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

POST-INTEGRATION CHECKOUT OF SUSPENSION CABLES

GP-B SCIENCE MISSION PROCEDURE P0434

19 May, 1999

PREPARED	_____	_____
	R. Brumley, Gyroscope RE	Date
APPROVED	_____	_____
	B. Bencze, GSS RE	Date
APPROVED	_____	_____
	Dorrene Ross, Q.A. and Safety	Date
APPROVED	_____	_____
	S. Buchman, Hardware Manager	Date

1. SCOPE

This procedure is to provide detailed capacitance measurements of the suspension lines in Probe C at room temperature after the gyroscopes are installed. This procedure will be completed with the probe horizontal in two different orientations (one would provide three-axis suspension for gyroscopes 1 and 2, while the other would provide three-axis suspension for gyroscopes 3 and 4). This makes the interpretation of the suspension line data much easier. In addition to measuring the capacitance of the cables themselves, the various combinations of the center to center capacitances will be checked. This will provides information on the rotor's position within the housing. No high-voltage testing is to be performed at this time. This procedure may be done either before or after the vacuum can is installed.

2. REFERENCES

2.1 Plans and Procedures

If the vacuum can has not been installed onto the probe, then any actions that take place near the probe must be done in accordance with the following procedures.

P0059	Probe C Contamination and Control Plan
PO147	GPB Contamination and Control Plan
P0057	Stanford Magnetic Control Plan

3. GENERAL REQUIREMENTS

3.1. Environmental Requirements

3.1.1 Cleanliness

This procedure takes place in the Class 1000 and/or the Class 10 Cleanrooms 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 1000 cleanroom and certified Class 10 cloth garments for wear during operations in the Class 10 clean room.

3.1.2 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 the Probe C Contamination Control Plan (P0059). Take all necessary precautions to keep tools and handling equipment free from particulate contamination.

3.1.3 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 may be sprayed with Freon from a pressure can filtered to 0.2 micron prior to use, or when contaminated.

3.2 Integration and Test Personnel

3.2.1 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.

3.2.2 Personnel

The following personnel are qualified to perform this procedure:

- David Hipkins
- Bruce Clarke
- Chris Gray
- Robert Brumley
- Michael Irwin
- Dr. William Bencze
- Dr. Sasha Buchman

See section 3.4 for details on which Quality Assurance personnel are required to be notified and/or witness this procedure.

3.3 Safety

3.3.1 General

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.

3.3.2 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.

3.4 Quality Assurances

- 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.
- Russ Leese (or his designate) must be present to monitor the completion of this procedure.

This procedure shall be conducted on a formal basis to its latest approved and released version. The QA Program Engineer shall be notified of the start of this procedure. A Quality Assurance representative designated by D. Ross shall review any discrepancy noted during assembly or test. Redlines shall be approved by the QA representative. The QA representative will nominally be Russ Leese. Upon completion of this procedure, the QA Program Engineer, D. Ross or Russ Leese, will certify her/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.

3.5 Red-line 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.

3.6 Electrical Connections

When mating to any flight connector, the following items are required:

- A grounded ESD strap must be worn by any person handling a connector on Probe C.
- Inspect both connectors being mated to ensure that there are no particles that might interfere with the mate.
- Each mate and demate of flight connectors must be logged in that connector's mate/demate log sheet. Note that these log sheets have already been started for all suspension lines.

4. REQUIRED EQUIPMENT

4.1 Flight Hardware

Hardware	Part Number
Probe-C Assembly, without sunshade	25771-101*

* Note that the vacuum can may be either on or off for the completion of this procedure, as dictated by program scheduling requirements.

4.2 Ground Support Equipment

4.2.1 Electronics

Manufacturer	Model	Serial Number	Calibr. Exp. Date
Andeen-Hagerling (precision capacitance bridge)	2500A	00129	18 Aug 2000
Fluke handheld multimeter	(fill in at time of test)		

4.2.2 Adapters

Description	Part No.	Rev. no.	Serial No.
GSS Reynolds-to-MHV connector adapter (MHV for inner shield, MHV for center conductor)	none	-	001
GSS Top Hat Connector Savers (x 48)	none	-	001-048

4.2.3 Miscellaneous

Description	No. Req'd
2m long DDC suspension cable (RG-59 with MHV male connectors on each end)	2

5. SETUP

5.1 Capacitance meter setup

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

5.1.2 Enter the following sequence on the front panel: [UNITS] → [4] → [ENTER]

5.1.3 Key in the sequence: [FUNCTION] → [PLACES] → [5] → [ENTER]

5.1.4 Key in the sequence: [FUNCTION] → [AVERAGE] → [5] → [ENTER]

5.2 Capacitance Bridge Functional Test

5.2.1 Ensure the measurement cables are disconnected from the back of the unit.

5.2.2 Press the key: [SINGLE]

5.2.3 Confirm that the measured capacitance is < 0.001 pF.

5.3 Zero Cable and Test Fixture Capacitance

5.3.1 Connect to test fixture.

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

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

5.3.4 Press the key: [SINGLE]

5.3.5 Record the measured value below:

Fixture Capacitance: _____ pF

5.3.6 Key in the sequence: [ZERO] → [ENTER]

5.3.7 Key in the sequence: [ZERO] → [SINGLE] → [ENTER]

5.3.8 Press the key: [SINGLE]

5.3.9 Confirm measured capacitance is < 0.001 pF.

5.3.10 Capacitance bridge setup complete.

6. Measure All Cable Caps (center to shield)

For each connector in the following table, perform the following steps.

6.1 Inspect the connector on Probe C for any particulate contamination or any damage.

6.2 Connect the test fixture to the relevant connector on the probe.

6.3 Press the key: SINGLE

6.4 Record the capacitance and loss in the table below.

NOTE: Since it is preferable for the measurements for the gyroscopes 1 and 2 to be taken in a different probe orientation than for gyroscopes 3 and 4, the rest of the procedure may be completed in its entirety only for gyroscopes 1 and 2, then repeated for gyroscopes 3 and 4 once the probe is rotated.

TABLE A: CENTER TO SHIELD CAPACITANCES

Loss Units: _____

NOTE: ***Measurements for Gyroscopes 1 and 2 should be conducted with the Probe in with the -X Axis up.***

Gyroscope #1 Connections

Gyroscope Electrode	Probe C Connection	Capacitance	Loss	Notes
R1	C11			
S1	C12			
R2	C13			
S2	C15			
R3	C16			
S3	C17			
GP	CG18			

Gyroscope #2 Connections

Gyroscope Electrode	Probe C Connection	Capacitance	Loss	Notes
R1	C21			
S1	C22			
R2	C23			
S2	C24			
R3	C25			
S3	C27			

GP	CG28			

NOTE: Measurements for Gyroscopes 3 and 4 should be conducted with the Probe in with the -Y Axis up.

Gyroscope #3 Connections

Gyroscope Electrode	Probe C Connection	Capacitance	Loss	Notes
R1	C32			
S1	C33			
R2	C34			
S2	C35			
R3	C31			
S3	C37			
GP	CG38			

Gyroscope #4 Connections

Gyroscope Electrode	Probe C Connection	Capacitance	Loss	Notes
R1	C43			
S1	C47			
R2	C41			
S2	C42			
R3	C44			
S3	C45			
GP	CG48			

7. Install Connector Savers

7.1 Install Connector Savers for gyroscope being tested. Note that if the connector savers may remain on for a while, then all 48 may be installed at this time. If it is deemed that the connector savers must be removed for future probe operations, then they may be applied one gyroscope at a time. See Table A for the proper connections.

8. Measure all Resistances

8.1 Using a calibrated resistance meter (recorded in Section 4.2.1), measure the resistance between the inner conductor and inner shield, the inner conductor and outer shield, and the inner shield and outer shield. Record in Table B. Note that these measurements are made on the connector savers, so it is permissible to measure using probes applied to the relevant conductor – no special fixturing is required.

NOTE: ***Measurements for Gyroscopes 1 and 2 should be conducted with the Probe in with the -X Axis up.***

Gyroscope #1 Connections

Gyroscope Electrode	Probe C Connection	Inner Conductor to Inner Shield Resistance	Inner Conductor to Outer Shield Resistance	Inner Shield to Outer Shield Resistance
R1	C11			
S1	C12			
R2	C13			
S2	C15			
R3	C16			
S3	C17			
GP	CG18			

Gyroscope #2 Connections

Gyroscope Electrode	Probe C Connection	Inner Conductor to Inner Shield Resistance	Inner Conductor to Outer Shield Resistance	Inner Shield to Outer Shield Resistance
R1	C21			
S1	C22			
R2	C23			
S2	C24			
R3	C25			
S3	C27			
GP	CG28			

NOTE: Measurements for Gyroscopes 3 and 4 should be conducted with the Probe in with the -Y Axis up.

Gyroscope #3 Connections

Gyroscope Electrode	Probe C Connection	Inner Conductor to Inner Shield Resistance	Inner Conductor to Outer Shield Resistance	Inner Shield to Outer Shield Resistance
R1	C32			
S1	C33			
R2	C34			
S2	C35			
R3	C31			
S3	C37			
GP	CG38			

Gyroscope #4 Connections

Gyroscope Electrode	Probe C Connection	Inner Conductor to Inner Shield	Inner Conductor to Outer Shield	Inner Shield to Outer Shield

		Resistance	Resistance	Resistance
R1	C43			
S1	C47			
R2	C41			
S2	C42			
R3	C44			
S3	C45			
GP	CG48			

9. Measure Center to Center Capacitances

9.1 Using the Andeen-Hagerling capacitance bridge, measure the following center conductor to center conductor cross capacitances.

NOTE: ***Measurements for Gyroscopes 1 and 2 should be conducted with the Probe in with the -X Axis up.***

Gyroscope #1 Connections

Probe C Connection	Probe C Connection	Capacitance (pF)	Loss
C11	C12		
C11	C13		
C11	C15		
C11	C16		
C11	C17		
C11	CG18		
C12	C13		
C12	C15		
C12	C16		
C12	C17		
C12	CG18		
C13	C15		
C13	C16		
C13	C17		
C13	CG18		
C15	C16		
C15	C17		
C15	CG18		
C16	C17		
C16	CG18		
C17	CG18		

Gyroscope #2 Connections

Probe C Connection	Probe C Connection	Capacitance (pF)	Loss

C21	C22		
C21	C23		
C21	C24		
C21	C25		
C21	C27		
C21	CG28		
C22	C23		
C22	C24		
C22	C25		
C22	C27		
C22	CG28		
C23	C24		
C23	C25		
C23	C27		
C23	CG28		
C24	C25		
C24	C27		
C24	CG28		
C25	C27		
C25	CG28		
C27	CG28		

NOTE: Measurements for Gyroscopes 3 and 4 should be conducted with the Probe in with the -Y Axis up.

Gyroscope #3 Connections

Probe C Connection	Probe C Connection	Capacitance (pF)	Loss
C32	C33		
C32	C34		
C32	C35		
C32	C31		
C32	C37		
C32	CG38		
C33	C34		
C33	C35		
C33	C36		
C33	C37		
C33	CG38		
C34	C35		
C34	C36		
C34	C37		
C34	CG38		
C35	C36		
C35	C37		
C35	CG38		
C36	C37		

C36	CG38		
C37	CG38		

Gyroscope #4 Connections

Probe C Connection	**Probe C Connection**	**Capacitance (pF)**	**Loss**
C41	C42		
C41	C43		
C41	C44		
C41	C45		
C41	C46		
C41	CG48		
C42	C43		
C42	C44		
C42	C45		
C42	C47		
C42	CG48		
C43	C44		
C43	C45		
C43	C47		
C43	CG48		
C44	C45		
C44	C47		
C44	CG48		
C45	C47		
C45	CG48		
C47	CG48		

10. Procedure Completion

Record Completion of this procedure in traveler, as appropriate.

Record any abnormalities or deviations from this procedure in the D-Log. If the QA representative decides it is appropriate, then open a Discrepancy Report to document the event.

This test has been completed according to the procedure contained herein. All redlines used have been integrated into this document (sign):

Test Director: (print)	(sign)
QA Representative: (print)	(sign)

TABLE A: DDC CONNECTIONS IN PROBE C (FOR REFERENCE ONLY)

Gyroscope #1 Connections

Gyroscope Electrode	Probe C Connection	DDC Axis	Color	Notes
R1	C11	X1	Red	
S1	C12	X2	Purple	
R2	C13	Y1	Brown	
S2	C15	Y2	Orange	
R3	C16	Z1	White	
S3	C17	Z2	Yellow	
GP	CG18	N/A	N/A	

Gyroscope #2 Connections

Gyroscope Electrode	Probe C Connection	DDC Axis	Color	Notes
R1	C21	X1	Red	
S1	C22	X2	Purple	
R2	C23	Y1	Brown	
S2	C24	Y2	Orange	
R3	C25	Z1	White	
S3	C27	Z2	Yellow	
GP	CG28	N/A	N/A	

Gyroscope #3 Connections

Gyroscope Electrode	Probe C Connection	DDC Axis	Color	Notes
R1	C32	X1	Red	
S1	C33	X2	Purple	
R2	C34	Y1	Brown	
S2	C35	Y2	Orange	
R3	C31	Z1	White	
S3	C37	Z2	Yellow	
GP	CG38	N/A	N/A	

Gyroscope #4 Connections

Gyroscope Electrode	Probe C Connection	DDC Axis	Color	Notes
R1	C43	X1	Red	
S1	C47	X2	Purple	
R2	C41	Y1	Brown	
S2	C42	Y2	Orange	
R3	C44	Z1	White	
S3	C45	Z2	Yellow	
GP	CG48	N/A	N/A	