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Gravity Probe B Relativity Mission

**FULL FUNCTIONAL TEST PROCEDURE FOR THE
GYROSCOPE SUSPENSION SYSTEM (GSS)
AFT SUSPENSION UNIT (ASU) SUBSYSTEM –
ENGINEERING UNIT WITH FLIGHT-SPARE PAYLOAD
PROCESSOR - USING THE
GSS TEST ENVIRONMENT**

**GP-B Procedure
P0752 Rev -**

DUT PN: 26226-EU REV -EU _____

SN: _____

Date Performed: _____

Prepared by: Scott Smader
RE

Date

Approved by: William Bencze
Payload Electronics Manager.

Date

Approved by: Dorrene Ross
GP-B Quality Assurance

Date

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1.0 Revision History

| Rev Level | Comments/notes | Date | Revised By |
|-----------|--------------------------------------|-------------|------------|
| - | First release of this test procedure | 20-Nov-2002 | S Smader |

2.0 Scope:

This procedure details the operations required to perform a box-level full functional test on a GSS aft engineering unit, PN 26226-EU with Flight Spare Payload Processor using the GSS Software Test Environment as described in P0670.

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. P0670 Board-Level Test Software Operational Procedure
- 3.4. P0772 Aft Full Functional Test Procedure
- 3.5. P0758 GSS GSE Electrical Test Procedure
- 3.6. 26224 Assembly Drawing for the Aft Computer Unit (ACU)
- 3.7. 26226 Assembly Drawing for the Aft Suspension Unit (ASU)
- 3.8. MIL-STD-1686 Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment
- 3.9. pitView4
Documentation GSS Board-Level Test software operations manual

4.0 Test Facilities (Check One)

| | |
|--|--------------------------|
| 5.1. ES3 Room 175, Stanford University | <input type="checkbox"/> |
| 5.2. Other (specify): | <input type="checkbox"/> |

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: _____
GP-B QA (D. Ross)

Date/time: _____
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. Scott Smader
- 6.3. Lo Van Ho
- 6.4. Jay Dusenbury

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.
- 7.5. In this document, "Perform Flight S/W system test commands:" means to prepare the test system software as described in P0670 Board-Level Test Software Operational Procedure, and then issue the listed commands according to the procedure described in P0670.
- 7.6. All software used in this procedure shall be released and under configuration control prior to the start of this procedure.

8.0 Hardware Safety Requirements:

- 8.1. This modules in this assembly are 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.
- 8.3. 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 Additional Test Equipment

The following support hardware, test equipment, or software 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 below.

| Equipment Description | Make | Model | SN | Cal Due |
|-----------------------------|-----------|-------|----|---------|
| 1. Digital Multimeter | Fluke | | | |
| 2. Oscilloscope with probes | Tektronix | | | |
| 3. SRE Clock simulator | - | - | | |
| 4. Gold System | - | - | | |
| 5. | | | | |
| 6. | | | | |
| 7. | | | | |
| 8. | | | | |
| 9. | | | | |
| 10. | | | | |

10.0 Start of Test:

| | | |
|----------------|-------|--|
| Test Operator: | Name: | |
|----------------|-------|--|

| | | |
|----------------|-------|--|
| Start of test: | Date: | |
| | Time: | |

11.0 Engineering Unit Pre-Assembly:

11.1. Components

The 26226-EU assembly consists of an engineering equivalent ACU (26224) and a power supply that is functionally equivalent to the APU (26223), but suitable for use in a Ground Test environment.

The ACU for this assembly shall contain Engineering Unit modules built to flight-like specifications with the exception of the Payload Processor module (“R6K” – P/N: 199A-964-1) which shall be of Flight Spare construction. Part numbers for the Engineering Unit component modules are listed in the following table. Revision for each of these modules is to be functionally equivalent to released flight revision.

| Module Name | TLA | Part Number | Flight Rev | S/N |
|------------------------|-----|-------------|------------|-----|
| Aft Backplane | ABP | 8A01901-101 | E | |
| Aft Monitor and Timing | AMT | 8A01899-101 | C | |
| Aft Clock Support | ACS | 8A01898-101 | D | |
| Aft Comm Link | ACL | 8A01897-101 | B | |
| Aft Test Card | ATC | 8A01900-101 | A | |

In addition to the above modules, the system being constructed also contains:

| Module Name | Acronym or Mfr | Part Number | Rev | S/N |
|--------------------|----------------|-------------|--------|-----|
| APU Simulator | N/A | PC640 | B | |
| Payload Processor | R6K | 199A-964-1 | Flight | |
| Bench Power Supply | | | N/A | |

11.2. Differences from Flight Unit Construction

This assembly is intended only for use in a controlled Ground Test environment. As a result, several flight-critical steps and methods are not required.

Modules shall be assembled into engineering unit chassis, with internal power supply cabling that terminates in a connector equivalent to J12. Internal cabling for 1553 busses (8A02541-101) is not required. Nor is the ACU Ground cable (8A02542-101). Nor is the internal Boost Computer Cable (8A02540-101). Nor is the top cover (8A02428-101). Nor is the bottom cover (8A02430GSE).

Epoxy and tie-down steps are not required. Power supply cable is connected electrically at J12, but mechanical attachment of power supply is not required due to non-flight form factor of power supply. PWAs may or may not have wedge-lock locking card-guide components installed.

The APU (26223) power supply subsystem shall be replaced by APU Simulator engineering unit power supply, incorporating APU Simulator PWA (PC640). Input power to the APU Simulator supply shall be from laboratory bench triple-output DC power supply.

12.0 ASU Test Procedure

Prior to assembly of this EU ASU with FS R6K, each candidate module except R6K, i.e., ABP, AMT, ACS, ACL, and ATC, shall be tested for short circuits between power input leads. After one module is tested for short circuits, it shall be inserted into a Gold System, then functionally verified via P0772, Full Functional Test Procedure for the Gyroscope Suspension System (GSS) Aft System Unit (ASU) Subsystem Using the GSS Test Environment.

For Power Supply Short Circuit Tests below, Pass/fail criterion is that DUT passes if all resistance measurements are greater than 5000 ohms. Note the polarity for meter hookup.

After passing P0772, the tested module shall be assembled into the new ASU-EU chassis. Each P0772 shall be attached to this procedure, with a printout of its automated test.

12.1. ABP Module

12.1.1. Module Installation

Install the new ABP module in the new ASU EU chassis (similar to 8A01425-101).

| Module Installed | S/N |
|------------------|-----|
| ABP | |

12.1.2. Power Leads Short Circuit Test

With all power off, ensure that Power Cable between APU and the device under test (DUT) is not installed. Set meter to “ohms”, record indicated resistance between the indicated test points.

| | P/F | Notes |
|--|-----|--------|
| 12.1.2.1. (-) TP1 DGND to (+) TP6 P5V | | Value: |
| 12.1.2.2. (-) TP1 DGND to (+) TP5 P3.3V | | Value: |
| 12.1.2.3. (+) TP1 DGND to (-) TP4 M15V | | Value: |
| 12.1.2.4. (-) TP1 DGND to (+) TP3 P15V | | Value: |
| 12.1.2.5. (+) TP6 P5V to (-) TP5 P3.3V | | Value: |
| 12.1.2.6. (+) TP6 P5V to (-) TP4 M15V | | Value: |
| 12.1.2.7. (-) TP6 P5V to (+) TP3 P15V | | Value: |
| 12.1.2.8. (+) TP6 P5V to (-) TP7 AGND | | Value: |
| 12.1.2.9. (+) TP5 P3.3V to (-) TP4 M15V | | Value: |
| 12.1.2.10. (-) TP5 P3.3V to (+) TP3 P15V | | Value: |
| 12.1.2.11. (+) TP5 P3.3V to (-) TP7 AGND | | Value: |
| 12.1.2.12. (-) TP4 M15V to (+) TP3 P15V | | Value: |
| 12.1.2.13. (-) TP4 M15V to (+) TP7 AGND | | Value: |
| 12.1.2.14. (+) TP3 P15V to (-) TP7 AGND | | Value: |
| 12.1.2.15. (+) TP1 DGND to (-) TP7 AGND. | | Value: |

12.1.3. ABP Module Functional Test

After the new ABP module has passed the above Power Leads Short Circuit Test, remove all modules from a Gold System except the ABP (and chassis enclosure). Install this module set into the new chassis with the new ABP, and connect the Gold System APU simulator power cable to the new chassis J12 connector. Perform P0772 on the resulting system. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|-------------------|------|------|--------------|
| ABP | | | |

Turn off power to the new DUT. Disconnect and remove the Gold System APU simulator and other modules from the new chassis (with new ABP), and reinstall them in the Gold System Chassis.

12.2. APU Simulator

12.2.1. APU Simulator Input Voltages Test

A calibrated voltmeter shall be used to confirm that bench supply voltages are within allowed limits prior to connection between bench supply banana jacks and APU Simulator banana jacks. Allowed power supply limits are listed in the following table.

| | Nominal | Maximum | Minimum | P/F | Measured |
|-----------|---------|------------|------------|-----|----------|
| 12.2.1.1. | +15 VDC | +15.75 VDC | +14.25 VDC | | |
| 12.2.1.2. | +5 VDC | +5.25 VDC | -4.75 VDC | | |
| 12.2.1.3. | -15 VDC | -14.25 VDC | -15.75 VDC | | |

12.2.2. APU Simulator Power Supply Voltages Test

Make and break connections only with all power removed from circuits. Connect banana plug leads between the bench supply and the APU Simulator. Connect the APU Simulator cable to J12 on the new ASU EU chassis. J12 is connected via internal cabling to the ABP module in the new ASU EU. No other modules shall be installed in the new ASU EU during this test.

Turn on the power supply, and measure the following voltages on the ABP test points **with respect to ABP TP7 (AGND)**.

| | Nominal | Maximum | Minimum | TP | P/F | Measured |
|-----------|----------|------------|------------|----|-----|----------|
| 12.2.2.1. | +15 VDC | +15.75 VDC | +14.25 VDC | 3 | | |
| 12.2.2.2. | -15 VDC | -14.25 VDC | -15.75 VDC | 4 | | |
| 12.2.2.3. | +3.3 VDC | +3.465 VDC | +3.135 VDC | 5 | | |
| 12.2.2.4. | +5 VDC | +5.25 VDC | +4.75 VDC | 6 | | |

12.2.3. APU Simulator APU Monitor Voltages Test

With the APU Simulator cover removed, monitor signals on the PC640 PWA. Turn on the bench supply, and measure the following voltages **with respect to APU simulator TP8 (GND)**.

Note: It may be necessary to adjust R27 until APU TEMP MON signal is within specified range.

| | Signal | Maximum | Minimum | TP | P/F | Measured |
|-----------|-----------------|----------|----------|----|-----|----------|
| 12.2.3.1. | APU P MONITOR A | +3.1 VDC | +2.9 VDC | 11 | | |
| 12.2.3.2. | APU P MONITOR B | +3.1 VDC | +2.9 VDC | 10 | | |
| 12.2.3.3. | APU TEMP MON | +3.1 VDC | +2.9 VDC | 17 | | |

12.2.4. APU Simulator Power Sequencing

After the APU Simulator power supply has passed the above Output Voltages Test, turn it off, remove it from the new ASU EU chassis, and connect it to the Gold System. With the APU Simulator cover removed, monitor signals on the PC640 PWA.

Connect oscilloscope Ground lead to TP2 or TP8 (Signal Ground). Connect oscilloscope probe CH1 to TP1 (+5V). Connect oscilloscope probe CH2 to TP3 (+3.3V). Set horizontal scale to 10 milliseconds. Set both channels' vertical scale to 2 volts/division. Set trigger source to CH1 rising edge. Set trigger level to 2.5 volts. Set acquisition mode to Single Trace. Then turn power on to APU simulator. Observe the following conditions during power-on transition.

| | | P/F |
|-----------|---|-----|
| 12.2.4.1. | TP3 (+3.3V) is always less than TP1 (+5V) during power-on transition. | |
| 12.2.4.2. | TP1 (+5V) is not on for more than 50 milliseconds without TP3 (+3.3V) being on. | |

Set oscilloscope trigger source to CH1 falling edge. Then turn power on to APU simulator. Observe the following conditions during power-off transition.

| | | P/F |
|-----------|---|-----|
| 12.2.4.3. | TP3 (+3.3V) is always less than TP1 (+5V) during power-on transition. | |
| 12.2.4.4. | TP1 (+5V) is not on for more than 50 milliseconds without TP3 (+3.3V) being on. | |

12.2.5. APU Simulator Reset Pulse

Connect oscilloscope Ground lead to TP8 (Signal Ground). Connect oscilloscope probe CH1 to TP1 (+5V). Connect oscilloscope probe CH2 to TP7 (System Reset Out). Set trigger source to CH1 rising edge. Leave other oscilloscope settings as in 12.2.3. Then turn power on to APU simulator. Observe the following conditions during power-on transition.

| | | P/F |
|-----------|--|-----|
| 12.2.5.1. | TP7 (System Reset Out) does not go high until at least 15 milliseconds after the time at which TP1 (+5V) attains 4.75 volts. | |

Turn off power to the APU simulator. Connect oscilloscope probe CH1 to TP3 (+3.3V). Leave other oscilloscope settings as in 12.2.4.1. Then turn power on to APU simulator. Observe the following conditions during power-on transition.

| | | P/F |
|-----------|--|-----|
| 12.2.5.2. | TP7 (System Reset Out) does not go high until at least 15 milliseconds after the time at which TP3 (+3.3V) attains +3.135 volts. | |

Turn off power to the APU simulator. Disconnect all leads.

12.2.6. APU Simulator Installation

Install APU simulator cover. Connect APU simulator cable to J12 of new EU chassis with previously tested ABP. Banana-jack cabling and bench power supply are components of the APU simulator. Confirm that these items are also properly connected to APU simulator enclosure.

| Module Installed | S/N |
|------------------|-----|
| APU Simulator | |

12.3. AMT Module

12.3.1. Power Supply Short Circuit Test

Set meter to “ohms”, record indicated resistance between the indicated pins.

| | P/F | Notes |
|--|-----|-------|
| 12.3.1.1. (+) to P1 pin 120 [P5V] ↔ (-) to P1 pin 118 [DGND] | | Value |
| 12.3.1.2. (+) to P1 pin 1 [P15V] ↔ (-) to P1 pin 118 [DGND] | | Value |
| 12.3.1.3. (+) to P1 pin 118 [DGND] ↔ (-) to P1 pin 3 [M15V] | | Value |

12.3.2. AMT Module Functional Test

Replace the Gold System AMT module with this AMT. Perform P0772 on the modified Gold System. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|-------------------|------|------|--------------|
| AMT | | | |

12.3.3. AMT Module Installation

Remove the AMT from the Gold System, and install it in the new ASU EU chassis with the tested ABP and APU simulator.

| Module Installed | S/N |
|------------------|-----|
| AMT | |

12.4. ACS Module

12.4.1. Power Supply Short Circuit Test

Set meter to “ohms”, record indicated resistance between the indicated pins.

| | P/F | Notes |
|---|-----|-------|
| 12.4.1.1. (+) to P2 pin 120 [Vcc] ↔ (-) to P2 pin 2 [AGND] | | Value |
| 12.4.1.2. (+) to P2 pin 1 [P15V] ↔ (-) to P2 pin 118 [DGND] | | Value |
| 12.4.1.3. (+) to P2 pin 118 [DGND] ↔ (-) to P2 pin 3 [M15V] | | Value |

12.4.2. ACS Module Functional Test

Replace the Gold System ACS module with this ACS. Perform P0772 on the modified Gold System. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|-------------------|------|------|--------------|
| ACS | | | |

12.4.3. ACS Module Installation

Remove the ACS from the Gold System, and install it in the new ASU EU chassis with the tested ABP, AMT, and APU simulator.

| Module Installed | S/N |
|------------------|-----|
| ACS | |

12.5. ACL Module

12.5.1. Power Supply Short Circuit Test

Set meter to “ohms”, record indicated resistance between the indicated pins.

| | P/F | Notes |
|-------------------------------------|-----|-------|
| 12.5.1.1. (+) to J1-58 to (-) J1-60 | | |

DUT passes this section if measurement is greater than 5 Kohm.

12.5.2. ACL Module Functional Test

Replace the Gold System ACL module with this ACL. Perform P0772 on the modified Gold System. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|-------------------|------|------|--------------|
| ACL | | | |

12.5.3. ACL Module Installation

Remove the ACL from the Gold System, and install it in the new ASU EU chassis with the tested ABP, AMT, ACS, and APU simulator.

| Module Installed | S/N |
|------------------|-----|
| ACL | |

12.6. ATC Module

12.6.1. Power Supply Short Circuit Test

Set meter to “ohms”, record indicated resistance between the indicated pins.

| Test | P/F | Notes |
|------------------------------------|-----|-------|
| 12.6.1.1. (+) P1-120 to (-) P1-118 | | Value |
| 12.6.1.2. (-) P1-120 to (+) P1-1 | | Value |
| 12.6.1.3. (+) P1-1 to (-) P1-118 | | Value |
| 12.6.1.4. (+) P1-1 to (-) P1-2 | | Value |
| 12.6.1.5. (-) P1-2 to (+) P1-120 | | Value |

12.6.2. ATC Module Functional Test

Replace the Gold System ATC module with this ATC. Perform P0772 on the modified Gold System. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|-------------------|------|------|--------------|
| ATC | | | |

12.6.3. ATC Module Installation

Remove the ATC from the Gold System, and install it in the new ASU EU chassis with the tested ABP, AMT, and APU simulator.

| Module Installed | S/N |
|------------------|-----|
| ATC | |

12.7. Pre-Assembly of All New Modules Except R6K

Once a full complement of modules (excepting the R6K) has been assembled, the EU R6K module from the Gold System shall be inserted into the new assembly. This new assembly will be pre-tested for power supply short circuits, followed by running P0772.

12.7.1. Power Supply Short Circuit Test

With all power off, ensure that Power Cable between APU and DUT is not installed. Set meter to “ohms”, record indicated resistance between the indicated pins using the ABP test points.

| | P/F | Notes |
|--|-----|--------|
| 12.7.1.1. (-) TP1 DGND to (+) TP6 P5V | | Value: |
| 12.7.1.2. (-) TP1 DGND to (+) TP5 P3.3V | | Value: |
| 12.7.1.3. (+) TP1 DGND to (-) TP4 M15V | | Value: |
| 12.7.1.4. (-) TP1 DGND to (+) TP3 P15V | | Value: |
| 12.7.1.5. (+) TP6 P5V to (-) TP5 P3.3V | | Value: |
| 12.7.1.6. (+) TP6 P5V to (-) TP4 M15V | | Value: |
| 12.7.1.7. (-) TP6 P5V to (+) TP3 P15V | | Value: |
| 12.7.1.8. (+) TP6 P5V to (-) TP7 AGND | | Value: |
| 12.7.1.9. (+) TP5 P3.3V to (-) TP4 M15V | | Value: |
| 12.7.1.10. (-) TP5 P3.3V to (+) TP3 P15V | | Value: |
| 12.7.1.11. (+) TP5 P3.3V to (-) TP7 AGND | | Value: |
| 12.7.1.12. (-) TP4 M15V to (+) TP3 P15V | | Value: |
| 12.7.1.13. (-) TP4 M15V to (+) TP7 AGND | | Value: |
| 12.7.1.14. (+) TP3 P15V to (-) TP7 AGND | | Value: |
| 12.7.1.15. (+) TP1 DGND to (-) TP7 AGND. | | Value: |

12.7.2. Pre-Assembly Functional Test

Perform P0772 on the new system. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|-------------------|------|------|--------------|
| All except R6K | | | |

12.8. Final Test

Return the EU R6K module to the Gold System.

Install the Flight Spare R6K module into the new ACU assembly that has passed the Pre-Assembly Functional Test above. A final run of P0772 completes the functional verification of this assembly. Attach the completed P0772 procedure with a printout of its automated test log.

| Module Under Test | Date | Time | Log Filename |
|---------------------|------|------|--------------|
| Final (all modules) | | | |

End of Section

13.0 Completion of Procedure:

Do not perform sections 13.1 through 13.5 if the calling procedure conflicts.

| | P/F | Notes |
|---|-----|----------------|
| 13.1. Turn off power to the new 26226-EU and all connected devices. | | Serial Number: |
| 13.2. Remove all external cables from 26226-EU. | | |
| 13.3. Assign serial number and attach label to new 26226-EU. | | |
| 13.4. Place new 26226-EU in storage containers as appropriate. | | |
| 13.5. Attach all test results. | | |

End of Section

14.0 Certification:

I 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