W. W. Hansen Experimental Physics Laboratory
STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305-4085

Gravity Probe B Relativity Mission

THERMAL/VACUUM TEST PROCEDURE FOR THE GYROSCOPE SUSPENSION SYSTEM (GSS) AFT SUSPENSION UNIT (ASU) SUBSYSTEM

P0696 Rev –

DUT PN: 26226-101 REV _____SN: _____

Date Performed:_____

Prepared by: William Bencze Date
RE, Gyroscope Suspension System (GSS) Group

Approved by: William Bencze Date
Payload Electronics Manager.

Approved by: Dorrene Ross Date
GP-B Quality Assurance

Approved by: Richard Whelan Date
GP-B Systems Engineering

Total DUT power-on time for this procedure (hrs)
(includes subordinate procedures)

Table of Contents:

1.0 Revision History

Rev Level	Comments/notes	Date	Revised By
-	First release of this test procedure	15-Nov-2000	WJ Bencze

2.0 Scope:

This procedure details the operations required to perform a box-level thermal vacuum test on a GSS aft unit, PN 26226-101

3.0 Formal Requirements Verification

This procedure verifies by test and/or inspection the following GSS box-level requirements:

Item	Spec Paragraph PLSE 13-1 Rev A	Requirement Title	Verified via test item in this procedure:
3.1.	3.3.8.4	Aft Unit Baseplate Operating Temperature Range	
3.2.	3.3.8.5	Aft Unit Survival Test Temperature Range	
3.3.	3.3.9.4	Aft Unit vacuum environment operational range, high pressure	
3.4.	3.3.9.5	Aft Unit vacuum environment operational range, low pressure	
3.5.	3.3.9.6	Aft Unit Corona Breakdown	

4.0 Reference Documents

4.1.	PLSE 13-1 Rev A	GSS Specification
4.2.	P0663	GSS Gold System Hardware and Software Configuration Standard
4.3.	P0768	GSS ASU Full Functional Test Procedure.
4.4.	P0695	Aft Full Functional Software Test Procedure
4.5.	P0758	GSS GSE Electrical Test Procedure
4.6.	26224	Assembly Drawing for the Aft Computer Unit (ACU)
4.7.	26226	Assembly Drawing for the Aft Suspension Unit (ASU)
4.8.	MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment
4.9.	MIL-STD-1540C	Test Requirements for Launch, Upper-stage, and Space Vehicles, Section 6.4.2.

5.0 Test Facilities

5.1. Primary facility: HEPL Room 175, (End Station III) Stanford University.

5.2. Alternate facility (specify):_____

6.0 QA Provisions:

6.1. This procedure shall be conducted on a formal basis to its latest approved and released version. The QA Program Engineer (D. Ross) and the ONR representative (E. Ingraham) shall be notified 24 hours prior to he start of this procedure. QA may monitor the execution of all or part of this procedure should they elect to do so.

Date/time:_____ Date/time:_____

GP-B QA (D. Ross) ONR (E. Ingraham)

6.2. Upon completion of this procedure, the GSS manager and the GP-B QA manager shall certify her/his concurrence that the procedure was performed and accomplished in accordance with the prescribed instructions by signing and dating his approval at the end of this procedure.

7.0 Test Personnel

This test procedure is to be conducted only by the following personnel, or others designated by the GSS RE at the time of test (redline names in below as required)

7.1. William Bencze

7.2. Ron Zilm

7.3. Scott Smader

7.4. Lo Van Ho

8.0 General Instructions

8.1. Redlines can be initiated by the test personnel listed in Section 7.0 and must be approved by QA.

8.2. Test operators shall read this procedure in its entirety and resolve any apparent ambiguities prior to beginning this test.

8.3. Any nonconformance or test anomaly should be reported by a Discrepancy Report. Refer to the Quality Plan, P0108, for guidance. Do not alter or break test configuration if a test failure occurs; notify quality assurance.

8.4. Only the following persons have the authority to exit/terminate this test or perform a retest: test operators listed in Section 7.0 and GP-B QA.

9.0 Hardware Safety Requirements:

9.1. This assembly is ESD sensitive; special care shall be exercised per the “Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment”, MIL-STD-1686

9.2. Ensure that power is removed from cable assemblies before connecting or disconnecting cable connectors.

9.3. Connector savers are to be used on all flight connector interfaces unless otherwise specified.

9.4. Examine all mating connectors before attempting to mate them. Remove any foreign particles. Look for any damaged pins or sockets. Do not force the coupling action if excessive resistance is encountered. Ensure that key-ways are aligned when mating connectors.

10.0 External Test Equipment

10.1. The following support hardware will be used and the applicable information for the instruments shall be recorded below. Hand-written additions to this list may be made in the space provided.

10.2. Equipment required by P0768, GSS ASU Full Functional Test Procedure, is in addition to the equipment listed below. All calibration information required for subordinate procedure P0786 is wholly contained in that document.

Item	Equipment Description	Qty	Make	PN	SN	Cal Due
1.	Thermal Vacuum test chamber	1	Env Stress Systems		001	
2.	Feedthrough FT-1	1	Douglas Engineering	20FG11	20941	NA
3.	Feedthrough FT-2	1	Douglas Engineering	25F61	20902	NA
4.	Feedthrough FT-3	1	Douglas Engineering	17F35	21325	NA
5.	Feedthrough FT-4	1	Douglas Engineering	25F61	20903	NA
6.	Feedthrough FT-5	1	Douglas Engineering	25F61	21092	NA
7.	Feedthrough FT-6	1	Douglas Engineering	(Part of Chamber)	20656	NA
8.	Feedthrough FT-8	1	Douglas Engineering	Dual BNC	21094	NA
9.	Feedthrough FT-9	1	Douglas Engineering	25F61	20904	NA
10.	T/Vac-FT GFAB 37 cable	1	SU	NA	001	NA
11.	Ext-FT GFAB 37 cable	1	SU	NA	001	NA
12.	T/Vac-FT GFAB 50 cable	1	SU	NA	001	NA
13.	Ext-FT GFAB 50 cable	1	SU	NA	001	NA
14.	T/Vac-FT ASU power cable	1	LMMS	8A02083GSE-104	NA	NA
15.	Ext-FT ASU power cable	1	LMMS	8A02083GSE-101	NA	NA
16.	T/Vac-FT 1553 cable	2	LMMS	8A00673GSE-501	NA	NA
17.	T/Vac-FT timing cable	1	LMMS	8A02084GSE-104	NA	NA
18.	T/Vac ASU mounting plate	1	SU	26237	NA	NA
19.	T/Vac-FT FSU Power cable	1	SU	NA	001	NA
20.	Ext-FT FSU Power cable	1	SU	NA	001	NA
21.	Hold-down straps w/ hware	2	SU	NA	NA	NA
22.	APU thermal transfer plate	1	SU	26238	NA	NA
23.	1553 drop cable	1	?	?	NA	NA
24.	1553 Tap	1	?	?	NA	NA
25.	1553 Bus cable	1	?	?	NA	NA
26.						
27.						
28.						

11.0 Thermal Vacuum Profile

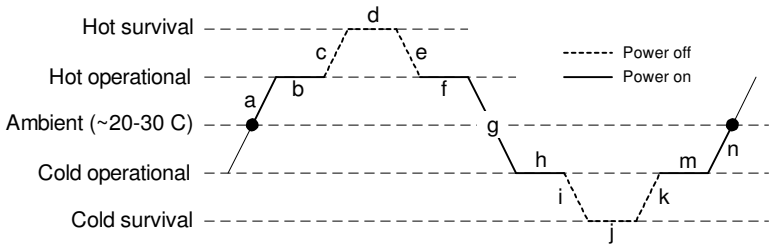
11.1. Each thermal cycle has the following general characteristics:

11.1.1. Transition regions between fixed end temperatures (a, c, e, g, i, k, n)

11.1.2. All temperature slew rates are fixed at 1 deg C/min (60 deg/hour).

11.1.3. Plateau regions where tests may be performed (b, d, f, h, j, m)

11.1.4. All cycles start and end at ambient temperature.



Test and transition segments identified by letters on profile above

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High Survival Temperature	High Operational Temperature	Low Operational Temperature	Low Survival Temperature
339K (+66C)	334K (+61C)	249K (-24C)	224K (-49C)

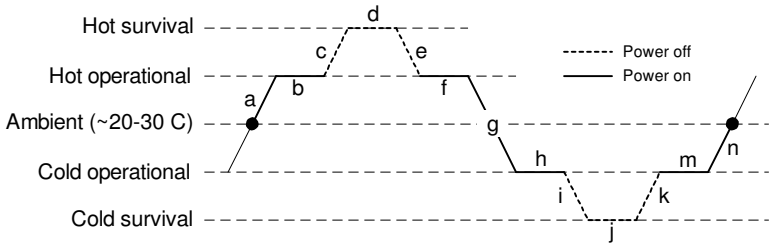
11.2. The following tests are performed at the specified plateaus:

Cycle	Segment	Temperature	Test case	Comments
Pre-vacuum	-	RT	28V FF	
1	F	Op High	28V FF	Hot Start
1	H	Op Low	28V FF	
1	M	Op Low	28V FF	Cold start
2	B	Op High	28V FF	
2	F	Op High	21V FF	Hot Start
2	H	Op Low	21V FF	
2	M	Op Low	21V FF	Cold start
3	B	Op High	21V FF	
3	F	Op High	35V FF	Hot Start
3	H	Op Low	35V FF	
3	M	Op Low	35V FF	Cold start
4	B	Op High	35V FF	
8	F	Op High	28V FF	Hot Start
8	H	Op Low	28V FF	
8	M	Op Low	28V FF	Cold start

12.0 Thermal Vacuum Chamber Profile Scripts

The following scripts are used to control the thermal vacuum chamber during this test.

Item	Name	Version	Description
12.1.	AFT_A2E.heat	-	Runs from ambient start to the end of the E transition. No plateau at B; 6 hour soak at D.
12.2.	AFT_IJK.heat	-	Performs the I, J, K transitions to survival low temp, 30 min soak at J.
12.3.	AFT_Ambient.heat	-	Returns the chamber to ambient temp (30 C)
12.4.	AFT_A.heat	-	Performs the A transition
12.5.	AFT_CDE.heat	-	Performs the C,D,E transitions to survival high temp, 30 min soak at D.
12.6.	AFT_G.heat	-	Performs the G transition
12.7.	AFT_C2N.heat	-	Performs the transitions and soaks from C to N; 30 min soaks at D, J. Other plateaus ignored.
12.8.	AFT_FULL.heat	-	Performs full thermal cycle to survival levels; 30 min soaks at D, J. Other plateaus ignored.



Test and transition segments identified by letters on profile above

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13.0 Equipment Pretest Requirements:

13.1. The GSS Gold System items with which this subsystem is to be tested must have passed the P0663 – Gold System Certification Procedure prior to the start of this test. Record the Gold System serial number and date of its certification, below

GSS Gold System	SN:	
	Date of Certification	
	Configuration (circle one)	Full Partial

	P/F	Notes:
13.2. Verify P0758 has been run on the Spacecraft Emulator GSE within the past 60 days or since the rack has been moved to the current test location.		Date:

14.0 Device Under Test (DUT):

Record the serial number of the Device Undergoing Test, or DUT.

26226-101 GSS Aft Suspension Unit (ASU)	SN:	

Test Operator:	Name:	

Start of test:	Date: Time:	

15.0 Installation of DUT in Chamber

Note: All handling of this DUT shall be performed using ESD control methods, as outlined in MIL-STD-1686. DUT shall be inspected at an ESD certified station. Wrist straps and/or heel grounding straps shall be used.

		P/F	Notes
15.1.	Remove DUT from storage container. Verify that all connectors appear undamaged		
15.2.	Mount DUT to TVAC mounting plate (See Figure 1)		
15.2.1.	Place thermal transfer plate PN 26238 on face of APU inside the bolt pattern. Secure in place with strips of Kapton tape.		
15.2.2.	Place DUT on chamber mounting plate APU-side down.		
15.2.3.	Secure ASU to mounting plate using two U-straps located at either end of the DUT. Upon installation, insure that the U-straps miss screw heads on the connector cover plate on the ACU. The four ¼ x 20 studs on the mounting plate are threaded through the holes in the U-straps.		
15.2.4.	Install washers then nuts onto the threaded studs. Torque ¼ x 20 nuts to 30 in-lbs ± 5 in-lbs and secure them with a jam nut.		
15.3.	Mount plate in TVAC chamber. Torque each of the four ¼ x 20 cap screws to 40 in-lbs ± 5 in-lbs.		

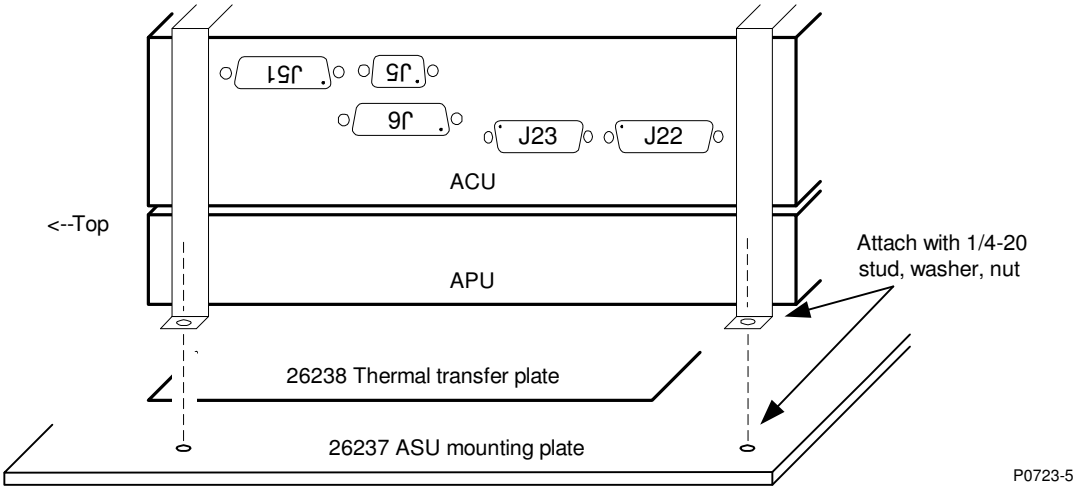
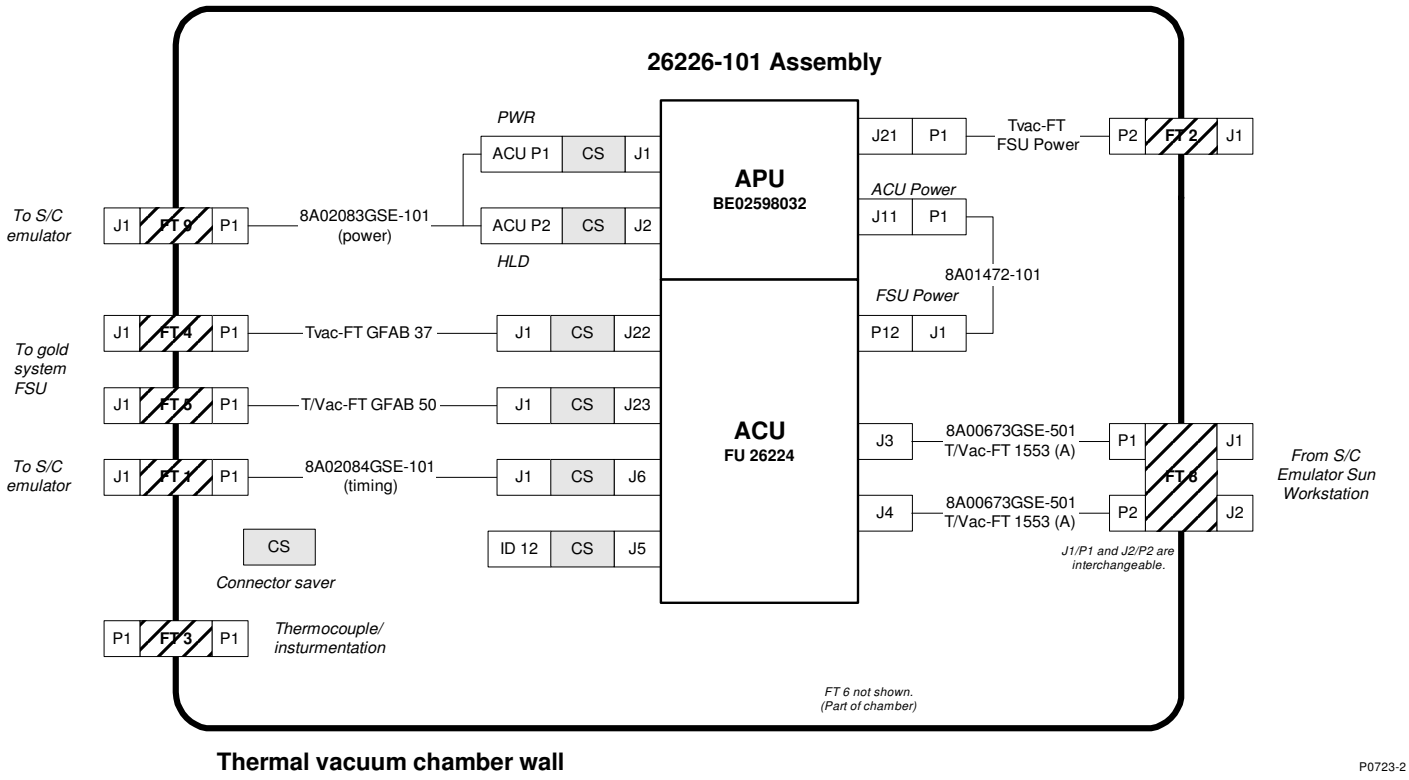


Figure 1 – Mounting of DUT to chamber mounting plate

	P/F	Notes
15.4. Cable the system to the chamber baseplate as shown in Figure 2.		

Figure 2 - Thermal Vacuum Chamber Connections



	P/F	Notes
15.5. Cable the chamber to the spacecraft emulator, testset and monitors as shown in Figures 3, 4, and 5.		

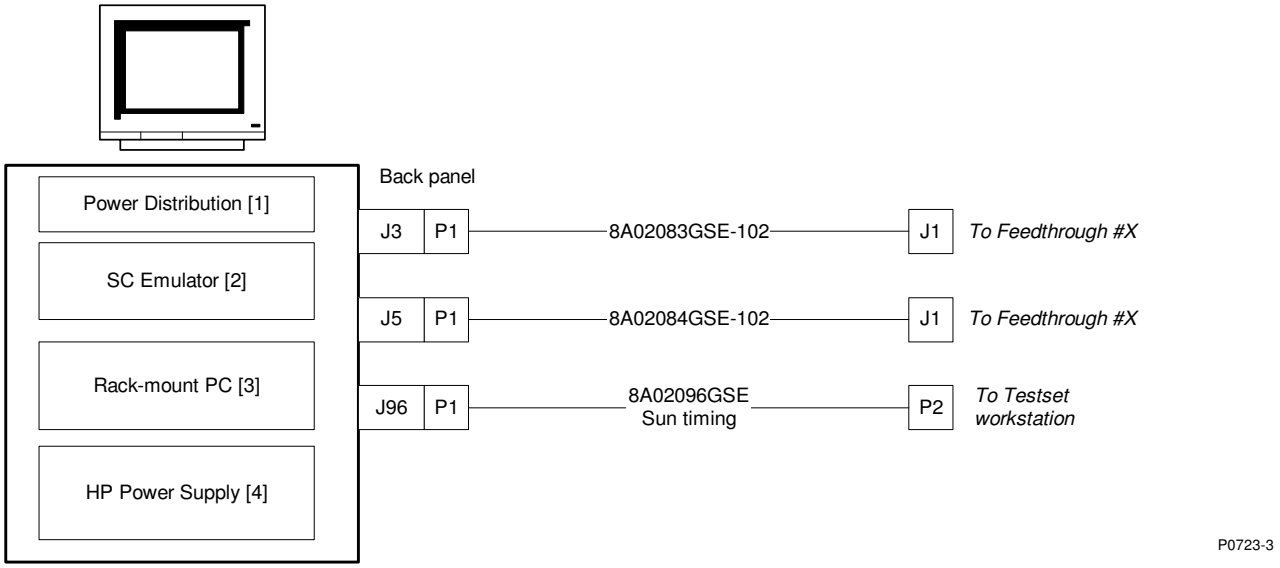


Figure 3 - Spacecraft Emulator Wiring Diagram

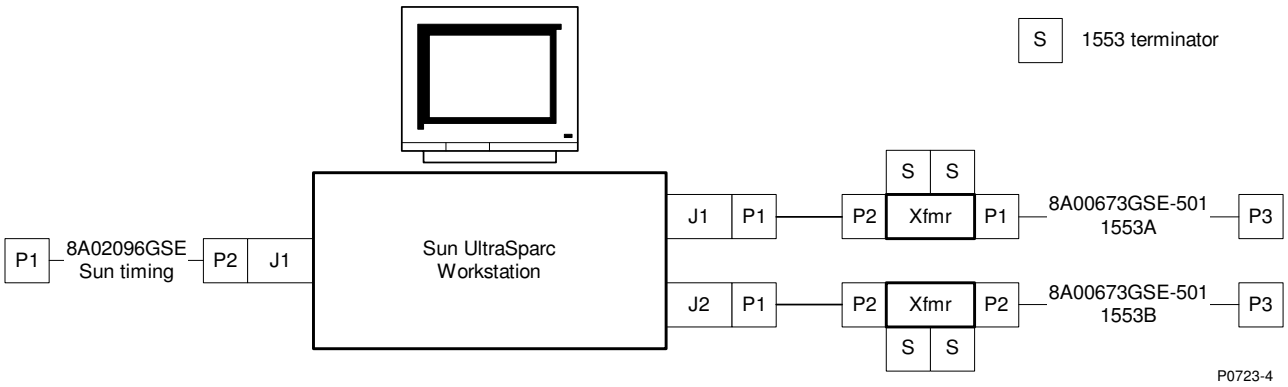


Figure 4 - Testset workstation wiring diagram

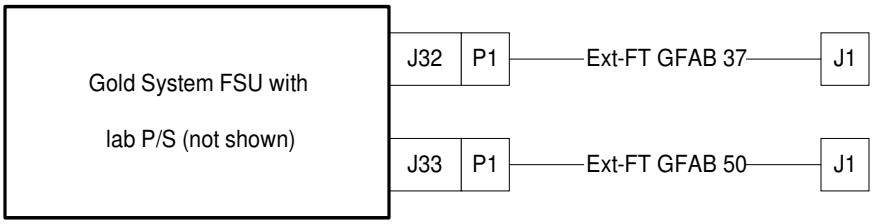


Figure 5 – Gold System FSU wiring diagram

16.0 Post-installation functional test

		P/F	Notes
16.1.	Set current limit on HP power supply in S/C emulator rack to 2.0 A A) Close any LabView program that may be running. B) Key in the following sequence on the front panel of the HP supply: "**LOCAL, CURRENT, 2.0, ENTER**"		
16.2.	Restart the LabView "GSE Test" virtual instrument.		
16.3.	Set Spacecraft clock simulator to the following: **16fo: A+B** **10 Hz: A+B** **Sun 10 Hz: A+B**		
16.4.	Apply power via by turning on "Aft Main" on LabView control panel.		
16.5.	Record power-on start time.		Start time:
16.6.	Record temperature of DUT.		Temp (C):
16.7.	Record indicated main bus current as indicated on HP power supply front panel.		Current:
16.8.	**Verify that current is < 550 mA; if greater remove power and cancel test.**		
16.9.	With DUT in chamber, Perform ACU Full Functional Test, P0768.		
16.10.	When test is complete, turn off power to DUT via the LabView control panel.		Stop time:

End of Section

17.0 Chamber Evacuation.

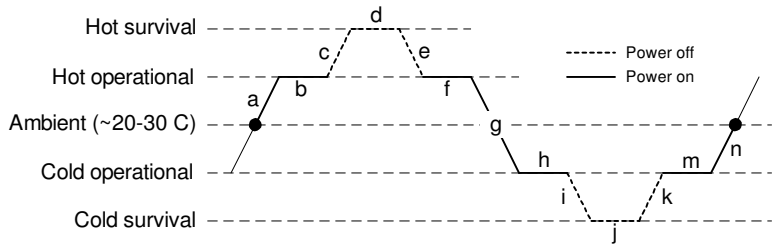
		P/F	Notes
17.1.	Inspect o-ring on chamber bell jar to ensure it is clean and seated properly.		
17.2.	Apply vacuum grease to o-ring as required.		
17.3.	Lower bell jar to seal the chamber		
17.4.	Verify that the vent valve on the chamber (left side, top, under top panel) is closed.		
17.5.	Switch chamber “POWER” and “PUMP” switches to the on (up) position. Record start time.		Start time:
17.6.	Monitor vacuum gauge to verify the pressure in the chamber is dropping. (Nominal atmospheric pressure is 1.00e3 mBar/760 Torr)		
17.7.	Record approximate time for chamber to stabilize at < 1e-5 mBar.		Vacuum time:
17.8.	Verify that a full tank of liquid nitrogen is connected to the chamber and the valve on the tank is open.		LN2 qty:
17.9.	Enter 25 C as the set point for the temperature controller.		
17.10.	Start new log file. Record filename at right:		Logfile:
17.11.	Switch chamber “HEATER” and “COLD” switches to the on (up) position.		

End of Section

Notes:

18.0 Thermal Cycle 1

Seg.	Item	P/F	Notes
A thru E	**18.1. Confirm power off to DUT.**		HP Current:
	18.2. Run *AFT_A2E.heat*; wait for temp to stabilize		Final temp:
F	18.3. HOT START. Apply 28 V to DUT via S/C emulator		HP Current:
	18.4. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
G	18.5. Run *AFT_G.heat*; wait for temp to stabilize		Final temp:
H	18.6. Perform SW test (specify version). Attach results; note this section number on SW TP.		HP Current: P0772___ P0695___
I, J, K	**18.7. Remove power from DUT**		
	18.8. Turn on survival heater via S/C emulator.		HP Current:
	18.9. Run *AFT_IJK.heat*; wait for temp to stabilize		Final temp:
M	18.10. Turn off survival heater via S/C emulator.		
	18.11. COLD START. Apply 28 V to DUT via S/C emulator		HP Current:
	18.12. Perform SW test (specify version). Attach results; note this section number on SW TP.		
N	18.13. Run *AFT_Ambient.heat*; wait for temp to stabilize		Final temp:
	18.14. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:



Test and transition segments identified by letters on profile above

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End of Section

19.0 Thermal Cycle 2

Seg.	Item	P/F	Notes
A	19.1. Confirm 28 V to DUT via S/C emulator		HP Current:
	19.2. Run *AFT_A.heat*; wait for temp to stabilize		Final temp:
B	19.3. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	19.4. Remove power from DUT.		
C, D, E	19.5. Run *AFT_CDE.heat*; wait for temp to stabilize.		Final temp:
F	19.6. HOT START; Apply 21 V to DUT via S/C emulator		HP Current:
	19.7. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
G	19.8. Run *AFT_G.heat*; wait for temp to stabilize.		
H	19.9. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	19.10. Remove power from DUT.		
	19.11. Turn on survival heater via S/C emulator.		HP Current:
I, J, K	19.12. Run *AFT_IJK.heat*; wait for temp to stabilize		Final temp:
M	19.13. Turn off survival heater via S/C emulator.		
	19.14. COLD START. Apply 21 V to DUT via S/C emulator		HP Current:
	19.15. Perform SW test (specify version). Attach results; note this section number on SW TP.		
N	19.16. Run *AFT_Ambient.heat*; wait for temp to stabilize		Final temp:
	19.17. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:

End of Section

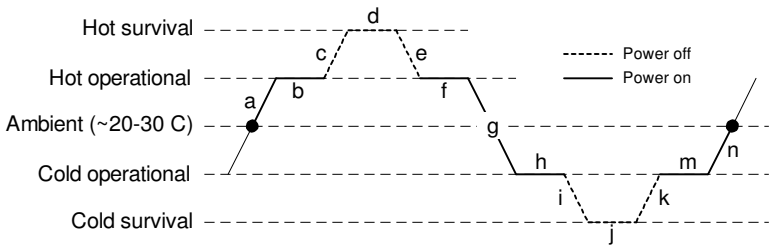
20.0 Thermal Cycle 3

Seg.	Item	P/F	Notes
A	20.1. Confirm 21 V to DUT via S/C emulator		HP Current:
	20.2. Run *AFT_A.heat*; wait for temp to stabilize		Final temp:
B	20.3. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	20.4. Remove power from DUT.		
C, D, E	20.5. Run *AFT_CDE.heat*; wait for temp to stabilize.		Final temp:
F	20.6. HOT START; Apply 35 V to DUT via S/C emulator		HP Current:
	20.7. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
G	20.8. Run *AFT_G.heat*; wait for temp to stabilize.		
H	20.9. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	20.10. Remove power from DUT.		
	20.11. Turn on survival heater via S/C emulator.		HP Current:
I, J, K	20.12. Run *AFT_IJK.heat*; wait for temp to stabilize		Final temp:
M	20.13. Turn off survival heater via S/C emulator.		
	20.14. COLD START. Apply 35 V to DUT via S/C emulator		HP Current:
	20.15. Perform SW test (specify version). Attach results; note this section number on SW TP.		
N	20.16. Run *AFT_Ambient.heat*; wait for temp to stabilize		Final temp:
	20.17. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:

End of Section

21.0 Thermal Cycle 4

Seg.	Item	P/F	Notes
A	21.1. Confirm 35 V to DUT via S/C emulator		HP Current:
	21.2. Run *AFT_A.heat*; wait for temp to stabilize		Final temp:
B	21.3. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	21.4. Remove power from DUT.		
	21.5. Turn on survival heater via S/C emulator.		HP Current:
C thru N	21.6. Run *AFT_C2N.heat*; wait for temp to stabilize.		Final temp:
	21.7. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:



Test and transition segments identified by letters on profile above

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End of Section

22.0 Thermal Cycle 5 (unpowered)

Seg.	Item	P/F	Notes
All	22.1. Confirm power off to DUT		
	22.2. Confirm survival heater ON		HP Current:
	22.3. Run *AFT_FULL.heat*; wait for temp to stabilize		Final temp:
	22.4. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:

23.0 Thermal Cycle 6 (unpowered)

Seg.	Item	P/F	Notes
All	23.1. Confirm power off to DUT		
	23.2. Confirm survival heater ON		HP Current:
	23.3. Run *AFT_FULL.heat*; wait for temp to stabilize		Final temp:
	23.4. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:

24.0 Thermal Cycle 7 (unpowered)

Seg.	Item	P/F	Notes
All	24.1. Confirm power off to DUT		
	24.2. Confirm survival heater ON		HP Current:
	24.3. Run *AFT_FULL.heat*; wait for temp to stabilize		Final temp:
	24.4. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:

25.0 Thermal Cycle 8

Seg.	Item	P/F	Notes
A	25.1. Confirm 28 V to DUT via S/C emulator		HP Current:
	25.2. Run *AFT_A.heat*; wait for temp to stabilize		Final temp:
B	25.3. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	25.4. Remove power from DUT.		
C, D, E	25.5. Run *AFT_CDE.heat*; wait for temp to stabilize.		Final temp:
F	25.6. HOT START; Apply 28 V to DUT via S/C emulator		HP Current:
	25.7. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
G	25.8. Run *AFT_G.heat*; wait for temp to stabilize.		
H	25.9. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
	25.10. Remove power from DUT.		
	25.11. Turn on survival heater via S/C emulator.		HP Current:
I, J, K	25.12. Run *AFT_IJK.heat*; wait for temp to stabilize		Final temp:
M	25.13. Turn off survival heater via S/C emulator.		
	25.14. COLD START. Apply 28 V to DUT via S/C emulator		HP Current:
	25.15. Perform SW test (specify version). Attach results; note this section number on SW TP.		P0772___ P0695___
N	25.16. Run *AFT_Ambient.heat*; wait for temp to stabilize (30 C)		Final temp:
	25.17. Check/record quantity of LN2 in dewar; switch cylinders if needed.		LN2 qty:

End of Section

26.0 Completion of procedure:

		P/F	Notes
26.1.	Confirm power to DUT is **off**.		
26.2.	Vent chamber using dry Nitrogen as purge gas.		
26.3.	Stop logging of temperature data on chamber controller PC. Plot as-run thermal profile and attach to this procedure.		
26.4.	Record total power on time on cover sheet of procedure.		
26.5.	Remove all external cables from ASU		
26.6.	Return DUT to storage container.		

27.0 Certification:

The undersigned certify that this procedure was performed in whole and that the data recorded above is complete and accurate.

Test Engineer		Date	

This is to certify that the information obtained under this test procedure is as represented and the documentation is completed and correct.

GSS Representative		Date	
Quality Assurance		Date	