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

Gravity Probe B Relativity Mission

GYROSCOPE SUSPENSION SYSTEM (GSS)
FORWARD SUSPENSION UNIT (FSU) SUBSYSTEM
LOW TEMP RELAY PERFORMANCE CHECK

P0751 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

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	20 March, 2002	P Shestople

2.0 Scope

This procedure details the operations performed to verify that the GSS FSU High Voltage Bridge Board's transistors and relays are not subject to low temperature failure. This procedure is to be run on every flight GSS FSU, per DR 429.

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 Reference Documents

3.1.	PLSE 13-1 Rev A	GSS Specification
3.2.	P0663	GSS Gold System Hardware and Software Configuration Standard
3.3.	P0702	GSS FSU Full Functional Test Procedure.
3.4.	P0758	GSS GSE Electrical Test Procedure
3.5.	SU 26225-101	Assembly Drawing for the Forward Suspension Unit (FSU)
3.6.	MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment
3.7.	P0875	GP-B Maintenance and Testing at all Facilities
3.8.	DR 429	GSS FSU Low Temperature HV relay switch filure discrepancy.
3.9.	MIL-STD-1540C	Test Requirements for Launch, Upper-stage, and Space Vehicles, Section 6.4.2.

4.0 Test Facilities

4.1. Primary facility: END STATION 3, 175 HEPL, GSS Electronics Lab.

4.2. Alternate facility (specify):_____

5.0 QA Provisions

5.1. 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)

5.2. 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.

6.0 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)

6.1. William Bencze

6.2. Paul Shestople

6.3. Scott Smader

7.0 General Instructions

7.1. Redlines can be initiated by the test personnel listed in Section 6.0 and must be approved by QA.

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

7.3. 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.

7.4. Only the following persons have the authority to exit/terminate this test or perform a retest: test operators listed in Section 6.0 and GP-B QA.

8.0 Hardware Safety Requirements:

8.1. 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

8.2. Ensure that power is removed from cable assemblies before connecting or disconnecting cable connectors, and during evacuation and venting of TVAC chamber.

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

8.4. 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.

9.0 External Test Equipment

9.1. 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.

9.2. 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	SU	TVAC01	001	NA
2.	Feedthrough FT-1 (33 pin)	1	Douglas Engineering	24056	22856	NA
3.	Feedthrough FT-2 (50 Pin)	1	Douglas Engineering	24056	22855	NA
4.	Feedthrough FT-3 (Power)	1	PaveMate	1647	NA	NA
5.	Feedthrough FT-4 (Dummy)	1	Douglas Engineering	24056	22858	NA
6.	TVac FSU mounting plate	1	SU	-	NA	NA
7.	Big Gerta Power Supply	1	SU	8A00740GSE_501	002	
8.	Space Craft Emulator	1	SU	NA	002	
9.	Pasternack Cables	7	Pasternack	NA	N/A	N/A
10.	Power Cables	1	SU	NA	NA	NA
11.	Data cables	2	SU	NA	NA	NA
12.	Dummy Load	1	SU	NA	04	NA
13.	Dummy Load Break Out Box	1	SU	NA	01	NA
14.	Pentium Class Computer for Data Acquisition	1	Brand X	01	NA	NA
15.	GOLD AFT SUSPENSION SYSTEM BOX	1	SU	ASU GOLD	001	NA
16.						
17.						

10.0 Special Thermal Vacuum Instructions

WARNING:

Do not allow the DUT voltage to be on during the pump down phase of the test.

Do not open the chamber to air while the DUT temperature is below 25 C.

This test is not a TVAC test; the formal TVAC requirement has been performed, per PDOC P0747, for each flight GSS FSU. However, because the relay/transistor failure manifests at low temperature, the SU TVAC facility is used to cool the DUT to test conditions. Please see P0747 for detailed TVAC instructions.

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

11.0 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:	

Step	Description	P/F	Notes
11.1	Annotate operation start time in Operations Log		

12.0 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.

Step	Description	P/F	Notes
12.1	Remove DUT from storage container. Visually inspect all connectors for damage.		
12.2	Install DUT into the TVAC Chamber.		
12.2.1	Place FSU DUT on cold plate adapter plate. Bolt FSU DUT to the cold plate adapter plate with eight 10-32 bolts with lock washers, torqued to 30 in-lbs ± 5 in-lbs.		
12.2.2	Align the cold plate adapter (with DUT) to the threaded rods sticking out of the cold plate.		
13.2.3	Secure the cold plate adapter to the cold plate using four ¼ x 20 bolts, torqued to 30 in-lbs ± 5 in-lbs.		
12.3	Install four feedthrus into TVAC chamber. The feedthru O-rings will be on the atmosphere side of the feedthru adapter plate.		
12.4	Install power and data cables, as shown in Figure 1. The six foot cables are used inside the chamber, and the 12 foot cables are used outside the chamber. Annotate Mate/Demate logs accordingly.		
12.5	Ensure dummy load connections using the Pasternack coax cables.		
12.6	Installation Complete: Date:_____ Time:_____		

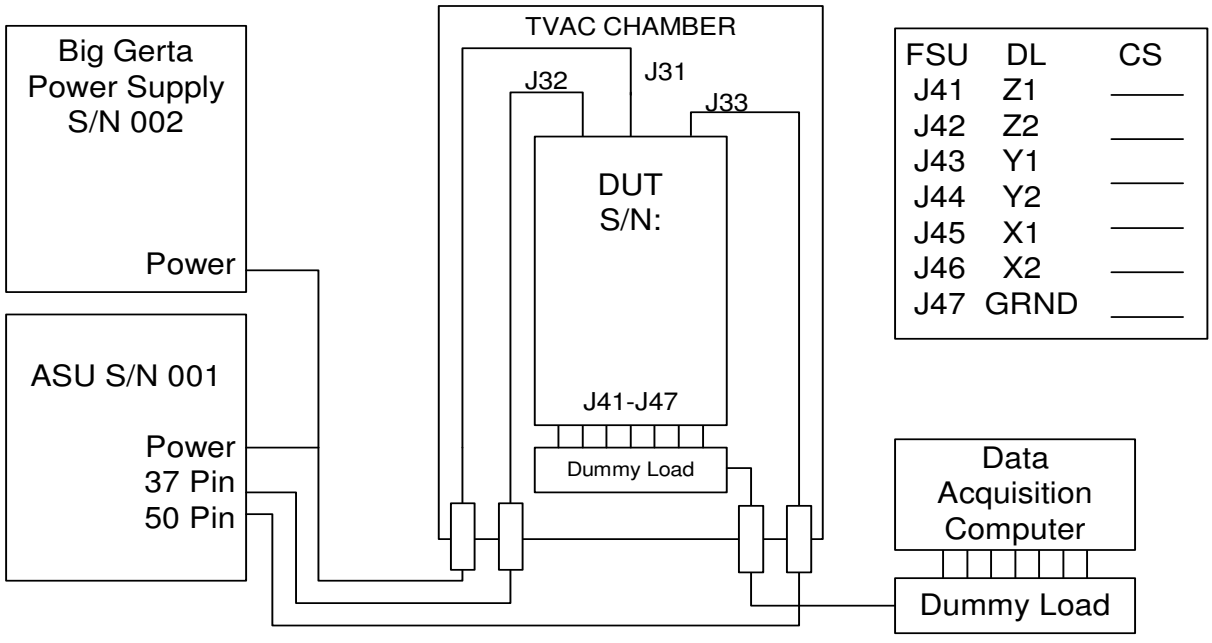

Figure 1: Installation Drawing

13.0 Procedure

Step	Description	P/F	Note
13.1	Before beginning the pump down of the TVAC chamber, perform the following aliveness test:		
13.1.1	Power up the DUT and ASU, including running **gssloader** and **startall**. Refer to P0702 for details. Record power up time in Power Log.		
13.1.2	At the CCCA Command Pit View 4 Window, open an Arbiter 7 and an ATC PIT window.		
13.1.3	Run the following scripts from the Command Pit client 2 Window:		
13.1.3.1	**P0702_start.scp**		
13.1.3.2	**P0702_FCL.scp**		
13.1.3.3	**P0702_FMR.scp**		
13.1.3.4	**P0702_ADDA.scp**		
13.2	Perform a room temperature component check		
13.2.1	From the CCCA Command Pit client 2 Window, send the following commands:		
13.2.1.1	Send the **16 13** command.		
13.2.1.2	Send the **16 5 0** command.		
13.2.1.3	Send the **16 8** command.		
13.2.1.4	Send the **16 5 3** command.		
13.2.1.5	Send the **16 7** command.		
13.2.1.6	Run the following script: **SN002_D6x**.		
13.2.1.7	Send the **14 23 8** command. This command displays DUT temperatures in FLT 1 - FLT 5 slots of the ATC PIT window. Record the temperatures. FLT 1 (X):_____ FLT 2 (Y):_____ FLT 3 (Z):_____ FLT 4 (FMR):_____ FLT 5 (MUX):_____		
13.2.1.8	Verify that the data acquisition computer is acquiring data. Send a **16 10** command, wait one minute, then send a **16 9** command. Voltage switching should be apparent on the DAQ computer monitor change.		
13.2.1.9	Run the following script: **Relaytest.scp**. This script tests the relay switching by sending **16 9** and **16 10** commands to the FSU at decreasing intervals, starting with an interval of one minute. Because the script repeats the switch 10 times per interval, the test takes about 20 minutes.		
13.3	**TURN OFF THE POWER TO THE DUT BEFORE CONTINUING WITH THE PROCEDURE.** Record power down time in Power Log.		
13.4	Begin pumping out the TVAC procedure. The pump-down will require at least 10 hours because the chamber pressure must be below 10^{-4} Torr before powering up the FSU.		

13.5	Set the chamber temperature controller set point to -25 C. This may be done concurrently with step 13.4. Verify sufficient LN.		
13.6	Once the chamber has soaked at -25 C for at least five hours and the chamber pressure is below 10^{-4} Torr, proceed with the following cold temperature relay test. Chamber Pressure: _____Torr Chamber Temperature: _____C Soak Time: _____Hours		
13.6.1	Power up the DUT and ASU, including running **gssloader** and **startall**. For details on how to do this, refer to P0702. Record power up time in Power Log.		
13.6.2	At the CCCA Command Pit View 4 Window, open an Arbiter 7 and an ATC PIT window.		
13.6.3	Run the following scripts from the Pit client 2 window:		
13.6.3.1	**P0702_start.scp**		
13.6.3.2	**P0702_FCL.scp**		
13.6.3.3	**P0702_FMR.scp**		
13.6.3.4	**P0702_ADDA.scp**		
13.7	Perform a cold temperature component check:		
13.7.1	At the Pit client 2 Window, send the following commands:		
13.7.1.1	Send the **16 13** command.		
13.7.1.2	Send the **16 5 0** command.		
13.7.1.3	Send the **16 8** command.		
13.7.1.4	Send the **16 5 3** command.		
13.7.1.5	Send the **16 7** command.		
13.7.1.6	Run the following script: **SN002_D6x**.		
13.7.1.7	Send the **14 23 8** command. This command displays DUT temperatures in FLT 1 - FLT 5 slots of the ATC PIT window. Record the temperatures. FLT 1 (X):_____ FLT 2 (Y):_____ FLT 3 (Z):_____ FLT 4 (FMR):_____ FLT 5 (MUX):_____ Note: These temperatures should be around -20 C. If not, drop the temperature accordingly before continuing. **DO NOT let the temperature drop below -23 C**.		
13.7.1.8	Verify that the data acquisition computer is acquiring data. Send a **16 10** command, wait one minute, send a **16 9** command. Voltage switching should be apparent on the DAQ computer monitor change.		
13.7.1.9	Run the following script: **Relaytest.scp**. This script tests the relay switching by sending **16 9** and **16 10** commands to the FSU at decreasing intervals, starting with an interval of one minute. Because the script repeats the switch 10 times per interval, the		

	test takes about 20 minutes.		
13.8	After completing the relay test, power off the FSU. Record power down time in Power Llog.		
13.9	Warm the TVAC chamber up to 25 C		
13.10	Verify DUT Power off, then bleed the chamber pressure up to room temperature.		
13.11	With the DUT at room temperature and pressure perform a P0702, Rev _____		

14.0 Completion of Procedure

Step	Description	P/F	Notes
14.1	Confirm power cable is disconnected. Annotate Mate/Demate Log.		
14.2	Stop PC data logging.		
14.3	Plot as-run thermal profile and attach to this procedure.		
14.4	Plot histograms of **relaytest.scp** data, and attach to this procedure		
14.5	Record total power on time on cover sheet of procedure.		
14.6	Remove DUT from TVAC Chamber.		
14.7	Return DUT to storage container.		
14.8	Record end of test time in Operations Log.		

15.0 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 _____