GRAVITY PROBE B

PROCEDURE FOR

ENGINEERING TESTS

GP-B PROBE C/GSS SUSPENSION LINE CHARACTERISTICS MEASUREMENT PROCEDURE

DRAFT 15 September, 1998

Prepared by: William J. Bencze

Approvals:

Program Responsibility	Signature	Date
Robert Brumley GSS Test and Verification Lead		
William J. Bencze GSS RE		
M. Taber Payload Test Director		
B. Taller GP-B Quality Assurance		
Sasha Buchman GP-B Hardware Manager		

NOTES:
Level of QA required during performance of this procedure:
___Stanford QA Representative
___Government QA Representative

Revision Record:

Rev	Rev Date	ECO #	Summary Description

Acronyms and Abbreviations:

Acronym / Abbreviation	**Meaning**

Table of Contents

A. SCOPE

This procedure describes two engineering tests to be done on the suspension lines inside the GP-B flight probe (Probe C) to confirm their characteristics for use in the final development and buildup of the GSS electronics. This test is intended to be run on the probe without gyroscopes connected to the suspension lines; it is a measurement of the intrinsic suspension line characteristics.

Two tests are performed for each suspension line:

A.1. Measure the capacitance of the line from the Tophat connector, and

A.2. Test for high-voltage breakdown of the suspension line.

Both of these tests are needed to confirm that the suspension lines in Probe C are compatible with the GSS electronics set.

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 inserted into the Science Mission Dewar and be near on-orbit operating cryogenic temperatures.

C.2. The probe shall be evacuated to a pressure less than or equal to that required during gyro spinup (5.3×10^{-4} torr).

C.3. No gyroscopes or other hardware shall be connected to the cold end of the suspension lines.

C.4. No SQUIDs shall be installed in the probe.

D. HARDWARE REQUIRED

D.1. Commercial test equipment (calibrations not required for this equipment)

Manufacturer	Model	Serial Number	Calibr. Exp. Date
Stanford Research Systems (high-voltage power supply)	SRS		
(low voltage power supply)			
Andeen-Hagerling (precision capacitance bridge)	2500A	00129	18 Aug 2000
Fluke handheld multimeter			
Tektronix (digital oscilloscope)	TDS 460A		

D.2. Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date
GSS Reynolds-to-MHV connector adapter box.	none	-	001	
GSS HV-to-picoammeter patch box.	none	-	001	
GSS Picoammeter	none	-	001	

D.3. Tools

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

D.4. Expendables

Description	Quantity
N/A	

E. SOFTWARE REQUIRED

No software is required for this procedure.

F. PROCEDURES REQUIRED

Procedure Name	Procedure No.

G. PERSONNEL REQUIREMENTS

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

- William Bencze
- David Hipkins
- Robert Brumley
- Chris Gray
- Bruce Clarke

H. SAFETY REQUIREMENTS

NOTE

This test is to be performed on Probe C alone, installed in the Science Mission dewar. There shall be no gyroscopes attached to the suspension cables and no SQUIDs installed in the probe.

H.1. Electrical mating and demating of flight hardware connectors

H.1.1. Connection and disconnection shall be performed only when the equipment involved is in a powered-down state.

H.1.2. Connectors shall be inspected for contamination and for bent, damaged, or recessed pins prior to mating.

H.1.3. Grounded wrist straps are to be worn prior to removal of connector caps or covers and during mating/demating operations.

H.1.4. All mating/demating operations on flight connectors shall be noted in the Probe C log.

I. GENERAL INSTRUCTIONS

I.1. Redlines can be initiated by a qualified person as noted in Section H*, QA approval is not required.*

I.2. 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.

I.3. Qualified test personnel have the authority to exit/terminate this test or perform a retest.

J. REFERENCES AND APPLICABLE DOCUMENTS

(none specified)

K. EQUIPMENT PRETEST REQUIREMENTS

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

K.1. Capacitance meter setup

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

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

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

K.1.2.2. Key in the sequence: [FUNCTION] → [PLACES] → [5] → [ENTER]

K.1.2.3. Key in the sequence: [FUNCTION] → [AVERAGE] → [5] → [ENTER]

K.1.3. Bridge functional test

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

K.1.3.2. Press the key: [SINGLE]

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

Section passed: (stamp)

K.1.4. Connect to test fixture.

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

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

K.1.4.3. Press the key: [SINGLE]

K.1.4.4. Confirm that the meter reads 17.2 ± 0.1 pF.

Measured Value: pF	Section passed: (stamp)

K.1.5. Zero the measurement fixture capacitance.

K.1.5.1. Key in the sequence: [ZERO] → [ENTER]

K.1.5.2. Key in the sequence: [ZERO] → [SINGLE] → [ENTER]

K.1.5.3. Press the key: [SINGLE]

K.1.5.4. Confirm measured capacitance is < 0.001 pF.

K.1.6. Capacitance bridge setup complete.

Section Complete: (stamp)

K.2. High voltage power supply setup:

K.2.1. With the power supply turned off, confirm that the polarity selector switch on the back of the unit is set to "pos".

Section passed: (stamp)

K.2.2. HV limit set:

K.2.2.1. Press the –SELECT- key until the "limit" selection is illuminated on the front panel.

K.2.2.2. Key in: [1] → [5] → [0] → [0] → [ENTER]

K.2.3. Initial output voltage set.

K.2.3.1. Press the [SELECT] key until the "limit" selection is illuminated on the front panel.

K.2.3.2. Key in: [1] → [0] → [0] → [0] → [ENTER]

Section passed: (stamp)

K.2.4. HV power supply setup complete.

Section Complete: (stamp)

K.3. Picoammeter Offset Calibration.

K.3.1. Make sure High Voltage is turned off

K.3.1.1. Turn on the AC power to the low voltage power supply for the Picoammeter box.

K.3.1.2. Confirm that the positive side DC power supply is set at +15.0 ± 0.1 V.

K.3.1.3. Confirm that the negative side DC power supply is set at -15.0 ± 0.1 V.

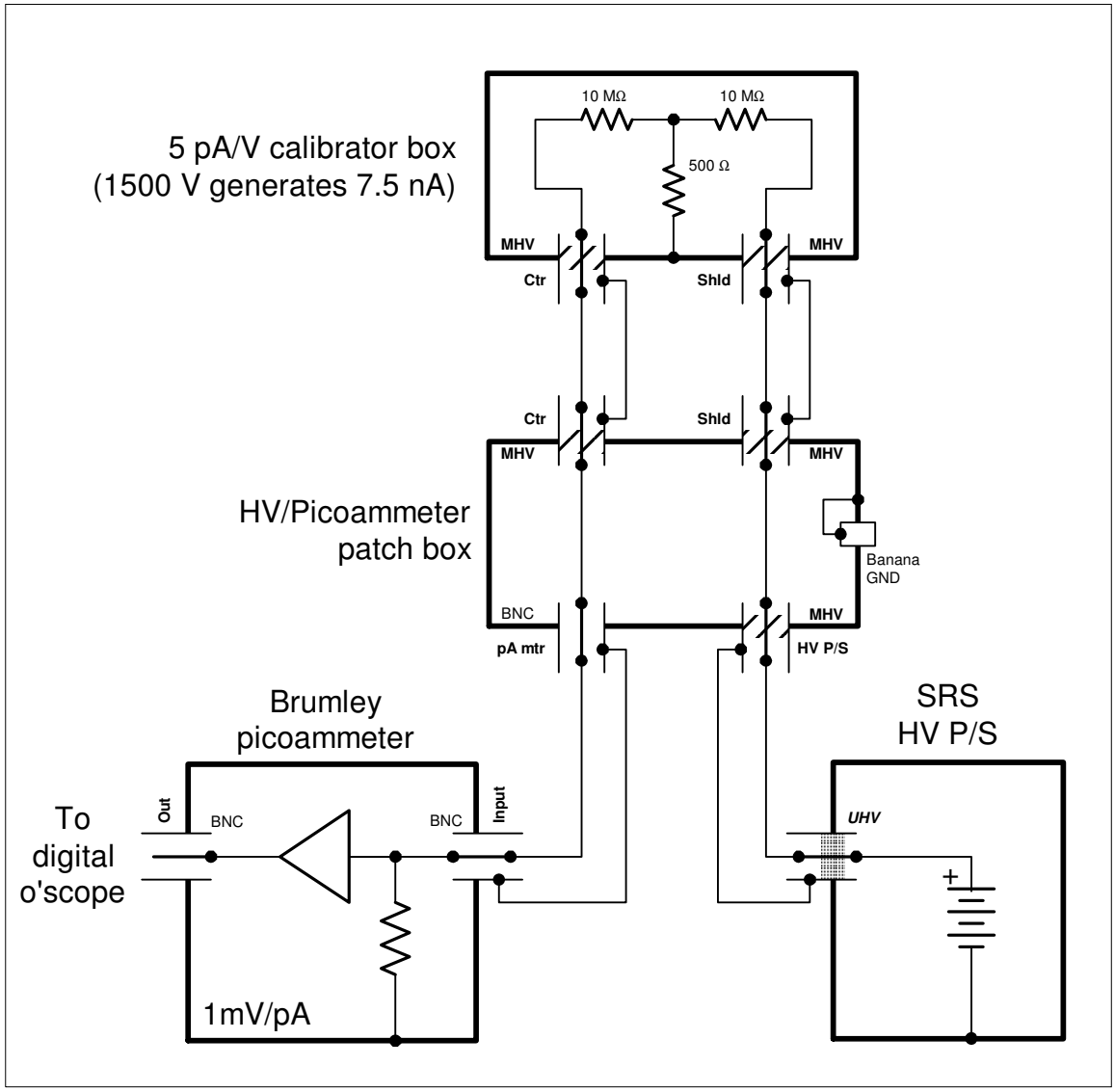
K.3.1.4. Confirm that the gain toggle switch on the side of the Picoammeter box is set in the "low" position.

Section passed: (stamp)

K.3.2. Calibration:

K.3.2.1. Connect the Picoammeter to *the HV/pA patch box* and to the *calibration load* as illustrated in the figure on the next page:

Section passed: (stamp)


5 pA/V calibrator box
(1500 V generates 7.5 nA)
10 MΩ
10 MΩ
500 Ω
MHV
Ctr
Shld
MHV
Ctr
Shld
MHV
MHV
HV/Picoammeter
patch box
Banana
GND
BNC
pA mtr
MHV
HV P/S
Brumley
picoammeter
SRS
HV P/S
To
digital
o'scope
Out
BNC
BNC
Input
UHV
+
1mV/pA

K.3.2.2. Observe the output of the Picoammeter on a calibrated multimeter. Adjust the gain knob on the side of the Picoammeter until the meter reads 0.00 V ± 0.01 V.

K.3.2.3. Enable the High Voltage and confirm that the HV power supply is outputting 1000 V.

K.3.2.4. Confirm that the picoammeter is outputting 4.6 V ± 0.2 V.

Section passed: (stamp)

K.3.3. Picoammeter offset calibration complete.

Section Complete: (stamp)

K.4. Digital oscilloscope setup.

K.4.1. Turn on the scope.

K.4.2. Trigger setup:

K.4.2.1. Press the [TRIGGER] button.

K.4.2.2. Set/Confirm the following:

Parameter	**Value**
Type	Edge
Source	Ch 1
Coupling	DC
Slope	Falling
Level	-500 mV ± 0.05 V
Mode	Normal

Section passed: (stamp)

K.4.3. Vertical setup

K.4.3.1. Press the [VERTICAL] button.

K.4.3.2. Set/Confirm the following:

Parameter	**Value**
Coupling	DC
Bandwidth	20 MHz
Fine scale	500 mV/div
Position offset	0 div
offset	0.00 V

Section passed: (stamp)

K.4.4. Horizontal setup

K.4.4.1. Press the HORIZONTAL button.

K.4.4.2. Set/Confirm the following:

Parameter	**Value**
Timebase	Main
Trigger posn	50%
Record length	2500 pts
Horizontal posn	50%

Section passed: (stamp)

K.4.5. Set the sweep rate on the scope to 20 ms/div.

K.4.6. Connect the scope to the Picoammeter output.

K.4.7. Scope setup complete.

Section Complete: (stamp)

L. OPERATIONS

NOTE 1:

To minimize mating/demating operations on the Probe C suspension connectors, the two tests 1) capacitance measurement and 2) HV breakdown measurement will occur in sequence once the test fixture is attached to the tophat connector of interest. This requires more reconfiguration of the test hardware during the test itself (i.e. switching the destination of two test cables), but has been judged to be safer to the flight hardware.

NOTE 2:

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.

WARNING!

The order of testing of suspension cables shall follow the order of entry of the weld-boss connector numbers (Cxx) outlined in the data tables in the next section. The proof mass cables, which are currently unused in the probe, are to be used as test items for the HV breakdown test. The cables and connectors are fully specified to handle 1g suspension voltages (> 1500 V) and no problem is anticipated. However, to protect flight hardware, the HV breakdown test will be run first on these cables. In the event of unexpected results – failure of the breakdown test on more than one cable – HV operations shall be stopped. Capacitance testing can continue with no risk to any of the cables.

L.1. Probe Measurement Setup:

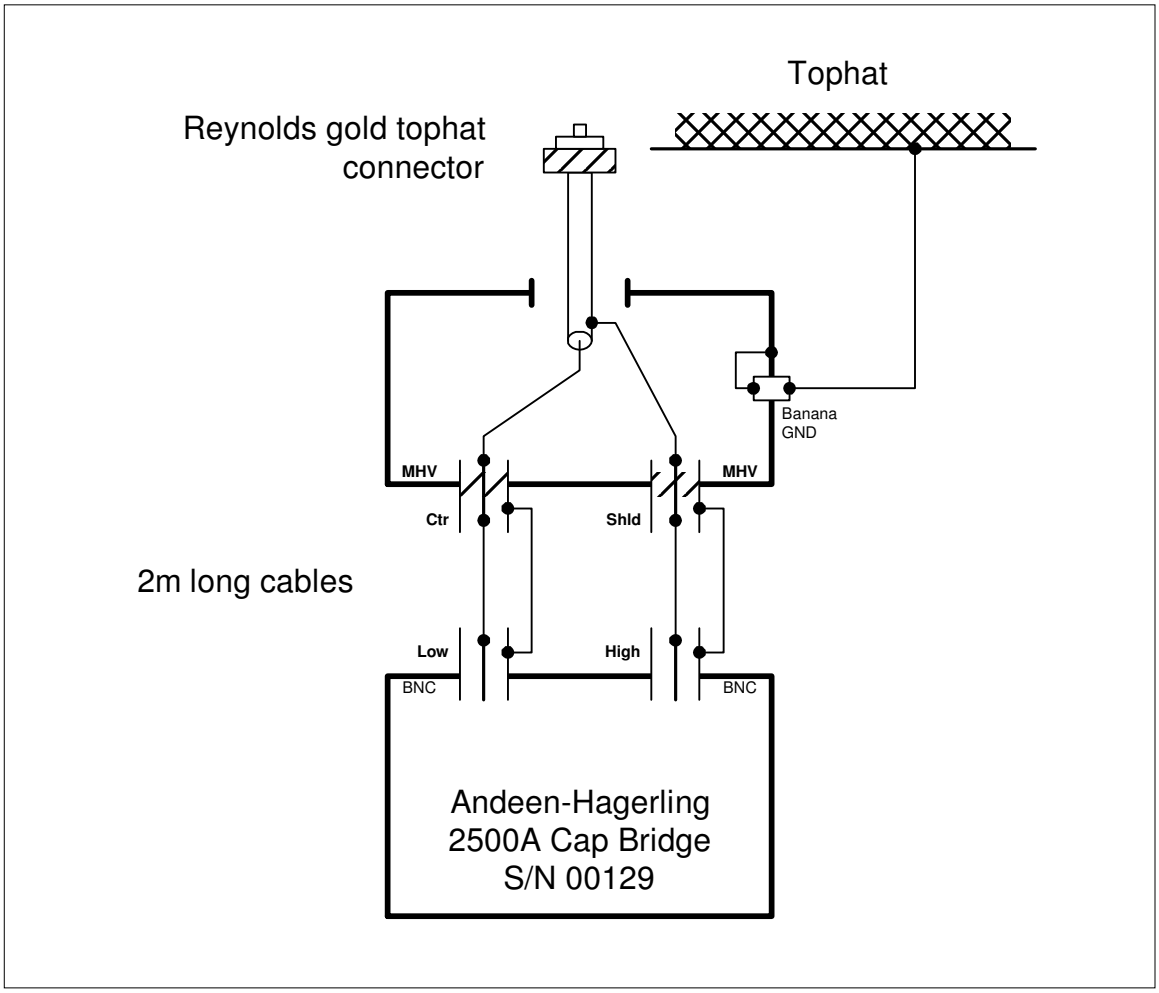
L.1.1. Connect Probe tophat ground strap to user wrist strap.

L.1.2. Connect Probe tophat ground strap to ground post on *MHV-to-Reynolds* test fixture.

L.1.3. Connect Probe tophat ground strap to ground post on *HV/pA patch box*.

L.2. Capacitance measurement:

L.2.1. Confirm that the capacitance bridge is connected to the *MHV-to-Reynolds* test fixture as shown in the following diagram:



L.2.2. Weld-boss connector cleanliness inspection

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

L.2.2.2. Inspect weld-boss connector center pin to insure it is straight, undamaged.

L.2.2.3. Inspect weld-boss connector inner threaded cylinder to insure is it undamaged.

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

L.2.3. Test fixture connector cleanliness inspection.

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

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

contamination.

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

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

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

L.2.5. Press the key: [SINGLE] on the capacitance bridge.

L.2.6. Record the capacitance measurement **and** the resistance measurement in the appropriate location in the data log, Table 1, in the appendix.

A.1.1. Confirm that the resistance measurement indicated on the capacitance meter is > 1000 GΩ. In the event that the measured resistance is less than this value, the capacitance measurement test has failed. **Terminate tests on this connector and flag the suspension line for review**.

L.3. HV breakdown measurement:

WARNING!

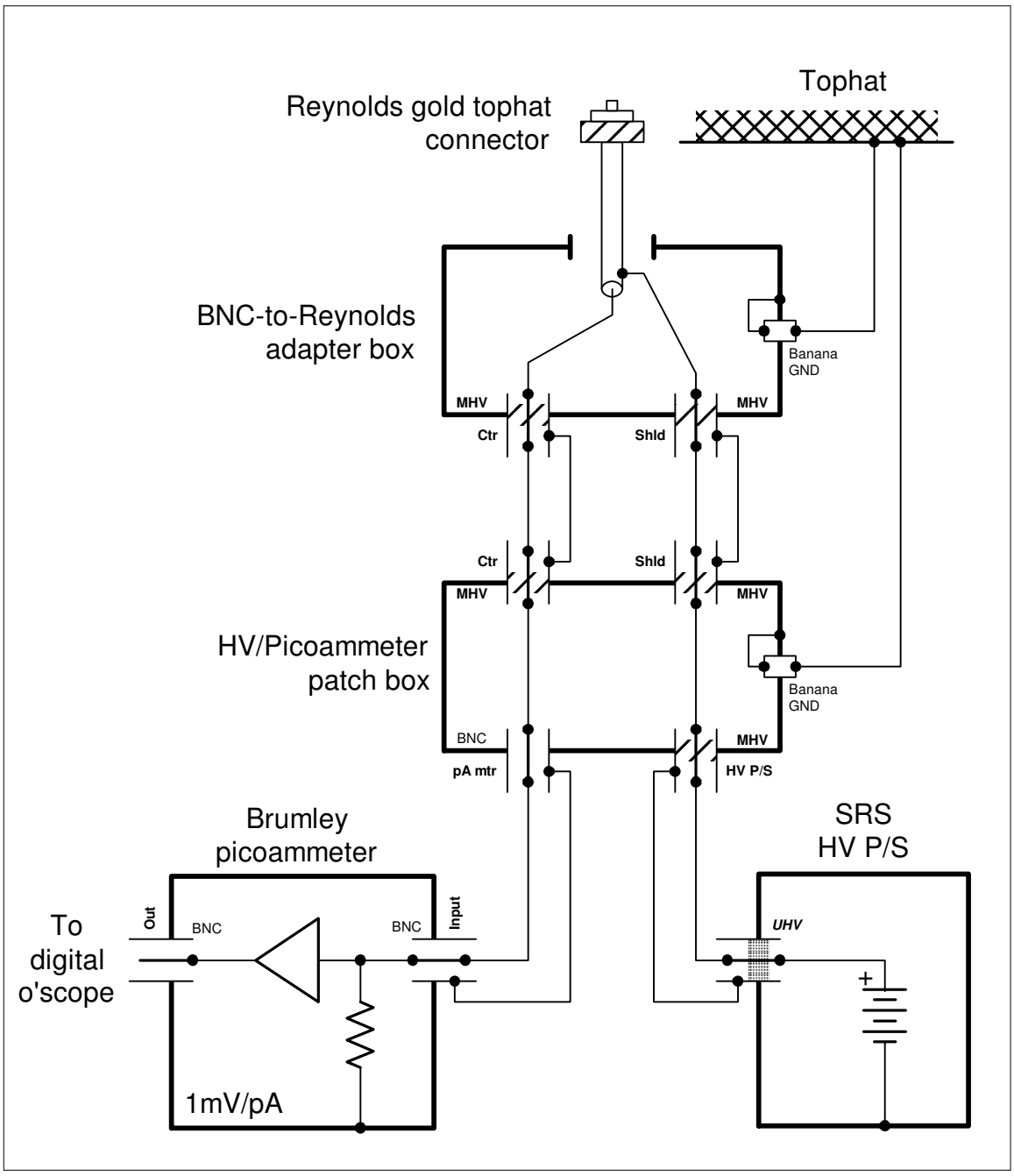
The order of testing of suspension cables shall follow the order of entry of the weld-boss connector numbers (Cxx) outlined in the data tables in the next section. The proof mass cables, which are currently unused in the probe, are to be used as test items for the HV breakdown test. The cables and connectors are fully specified to handle 1g suspension voltages (> 1500 V) and no problem is anticipated. However, to protect flight hardware, the HV breakdown test will be run first on these cables. In the event of unexpected results – failure of the breakdown test on more than one cable – HV operations shall be stopped. Capacitance testing can continue with no risk to any of the cables.

L.3.1. Connection of the test equipment:

L.3.1.1. Disconnect measurement cables from the back of the capacitance bridge.

L.3.1.2. Confirm that the HV power supply output voltage is disabled.

L.3.1.3. Connect measurement cables to the *HV/pA patch box* as shown in the following diagram:



L.3.2. Run HV test:

L.3.2.1. Confirm the capacitance test resistance measurement gave a measured resistance > 1000 GΩ. If less, do not perform this HV test; **Terminate HV test and flag the suspension line for review.**

L.3.2.2. Set the HV power supply to 900 V.

WARNING!

The following step will apply high voltage to the shield portion of the Reynolds connector that is screwed into the weld-boss connector on the top hat. High voltage will be present on the uninsulated portion of this connector ring while the test is in process. This connector shall not be touched until the end of this test when the HV is confirmed to be disabled. It is recommended that test personnel stay at a safe distance (> 10 cm) away from the tophat connector while the test is in progress.

L.3.2.3. 900 V test

L.3.2.3.1. Enable the HV output of the HV power supply.

L.3.2.3.2. Manually trigger the scope to clear the screen.

L.3.2.3.3. Observe the scope for 1-15 minutes for triggers indicating a HV breakdown. An example HV breakdown trace is shown in the Appendix for reference.

L.3.2.3.4. In the event of a trigger, make a printout of the scope trace and append it to this procedure. **Terminate the HV test and flag the suspension line for review.**

L.3.2.4. 1100 V test: Repeat previous test at 1100 V

L.3.2.5. 1300 V test: Repeat previous test at 1300 V

L.3.2.6. 1500 V test: Repeat previous test at 1500 V

L.4. Test termination.

L.4.1. Disable HV output of HV power supply.

L.4.2. Remove the gold Reynolds connector from the weld-boss connector by slowly unscrewing in a counter-clockwise direction.

L.4.3. Record the mate/de-mate cycle in the Probe C log for this weld-boss connector of interest.

L.5. Repeat tests for full set of suspension lines indicated in the test data record in the next section.

L.6. Test Complete

Test Engr: (stamp) Date: Time:	QA Witness: (stamp) Date: Time:

M. TEST DATA RECORDS:

M.1. Capacitance Measurement Data Log 1 of 3:

Test order:	Weld-boss connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
1.	C51					
2.	C52					
3.	C53					
4.	C54					
5.	C55					
6.	C56					
7.	C57					

Test Engr: (stamp)

Date:
Time:

QA Witness: (stamp)

Date:
Time:

M.2. Capacitance Measurement Data Log 2 of 3

Test order	Weld-boss connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
8.	C11					
9.	C12					
10.	C13					
11.	C14					
12.	C15					
13.	C16					
14.	C17					
15.	C21					
16.	C22					
17.	C23					
18.	C24					
19.	C25					
20.	C26					
21.	C27					

Test Engr: (stamp)

Date:
Time:

QA Witness: (stamp)

Date:
Time:

M.3. Capacitance Measurement Data Log 3 of 3

Test order	Weld-boss connector ID# on Tophat	Weld-boss cleanliness inspection	Test fixture cleanliness inspection	Capacitance measurement (pF)	Resistance measurement (GΩ)	Capacitance test PASS/FAIL
22.	C31					
23.	C32					
24.	C33					
25.	C34					
26.	C35					
27.	C36					
28.	C37					
29.	C41					
30.	C42					
31.	C43					
32.	C44					
33.	C45					
34.	C46					
35.	C47					

Test Engr: (stamp)

Date:
Time:

QA Witness: (stamp)

Date:
Time:

M.4. HV Breakdown Measurement Data Log 1 of 3

Test order:	Weld-boss connector ID# on Tophat	Cap meas resistance > 1000 GΩ	900 V test passed	1100 V test passed	1300 V test passed	1500 V test passed	Mate/ demate log entry	HV test PASS/FAIL
1.	C51							
2.	C52							
3.	C53							
4.	C54							
5.	C55							
6.	C56							
7.	C57							

WARNING!

If any of these cables fail the HV breakdown test, do not continue HV testing on the remainder of the suspension lines. Terminate HV testing and flag this test data for review.

Capacitance testing can continue with no risk to the flight hardware, however.

Test Engr: (stamp)

Date:
Time:

QA Witness: (stamp)

Date:
Time:

M.5. HV Breakdown Measurement Data Log 2 of 3

Test order:	Weld-boss connector ID# on Tophat	Cap meas resistance > 1000 GΩ	900 V test passed	1100 V test passed	1300 V test passed	1500 V test passed	Mate/ demate log entry	HV test PASS/FAIL
8.	C11							
9.	C12							
10.	C13							
11.	C14							
12.	C15							
13.	C16							
14.	C17							
15.	C21							
16.	C22							
17.	C23							
18.	C24							
19.	C25							
20.	C26							
21.	C27							

Test Engr: (stamp)

Date:
Time:

QA Witness: (stamp)

Date:
Time:

Test order:	Weld-boss connector ID# on Tophat	Cap meas resistance > 1000 GΩ	900 V test passed	1100 V test passed	1300 V test passed	1500 V test passed	Mate/ demate log entry	HV test PASS/FAIL
22.	C31							
23.	C32							
24.	C33							
25.	C34							
26.	C35							
27.	C36							
28.	C37							
29.	C41							
30.	C42							
31.	C43							
32.	C44							
33.	C45							
34.	C46							
35.	C47							

Test Engr: (stamp)

Date:
Time:

QA Witness: (stamp)

Date:
Time:

N. 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

O. APPENDIX – SAMPLE BREAKDOWN TRACE:

Paste Figure Here