STANFORD UNIVERSITY
W.W. HANSEN EXPERIMENTAL PHYSICS LABORATORY
GRAVITY PROBE B, RELATIVITY GYROSCOPE EXPERIMENT
STANFORD, CALIFORNIA 94305-4085

SUSPENSION CABLE CHECKOUT PRIOR TO GYROSCOPE INTEGRATION

GP-B SCIENCE MISSION PROCEDURE P0428

December 6, 1998

PREPARED	_____	_____
	R. Brumley, Gyro Manager (Acting)	Date
APPROVED	_____	_____
	D. Bardas, Integration Manager	Date
APPROVED	_____	_____
	J. Janicki, Safety Engineering	Date
APPROVED	_____	_____
	B. Taller, Quality Assurance	Date
APPROVED	_____	_____
	S. Buchman, Hardware Mgr. (Acting)	Date

Revision Record:

Rev	Rev Date	ECO #	Summary Description
Rev -	Dec 4, 1998		Original Release

A. SCOPE

This procedure describes an engineering test to be done on the suspension lines inside the GP-B flight probe (Probe C) as a final room-temperature measurement of their characteristics prior to gyroscope integration. It is intended to be performed in the Class 10 clean room after the vacuum can has been removed, but prior to gyroscope integration.

The following tests are to be performed on each suspension line:

A.1 Verify there are no shorts in the suspension lines between the inner conductor and the inner shield, the inner conductor and the outer shield, and the inner shield and the outer shield.

A.2 Verify continuity of the inner conductor and inner shield from the top hat to the LEMO connectors inside the vacuum can.

A.3 Measure the capacitance between the inner conductor and the inner shield.

No high-voltage tests will be performed on the suspension lines at this time.

B. REQUIREMENTS VERIFICATION

B.1 Requirements Cross Reference:

None

B.2 Expected Data for verification per requirement:

This data is for engineering purposes only.

C. CONFIGURATION REQUIREMENTS

C.1 Probe C shall be located in the clean room with the vacuum can off.

C.2 No gyroscopes or other hardware shall be connected to the end of the suspension lines.

C.3 No SQUIDs shall be installed in the probe.

D. HARDWARE REQUIRED

D.1 Commercial test equipment (calibrations not required for this equipment as the measurements used do not verify any science mission requirement)

Manufacturer	Model	Serial Number	Calibr. Exp. Date (OPTIONAL)
Andeen-Hagerling (precision capacitance bridge)	2500A	00129	18 Aug 2000
Keithley DMM (recommended)	196	467891	7/99

The Keithley DMM is recommended. However, any other DMM capable of verifying that a resistance exceeds 20 MΩ is acceptable.

D.2 Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date (OPTIONAL)
GSS Reynolds-to-MHV connector adapter box.	none	-	001	N/A
LEMO to banana connector adapter (the LEMO connector must be phosphor bronze and flight qualified)	LEMO: 1C34318-101	-	001	N/A

D.3 Tools

Description	No. Req'd
2m long DDC suspension cable (RG-59 with MHV male connectors on each end) THESE DO NOT TOUCH FLIGHT PARTS	2
MHV to banana plug adapters THESE DO NOT TOUCH FLIGHT PARTS	2
Banana Plug – Banana plug cables THESE DO NOT TOUCH FLIGHT PARTS	2

E. SOFTWARE REQUIRED

No software is required for this procedure.

F. PROCEDURES REQUIRED

Procedure Name	Procedure No.

G. GENERAL REQUIREMENTS

G.1 Personnel

G.1.1 Test Director

The test director for this procedure is Robert Brumley, or his appointed replacement. This procedure also falls under the jurisdiction of the Integration Manager, Dr. Doron Bardas, who will review and sign off the procedure. The Integration Manager is also responsible in general for the coordination of all integration procedures, and will therefore schedule appropriate times for the performance of this procedure. Doron Bardas should be notified of the time the procedure is beginning.

G.1.2 Personnel

This test to be conducted only by certified personnel. At least two persons from the following list must be present during the execution of the test:

- Chris Gray
- David Hipkins
- Robert Brumley
- Bruce Clarke
- Dr. Yueming Xiao
- Dr. William Bencze
- Dr. Sasha Buchman
- Tim Carson

G.2 Environmental Requirements

G.2.1 Cleanliness

This procedure takes place in the Class 1000 and/or the Class 10 clean rooms in the HEPL building. Minimum protective garments for personnel working in

the clean rooms shall be the standard Tyvek clean room apparel for the Class 10000 clean room and certified Class 10 cloth garments for wear during operations in the Class 10 clean room.

G.2.2 Particulate Contamination

All parts and tools shall be cleaned at least to the cleanliness levels of the rooms where they are used for assembly or testing. In addition, all flight parts shall be maintained at level 100 cleanliness per GP-B Contamination Control Plan (P0059). Take all necessary precautions to keep tools and handling equipment free from particulate contamination.

When in the Class 10 room, to the maximum extent possible, personnel shall keep all parts of their bodies downstream of the Probe, relative to the HEPA wall.

G.2.3 Magnetic Contamination

All parts and tools shall be cleaned using methods consistent with achieving Mil Spec Level 100 cleanliness. In addition, all parts shall be maintained at level 100 cleanliness per GP-B Magnetic Control Plan, Science Mission (P0057). Take all necessary precautions to keep tools and handling equipment free of particulate contamination. Tool should be sprayed with Freon from a pressure can filtered to 0.2 micron prior to use, or when contaminated.

G.3 Safety

G.3.1 General

Safety Engineering is to be notified prior to the start of this procedure.

All participating personnel shall ensure they are aware of the specific and hardware safety concerns indicated in the safety requirements, cautions, and warnings in the procedure. Personnel working in the Class 10 Cleanroom must be cognizant of the base of the Precision Manipulator, and take special care to avoid tripping or bumping into it.

G.3.2 Safety Engineering Contact

J. Janicki will be the safety contact for this procedure.

G.3.3 Maximum Number of People in Cleanroom

Under normal operating conditions, there shall be no more than 5 people in the

Class 10 Cleanroom. This is to avoid violating legal make up air requirements, and to provide an efficient workspace. Exceptions must be for short periods only, and be approved by the test director.

G.3.4 Hardware Safety

Extreme care must be taken to avoid accidentally bumping the Probe or damaging connectors. Only flight-approved connectors can mate with Probe C connectors.

G.4 Quality Assurance

Stanford QA must be notified at least one hour before beginning this procedure.

ONR QA must be notified at least one hour before beginning this procedure.

Art Nakashima (or another QA Representative) must be present to monitor the entire procedure. He will log data, results and redlines into the electronic file of this document provided to him on a floppy.

This procedure shall be conducted on a formal basis to its latest approved and released version. The procedure will be performed per QA plan P0108. The QA Program Engineer shall be notified of the start of this procedure. A Quality Assurance representative designated by B. Taller shall review any discrepancy noted during assembly or test. Redlines shall be approved by the QA representative. The QA representative will nominally be A. Nakashima. Upon completion of this procedure, the QA Program Engineer, B. Taller or P. Unterreiner, will certify his concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating his approval line at the end of the procedure. Discrepancies shall be recorded in the D-Log or in Discrepancy Reports according to P0108.

G.5 Redline Authority

Authority to red-line (make minor changes during execution) this procedure is given to the qualified personnel listed in section 3.2.2. All redlines must be approved by the QA representative. In addition, approval by the Hardware Manager shall by required if, in the judgement of the test director or QA Representative, experiment functionality may be affected. For procedures in the cleanroom, "redlines" shall be accomplished using red bold italics and "signatures" in black bold italics.

G.6 Electrical mating and demating of flight hardware connectors

G.6.1 Connection and disconnection shall be performed only when the equipment involved is in a powered-down state.

G.6.2 Connectors shall be inspected for contamination and for bent, damaged, or recessed pins prior to mating.

G.6.3 Grounded wrist straps are to be worn prior to removal of connector caps or covers and during mating/demating operations.

G.6.4 All mating/demating operations on flight connectors shall be noted in the Probe C log.

G.7 Electrostatic Discharge (ESD)

G.7.1 Grounding wrist straps will be worn at all times when touching flight equipment. The operations section of this procedure spells out specific steps which must be done in order to prevent hardware damage due to electrostatic discharge.

H. References and Applicable Documents

P0059 GPB Contamination and Control Plan
P0057 Stanford Magnetic Control Plan
P0108 Stanford University Quality Assurance Plan

I. EQUIPMENT PRETEST SETUP

The following procedure is required to set up and calibrate the support equipment for this test.

I.1 Capacitance meter setup

I.1.1 Turn on unit; wait until "oven not ready" light stops flashing.

I.1.2 Set unit display range. Measure the resistance of the capacitor under test.

I.1.2.1. Enter the following sequence on the front panel: [UNITS] → [4] → [ENTER]

I.1.3 Bridge functional test

I.1.3.1. Ensure the measurement cables are disconnected from the back of the unit.

I.1.3.2. Press the key: [SINGLE]

I.1.3.3. Confirm that the measured capacitance is < 0.001 pF.

Section Passed	QA Concurrence

I.1.4 Connect to test fixture.

I.1.4.1. Connect the "High" output on the meter to the "Ctr" side of the test fixture.

I.1.4.2. Connect the "Low" output on the meter to the "Shld" side of the test fixture.

I.1.5 Set the display resolution of the meter. 5 significant digits.

I.1.5.1. Key in the sequence: [FUNCTION] → [PLACES] → [5] → [ENTER]

I.1.5.2. Press the key: [SINGLE]

I.1.5.3. Confirm that the display does not indicate any error condition.

I.1.5.4. Confirm that the indicated resistance (the bottom number displayed) is positive.

I.1.6 Zero the measurement fixture capacitance.

I.1.6.1. Key in the sequence: [ZERO] → [ENTER]

I.1.6.2. Key in the sequence: [ZERO] → [SINGLE] → [ENTER]

I.1.6.3. Press the key: [SINGLE]

I.1.6.4. Confirm measured capacitance is < 0.001 pF.

I.1.7 Capacitance bridge setup complete

I.2 Keithley DMM Setup

I.2.1 Plug in Keithley DMM downwind from the probe in a convenient location.

I.2.2 Press the power button. Confirm the instrument comes on.

I.2.3 Press the " Ω" button.

I.2.4 DMM Setup Complete

Section Passed	QA Concurrence

J. OPERATIONS

This operations section shall be repeated for each suspension line. The data taken in this section shall be recorded in the tables at the end of this section. The order of testing of suspension cables is not important and they can be done in any convenient order.

J.1 Make sure all personnel who may touch the probe have wrist grounding straps on, and that those grounding straps are connected to an appropriate metal fixture on the probe.

J.2 Connect the test fixtures to the probe.

J.2.1 Connect the LEMO test fixture to the connector being tested on the bottom of the probe.

J.2.2 Weld-boss connector cleanliness inspection

J.2.2.1. Locate gyro weld-boss connector of interest on tophat.

J.2.2.2. Inspect weld-boss connector center pin to ensure it is straight, undamaged.

J.2.2.3. Inspect weld-boss connector inner threaded cylinder to ensure is it undamaged.

J.2.2.4. Inspect weld-boss connector for particles, debris, metal shavings.

J.2.3 Test fixture connector cleanliness inspection.

J.2.3.1. Examine center pin socket on gold Reynolds connector for damage, contamination.

J.2.3.2. Examine white insulating sleeve on gold Reynolds connector for damage, contamination.

J.2.4 Mate test fixture connector to the tophat weld-boss connector of interest.

Note: The test fixture should have the coaxial cables connected to it at all times. All disconnections /connections are made at the test equipment side of the coaxial cables, not the test fixture side.

J.2.4.1. Gently insert gold Reynolds connector to the weld-boss connector insuring that the center pin slides into its jack.

J.2.4.2. Screw down in the clockwise direction the gold Reynolds connector until some resistance is felt. Do not over tighten!

J.3 Continuity Confirmation

J.3.1 Disconnect BNC cables from the back of the capacitance bridge

J.3.2 Connect the BNC cables to the banana plug adapters. There should be a banana plug corresponding to the inner conductor, the inner shield, and the outer shield.

The shield of the BNC cables corresponds to the shield of the probe, so be careful not to short it to another metallic object.

J.3.3 Inner Conductor (top) to Inner Conductor (bottom)

J.3.3.1. Connect the banana plug corresponding to inner conductor of the LEMO adapter (probe "cold" end) to one input of the Keithley DMM.

J.3.3.2. Connect the banana plug corresponding to the inner conductor of the top hat adapter fixture to the other input of the Keithley DMM.

J.3.3.3. If the resistance indicated is less than 50 ohms, put a 🗐 mark in the "IC-IC" column of the test data table in the row corresponding to the connector being tested. If the resistance is greater than 50 ohms, record in D-LOG and continue.

J.3.4 Inner Shield (top) to Inner Shield (bottom)

J.3.4.1. Connect the banana plug corresponding to inner shield of the LEMO adapter (probe "cold" end) to one input of the Keithley DMM.

J.3.4.2. Connect the banana plug corresponding to the inner shield of the top hat adapter fixture to the other input of the Keithley DMM.

J.3.4.3. If the resistance indicated is less than 50 ohms, put a 🗐 mark in the "IS-IS" column of the test data table in the row corresponding to the connector being tested. If the resistance is greater than 50 ohms, record in D-LOG and continue.

J.3.5 Remove the LEMO test connector from the cold end of the probe.

J.4 Confirm no shorts

All connections in this subsection come from the Reynolds test fixture at the top hat. The LEMO test fixture on the probe "cold" end should already be disconnected.

J.4.1 Inner Conductor to Inner Shield

J.4.1.1. Connect the banana plug corresponding to the inner conductor to one input of the Keithley DMM.

J.4.1.2. Connect the banana plug corresponding to the inner shield to one input

of the Keithley DMM.

J.4.1.3. Confirm that the measured resistance is greater than 20 MΩ. If so, put a 🗐 mark in the IC-IS column of the data table in the row corresponding to the appropriate connector. If not, record in the D-Log.

J.4.2 Inner Conductor to Outer Shield

J.4.2.1. Connect the banana plug corresponding to the inner conductor to one input of the Keithley DMM.

J.4.2.2. Connect the banana plug corresponding to the outer shield to one input of the Keithley DMM.

J.4.2.3. Confirm that the measured resistance is greater than 20 MΩ. If so, put a 🗐 mark in the IC-IS column of the data table in the row corresponding to the appropriate connector. If not, record in the D-Log.

J.4.3 Inner Shield to Outer Shield

J.4.3.1. Connect the banana plug corresponding to the inner shield to one input of the Keithley DMM.

J.4.3.2. Connect the banana plug corresponding to the outer shield to one input of the Keithley DMM.

J.4.3.3. Confirm that the measured resistance is greater than 20 MΩ. If so, put a 🗐 mark in the IC-IS column of the data table in the row corresponding to the appropriate connector. If not, record in the D-Log.

J.5 Capacitance measurement:

J.5.1 Connect the capacitance bridge to the cables coming from the *MHV-to-Reynolds* test fixture. One coaxial cable should be connected to the BNC marked "Low" on the back of the capacitance bridge, and the other one should be connected to the BNC marked "High" on the back of the capacitance bridge.

J.5.2 Press the key: SINGLE on the capacitance bridge.

J.5.3 Record the capacitance measurement **and** the resistance measurement in the appropriate location in the data log, Table 1, in the appendix.

J.5.4 Confirm that the resistance measurement indicated on the capacitance meter is > 1000 G Ω. In the event that the measured resistance is less than this value, record in the D-LOG and continue with the other connectors.

J.5.5 Remove Adapter Fixture from connector on the top hat

J.6 Repeat J.1 – J.5 for all connectors listed in the data table.

K. CAPACITANCE MEASUREMENT DATA LOG

GYROSCOPE #1

				Continuity (J.3)		No Shorts (J.4)			Capacitance (J.5)		
Test order:	Connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	IC-IC	IS-IS	IC-IS	IC-OS	IS-OS	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
1.	C11										
2.	C12										
3.	C13										
4.	C14										
5.	C15										
6.	C16										
7.	C17										
8.	CG18										

GYROSCOPE #2

				Continuity (J.3)		No Shorts (J.4)			Capacitance (J.5)		
Test order:	Connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	IC-IC	IS-IS	IC-IS	IC-OS	IS-OS	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
9.	C21										
10.	C22										
11.	C23										
12.	C24										
13.	C25										
14.	C26										
15.	C27										
16.	CG28										

GYROSCOPE #3

				Continuity (J.3)		No Shorts (J.4)			Capacitance (J.5)		
Test order:	Connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	IC-IC	IS-IS	IC-IS	IC-OS	IS-OS	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
17.	C31										
18.	C32										
19.	C33										
20.	C34										
21.	C35										
22.	C36										
23.	C37										
24.	CG38										

GYROSCOPE #4

				Continuity (J.3)		No Shorts (J.4)			Capacitance (J.5)		
Test order:	Connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	IC-IC	IS-IS	IC-IS	IC-OS	IS-OS	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
25.	C41										
26.	C42										
27.	C43										
28.	C44										
29.	C45										
30.	C46										
31.	C47										
32.	CG48										

PROOF MASS

				Continuity (J.3)		No Shorts (J.4)			Capacitance (J.5)		
Test order:	Connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	IC-IC	IS-IS	IC-IS	IC-OS	IS-OS	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
33.	C51										
34.	C52										
35.	C53										
36.	C54										
37.	C55										
38.	C56										
39.	C57										
40.	CG58										

L. Anomalous test data

Attach any anomalous test data to the end of this procedure, and log it in the spaces below. Add additional sheets as necessary.

No.	Connector #	Failure description	Page numbers of attached sheets

M. PROCEDURE COMPLETION

The results obtained in the performance of this procedure are acceptable:

Test Engineer: _____ Date: _____

Responsible Engineer: _____ Date: _____

The information obtained under this assembly and test procedure is as represented and the documentation is complete and correct.

QA Representative: _____ Date: _____

QA Program Engineer: _____ Date: _____

N. DATABASE ENTRY

The following data shall be entered into the GP-B database:

N.1 Name, number, and revision of this procedure

N.2 Date of procedure completion