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

CHECK READOUT LOOP CONTINUITY IN PROBE C

GP-B SCIENCE MISSION PROCEDURE
P0726 Rev. -

August 2, 2000

PREPARED	_____	_____
	R. Brumley, Gyroscope RE	Date
APPROVED	_____	_____
	D. Ross, Quality Assurance and Safety	Date
APPROVED	_____	_____
	G. Keiser, Chief Scientist and Chair Cleanliness Control Committee	Date
APPROVED	_____	_____
	B. Muhlfelder, Technical Manager	Date

1. SCOPE

This procedure can be used to verify the continuity of the gyroscope readout loop, after that gyroscope has been installed in Probe C. It assumes that the SQUID lid is installed and staked with epoxy. This measurement is sensitive enough to indicate if the gyroscope pickup loop has become discontinuous.

2. REFERENCES

2.1 Plans and Procedures

P0023 GPB Clean Room Procedures

P0057 GPB Magnetic Control Plan

P0059 Probe Contamination Control Plan

P0108 Science Mission Quality Plan

P0147 Relativity Mission Contamination Control Plan, Master

P0327 Gravity Probe B Relativity Mission System Safety Program Plan

P0476 ESD/EOS Risk Mitigation Procedure

3. GENERAL REQUIREMENTS

3.1 Environmental Requirements

This procedure will be conducted in the Stanford Class 10 Cleanroom in the HEPL facility.

3.1.1 Room Cleanliness

The Class 10 clean room where this integration takes place shall be maintained at the cleanliness levels per Federal Standard 209E. All personnel in the clean room shall wear Class 10 cloth garments.

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 parts shall be maintained at level 100 cleanliness per GP-B Contamination Control Plan (P0059). A portable particle counter shall be set up on a table downstream of the local work area, and monitored during the work performed. If, at the discretion of the test director or QA, particulate counts rise to an unacceptable level for the specific work being performed, then work shall stop. Work shall not resume until the cause of the extra particulation has been assessed and necessary mitigating steps have been incorporated into the GSE and procedures. Take all necessary precautions to keep tools and handling equipment free of particulate contamination.

Since this operation is performed on extremely delicate flight equipment that is already assembled, there is a limitation on how well inspections and cleaning can be performed. In some cases this means that it will not be possible to rigorously verify level 100 cleanliness. At all times it is important to weigh hardware safety versus verifying and maintaining cleanliness. Therefore the test director and QA have discretion in arriving at the proper balance.

To the maximum extent possible, personnel shall keep all parts of their bodies downstream of the probe, defined by the direction of HEPA airflow.

At all times during the completion of this procedure a portable particle detector shall be situated near the work area to monitor for the generation of particles.

Ensure that properly calibrated ion bars are situated properly and operating.

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 constructed and screened as prescribed by the GP-B Magnetic Control Plan, Science Mission (P0057). Take all necessary precautions to keep tools and handling equipment free of particulate contamination.

Only nonmagnetic materials are allowed to touch the cold end of the probe.

3.1.4 Electrostatic Discharge (ESD)

ESD wrist straps shall be worn by all personnel who touch the probe. Note that per the previous section the steel alligator clips which connect to most wrist straps can not be connected to the cold end of the probe. The Precision Manipulator (PM) is in electrical contact with the probe, and may be used as a grounding site for ESD wrist straps.

3.2 Test Personnel

3.2.1 Test Director

The test director for this procedure shall be Dr. Barry Muhlfelder, or his appointed replacement.

3.2.2 Personnel

The following personnel are qualified to perform this procedure

- Dr. Barry Muhlfelder
- Ming Luo
- Chris Gray
- Ken Bower
- Bruce Clarke

- Robert Brumley

See section 3.4 for details on the requirements for Quality Assurance notification and witnessing of this procedure.

3.2.3 Minimum Personnel

No activity shall be performed on the science mission probe without at least two people in the room, i.e. at least one person to perform the procedure and one person to observe the procedure.

3.3 Safety

3.3.1 Hardware Safety -- General

Great care should be taken in the handling of the gyroscope and its hardware to avoid damage to them.

3.3.2 Electrostatic Discharge

Grounded wrist straps shall be worn when making connections to the readout cable. Also, it is important to use one of the multimeters specified in Section 4 so as to avoid any possibility of damaging the pickup loop.

The particle ionizer should always be upstream of the quartz block relative to the fan wall, to prevent electrostatic charge buildup on the quartz block. P0476 shall be read prior to starting this procedure and shall be signed here:

_____	_____	_____
Test Director (sign)	Test Director (print)	Date

3.3.3 Personnel Safety

All operations shall take place according to Stanford University safety guidelines. Any person observing a situation which they deem unsafe shall report the fact immediately to the test director. The Quality Assurance representative shall be responsible for monitoring that all activities are performed in a safe manner.

3.4 Quality Assurance

- Stanford QA must be notified at least 24 hours before beginning this procedure.
- ONR QA must be notified at least 24 hours before beginning this procedure.

- D. Ross (or her 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 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 R. Leese, shall certify his or her concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating the appropriate approval line at the end of the procedure.

3.5 Red-Line Authority

Authority to red-line (make minor chances 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 Technical Manager shall be required if, in the judgement of the test director or the QA representative, experiment functionality may be affected.

4. REQUIRED EQUIPMENT

The following equipment is necessary to perform this procedure:

Flight Hardware:

PART Name	Total Qty	P/N	S/N or LDC
Integrated Probe C / SIA Assembly	1		SM-01
Gasket, Lead	1	25043-101	
Screw, SHC, #2-56 X .180, Vented	6 (4 needed)	25054-102	

GSE Hardware:

Item	Calibration Required
Keithley Model 580 Digital Multimeter or Fluke 85 or Fluke 87	Yes
(OPTIONAL) Capacitance Meter	Yes
Standard Gyroscope Non-Magnetic Tool Kit	No

Secondary Containment for Flight Parts	No

5. INITIAL CONDITIONS

5.1 Verify Probe is on the Precision Manipulator in the Class 10 room, the vacuum can is off, and the probe is horizontal. _____

5.2 Verify all initial inspections have been performed, and the initial state of the SIA documented prior to beginning this procedure. _____

6. OPERATIONS

6.1 Procedure Initialization

Start Date: _____ Start Time: _____

Gyro Position being checked: _____

Test Engineer: _____ (print)

QA Representative: _____ (print)

Record Model Numbers, Serial Numbers, and Calibration Dates (if applicable) for the equipment designated in Section 4.

Model	**Serial Number**	**Calibration Date**

6.2 Prepare Workspace

6.2.1 A table and workspace needs to be set up underneath the SIA. First, verify that the probe is situated at a height well above the table so that there is no chance that the SIA will be bumped while the table is moved. _____

6.2.2 Inspect and clean the workspace table. Note that this table should have _____

been recently cleaned and certified as part of an overall Class 10 cleanroom cleaning and re-certification. _____

6.2.3 Note that non-magnetic tools should not be placed on a stainless steel surface, so either clean room wipes or clean bags should be provided on which to place these tools. _____

6.2.4 Install the particle collection system on the table. This consists of a HEPA vacuum cleaner with special positionable nozzles. _____

6.3 Disconnect Leads of Readout Cable from SQUID Package

6.3.1 This section should be completed with Barry Muhlfelder or his designate present. _____

6.3.2 Have QA double check SQUID position by tracing the readout cable route from the gyroscope to the SQUID. _____

6.3.3 Rotate the probe so that the SQUID for the gyroscope being removed is accessible, yet pointed down as far as feasible so that particles generated during this step tend to fall away from the rest of the science instrument. _____

6.3.4 Power up the particle collection system and position dust collection nozzles to trap released particles. This position may be changed during the procedure as required so that the suction is focused on the work area. _____

6.3.5 Using care to prevent damage to the screw, break the epoxy bond on each of the four screws (25054-102) which hold the lid on the SQUID. This can only be performed by Ken Bower or Chris Gray. Both have carefully calibrated their "feel" for how much torque is necessary and allowed in this process. If there is difficulty in breaking the staking, then a calibrated torque driver set to 50 oz in. shall be used. It is not necessary to use a calibrated torque driver if C. Gray and K. Bower feel that they are not approaching the yield strength of the screw (this is because they have much better "feel", and there is lower particulation risk, with the use of a standard hex wrench). _____

6.3.6 Using care to prevent damage to the screw, break the epoxy bond on each of the four screws which hold on the capacitor kit. _____

6.3.7 Inspect area around screws and remove any large pieces of epoxy which came loose but were not removed by the particle collection system. _____

6.3.8 Remove the four screws on the lid. Place these screws in a clean room bag, mark the bag, and remove from the work area. _____

6.3.9 Carefully remove the lid to the SQUID. Place the lid in a clean room bag, mark, and remove from the work area. _____

6.3.10 Remove the lead gasket (25043-101). Place in a clean room bag, mark, and remove from the work area.
Note: this should leave the connection between the readout cable and the SQUID exposed, but DO NOT remove the shield over the main SQUID electronics.

_____

6.3.11 Using the multimeter, measure the resistance across the readout cable. This is the parallel resistance of SQUID and pickup loop.

For Information Only: For the gyro #4 installation which finished 6/28/99, this was 107.9 Ω. The Input resistance of the SQUID was 109.4 Ω, and gyro pickup loop round-trip resistance before hookup was 7.17 kΩ.

R(parallel) = _____ Ω

6.3.12 Using the multimeter, measure the resistance between the pickup loop and ground. This should be approximately 2 MΩ.

R(to ground) = _____ Ω

6.3.13 (Optional) Using a calibrated capacitance meter, measure the capacitance between each lead to ground. This should be approximately 10 nF for each lead. If this step is performed, make sure the Model and Serial Number are recorded in Section 6.1.

C(First conductor to ground) = _____

C(Second conductor to ground) = _____

6.3.14 (Optional) Using a calibrated capacitance meter, measure the capacitance between the leads. This should be approximately 5 nF. If this step is performed, make sure the Model and Serial Number are recorded in Section 6.1.

C(Between cable leads) = _____

6.3.15 Carefully inspect the lid of the SQUID. Make sure there are no particles or pieces of epoxy remaining on the lid.

_____

6.3.16 Place a new lead gasket (25043-101) onto the top of the SQUID housing. Make sure the lot date code of the gasket used in recorded in the flight equipment table at the beginning of this procedure.

_____

6.3.17 Place the SQUID lid on top of the gasket and secure with the 4 screws (25054-102). Assuming there is an adequate availability of flight spares, it is preferred to use new screws for this step. If the original screws are reused, they must be inspected under a microscope for epoxy contamination, damage to the threads, and damage to the screw head.

Circle One: Original Screws Reused New Screws Used

Verify Inspection of Original Screws Performed (if reused):

_____ _____

Inspection Engineer Date

6.3.18 If new screws were used in the above step, verify that their lot date code has been recorded in the flight equipment table at the beginning of this procedure. _____

6.3.19 *Note: It is not necessary to epoxy stake these screws at this time. This will be performed after any and all rework to the probe has been completed.*

6.4 Storage and Documentation of "Used" Flight Hardware

6.4.1 Place all flight parts that are to be reused in a secondary containment vessel marked "SIA FLIGHT PARTS REMOVED FROM PROBE: SQUID Position# _____" and mark the date. These are to be stored in gyroscope bonded stores in the Class 10,000 room.

Note: Each part requires QA and ONR approval to reuse for flight. This entails the use of a special traveler for each part which documents its history while removed from the probe, and a new cleaning and inspection. For parts which contain portions of epoxy staking, the preference is to scrap the parts removed and replace with new parts. _____

7. PROCEDURE COMPLETION

Record completion of this procedure in the traveler, as appropriate.

Record any abnormalities or deviations from this procedure in the D-Log. If the QA representative decides it is appropriate, 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.

Test Director:	_____ (sign) _____ (print)	(date and stamp)
(optional) **Test Engineer:**	_____ (sign) _____ (print)	(date and stamp)
(optional) **Test Engineer:**	_____ (sign) _____ (print)	(date and stamp)
QA Representative:	_____ (sign) _____ (print)	(date and stamp)