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) FORWARD SUSPENSION UNIT (FSU) SUBSYSTEM

P0747 Rev –

DUT PN: 26225-101 REV _____SN: _____

Date Performed:_____

Prepared by: Paul Shestople Date

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)

ITAR Assessment Performed _____ ITAR Control Req'd? ☐ Yes ☐ No
Tom Langenstein

Table of Contents:

1.0 Revision History

Rev Level	Comments/notes	Date	Revised By
-	First release of this test procedure	23-Sep-2001	P Shestople

2.0 Scope

This procedure details the operations required to perform a box-level thermal vacuum test on a GSS forward unit, PN 26225-101.

This procedure ☒ Does ☐ Does not provide formal verification of GP-B requirements.
This procedure ☐ Does ☒ Does not include constraints and restrictions for the Payload.

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.	3.3.8.1	Forward Unit Operational Temperature Range	14.0
3.2.	3.3.8.2	Forward Unit Survival Temperature Range	14.0
3.3.	3.3.9.1	Forward Unit vacuum environment operational range, high pressure	14.0
3.4.	3.3.9.2	Forward Unit vacuum environment operational range, low pressure	14.0
3.5.	3.3.9.3	Forward Unit Corona Breakdown	14.0

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.	P0702	GSS FSU Full Functional Test Procedure.
4.4.	P0758	GSS GSE Electrical Test Procedure
4.5.	SU 26225-101	Assembly Drawing for the Forward Suspension Unit (FSU)
4.6.	MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment
4.7.	P0875	GP-B Maintenance and Testing at all Facilities
4.8.	MIL-STD-1540C	Test Requirements for Launch, Upper-stage, and Space Vehicles, Section 6.4.2.

5.0 Test Facilities

5.1. Primary facility: Lockheed Sunnyvale TVAC Complex, Bldg 151.

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 the 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. Paul Shestople

7.3. Scott Smader

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, and during evacuation and venting of TVAC chamber.

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 P0702, GSS FSU Full Functional Test Procedure, is in addition to the equipment listed below. All calibration information required for subordinate procedure P0702 is wholly contained in that document.

Item	Equipment Description	Qty	Make	PN	SN	Cal Due
1.	Thermal Vacuum test chamber	1				
2.	Feedthrough FT-1 (33 pin)	1	Douglas Engineering	24056		NA
3.	Feedthrough FT-2 (50 Pin)	1	Douglas Engineering	24056		NA
4.	Feedthrough FT-3 (Power)	1	PaveMate	1647		NA
5.	TVac FSU mounting plate	1	SU		NA	NA
6.	Tvac Feedthru plate	1	SU		NA	NA
7.	Power/Test Console	1	SU			
8.	Pasternack Cables	7	Pasternack		N/A	N/A
9.	Power Cables	1	SU			
10.	Data cables	2	SU			
11.						
12.						
13.						
14.						
15.						

11.0 Thermal Vacuum Profile

11.1. Each thermal cycle has the following general characteristics, as shown in figure 1:

11.1.1. Transition regions between fixed end temperatures (B, D, F, H)

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 (A, C, E, G, I)

11.1.4. All cycles start and end at ambient temperature (A, I).

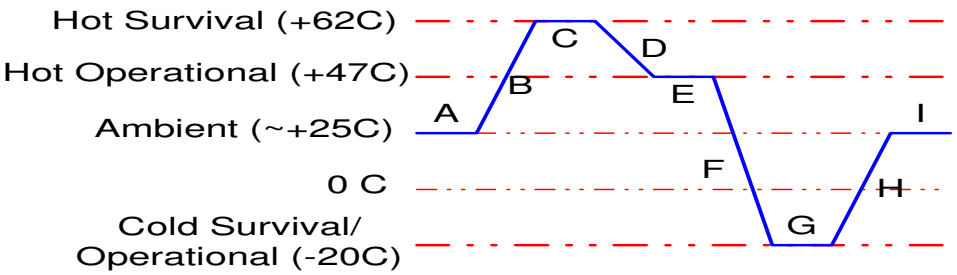
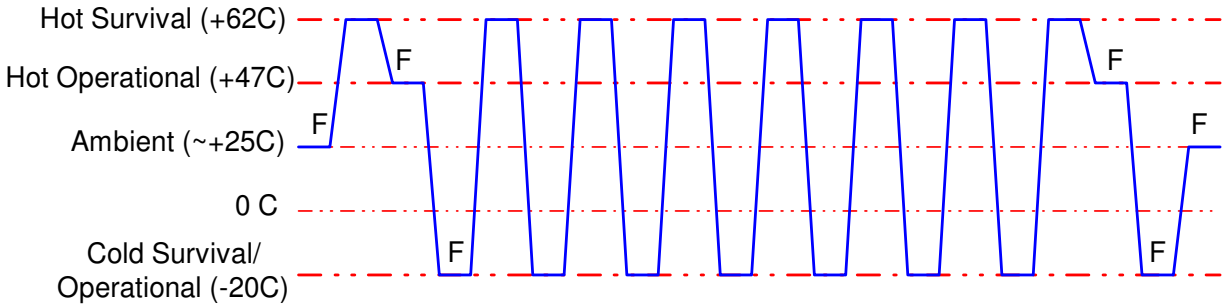


Figure 1 - TVAC Profile Characteristics

High Survival Temperature	High Operational Temperature	Low Operational Temperature	Low Survival Temperature
335K (+62C)	320K (+47C)	253K (-20C)	253K (-20C)

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

Cycle	Segment	Temperature	Test Type
Pre-vacuum	A	Ambient	Functional*
1	E	+47 C	Functional*
1	G	-20 C	Functional*
8	E	+47 C	Functional*
8	G	-20 C	Functional*
Post-vacuum	I	Ambient	Functional*



*Functional tests shall be conducted per P0702.

12.0 Device Under Test (DUT):

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

26225-101 GSS Forward Suspension Unit (FSU)	SN:	

Test Operator:	Name:	

Start of test:	Date: Time:	

13.0 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.

13.1 Remove DUT from its storage container. Visually inspect all connectors for damage. Istall the dummy loads using the Pasternack coax cables.

13.2 Install DUT into the TVAC Chamber.

13.2.1 Place FSU DUT on cold plate adapter plate. Bolt the FSU DUT to the cold plate adapter plate with four ¼ x 20 bolts, with washers, torqued to 30 in-lbs ± 5 in-lbs.

13.2.2 Place the FSU DUT and cold plate adapter plate into the TVAC Chamber.

13.2.3 Secure the cold plate adapter to the cold plate using with four ¼ x 20 bolts, with washers, torqued to 30 in-lbs ± 5 in-lbs.

13.3 Install circular feedthru adapter plate onto TVAC chamber, using the facilities bolts. The feedthrus must be installed first, and the feed thru O-rings will on the atmosphere side of the feedthru adapter plate.

13.4 Install power and data cables, as shown in Figure 2. The six foot cables are used inside the chamber, and the 12 foot cables are used outside the chamber.

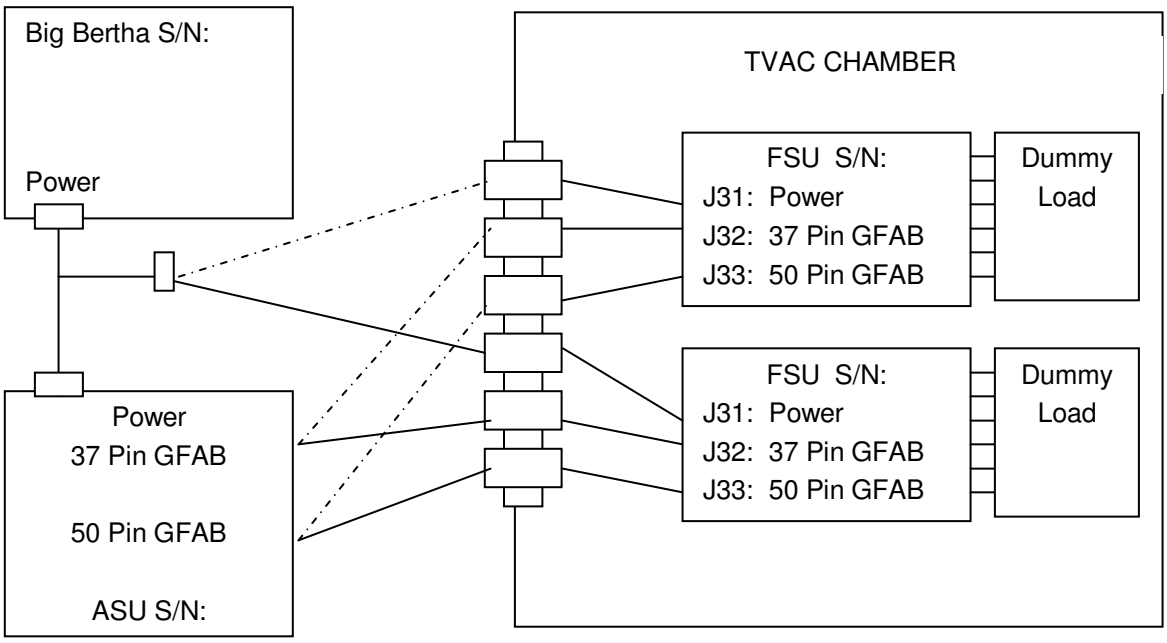


Figure 2 – Power and data cables (dashed lines indicate alternate set up)

Installation Complete:

Test Engineer | | Date | |

Comments

14.0 Cycle Tracking

THE FSU USES HIGH VOLTAGE (750 V). IF THE UNIT IS POWERED ON DURING THE EVACUATION OF THE CHAMBER, THE FSU WILL ALM0ST CERTAINLY SHORT, POSSIBLE DAMAGING THE FSU. THEREFORE:

IT IS ESSENTAIL THAT THE EXTERNAL POWER CABLES ARE DISCONNECTED DURING THE EVACUATION AND VENTING OF THE TVAC CHAMBER.

Cycle	Time / Temp / Pressure	Functional
P0875 Pre-Test Checklist		
Pre Vacuum		X
Evacuate chamber to 10E-5 Torr		
1st Survival High		
1st Operational High		X
1st Operational/Survival Low		X
2nd Survival High		
2nd Operational/Survival Low		
3rd Survival High		
3rd Operational/Survival Low		
4th Survival High		
4th Operational/Survival Low		
5th Survival High		
5th Operational/Survival Low		
6th Survival High		
6th Operational/Survival Low		
7th Survival High		
7th Operational/Survival Low		
8th Survival High		
8th Operational High		X
8th Operational/Survival Low		X
Vent chamber to ambient pressure		
Post Vacuum		X
P0875 Post-Test Checklist		

15.0 Completion of Procedure

	P/F	Notes
Confirm power cable is disconnected.		
Vent chamber using dry Nitrogen as purge gas.		
Once Chamber is at ambient temperature and pressure, perform final functional test, per P0747		
Stop logging of temperature data on chamber controller PC. Plot as-run thermal profile and attach to this procedure.		
Record total power on time on cover sheet of procedure.		
Remove DUT from TVAC Chamber.		
Return DUT to storage container.		

16.0 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	