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

HOOK-UP AND CHECK-OUT OF ALL GYRO CABLES WITH PROBE CONNECTORS

GPB SCIENCE MISSION PROCEDURE

4 May, 1999

PREPARED _____ _____
D. Bardas, Integration Manager Date

APPROVED _____ _____
D. Bardas, Integration Manager Date

APPROVED _____ _____
B. Taller, Quality Assurance Date

APPROVED _____ _____
S. Buchman, Hardware Manager Date

TABLE OF CONTENTS

1 SCOPE

This document provides procedures for connecting the cables (suspension, ground, fiberoptics and fiberoptic bias wires) with the SM probe

Note that, different to other integrations in the past of this nature, where a simple clocking of the gyro cables was followed to the probe connectors, this time there is the additional constraint that if possible predetermined probe suspension lines should be used for each electrode.

Preference of electrode to cable hook-up was determined by Robert Brumley and is documented below. Every attempt to comply with that configurational constraint will be made, however the ITD (D. Bardas), with the concurrence of QA, may override these additional constraints if it proves too difficult or is otherwise incompatible with the integration in any aspect.

The following operations are contained in this procedure:

- Determination of routing of 6 ea. suspension lines per gyro
- Determination or routing of 1 ea. ground line per gyro
- Determination of routing of 2 ea. fiberoptic cables per gyro
- Determination of routing of 2 ea. fiberoptic bias wires per gyro
- Hook-up and checkout of the suspension lines for each gyro
- Hook-up and ring checkout of the ground line for each gyro
- Hook-up and ring checkout of the fiberoptic line lines for each gyro
- Hook-up and checkout of the fiberoptic bias wires for each gyro

1.1 Acronyms

The following acronyms are used in this document

- QB Quartz Block
- QBF Quartz Block Flange
- QBS Quartz Block Support (aluminum support on probe)
- QB/T Integrated Quartz Block/Telescope
- SIA Science Instrument Assembly
- ITD Integration and Test Director
- Pr-C Probe C, the Science Mission flight probe
- QA Quality Assurance
- TB Terminal Block

2 REFERENCES

2.1 Plans and Procedures

- P0059 GPB Contamination Control Plan
- P0057 Stanford Magnetic Control Plan
- P0419 Operations Manual for the probe Precision Manipulator
- Guidelines for Connection Suspension Lines, Memo by R. Brumley, 4/14/99

2.2 Drawings

- 23170 Science Instrument Assembly Kit
- 23171 Science Instrument Assembly
- 1C34121 QBA Mounting Kit
- 1C34103 Probe / SIA Interface
- 1C34355 Pr-C to SU External Interfaces

3 GENERAL REQUIREMENTS

ONR representative, QA and Safety to be notified prior to beginning this procedure

3.1 Environmental Requirements

3.1.1 Cleanliness

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

The Class 10 clean room where this integration takes place shall be maintained at the cleanliness levels per GPB Contamination Control Plan P0059. Certified Class 10 cloth garments shall be worn 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 GP-B Contamination Control Plan (P0059). Take all necessary precautions to keep tools and handling equipment free of particulate contamination.

To the maximum extent possible, personnel shall keep their bodies and garments downstream of the SIA, relative to the HEPA wall.

3.1.3. Magnetic Contamination

All parts and tools shall be screened per Procedure P0057. 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, P0057. Take all necessary precautions to keep tools and handling equipment free of particulate contamination. Tools to be cleaned with Ethyl Alcohol prior to use, or when contaminated.

3.2 Electrostatic Discharge Control

To prevent electrostatic charge buildup on the QB/T the particle ionizer shall always be upstream of the QB/T relative to the fan wall and the PM and the QB/PM shall be grounded.

3.3 Integration and Test Personnel

3.3.1 Integration and Test Director

The Integration and Test Director (ITD) shall be Dr. Doron Bardas or an alternate that he shall designate. The ITD has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it.

3.3.2 Integration Engineers and other personnel

All engineers and technicians participating in this procedure shall work under the direction of the ITD who shall determine personnel that are qualified to participate in this procedure. Participants in this procedure are expected to be D. Bardas, G. Asher, C. Gray, R. Brumley.

3.3.4 General

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.

3.3.5 Hardware Safety

Extreme care must be taken to avoid accidentally bumping or scratching the QB/Telescope.

3.3.6 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 approved by the ITD.

3.4 Quality Assurance

Integration shall be conducted on a formal basis to approved and released procedures. The QA program office shall be notified of the start of this procedure. A Quality Assurance Representative, designated by B. Taller, nominally R. Leese, shall be present during the procedure and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Program Engineer, B. Taller or his designate, will certify his concurrence that the effort was performed and accomplished in accordance with the prescribed instructions by signing and dating in the designated place(s) in this document. Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108.

3.5 Red-line Authority

3.5.1 Authority to red-line (make minor changes during execution) this procedure is given solely to the ITD or his designate and shall be approved by the QA Representative. Additionally, approval by the Hardware Manager shall be required, if in the judgment of the ITD or QA Representative, experiment functionality may be affected.

3.5.2 Procedure Computerization Special Requirements

Because of cleanliness requirements in the Class 10 room, and to conveniently record data directly into the procedure thus generating the "as-built" document, the procedure will be handled in a paperless fashion until completed. A Laptop computer containing an electronic version of this procedure will be operated by the ITD or QA Representative and data shall be recorded by typing directly into the electronic file.

3.5.3 As-Built Documentation

Following completion of the procedure, a hard copy of the "as-built" procedure shall be printed ***and signed off by all the designated parties***. It shall then be filed, including an electronic copy into the data base.

The electronic editing of this document shall be as follows:

- Data will be inserted into the document using normal font, i.e. non-bold, non-italic
- "Signatures" shall be designated by **BLACK CAPITAL BOLD LETTERS**.
- "Redlines" shall be in ***RED BOLD ITALICS*** to make them distinguishable both on the Laptop screen and on the hard copy printout.
- If available, digital pictures shall be inserted into the document where appropriate.

4 REQUIRED EQUIPMENT

The following equipment shall be in the Class 10 cleanroom.

Ground Support Equipment

- Keithley 87 Hand held VOM plus auxiliary cables and probe pins/sockets

Tools and Miscellaneous

- BeCu Allen wrenches
- Tweezers and pliers

5 CONNECTING SUSPENSION AND GROUND LINES

5.1 Preferred Configuration

This information is paraphrased from the memo of R. Brumley, dated 4/14/99

Mismatch of the capacitances on one gyroscope axis looks to the GSS like a rotor position offset. Although the digital controller in the GSS can calibrate this error and correct for it, the analog backups can not. Note that a 2.3 pF mismatch in cable capacitance will results in ~1 μm rotor offset when in analog backup mode.

- It is important that capacitance of lines going to opposite electrodes in a gyroscope be matched as well as possible.
- If possible, connect the lines according to the suggestions given in Tables 1 through 4. This yields the best matching of opposite electrodes possible.
- If using an alternative connection scheme, try to switch connections in pairs. For example, it is suggested that for Gyroscope 1 R1 and S1 go to C11 and C12, respectively, while R2 and S2 go to C13 and C15, respectively. There is zero mission impact if R2 and S2 go to C11 and C12, while R1 and S1 go to C13 and C15. There is also zero impact to swap cables within a pair (e.g. R1 goes to C12 and S1 goes to C11). It only matters that the capacitance of opposite electrodes be well matched.
- If possible, avoid connecting to C36. There was a problem with this line during the cold measurement of Probe C's suspension lines. Although that problem has been fixed and the line is now 100% healthy, we do not have a knowledge of it cold capacitance.
- The recommended connections listed in the tables below are only suggestions. The actual connections are at the discretion of the ITD. Deviations from the recommended connections do not warrant a D-Log entry or a Discrepancy Report.

5.2 Determine Suspension and Ground Line Routing

5.2.1 For each gyro, D. Bardas and C. Gray shall make tentative routing decisions for the gyro and suspension and ground lines consistent, if possible with the Tables 1 through 4 below. Also to be considered are how the lines (including the fiberoptic and bias) shall be ordered as they pass through the slot in the Bird Cage extrusion adjacent to each gyro.

5.2.2 Record the tentative connection to the probe suspension and ground connectors in Tables 1 through 4 together with comments.

5.3 Preferred Gyroscope #1 Connections

Table 1.

Gyroscope Electrode	Recommended Connection	Cap. Rec. Connection	Tentative Connect Choice	Comments
R1	C11	64.111		
S1	C12	64.800		
R2	C13	65.799		
S2	C15	65.536		
R3	C16	66.740		
S3	C17	66.351		
GP	CG18	65.725		

5.4 Preferred Gyroscope #2 Connections

Table 2.

Gyroscope Electrode	Recommended Connection	Cap. Rec. Connection	Tentative Connect Choice	Comments
R1	C21	67.821		
S1	C22	67.538		
R2	C23	66.979		
S2	C24	67.353		
R3	C25	68.799		
S3	C27	67.993		
GP	CG28	69.564		

5.5 Preferred Gyroscope #3 Connections

Table 3.

Gyroscope Electrode	Recommended Connection	Cap. Rec. Connection	Tentative Connect Choice	Comments
R1	C32	68.604		
S1	C33	68.421		
R2	C34	67.208		
S2	C35	68.103		
R3	C31	66.590		
S3	C37	66.847		
GP	CG38	70.225		

5.6 Preferred Gyroscope #4 Connections

Table 4.

Gyroscope Electrode	Recommended Connection	Cap. Rec. Connection	Tentative Connect Choice	Comments
R1	C43	69.244		
S1	C47	69.290		
R2	C41	70.120		
S2	C42	70.379		
R3	C44	70.458		
S3	C45	70.767		
GP	CG48	73.098		

5.7 Gyro RE Concurrence

R. Brumley to agree with the tentative selections after discussion with D. Bardas and C. Gray. These selections or alternatives agreed to shall be used for the final hookup.

5.8 Section 5 Completed:

Integration Engineer(s) _____ Date _____
C. Gray

Concurrence: _____ Date _____
R. Brumley

Discrepancies if any:

Disposition./.sign-off: _____ Date _____
D. Bardas

Concurrence: _____ Date _____
R. Leese (QA)

6 FINAL HOOK-UP OF ALL CABLES

6.1 Routing, Connecting and Securing Cables

The order of installation is gyros 4, 3, 2, 1.

6.1.1 Assuming concurrence by all parties with the tentative hook-ups in Tables 1 through 4 begin the process of actually feeding the cables, if not already done in Section 5, through the keyholes in the extrusions. Ensure that the order is consistent with the agreed hookup pattern.

6.1.2 Pay particular care to the handling of the fiberoptic cables because of their delicate nature.

6.1.3 Slide the grommets on each cable till they touch and lock them in place with the grommet retainer by pushing it into the plug hole at each end of the grommet slot.

6.1.4 Install each Lemo (suspension and Ground into its designated mating probe Lemo, ensuring that it snaps home and is locked in place. Connect the lower level of Lemos first for easier access.

6.1.5 Using a wire probe check for continuity between each electrode of the gyro to the designated Top Hat center pin. Record the installation at this point in Tables 5 through 8 below.

6.1.6 Verify that the shields are connected to the shield of the coax connector at the Top Hat.

6.1.7 Route the fiberoptic cable from each gyro to its designated plug. Note that they all pass over the spider except for #1A which has been rerouted to the proof mass position.

6.1.8 Connect the fiberoptic bias wires to their respective probe connectors.

6.1.9 Inspect the final integrated assembly for neatness, lack of cable strain and secure routing.

6.1.10 R. Brumley and B. Clark to join in final inspection and sign Section 7 below.

Table 5. Gyro 1 Final Cable Connections

Gyro Electrode	Suspension / Ground Cables		Fiberoptic Connections				Comments
	Probe Connector	Res. (Ω) to Top Hat	Gyro FO	Probe conn.	FO Bias	Probe conn.	Note: Gyro 1 uses UV2 & UV5 Lemos
R1			A	UV5A	A	5A	
S1							
R2							
S2							
R3			B	UV2B	B	2B	
S3							
GP							

Table 6. Gyro 2 Final Cable Connections

Gyro Electrode	Suspension / Ground Cables		Fiberoptic Connections				Comments
	Probe Connector	Res. (Ω) to Top Hat	Gyro FO	Probe conn.	FO Bias	Probe conn.	Note: Gyro 2 uses UV1 Lemos
R1			A	UV1A	A	1A	
S1							
R2							
S2							
R3			B	UV1B	B	1B	
S3							
GP							

Table 7. Gyro 3 Final Cable Connections

Gyro Electrode	Suspension / Ground Cables		Fiberoptic Connections				Comments
	Probe Connector	Res. (Ω) to Top Hat	Gyro FO	Probe conn.	FO Bias	Probe conn.	
R1			A	UV3A	A	3A	
S1							
R2							
S2							
R3			B	UV3B	B	3B	
S3							
GP							

Table 8. Gyro 4 Final Cable Connections

Gyro Electrode	Suspension / Ground Cables		Fiberoptic Connections				Comments
	Probe Connector	Res. (Ω) to Top Hat	Gyro FO	Probe conn.	FO Bias	Probe conn.	
R1			A	UV4A	A	4A	
S1							
R2							
S2							
R3			B	UV4B	B	4B	
S3							
GP							

7 PROCEDURE COMPLETION

The results obtained in the performance of this procedure are acceptable. We have inspected the hardware and studied the data and are satisfied that the integrated configuration is satisfactory:

Integration Engineers _____ Date _____
C. Gray

_____ Date _____
R. Brumley

_____ Date _____
R. Brumley

Integration Test Director _____ Date _____
D. Bardas

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

QA Representative _____ Date _____
R. Leese

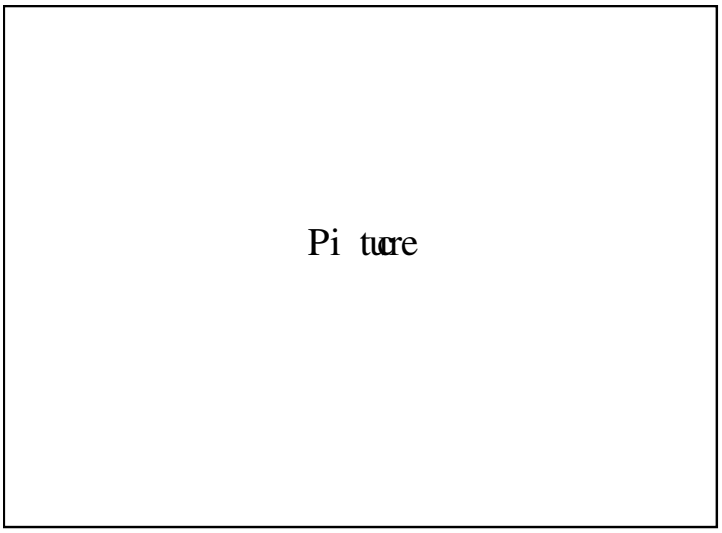
QA Program Engineer _____ Date _____
B. Taller

Copy discrepancies to D-Log and open Discrepancy Reports when required.

8 DATA BASE ENTRY

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

- Name, number and revision of this procedure
- An electronic copy of this document
- A copy of the "as-built" procedure with data and pictures, when completed.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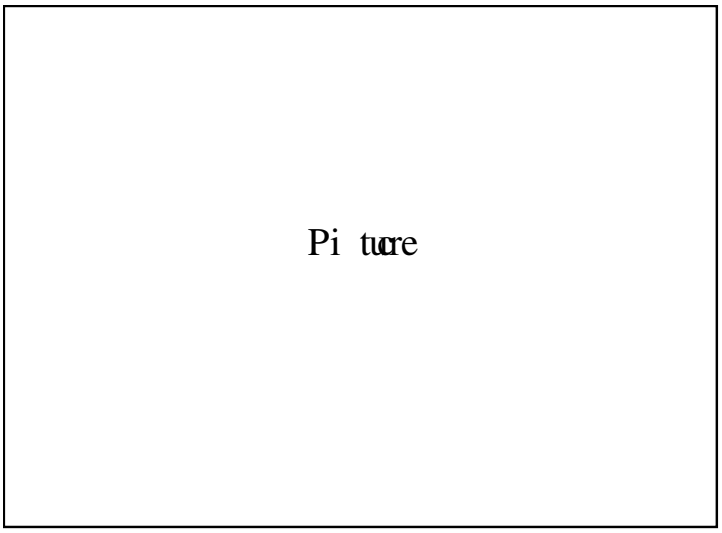
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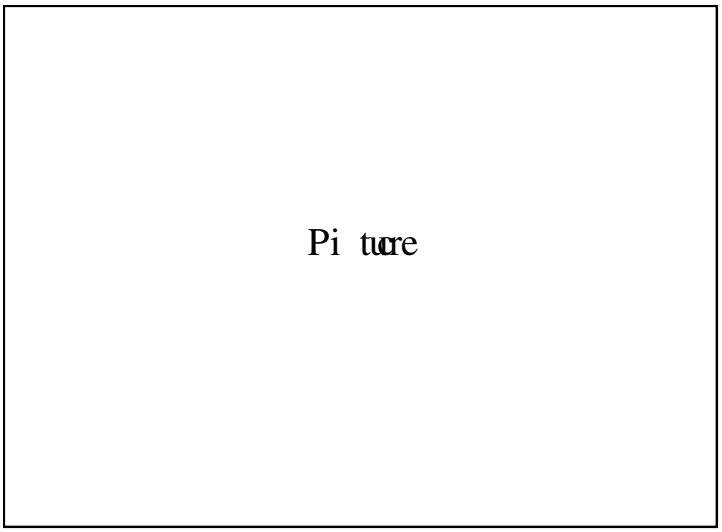
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