick connect o-ring vacuum flange (xx mm diameter)	VF-x	Liquid helium Fill line valve
LHe	Liquid Helium	VG-x	Gauge x of Vacuum Module
LHSD	Liquid Helium Supply Dewar	VM	Vacuum Module
LHV-x	Liquid Helium Supply Dewar valves	VV-x	Valve x of Vacuum Module
LLS	Liquid level sensor	VW-x	Valve x of Dewar Adapter

LM	Lockheed Martin Co.

LIST OF SPECIFIC HEADING DEFINITIONS

Each type of alert message will precede the procedural step to which it applies

1. NOTE: Used to indicate an operating procedure of such importance that it must be emphasized
2. CAUTION: Used to identify hazards to equipment
3. WARNING: Used to identify hazards to personnel

A. SCOPE

This procedure is used to verify the operation of the Temperature Monitor and Alarm system (TM&A) before it is connected to the Science Mission Dewar (SMD). The TM&A system includes two 10μA battery operated current sources, a battery operated three channel Endevco pressure sensor readout, a battery operated National Instruments SCXI data acquisition chassis (SCXI DC 1000 chassis, SCXI 1200-8 channel A/D, SCXI 1100-32 channel MUX and SCXI 1161-8 channel relay) with both a fast charge and a trickle charge power supply, the associated interface box and cabling and a laptop computer. Successful completion of this procedure certifies that the TM&A is operating normally and is ready to be connected to the SMD.

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B. SAFETY

B.1. Potential Hazards

Personal injury and hardware damage can result during normal positioning, assembly and disassembly of hardware.

Liquid helium used in the SMD represents a hazardous material for the personnel involved in the operations. Cryogenic burns can be caused by contact with the cold liquid or gas, high pressures can result if boiling liquid or cold gas is confined without a vent path, and asphyxiation can result if the vent gas is allowed to accumulate.

The SMD Safety Compliance Assessment, document GPB-100153C and the Missile System Prelaunch Safety Package discuss the safety design, operating requirements and the hazard analysis of the SMD.

B.2. Mitigation of Hazards

B.2.1. Lifting hazards

There are no lifting operations in this procedure

B.2.2. Cryogenic Hazards

In VAFB building 1610/MST, the GP-B cryogenic team provides an oxygen deficiency monitor that alarms when the oxygen level is reduced to 19.5%. Additional temperature and pressure alarms, provided by the DAS, warn of potential over-pressure conditions. Emergency vent lines are installed over the four burst disks to direct any flow to an outside area.

Only authorized and trained personnel are allowed in VAFB facilities without escort. All personnel working on platforms at a height 30 inches or more off the floor are required to have an approved air tank (emergency breathing apparatus) within easy reach. Note that tank need not be kept available when working from ladder. In the unlikely

event of a large LHe spill all employees have been instructed to evacuate the room and contact NASA safety.

The following additional requirements apply to all personnel involved directly in cryogenic operations. Gloves that are impervious to liquid helium and liquid nitrogen are to be worn whenever the possibility of splashing or impingement of high-velocity cryogens exists or when handling equipment that has been cooled to cryogenic temperatures. Protective clothing, non-absorbent shoes and full-face shields with goggles/glasses are to be worn whenever the possibility of splashing cryogens exists.

B.2.3. Other Hazards

All tools or other items used with the potential to damage the space vehicle shall be tethered.

B.3. Mishap Notification

B.3.1. Injury

In case of any injury or illness requiring emergency medical treatment **DIAL 911**.

B.3.2. Hardware Mishap

In case of an accident, incident, or mishap, notification is to proceed per the procedures outlined in Lockheed Martin Engineering Memorandum EM SYS229 and Stanford University GP-B P0879. Additionally, VAFB NASA Safety and 30th Space Wing Safety will be notified as required.

B.3.3. Contingency Response

Responses to contingencies/emergency (e.g., power failure) are listed in Appendix 3.

C. QUALITY ASSURANCE

C.1. QA Notification

The NASA program representative and SU QA shall be notified 24 hours prior to the start of this procedure. Upon completion of this procedure, the QE Manager will certify his/her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document.

C.2. Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the TD or his designate and shall be approved by the QA Representative. Additionally, approval by the Payload Technical Manager shall be required, if in the judgement of the TD or QA Representative, experiment functionality may be affected.

C.3. Discrepancies

A Quality Assurance Representative designated by D. Ross shall review any discrepancy noted during this procedure, and approve its disposition. Discrepancies will be recorded in a D-log or a DR per Quality Plan P0108. Any time a procedure calls for verification of a specific configuration and that configuration is not the current configuration, it represents a discrepancy of one of three types. These types are to be dealt with as described below.

1. If the discrepancy has minimal effect on procedure functionality (such as the state of a valve that is irrelevant to performance of the procedure) it shall be documented in the procedure, together with the resolution. Redlines to procedures are included in this category.
2. If the discrepancy is minor and affects procedure functionality but not flight hardware fit or function, it shall be recorded in the D-log. Resolution shall be in consultation with the PTD and approved by the QA representative.
3. All critical and major discrepancies, those that effect flight hardware fit or functions, shall be documented in a D-log and also in a Discrepancy Report, per P0108.

D. TEST PERSONNEL

D.1. Personnel Responsibilities

The performance of this procedure requires a minimum complement of personnel as determined by the Test Director. The person performing the operations (Test Director or Test Engineer) is to sign the “Completed by” sign-off. Any other qualified person or QA person who can attest to the successful performance of this procedure may sign the “Witnessed by” sign-off. The Test Director will perform Pre-Test and Post-Test Briefings in accordance with P0875 “GP-B Maintenance and Testing at all Facilities.” Checklists will be used as directed by P0875

D.2. Personnel Qualifications

The Test Director must have a detailed understanding of all procedures and facility operations and experience in all of the SMD operations. Test Engineers must have SMD Cryogenic operations experience and an understanding of the operations and procedures used for the cryogenic servicing/maintenance of the Dewar.

D.3. Required Personnel

The following personnel are essential to the accomplishment of this procedure:

FUNCTIONAL TITLE	NUMBER	AFFILIATION
Test Director/Test Engineer	1	Stanford
GP-B Quality Assurance	1	Stanford

E. REQUIREMENTS

E.1. Electrostatic Discharge Requirements

This procedure does not include any equipment sensitive to electrostatic discharge.

E.2. Lifting Operation Requirements

There are no lifting operations in this procedure

E.3. Hardware/Software Requirements

E.3.1. Ground Support Equipment

None required

E.3.2. Test Equipment

Description
SMD simulator

E.3.3. Additional Hardware

N/A

E.3.4. Test Support Software

1. Labview Data Acquisition version 6.0
2. TM&A_V003.vi

E.3.5. Tools

None required

E.3.6. Expendables

Description	Quantity	Mfr./Part No.
None	N/A	N/A

E.4. Configuration Requirements

N/A

E.5. Optional Non-flight Configurations

N/A

F. REFERENCE DOCUMENTS

F.1. Drawings

Drawing No.	*Title*
LMMS-5833394	Instrumentation Installation

F.2. Supporting documentation

Document No.	*Title*
LMMC-5835031	GP-B Magnetic Control Plan
GPB-100153C	SMD Safety Compliance Assessment
LM/P479945	Missile System Prelaunch Safety Package
SU/GP-B P0141	FIST Emergency Procedures
LMSC-P088357	Science Mission Dewar Critical Design Review
SU/GP-B P0108	Quality Plan
LMMS GPB-100333	Science Mission Dewar Failure Effects and Causes Analysis
SU/GP-B P059	GP-B Contamination Control Plan
EM SYS229	Accident/Mishap/Incident Notification Process
EWR 127-1	Eastern and Western Range Safety Requirements
KHB 1710.2 Rev E	Kennedy Space Center Safety Practices Handook

F.3. Additional Procedures

Document No.	*Title*
SU/GP-B P0879	Accident/Incident/Mishap Notification Process
SU/GP-B P1015	Connect Vacuum Module to SMD
SU/GP-B P0875	GP-B Maintenance and Testing at all Facilities
SU/GP-B P1024	Prepare Payload GSE for Transport

Operation Number:_____

Date Initiated:_____

Time Initiated:_____

G. OPERATIONS

G.1. Pre-Operations Verifications

- Verify SU QA notified.

  Record: Individual notified _____,

  Date/time _____/_____.

- Verify NASA program representative notified.

  Record: Individual notified _____,

- Record calibration due dates in sections. E.3.2
- Persons actually performing this procedure should list their names in Sec D.3.
- Verify completion of the pre-operations checklist (Appendix 1).
- Verify proper operation of GP-B Cryogenic Team oxygen monitor
- Verify availability and functioning of emergency shower

Section Complete QA Witness:_____

G.2. Certify TM&A

G.2.1. Assure that the 1382/a battery has enough charge to run the components of the TM&A. If needed, half an hour on the fast charger should provide enough charge to run this procedure

G.2.2. Check that all the TM&A components are powered down and the horn switch is in the off position

G.2.3. Connect the TM&A cables to the SMD simulator and to the dummy ENDEVCO heads. Connect the laptop computer interface to the SCXI chassis

1. Cable K/A-D-G connects to the interface box (connector K to L) and to the SMD simulators (A to SP800, G to SP801, D to SP804).
2. Connect the main tank and guard tank ENDEVCO cables to the dummy ENDEVCO heads using the cables EDV MT and EDV GT
3. Connect the parallel port of the laptop computer to the SCXI 1200 using the parallel interface cable.

G.2.4. Power on all the TM&A components and activate the horn circuit

G.2.5. Boot the laptop computer and start the 'TM&A' program, TM&A_V002.vi. Allow the scanner to cycle. This could take between 30 seconds up to several minutes depending on the sampling rate, number of samples to average and the delay between relay pulses. Record the displayed values in the table below

Device ID	description	channel #	Value Read	Reference Record Last Opt_____	acceptable range	PASS / fail
T22D	**top lead bag /a GRT**	**0**			**4 K – 5 K**	
T23D	**top lead bag /b GRT**	**1**			**4 K – 5 K**	
T09D	**main tank bot SDT**	**2**			**20 K – 30 K**	
T15D	**guard tank /a SDT**	**3**			**20 K – 30 K**	
T24D	**fill valve V13 SDT**	**4**			**20 K – 30 K**	
T20D	**top lead bag /c GRT**	**5**			**3.8 K – 5 K**	
T21D	**top lead bag /d GRT**	**6**			**4 K – 5 K**	
T01D	**station 200 /a SDT**	**7**			**4 K – 5 K**	
T10D	**MT top /a GRT**	**8**			**4 K – 5 K**	
T05D	**VCS-1 bot SDT**	**9**			**20 K – 30 K**	
T08D	**HEX-4 SDT**	**10**			**20 K – 30 K**	
EDV MT	**main tank press**	**11**			**-100 – 100 torr**	
EDV GT	**guard tank press**	**12**			**-100 – 100 torr**	

QA Witness:_____

G.2.6. Test the horn by causing an out of range condition on any channel. This may be done by simply disconnecting the any cable from the SMD simulator (see TM&A software and wiring chart at the end of this document).

G.2.7. If all channels above pass and the horn is functional, the TM&A is deemed certified and ready to connect to the SMD/payload per procedure P0789. If any channels do not pass, exit this procedure without certification of the TM&A and proceed to troubleshoot the problem. The wiring chart for the TM&A cables, 1161 relay interface and the 1303 MUX interface is given at the end of this procedure.

G.2.8. Verify Completion of the Post Operations Checklist

Section Complete QA
Witness:_____

H. PROCEDURE COMPLETION

Completed by:_____

Witnessed by:_____

Date: _____

Time:_____

Quality Manager_____**Date**_____

Payload Test Director_____**Date**_____

TM&A CABLING

		A	K	L		1303	1161	other
Device	**function**	**P800/ P1**			**L jumpers**			
T22D	-	-	1	1		GND		
top lead	V+	60	2	2		CH0+		
bag /a	V-	53	3	3		CH0-		
	-	-	4	4	10	GND		
GRT	I+	64	5	5			NO(0)	
	I-	59	6	6	11			
T23D	shield	-	7	7		GND		
top lead	V+	37	8	8		CH1+		
bag /b	V-	38	9	9		CH1-		
	shield	-	10	10	34			
GRT	I+	45	11	11	6			
	I-	46	12	12	35			
T09D	shield	-	13	13		GND		
main tank	V+	57	14	14		CH2+		
bottom	V-	49	15	15		CH2-		
	shield	-	16	16		GND		
SDT	I+	63	17	17			NO(1)	
	I-	56	18	18				10uA(-) SDT
T15D	shield	-	19	19		GND		
guard tank /a	V+	61	20	20		CH3+		
	V-	62	21	21		CH3-		
SDT	shield	-	22	22		GND		
	I+	65	23	23			NO(2)	
	I-	66	24	24				10uA(-) SDT
T24D	shield	-	25	25		GND		
fill valve V13	V+	52	26	26		CH4+		
	V-	44	27	27		CH4-		
SDT	shield	-	28	28		GND		
	I+	58	29	29			NO(3)	
	I-	51	30	30				10uA(-) SDT
		D	**K**	**L**		**1303**	**1161**	**other**
Device	**function**	**P804/P5**			**L jumpers**			
T20D	-	-	31	31		GND		
top lead bag	V+	26	32	32		CH5+		
/c	V-	27	33	33		CH5-		
	-	-	34	34	40			
GRT	I+	35	35	35	12			
	I-	36	36	36	41			
T21D	shield	-	37	37		GND		
top lead bag	V+	57	38	38		CH6+		
/d	V-	49	39	39		CH6-		
	shield	-	40	40	46			
GRT	I+	63	41	41	36			
	I-	56	42	42	47			
		D	**K**	**L**		**1303**	**1161**	**other**
Device	**function**	**P801/P2**			**L jumpers**			
T01D	-	-	43	43		GND		
station 200 /a	V+	57	44	44		CH7+		
	V-	49	45	45		CH7-		
GRT	-	-	46	46	52			
	I+	63	47	47	42			
	I-	56	48	48	53			
T10D	shield	-	49	49		GND		
MT top /a	V+	8	50	50		CH8+		
	V-	9	51	51		CH8-		
GRT	shield	-	52	52	46			
	I+	15	53	53	48			
	I-	16	54	54				10uA(-) GRT
T05D	shield	-	55	55		GND		

VCS-1 Bottom	V+	37	56	56		CH9+		
	V-	38	57	57		CH9-		
SDT	shield	-	58	58		GND		
	I+	45	59	59			NO(4)	
	I-	46	60	60				10uA(-) SDT
T08D	shield	-	61	61		GND		
HEX-4	V+	25	62	62		CH10+	NO(5)	
	V-	17	63	63		CH10-		10uA(-) SDT
SDT	shield	-						
	I+	43						
	I-	34						

ENDEVCO AND SPARE A/D CHANNELS

		1303			**1303**
spare 63-pin	**ENDEVCO**		**spare 63-pin**	**ENDEVCO**	
	CH1-pin	CH11+	24		GND
	CH1-shield	CH11-	25		CH22+
		GND	26		CH22-
	CH2-pin	CH12+	27		GND
	CH2-shield	CH12-	28		CH23+
		GND	29		CH23-
	CH3-pin	CH13+	30		GND
	CH3-shield	CH13-	31		CH24+
		GND	32		CH24-
1		CH14+	33		GND
2		CH14-	34		CH25+
3		GND	35		CH25-
4		CH15+	36		GND
5		CH15-	37		CH26+
6		GND	38		CH26-
7		CH16+	39		GND
8		CH16-	40		CH27+
9		GND	41		CH27-
10		CH17+	42		GND
11		CH17-	43		CH28+
12		GND	44		CH28-
13		CH18+	45		GND
14		CH18-	46		CH29+
15		GND	47		CH29-
16		CH19+	48		GND
17		CH19-	49		CH30+
18		GND	50		CH30-
19		CH20+	51		GND
20		CH20-	52		CH31+
21		GND	53		CH31-
22		CH21+	54		GND
23		CH21-			

CURRENT SOURCE AND BATTERY TO 1161 RELAY

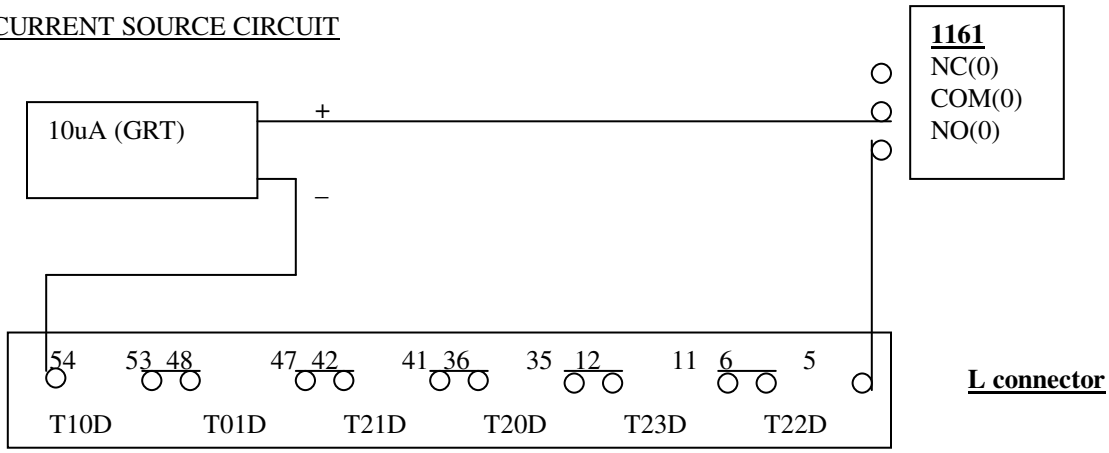
1161		**10 uA GRT**	**10uA SDT**	**12VDC**
	1161 jumper			
NC(0)				
COM(0)		10 uA (+)		
NO(0)				
NC(1)				
COM(1)	COM(2)		10 uA (+)	
NO(1)				
NC(2)				
COM(2)	COM(3)			
NO(2)				
NC(3)				
COM(3)	COM(4)			
NO(3)				
NC(4)				
COM(4)	COM(5)			
NO(4)				
NC(5)				
COM(5)	COM(4)			
NO(5)				
NC(6)				
COM(6)				
NO(6)				
NC(7)				
COM(7)				12 V (+)
NO(7)				

ENDEVCO CABLES

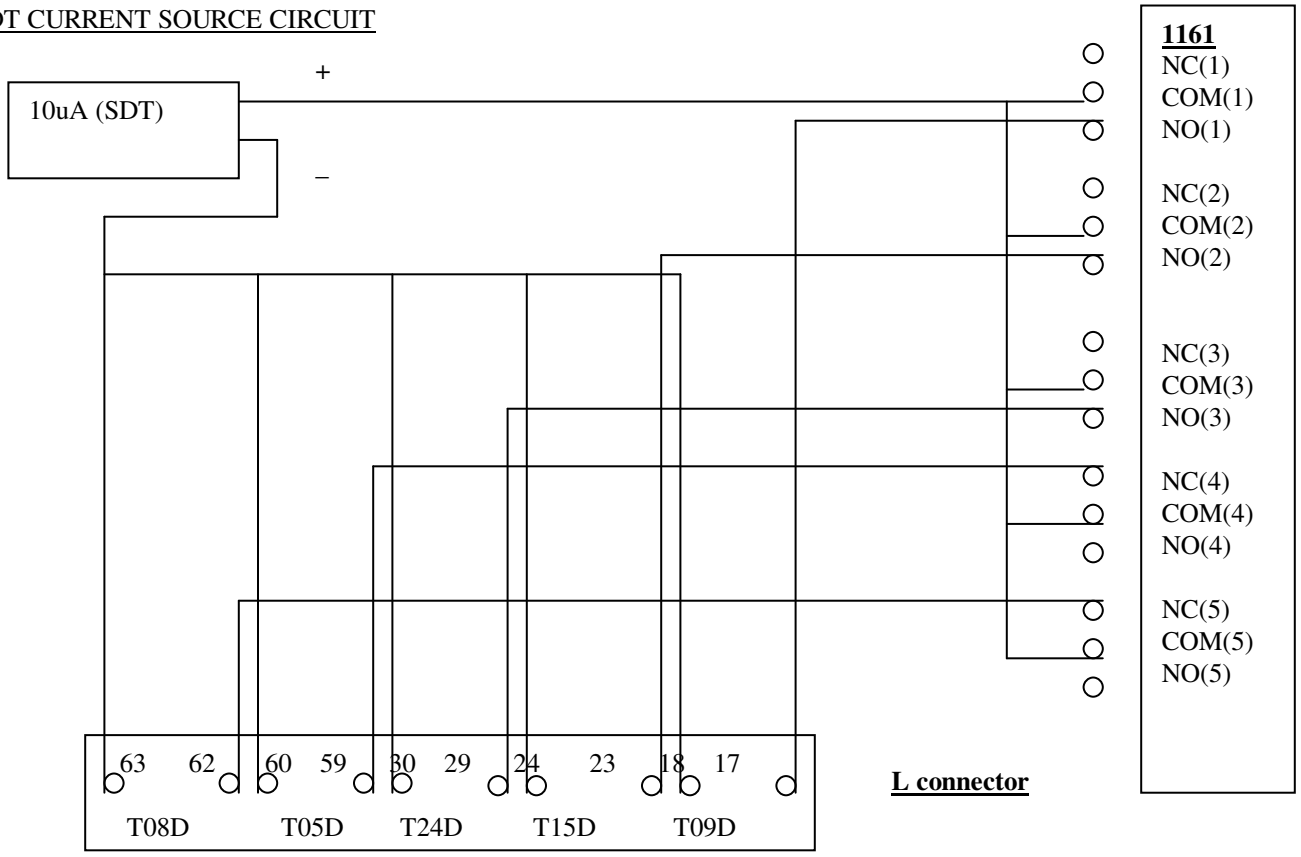
pin #	function	color
4		white
5		green
7		red
8		black
9	shield	none

Sensor end = female 9-pin D-style
Readout end = male 9=pin D-style

GRT CURRENT SOURCE CIRCUIT

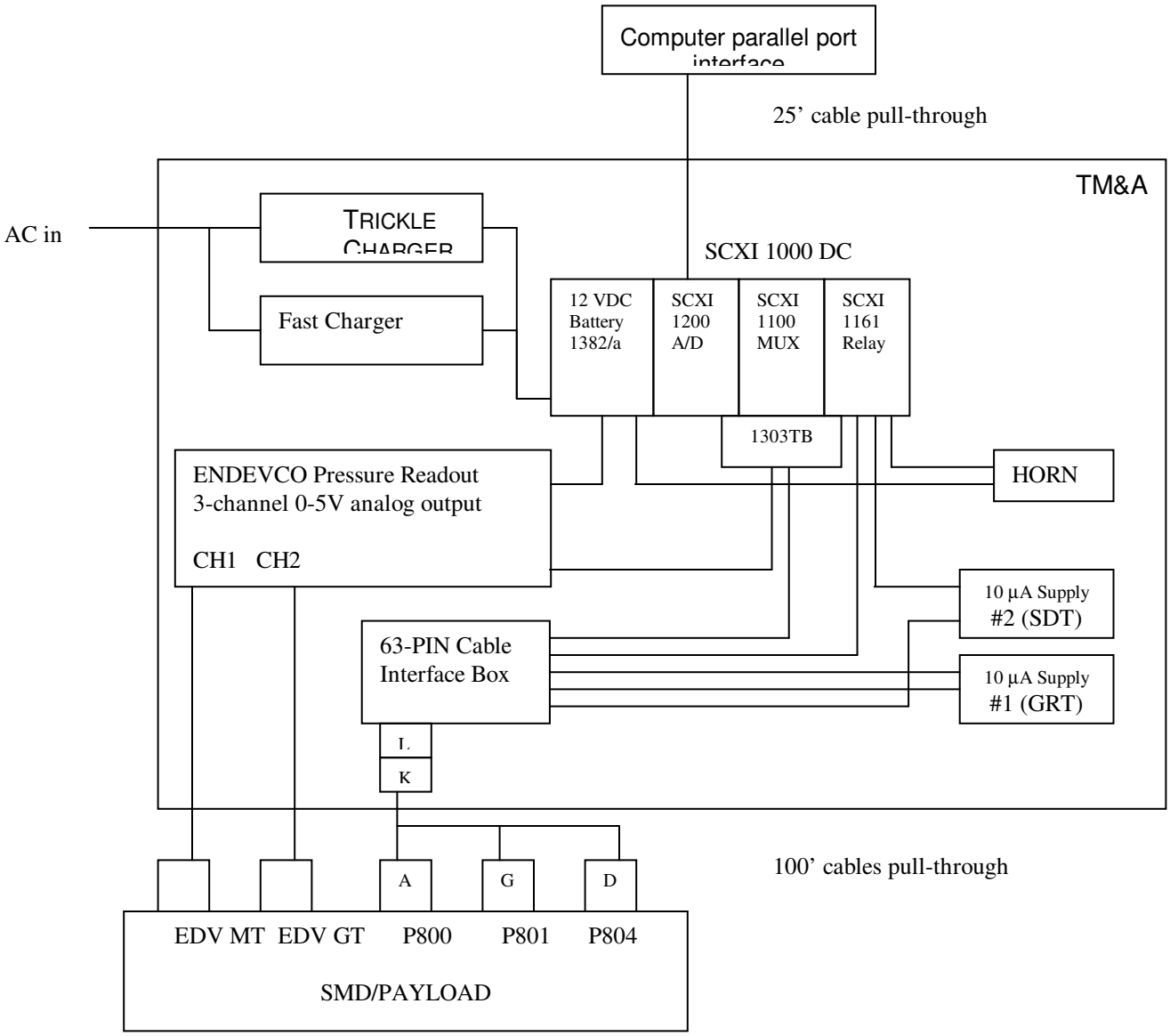


SDT CURRENT SOURCE CIRCUIT



I. TM&A CONFIGURATION

THE FIGURE BELOW SHOWS THE SET-UP OF THE TM&A AS IT IS INTENDED TO BE USED ON THE SMD/PAYLOAD. THE CABLE CONNECTIONS TO THE SMD/PAYLOAD ARE K/A-D-G (K = 63-PIN FEMALE, A, D AND G = 66-PIN FEMALE) AND TWO 5-CONDUCTOR ENDEVCO CABLES (MALE/FEMALE, 9-PIN D-STYLE CONNECTOR).



APPENDIX 1 PRE OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify the test procedure being used is the latest revision.		
	2. Verify all critical items in the test are identified and discussed with the test team.		
	3. Verify all required materials and tools are available in the test area.		
	4. Verify all hazardous materials involved in the test are identified to the test team.		
	5. Verify all hazardous steps to be performed are identified to the test team.		
	6. Verify each team member is certified and knows their individual responsibilities.		
	7. Confirm that each test team member clearly understands that he/she has the authority to stop the test if an item in the procedure is not clear.		
	8. Confirm that each test team member clearly understands that he/she must stop the test if there is any anomaly or suspected anomaly.		
	9. Notify management of all discrepancy reports or d-log items identified during procedure performance. In the event an incident or major discrepancy occurs during procedure performance management will be notified immediately.		
	10. Perform pre-test Engineering and Safety high bay walk down. Ensure all discrepancies are corrected prior to start of operation.		
	11. Confirm that each test team member understands that there will be a post-test team meeting.		
	Team Lead Signature: _____		

J. APPENDIX 2 POST OPERATIONS CHECKLIST

DATE	CHECKLIST ITEM	COMPLETED	REMARKS
	1. Verify all steps in the procedure were successfully completed.		
	2. Verify all anomalies discovered during testing are properly documented.		
	3. Ensure management has been notified of all major or minor discrepancies.		
	4. Ensure that all steps that were not required to be performed are properly identified.		
	5. If applicable sign-off test completion.		
	6. Verify all RAV valve operations have been entered in log book		
	7. Verify the as-run copy of procedure has been filed in the appropriate binder		
	Team Lead Signature: _____		

K. APPENDIX 3– CONTINGENCY/EMERGENCY RESPONSES

Condition	Circumstance	Response
Power Failure	Anytime	Wait for power restoration, and resume procedure
Liquid nitrogen spill	Anytime	Clear area until all spilled liquid has evaporated
Temperature limits (CN 29 or 28) exceeded	Any time	Close EV-17 (if open) and open EV-9. Crack open SV-9 to allow MT to vent. Adjust SV-9 as necessary to restore temperature(s) below alarm limits. Open EV-6 and EV-18 if higher flow rate is needed.
Burst disk rupture (MT/GT)	Any time	Evacuate room
Pressure in Main Tank exceeds limit	Anytime	Open Main Tank Vent Valve
Oxygen monitor alarm	Anytime	Evacuate room