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SCIENCE MISSION SQUID CARRIER ASSEMBLY PROCESS AND ENDURANCE TESTING

Document Revision Record

Rev	Date	ECO No.	Pages Affected	Description
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1.0 CARRIER ASSEMBLY

1.0.1 Carrier Assembly Drawing 25018-201 Rev A

1.1. SET UP FACILITIES.

1.1.1 SCOPE: This section of the procedure covers the setup and operation of support facilities used in the assembly of the SQUID carriers in order to assure adequate cleanliness, as well as personal safety.

1.1.2 EQUIPMENT:

Anemometer
Particle Counter

1.1.3 PROCEDURE:

Turn on the Solder Fume Exhaust Extractor. Using the anemometer measure the air velocity at the nozzle of the fume extractor. The velocity must exceed 800 feet per minute.

Using particle counter measure the cleanliness of the air at the epoxy station and at the ultrasonic bonder station. In both areas particle counts must be below 100 per cubic foot of particles 0.5 micron and larger.

1.2 MEASURE VALUES OF COMPONENTS

1.2.1 SCOPE: This section of the procedure covers the measurement of resistance of the components to be assembled onto the SQUID carrier.

1.2.2 EQUIPMENT:

HP 4277A LCZ meter with 16047A test fixture
Keithley Model 580 Micro-ohmmeter
Fluke 77 Multimeter
Beckman Capacitance Meter Model 1830

1.2.3 MATERIALS:

SQUID Carrier Assembly Traveler
Table P0153-1
7 ea 100 Ω resistor Part No. 25429-101
2 ea 10 Ω resistor Part No. 25430-101
1 ea 2 MΩ resistor Part No. 25429-102

2 ea 2 nF capacitor Part No. 25427-201
1 ea center tapped output transformer with wire resistors soldered to primary leads Part No. 25432-201

1.2.4 PROCEDURE:

Turn on the LCZ meter. Allow at least 30 minutes warm up prior to making measurements.

Set up the LCZ meter as follows:
CKT MODE in AUTO
LC|Z| RANGE in AUTO
TEST SIGNAL in LOW
DISPLAY in L
FREQ at 420kHz

Connect the Primary leads of the transformer to be tested to the input terminals of the LCZ meter. Measure and record in table P0153-1the inductance of the transformer primary.

Unsolder the previously connected primary and secondary end leads. Remove the primary lead from the LCZ meter. Connect the now free secondary end lead to the free terminal of the LCZ meter. Measure and record in table P0153-1the inductance of the transformer secondary.

Remove one of the secondary end leads from the LCZ meter and connect the secondary center tap lead in its place. Measure and record in table P0153-1under **Secondary Leg 1** the resulting inductance.

Remove the secondary end lead from the LCZ meter and connect the other secondary end lead in its place. Measure and record in table P0153-1under **Secondary Leg 2** the resulting inductance.

Measure and record on Table P0153-1
the resistance of each of the following components with the Keithley ohmmeter in the dry contact mode, pulsed 20Ω range:

- Primary winding of output transformer with series wire resistors
  - Secondary winding of output transformer

- 10Ω chip resistor (1 ea.) Part No. 25430-101

Measure and record on Table P0153-1 the resistance of each of
the following components with the Keithley ohmmeter in the non-dry contact mode, pulsed 200Ω range:

- 100Ω chip resistor (7 ea.) Part No. 25429-101

Measure and record on Table P0153-1 the resistance of each of
the following components with the Fluke multimeter in the 32 MΩ range.

- 2MΩ chip resistor (1 ea.) Part No. 25429-102

Measure and record on the resistance traveler sheet the resistance of each of the primary to secondary of output transformer with the Fluke multimeter in the 32 MΩ range.

Using the capacitance meter measure the capacitance of the two chip capacitors. Record the value on table P0153-1

1.3. SOLDER LEADS TO LEMO CONNECTOR

1.3.1 SCOPE: This section of the procedure covers the solder attachment of the wires that interface the SQUID carrier to the Lemo connector.

1.3.2 EQUIPMENT:

Soldering iron, Weller WCC 100 with Vanier H09 tip
Lemo Connector Soldering Jig
Leica Stereozoom 4 microscope
Non Magnetic Wire cutters
Squid Assembly Traveler

1.3.3 MATERIALS:

Lemo connector (machined to 0.232” dia),
Part #25020-101
AWG 30 HPN magnet wire, Find #12 Drawing 25018-201 Rev A
60/40 Sn-Pb rosin core solder, 20 gauge, Find #15 Drawing 25018-201 Rev A

Isopropanol
Ultrajet 2000 Dust Remover (Chemtronics Inc.)

1.3.4 PROCEDURE:

Set soldering iron temperature to 600° F.
Place Lemo connector soldering jig under microscope. Place the Lemo connector in one of the holes in the Lemo connector soldering jig.

Cut 8-1 inch lengths of magnet wire.

Remove ~1/8 inch of insulation from one end of each of the wires using the ceramic knife.

After tinning the terminals on the Lemo connector Part No. 25020-101, remove the gold plating from the inside of each of the terminals by inserting then removing a piece of wire after stripping the insulation as above. Re-tin the terminals and repeat the above procedure two more times using fresh end on the wire for each terminal.

Solder one wire each to pins 1,2,3,4,5,8,9 & 10 of the Lemo connector (see Fig 1).

During the above tinning and soldering operation the Lemo connector is rotated in the jig so the pin being worked on is in the uppermost position.

Trim the wires to lengths that are sufficient to reach their respective contact pads on the SQUID carrier with enough excess length to allow cutting and reconnecting to the pads if necessary. Remove the insulation from the trimmed ends using the same procedure as used previously.

After the wires have been soldered to the Lemo connector rinse the connector with isopropanol then blow dry with Ultrajet 2000.

Record completion date and sign traveler

1.4. SOLDER CONNECTIONS ON SQUID CARRIER

1.4.1 SCOPE: This section of the procedure covers the soldering of all connections onto the SQUID carrier substrate, including wires from the Lemo connector, chip resistors, output transformer and mounting stud for the output transformer.

1.4.2 EQUIPMENT:

Soldering iron, Weller WCC 100 with
Vanier H09 Soldering Iron Tip
Vanier H05 Soldering Iron Tip
Non Magnetic Wire cutters
Plastic Tweezers
Heated vacuum chuck with aluminum adapter plate for SQUID carriers
Leica Stereozoom 4 microscope
SQUID Carrier Soldering Jig
Keithley Model 580 Micro-ohmmeter
Fluke 77 Multimeter
Lemo Connector Switch Box Interface
100 cN scale

1.4.3 MATERIALS:

Substrate, Sapphire, Part # 25019-201
Lemo connector (machined to 0.232" dia),
Part #25020-101 with leads attached
Wire wound output transformer (with Platinum-Tungsten wire resistors soldered to primary leads), Part # 25432-201
7-100Ω chip resistors, Part # 25429-101
2-Damping resistors Part # 25430-101 (10Ω)
2-Damping capacitors Part # 25427-201 (2nF)
2MΩ resistor, Part # 25429-102
Phosphor bronze post for output transformer Part # 25431-101
Thermal Ground Strap Part No. 25450-101
50/50 Sn-In solder, 0.02" dia. Find #14
#5 RMA soldering flux (Indium Corporation of America)
Scotch Bright 7448 Ultrafine Hand pad
Small Foam swabs, P/N: HT1002 Wilshire Contamination Control
Ethyl alcohol
Ultrajet 2000 Dust Remover (Chemtronics Inc.)
Methyl alcohol
Deionized water.
Squid Assembly Traveler
Table P0153-2
Table P0153-3
Table P0153-4

1.4.4 PROCEDURE:

Record serial number of the SQUID carrier substrate on the assembly traveler.

Mount carrier on vacuum chuck under the microscope.

Install the Varnier H105 tip on the soldering iron. Set soldering iron temperature to 600° F. Set vacuum chuck temperature at 70ºC

With the SQUID carrier mounted on the heated vacuum chuck lightly scrub the copper solder pads with a ~1/8" piece Scotch Bright dipped in RMA solder flux using tweezers. Tin all copper pads on the substrate with Sn-In solder.

Do not use foam swabs on the carrier while it is heated

After tinning the copper pads turn off the heat to the vacuum chuck and allow a minimum of 5 minutes to cool.

Clean the excess flux off of the solder pads using a foam swab dipped in ethanol.

Fresh flux is applied to the pads and components during the following soldering operations. Refer to Figure 2 for pad locations.

Solder 100Ω chip resistors between the following pads:

- S8 and S9
- S10 and S11
- S12 and S13
- S22 and S24
- S3 and S4
- S1 and S2
- S6 and S7

Solder 10Ω chip resistors between the following pads:

S5 and S6.
S30 and S7

Solder 2nF chip capacitors between the following pads**:**

S6 and S29
S30 and S14

Solder the 2 MΩ resistor between pads S14 and S15.

Using the Fluke 77 multimeter in the auto range mode, measure the resistance between the following pairs of solder pads and record the values on table P0153-2:

- S18 and S3
- S18 and S4
- S20 and S1
- S20 and S2
- S17 and S10
- S17 and S11
- S19 and S12
- S19 and S13
- S25 and S8
- S25 and S9
- S26 and S22
- S26 and S24
- S27 and S15
- S7 and S30
- S7 and S6
- S6 and S5

Solder the phosphor bronze post, Part No. 25431-101, to pad #31.

Screw the thermal link in place on the bracket provided on the soldering jig with the opposite end positioned over pad s16. The loop should be toward the input connector end of the carrier.

Turn the heat on to the vacuum chuck with the temperature set to 70°C. After allowing a few minutes for the carrier to come up to temperature solder the thermal link to pad S16 of the carrier.

Using the scale apply 100 cN of force to the top of the phosphor bronze post, Part No. 25431-101. If the solder joint fails, resolder the post and repeat the test.

Slip the output transformer over the phosphor bronze post.

Solder the free ends of the series wire resistors from the primary of the output transformer to pads B15 and B16. Solder the secondary leads of the output transformer to pads S21 and S23.

Solder the center tap of the output transformer secondary to pad S27.

Using the Keithley micro-ohmmeter in the dry contact pulsed mode 20Ω range measure the resistance between the following pads to confirm the integrity of the output transformer.

- S21 and S23
- S21 and B15
- B16 and B15
- B16 and B23
- S24 and S27

Record the results in table P0153-4

Figure 1

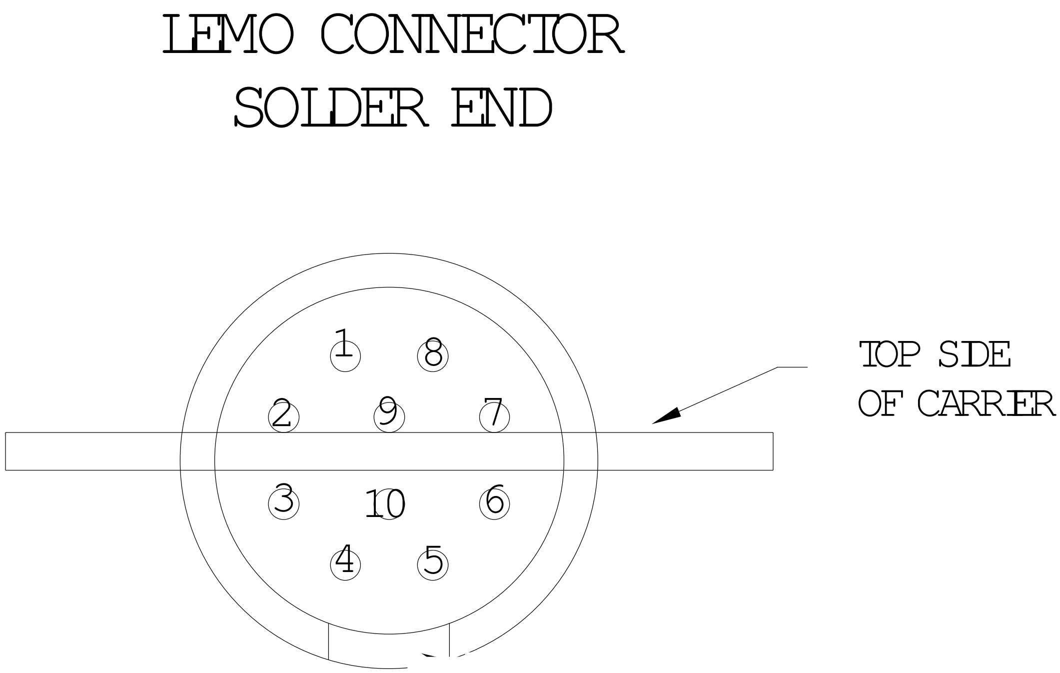
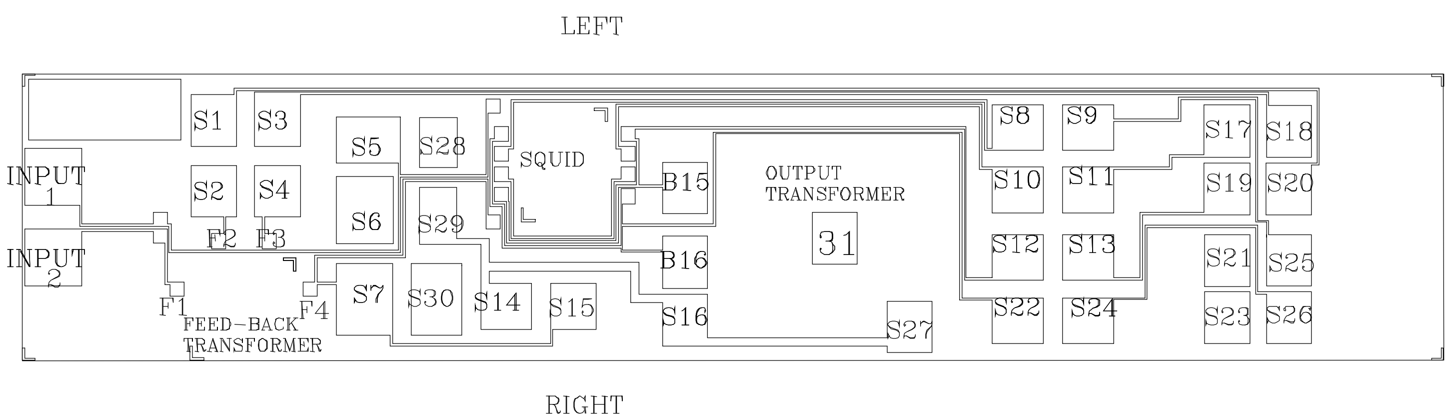


Figure 2



Place the wired Lemo connector in the recess provided with the solder end against the stop in the recess and secure in place with the clamp.

Solder wires lengths AWG 30 wire between the following locations:

- Pin 1 of the Lemo connector to pad S18 of the carrier
- Pin 8 of the Lemo connector to pad S20 of the carrier
- Pin 2 of the Lemo connector to pad S25 of the carrier
- Pin 9of the Lemo connector to pad S26 of the carrier
-

The wires from pins 1 and 8 should be first soldered to the Lemo connector then twisted together before soldering to the carrier.

Twist the wires from pins 4 and 5 on the Lemo connector (signal out) together between the Lemo connector and the right edge of the carrier. Form the wires so they fit snug and flat around the edge of the carrier, then twist the remaining lengths of the wires together between the edge of the carrier and the pads to which they are subsequently soldered on the carrier. The wires should cross the edge of the carrier from bottom to top between the Lemo connector and the pads to which they are soldered. Twist the secondary leads from the output Transformer with the free ends of the wires from pads 4 and 5 on the Lemo connector. Solder the wire from pin 4 of the Lemo connector to pad S21 of the carrier. Solder the wire from pin 5 of the Lemo connector to pad S23 of the carrier.

Solder a wire from pins 3 of the Lemo connector to pad S17 of the carrier after forming the wire to fit snug around the left edge of the carrier. Solder a wire from pins 10 of the Lemo connector to pad S19 of the carrier after forming the wire to fit snug around the left edge of the carrier. The wires should cross the edge of the carrier from bottom to top between the Lemo connector and the pads to which they are soldered. These wires should be kept separate and not be twisted as pairs with other wires.

Turn off the heat to the vacuum chuck. Allow at least 5 minutes to cool before removing the carrier from the SQUID carrier soldering jig.

Connect the Lemo Connector Interface Switch Box to the Lemo connector using care not to stress the solder joint between the Lemo connector and the substrate.

Connect the Keithley micro-ohm meter to the switch box.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 2Ω range measure and record the resistance on table P0153-3 between pins 4 and 5 of the Lemo connector.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 20Ω range measure and record the resistance on table P0153-3 between pins 1 and 8 and between pins 2 and 3 of the Lemo connector .

With the Keithley micro-ohm meter in the non-dry contact, pulsed mode, 2kΩ range measure and record the resistance on table P0153-3 between pins 1 and 8 and between pins 9 and 10 of the Lemo connector .

Disconnect the Keithley micro-ohm meter from the switch box and connect the Fluke 77 Multimeter to the switch box. With the multimeter in the 32MΩ range measure and record the resistance on table P0153-3 between the following pairs of pins of the Lemo connector.

- 1 and 2
- 1 and 3
- 1 and 4
- 1 and 5
- 1 and 6
- 1 and 7
- 1 and 9
- 1 and 10
- 2 and 4
- 2 and 5
- 2 and 6
- 2 and 7
- 2 and 8
- 2 and 9
- 2 and 10
- 4 and 6
- 4 and 7
- 4 and 8
- 4 and 9
- 4 and 10
- 6 and 8
- 6 and 9
- 6 and 10
- 7 and 8
- 7 and 9
- 7 and 10

Record completion date and sign traveler

1.5. CLEAN.

1.5.1 SCOPE: This section of the procedure covers the removal of soldering flux and other residues following the soldering operation.

1.5.2 EQUIPMENT:

Class 100 Fume Hood in Lithography Area
Crystallizing Dish
Filtered Nitrogen Gun
Ziess Fluorescence Microscope in Lithography Area

1.5.3 Materials

Rostech^{tm} 119 EC Safety Solvent
DI Water
Methanol
Squid Assembly Traveler

1.5.4 PROCEDURE:

Place SQUID carrier the crystallizing dish. Pour enough Rostech^{tm} 119 EC Safety Solvent into the dish to cover the SQUID carrier. Allow the carrier to soak for 1 to 1-1/2 hour.

Remove the carrier from the Rostech^{tm} 119 EC Safety Solvent and rinse with running DI water for a minimum of 10 seconds.

Rinse the carrier with methanol then immerse the carrier in a dish of methanol for a minimum of 5 minutes. After removing from the methanol bath, rinse again with methanol then blow dry with nitrogen gun.

Inspect the carrier under the microscope in the white light mode at 100X magnification. There should be no visible trace of solder flux or other residue.

Inspect the carrier at 100X with the microscope in fluorescence mode. There should be no visible trace of residue.

If any residue is found in the above inspection the part cleaning should be repeated until the residue is removed.

Record completion date and sign traveler

1.6. ATTACH SQUID, FEEDBACK TRANSFORMER AND OUTPUT TRANSFORMER TO SQUID CARRIER.

1.6.1 SCOPE: This section of the procedure covers epoxy attachment of components to the SQUID carrier

1.6.2 EQUIPMENT:

Ohaus model CT1200-S scale
Baxter Vortex Mixer
Plastic bottle
ATV Epoxy Die Mounter fitted with Leica Stereozoom 4 microscope
Vacuum chuck
1 cc plastic syringe
Vacuum dessicator
Tweezers

1.6.3 MATERIALS:

SQUID carrier, Part # 25019-201
SQUID, Part# 25428-101
Feedback Transformer, Part# 25426-101
Stycast 1266 epoxy part A and part B, Find #16 Drawing 25018-201 Rev A
Acetone
Squid Assembly Traveler

1.6.4 PROCEDURE:

The following ESD measures shall be followed from this point onward in SQUID carrier fabrication and testing:

All work will be performed on ESD certified work area that includes grounded bench top or mat, grounded wrist strap worn by operator. The effectiveness of the ground shall be checked before starting work using approved wrist strap tester. The Storage and handling of parts will be done using ESD protective boxes.

Record the serial numbers of the SQUID and feedback transformer on the traveler.

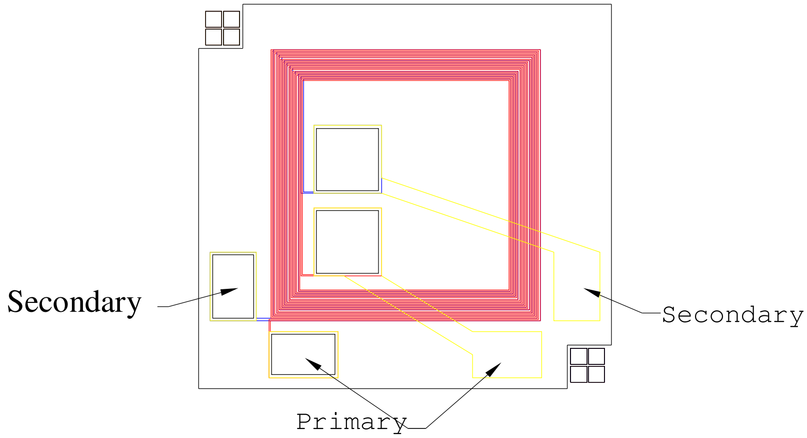
Weigh out 10 grams of epoxy part A and 2.8 grams part B into the plastic bottle. Mix for 3 minutes with the vortex mixer set at 7.5. Put the bottle containing the mixed epoxy with the lid on loose into the vacuum dessicator for 5 minutes at 3 torr to remove bubbles. Fill the syringe with epoxy. Fill the dispense cartridge on the die mounter with epoxy from the syringe.

Secure the SQUID carrier on the vacuum chuck. Place the SQUID and the feedback transformer on the chuck near the carrier.

Rotate the head on the epoxy die mounter into the dispense position. Dispense 5 drops of epoxy onto the area labeled SQUID in the above drawing. Rotate the head into the vacuum pickup position. Pick up the SQUID die and set it in place. The input pads of the SQUID should face the cold end of the carrier. These are the corner pads with blemishes from previous bonds. The corner pads on the other side of the die can be distinguished from the input pads as they are shorted together.

Repeat the above procedure with the feedback transformer. The primary pads of the feedback transformer should face the left side of the carrier. The primary pads lie along one edge of the transformer die. The secondary pads lie on opposite edges.

Feedback Transformer



Dispense 10 drops of epoxy to the top of the output transformer support stud.

Place SQUID carrier in the vacuum dessicator and evacuate to 3 torr for 5 minutes. Backfill and remove the SQUID carrier.

Set the carrier aside on a class 100 bench and allow a minimum of 12 hours for the epoxy to set before continuing assembly.

Remove the epoxy cartridge from the die mounter and rinse thoroughly with acetone.

Record completion date and sign traveler

1.7. ULTRASONIC BONDING OF CONNECTIONS TO THE SQUID AND OUTPUT TRANSFORMER

1.7.1 SCOPE: This section of the procedure covers ultrasonic bonding of fly wires from the SQUID and feedback transformer to the SQUID carrier

1.7.2 EQUIPMENT:

West Bond model 7400B ultrasonic wedge bonder fitted with Deweyl bonding tip # MCLOD-1/16-750-45-CG/CG-3550-MP
Vacuum chuck
ATV Micro-Manipulator fitted with Destruct Wire Bond Pull Tester
Keithley Model 580 Micro-ohmmeter

1.7.3 MATERIALS:

SQUID and feedback transformer die bonded to SQUID carrier
Tanaka's Superconductive Wire, 2 mil dia. Find 13, Drawing 25018-201 Rev A
Bonding Qualification Substrate (.025" thick sapphire with 4KÅ Nb + 500Å Au)
Squid Assembly Traveler
Table P0153-4
SQUID Carrier Assembly Log Book

1.7.4 PROCEDURE:

1.7.4.1 SET UP BONDER

Turn on power to the bonder and ultrasonic power supply. Assure that the bonding parameters are set as follows:

Machine Settings

CLAMP HOME, MOTOR STEPS FROM FWD LIMIT 10
WIRE PULL MOTOR STEPS 18
WIRE TAIL MOTOR STEPS 20
TAIL RUN DURING LOOP ON
DUAL FORCE OFF
HIGH FORCE 22 GR
BEEP UPON CONTACT ON
CONTACT BEEP = ULTRASONIC TIME
LIFT BEFORE PULL OFF
ULTRASONIC POWER BEFORE PULL OFF
ULTRASONIC POWER DURING FEED = 0
ULTRASONIC POWER DURING THREAD = 0
ULTRASONIC DIAGNOSTIC TEST ON
SELF THREAD OFF

Bond Buffer Settings

BONDS PER WIRE = 2
ULTRASONIC POWER = 420
ULTRASONIC TIME = 40 mSec
ULTRASONIC RAMP OFF
LOOP HEIGHT = 50 (1270μ)
DROP BEFORE CLAMP = 20 (508μ)

1.7.4.2 BONDING QUALIFICATION TEST

The following test is to be performed just prior to commencing bonding operations on GTU-2 or Science Mission SQUID carriers.

Secure the bonding qualification substrate to the vacuum chuck.

Perform 20 wire bonds on the qualification substrate (10 wires bonded at both ends) using the above bonder settings.

Using the wire bond pull tester pull each of the 10 bond wires until either one of the bonds fail or the wire breaks and record the force at which each failure occurs. . Record break force values in the SQUID Carrier Assembly Log Book.

The mean force required to cause failure as averaged over the 10 bond wires must be 6 centanewtons or higher. The lowest force required to cause failure must be 4 centanewtons or higher. There must be no failures of the interface of the bond wire and substrate. The failures must all occur in the bond wire.

Wire bonds must not be performed on the SQUID carrier until the above bond strength statistics have been met.

1.7.4.2 BOND FLY WIRES FROM SQUID AND FEEDBACK TRANSFORMER TO CARRIER AND SHORT INPUT

The following ESD measures shall be followed from this point onward in SQUID carrier fabrication and testing:

All work will be performed on ESD certified work area that includes grounded bench top or mat, grounded wrist strap worn by operator. The effectiveness of the ground shall be checked before starting work using approved wrist strap tester. The Storage and handling of parts will be done using ESD protective boxes. The bonder shall be grounded.

Secure the SQUID carrier to the vacuum chuck.
Bond the 10 pads on the SQUID to the adjoining pads on the carrier.

Using the Keithley micro-ohmmeter in non-dry contact, pulsed mode, 200Ω range measure the resistance between pads S5 and S7 and record the values on table P0153-4.

Bond the 4 pads on the feedback transformer to the adjoining pads on the carrier.

Using the Keithley micro-ohmmeter in non-dry contact, pulsed mode, 200Ω range measure the resistance between two input pads and record the values on table P0153-4.

Bond wire between input shorting pads.

Record completion date and sign traveler

1.8. INSPECTION AND ROOM TEMPERATURE ELECTRICAL TEST OF ASSEMBLED CARRIER (Readout Test 7.1 and 7.5)

1.8.1 SCOPE: This section of the procedure covers visual inspection and room temperature electrical test of the assembled SQUID carrier for the purpose of identifying any gross electrical malfunctions.

1.8.2 EQUIPMENT:

Phosphor Bronze Handling fixture
Storage Case for SQUID carrier fabricated from 1" VCR fittings
Keithley Model 580 Micro-Ohm Meter
Fluke 77 Multimeter
Lemo Connector Interface Switch Box
Low Power (7-30X) Microscope

1.8.3 MATERIALS:

Assembled SQUID carrier, Part # 25018-201
SQUID Assembly Traveler
Table P0153-5

1.8.4 PROCEDURE:

The following ESD measures shall be followed from this point onward in SQUID carrier fabrication and testing:

All work will be performed on ESD certified work area that includes grounded bench top or mat, grounded wrist strap worn by operator. The effectiveness of the ground shall be checked before starting work using approved wrist strap tester. The Storage and handling of parts will be done using ESD protective boxes.

Using the microscope inspect all solder joints, epoxy bonds and wire bonds. Check metal traces for the presence of solder bridges.

If any defects are found they must be corrected or the carrier is to be rejected.

Connect the Lemo Connector Interface Switch Box to the Lemo connector using care not to stress the solder joint between the Lemo connector and the substrate. (Support the carrier by the Lemo connector, not the substrate when making and breaking this connection.)

Connect the Keithley micro-ohm meter to the switch box.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 20Ω range measure and record the resistance on table P0154-5 between pins 4 and 5 of the Lemo connector.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 20Ω range measure and record the resistance on table P0153-5 between pins 1 and 8 and between pins 2 and 3 of the Lemo connector .

With the Keithley micro-ohm meter in the non-dry contact, pulsed mode, 2kΩ range measure and record the resistance on table P0153-5 between pins 1 and 8 and between pins 9 and 10 of the Lemo connector .

Disconnect the Keithley micro-ohm meter from the switch box and connect the Fluke 77 Multimeter to the switch box. With the multimeter in the 32MΩ range measure and record the resistance on table P0153-5 between the following pairs of pins of the Lemo connector.

- 1 and 2
- 1 and 3
- 1 and 4
- 1 and 5
- 1 and 6
- 1 and 7
- 1 and 9
- 1 and 10
- 2 and 4
- 2 and 5
- 2 and 6
- 2 and 7
- 2 and 8
- 2 and 9
- 2 and 10
- 4 and 6
- 4 and 7
- 4 and 8
- 4 and 9
- 4 and 10
- 6 and 8
- 6 and 9
- 6 and 10
- 7 and 8
- 7 and 9
- 7 and 10

Record completion date and sign traveler

2.0 ENDURANCE TESTING OF ASSEMBLED SQUID CARRIER

2.1. LIQUID HELIUM DIP TEST (Readout Test 7.3)

2.1.1 SCOPE: This section of the procedure covers endurance testing of the assembled SQUID carrier by cycling to liquid helium temperature.

2.1.2 EQUIPMENT:

Low Temperature Testing Probe Fabricated from 1” Stainless Steel Pipe
L’Air Liquid RS 65A Dewar
1-3/4” Open End Wrench
1-5/8” Open End Wrench
Pumping Station With 1/4” Swagelok Fittings for Connection to Low Temperature Probe and Helium Backfill
3’ length of 1/4” OD flexible plastic tube with Swagelok nut and ferrules on both ends

7’ length of 1/4” OD flexible plastic tube with Swagelok nut and ferrules on one end
Keithley Model 580 Micro-Ohm Meter
Fluke 77 Multimeter
Lemo Connector Interface Switch Box

2.1.3 MATERIALS:

Assembled SQUID carrier secured to Phosphor Bronze Handling fixture
in Storage Case fabricated from 1” VCR fittings
1” VCR gasket
Liquid Helium
Cylinder of gaseous Helium with Regulator and 1/4” OD tube

2.1.4 PROCEDURE:

The following ESD measures shall be followed from this point onward in SQUID carrier fabrication and testing:

All work will be performed on ESD certified work area that includes grounded bench top or mat, grounded wrist strap worn by operator. The effectiveness of the ground shall be checked before starting work using approved wrist strap tester. The Storage and handling of parts will be done using ESD protective boxes.

Remove the VCR cap from the SQUID carrier storage case. Hand tighten the SQUID carrier storage case containing the SQUID carrier to the fitting on the low temperature probe using a new VCR gasket. Tighten the fitting using the wrenches.

Connect probe Swagelok fitting to the pumping port on the pumping station using the 3’ plastic tube. Connect the Swagelok nut on the 7’ length of plastic tube to the back fill port of the pumping station.

Open the helium cylinder valve and set the regulator at 1 - 2 psig. Insert the free end of the 1/4” OD plastic tube coming from the backfill port into the 1/4” ID tube going to the helium cylinder.

Start the pump.

Close the valve on the backfill port of the pumping station. Open the valve between the pump and the pumping port. Open the isolation valve on the probe.

After the pressure falls below 1 torr close the valve between the pump and the pumping port. Open the backfill valve on the pumping port and allow the probe to backfill with helium until helium begins to escape from the check valve on the probe.

Repeat the pumpdown and helium backfill of the probe two more times. Close the probe isolation valve and disconnect the probe from the plastic tube.

Assure that the dewar is filled to a depth of at least 6”.

Insert the end of the probe containing the SQUID carrier under test into the dewar. 30 - 60 minutes should elapse between the time the probe is first inserted in the dewar and the time it reaches the surface of the liquid helium to avoid boiling off excessive helium.

Allow the probe to remain in the liquid helium for a minimum of 30 minutes, then remove from the dewar.

Allow the probe sufficient time for the temperature to rise above freezing as evidenced by melting of the frost on the end. This time will vary but may be reduced by warming the end with an electric space heater or hot air gun. Do not overheat!

Repeat the above thermal cycle 2 more times for a total of 3 thermal cycles.

Remove the SQUID storage case from the probe. Remove the SQUID from the storage case

Connect the Lemo Connector Interface Switch Box to the Lemo connector using care not to stress the solder joint between the Lemo connector and the substrate. (Support the carrier by the Lemo connector, not the substrate when making and breaking this connection.)

Connect the Keithley micro-ohm meter to the switch box.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 2Ω range measure and record the resistance on table P0153-6 between pins 4 and 5 of the Lemo connector.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 20Ω range measure and record the resistance on table P0153-6 between pins 1 and 8 and between pins 2 and 3 of the Lemo connector .

With the Keithley micro-ohm meter in the non-dry contact, pulsed mode, 2kΩ range measure and record the resistance on table P0153-6 between pins 1 and 8 and between pins 9 and 10 of the Lemo connector .

Disconnect the Keithley micro-ohm meter from the switch box and connect the Fluke 77 Multimeter to the switch box. With the multimeter in the 32MΩ range measure and record the resistance on table P0153-6 between the following pairs of pins of the Lemo connector.

- 1 and 2
- 1 and 3
- 1 and 4
- 1 and 5
- 1 and 6
- 1 and 7
- 1 and 9
- 1 and 10
- 2 and 4
- 2 and 5
- 2 and 6
- 2 and 7
- 2 and 8
- 2 and 9
- 2 and 10
- 4 and 6
- 4 and 7
- 4 and 8
- 4 and 9
- 4 and 10

- 6 and 8
- 6 and 9
- 6 and 10
- 7 and 8
- 7 and 9
- 7 and 10

Record completion date and sign traveler

2.2. LIQUID NITROGEN THERMAL CYCLING (Readout Test 7.2)

2.2.1 SCOPE: This section of the procedure covers endurance testing of the assembled SQUID carrier by repeated cycling from ambient to liquid nitrogen temperature.

2.2.2 EQUIPMENT:

Low Temperature Testing Probe Fabricated from 1" Stainless Steel Pipe
4-way Adapter Manifold for Low Temperature Probe
7-3/4" Dia. X 11-3/4" Deep Stainless Steel Dewar Flask
1-3/4" Open End Wrench
1-5/8" Open End Wrench
Pumping Station With 1/4" Swagelok Fittings for Connection to Low Temperature Probe and Helium Backfill
3' length of 1/4" OD flexible plastic tube with Swagelok nut and ferrules on both ends
7' length of 1/4" OD flexible plastic tube with Swagelok nut and ferrules on one end
Park Tool Professional Bicycle Race Stand Model PRS-5
Heater Plus Fan by Patton Model HF-8
Keithley Model 580 Micro-Ohm Meter
Fluke 77 Multimeter
Lemo Connector Interface Switch Box

2.2.3 MATERIALS:

Assembled SQUID carrier secured to Phosphor Bronze Handling fixture in Storage Case fabricated from 1" VCR fittings
1" VCR gasket
Liquid Nitrogen
Cylinder of gaseous Helium with Regulator and 1/4" OD tube

2.2.4 PROCEDURE:

The following ESD measures shall be followed from this point onward in SQUID carrier fabrication and testing:
All work will be performed on ESD certified work area that includes grounded bench top or mat, grounded wrist strap worn by operator. The effectiveness of the ground shall be checked before starting work using approved wrist strap tester. The Storage and handling of parts will be done using ESD protective boxes.

If more than one SQUID carrier is to be tested attach the 4-way adapter manifold to the low temperature probe using a new VCR gasket.

Remove the VCR cap from the SQUID carrier storage case. Hand tighten the SQUID carrier storage case containing the SQUID carrier to the fitting on the low temperature probe or to the 4-way adapter if more than one SQUID carrier is to be tested using new VCR gaskets. Tighten the VCR fittings using the wrenches.

Connect probe Swagelok fitting to the pumping port on the pumping station using the 3' plastic tube. Connect the Swagelok nut on the 7' length of plastic tube to the back fill port of the pumping station.

Open the helium cylinder valve and set the regulator at 1 - 2 psig. Insert the free end of the 1/4" OD plastic tube coming from the backfill port into the 1/4" ID tube going to the helium cylinder.

Start the pump.

Close the valve on the backfill port of the pumping station. Open the valve between the pump and the pumping port. Open the isolation valve on the probe.

After the pressure falls below 1 torr close the valve between the pump and the pumping port. Open the backfill valve on the pumping port and allow the probe to backfill with helium until helium begins to escape from the check valve on the probe.

Repeat the pumpdown and helium backfill of the probe two more times. Close the probe isolation valve and disconnect the probe from the plastic tube.

Fill the dewar with liquid nitrogen to a depth of 7-9 inches.

Insert the end of the probe containing the SQUID carrier under test into the dewar. Secure the probe vertically at mid length with the bicycle stand. Allow a minimum of 10 minutes for the probe to cool then remove from the dewar.

Place the cold end of the probe in front of the heater and turn the heater on, again securing the probe vertically at mid length with the bicycle stand.

Allow the probe sufficient time for the temperature to rise above freezing as evidenced by melting of the frost on the end.

Repeat the above thermal cycling for a total of 3 times.

Remove the SQUID storage case from the probe. Remove the SQUID from the storage case.

The Following measurements should be witnessed and signed off by Barry Muhlfelder.

Connect the Lemo Connector Interface Switch Box to the Lemo connector using care not to stress the solder joint between the Lemo connector and the substrate. (Support the carrier by the Lemo connector, not the substrate when making and breaking this connection.)

Connect the Keithley micro-ohm meter to the switch box.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 2Ω range measure and record the resistance on table P0153-7 between pins 4 and 5 of the Lemo connector.

With the Keithley micro-ohm meter in the dry contact, pulsed mode, 20Ω range measure and record the resistance on table P0153-7 between pins 1 and 8 and between pins 2 and 3 of the Lemo connector .

With the Keithley micro-ohm meter in the non-dry contact, pulsed mode, 2kΩ range measure and record the resistance on table P0153-7 between pins 1 and 8 and between pins 9 and 10 of the Lemo connector .

Disconnect the Keithley micro-ohm meter from the switch box and connect the Fluke 77 Multimeter to the switch box. With the multimeter in the 32MΩ range measure and record the resistance on table P0153-7 between the following pairs of pins of the Lemo connector.

- 1 and 2
- 1 and 3
- 1 and 4
- 1 and 5
- 1 and 6
- 1 and 7
- 1 and 9
- 1 and 10
- 2 and 4
- 2 and 5
- 2 and 6
- 2 and 7
- 2 and 8
- 2 and 9
- 2 and 10
- 4 and 6
- 4 and 7
- 4 and 8
- 4 and 9
- 4 and 10
- 6 and 8
- 6 and 9
- 6 and 10
- 7 and 8
- 7 and 9
- 7 and 10

Record completion date and sign traveler

3. STORAGE OF COMPLETED SQUID CARRIERS

Following completion of assembly and endurance testing place the SQUID carrier in a conductive plastic box for ESD protection. Label the box with the SQUID carrier serial number.
Place the box containing the SQUID carrier in the dessicator in the SQUID carrier assembly area

4. DELIVERABLES

The following documentation should be delivered with the completed SQUID carrier:

- SQUID Carrier Assembly Travel Sheet
- Certificate of Compliance for SQUID Carrier-
- Certificate of Compliance for Feedback Transformer
- RoomTemperature Resistance Measurements (P0153 Tables 1-7)
- Output Transformer Travel Sheet.

Place copies of tables P0153-1 through P0153-7 in the SQUID Assembly Log Book.

P0153 Table 0
Parts List

Component	**Part No.**	**Quantity**
Sapphire Substrate	25019-201	1
100Ω Resistor	25429-101	7
10Ω Resistor	25430-101	2
2 MΩ Resistor	25429-102	1
2 nF Capacitor	25427-201	2
Output Transformer	25432-201	1
Lemo Connector	25020-101	1
Output Transformer Post	25431-101	1
Thermal Ground Strap	25450-101	1
SQUID	25428-101	1
Feedback Transformer	25426-101	1

P0153 Table 1
SQUID CARRIER COMPONENT ROOM TEMPERATURE MEASUREMENTS

Carrier Serial Number _______________

Component	Part No.	Lot No.	Nominal Value	Measured Value	Operator	Date
Output Transformer Primary Inductance	25432-201		5.4 µH ±10%			
Output Transformer Secondary Inductance	25432-201		560 µH ±10%			
Output Transformer Secondary Center Tap to Leg 1 Inductance	25432-201		140 µH ±10%			
Output Transformer Secondary Center Tap to Leg 2 Inductance	25432-201		140 µH ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25429-101		100Ω ±10%			
Chip Resistor Resistance	25430-101		10 Ω ±10%			
Chip Resistor Resistance	25429-102		2M Ω ±10%			
Chip Resistor Resistance	25430-101		10 Ω ±10%			
Chip Capacitor Capacitance	25427-201		2 nF ±20%			
Chip Capacitor Capacitance	25427-201		2 nF ±20%			
Output Transformer Primary inc. Series Resistors Resistance	25432-201		1.6 Ω ±20			
Output Transformer Secondary Resistance	25432-201		1.08Ω ±20			
Output Transformer Primary to Secondary Resistance	25432-201		>20 MΩ			
Feedback Transformer Primary Resistance	25426-101		2738Ω ±50%			
Feedback Transformer Secondary Resistance	25426-101		871Ω ±50%			
Feedback Transformer Primary to Secondary Resistance	25426-101		>20 MΩ			

Fluke Ohmmeter Serial No.____________________

Keithley 580 Micro-ohmmeter Serial No.____________________

HP 4277A LCZ Meter Serial No._______________________

Beckman Model 1830 Capacitance Meter Serial No._______________________

P0153 Table2

Resistance Measurements
Solder Pads Following Attachment of Resistors and Damping Capacator

Carrier Serial No.___________

Pad Numbers	Nominal Resistance	Measured Resistance
S18 and S3	105Ω*	
S18 and S4	205Ω*	
S20 and S1	120Ω*	
S20 and S2	219Ω*	
S17 and S10	110Ω†	
S17 and S11	10.6Ω*	
S19 and S12	116Ω†	
S19 and S13	15.7Ω*	
S25 and S8	148Ω*	
S25 and S9	48Ω*	
S26 and S22	135Ω*	
S26 and S24	35.6Ω*	
Operator_____________		Date__________

"∞" implies resistance greater then 20 MΩ
* +100%, -50% tolerance
† ±20%

Fluke Ohmmeter Serial No.______________________

Keithley 580 Micro-ohmmeter Serial No.______________________

P0153 Table 3
Resistance Measurements
SQUID Carrier Following completion of Soldering Operation

Carrier Serial No.___________

Lemo Connector Pins	Nominal Resistance	Measured Resistance
4-5 (Signal)	1.2-1.3Ω ±20%	
1-8 (FB)	>20 MΩ	
2-3 (Mod)	>20 MΩ	
9-10 (Bias)	400Ω +100% -50%	
1-2	>20 MΩ	
1-3	>20 MΩ	
1-4	>20 MΩ	
1-5	>20 MΩ	
1-6	>20 MΩ	
1-7	>20 MΩ	
1-9	>20 MΩ	
1-10	>20 MΩ	
2-4	>20 MΩ	
2-5	>20 MΩ	
2-6	>20 MΩ	
2-7	>20 MΩ	
2-8	>20 MΩ	
2-9	>20 MΩ	
2-10	>20 MΩ	
4-6	>20 MΩ	
4-7	>20 MΩ	
4-8	>20 MΩ	
4-9	>20 MΩ	
4-10	>20 MΩ	
6-8	>20 MΩ	
6-9	>20 MΩ	
6-10	>20 MΩ	
7-8	>20 MΩ	
7-9	>20 MΩ	
7-10	>20 MΩ	
Operator_____________		Date__________

Fluke Ohmmeter Serial No.____________________

Keithley 580 Micro-ohmmeter Serial No.____________________

P0153 Table4
Resistance Measurements
Output Transformer and SQUID Input

Carrier Serial No.__________

Pad Numbers	Nominal Resistance	Measured Resistance
S21and S23	1.1Ω†	
S21 and B15	>20 MΩ	
B16 and B15	2.1Ω†	
B16 and S23	>20 MΩ	
---------------------------	-------------------	---------------------
S5 and S7	110Ω *	
---------------------------	-------------------	---------------------
Input Pads	100Ω *	
Operator____________		Date_________

* +100% -50%
† ±20%

Keithley 580 Micro-ohmmeter Serial No.____________________

P0153 Table 5
Resistance Measurements
Carrier Following Completion of Assembly

Carrier Serial No.___________

Lemo Connector Pins	Nominal Resistance	Measured Resistance
4-5 (Signal)	1.2-1.3Ω †	
1-8 (FB)	2.9-3.8KΩ *	
2-3 (Mod)	4.2-4.7KΩ *	
9-10 (Bias)	380-450Ω *	
1-2	>20 MΩ	
1-3	>20 MΩ	
1-4	>20 MΩ	
1-5	>20 MΩ	
1-6	>20 MΩ	
1-7	>20 MΩ	
1-9	>20 MΩ	
1-10	>20 MΩ	
2-4	>20 MΩ	
2-5	>20 MΩ	
2-6	>20 MΩ	
2-7	>20 MΩ	
2-8	>20 MΩ	
2-9	>20 MΩ	
2-10	>20 MΩ	
4-6	>20 MΩ	
4-7	>20 MΩ	
4-8	>20 MΩ	
4-9	>20 MΩ	
4-10	>20 MΩ	
6-8	>20 MΩ	
6-9	>20 MΩ	
6-10	>20 MΩ	
7-8	>20 MΩ	
7-9	>20 MΩ	
7-10	>20 MΩ	
Visual Inspection: Pass____ Fail____ Comments_________________________ Operator_____________ Fluke Ohmmeter Serial No.____________ Keithley 580 Micro-ohmmeter Serial No._____________________		Date_________

* +100% -50%
† ±20%

P0153 Table6
Resistance Measurements
Carrier Following Liquid Helium Thermal Cycle

Carrier Serial No.___________

Lemo Connector Pins	Nominal Resistance	Measured Resistance
4-5 (Signal)	1.2-1.3Ω †	
1-8 (FB)	2.9-3.8KΩ *	
2-3 (Mod)	4.2-4.7KΩ *	
9-10 (Bias)	380-450Ω *	
1-2	>20 MΩ	
1-3	>20 MΩ	
1-4	>20 MΩ	
1-5	>20 MΩ	
1-6	>20 MΩ	
1-7	>20 MΩ	
1-9	>20 MΩ	
1-10	>20 MΩ	
2-4	>20 MΩ	
2-5	>20 MΩ	
2-6	>20 MΩ	
2-7	>20 MΩ	
2-8	>20 MΩ	
2-9	>20 MΩ	
2-10	>20 MΩ	
4-6	>20 MΩ	
4-7	>20 MΩ	
4-8	>20 MΩ	
4-9	>20 MΩ	
4-10	>20 MΩ	
6-8	>20 MΩ	
6-9	>20 MΩ	
6-10	>20 MΩ	
7-8	>20 MΩ	
7-9	>20 MΩ	
7-10	>20 MΩ	
Operator_____________ Fluke Ohmmeter Serial No.____________ Keithley 580 Micro-ohmmeter Serial No.____________________		Date_________

* +100% -50%
† ±20%

P0153 Table 7
Resistance Measurements
Carrier Following Liquid Nitrogen Thermal Cycle

Carrier Serial No.___________

Lemo Connector Pins	Nominal Resistance	Measured Resistance
4-5 (Signal)	1.2-1.3Ω †	
1-8 (FB)	2.9-3.8KΩ *	
2-3 (Mod)	4.2-4.7KΩ *	
9-10 (Bias)	380-450Ω *	
1-2	>20 MΩ	
1-3	>20 MΩ	
1-4	>20 MΩ	
1-5	>20 MΩ	
1-6	>20 MΩ	
1-7	>20 MΩ	
1-9	>20 MΩ	
1-10	>20 MΩ	
2-4	>20 MΩ	
2-5	>20 MΩ	
2-6	>20 MΩ	
2-7	>20 MΩ	
2-8	>20 MΩ	
2-9	>20 MΩ	
2-10	>20 MΩ	
4-6	>20 MΩ	
4-7	>20 MΩ	
4-8	>20 MΩ	
4-9	>20 MΩ	
4-10	>20 MΩ	
6-8	>20 MΩ	
6-9	>20 MΩ	
6-10	>20 MΩ	
7-8	>20 MΩ	
7-9	>20 MΩ	
7-10	>20 MΩ	
Operator_____________ Barry Muhlfelder_____________ Fluke Ohmmeter Serial No.____________ Keithley 580 Micro-ohmmeter Serial No._____________________		Date__________ Date__________

* +100% -50%
† ±20%

FEEDBACK TRANSFORMER CERTIFICATE OF COMPLIANCE

Feedback transformer No. ______ installed on SQUID carrier No. _______
conforms to specification for Gravity Probe-B SQUID feedback transformer.

Signed__________________
Date__________________

SQUID CARRIER CERTIFICATE OF COMPLIANCE

SQUID carrier No.______ was built in accordance with Procedure P0153,

Signed__________________
Date__________________

Major Discrepancies: Yes

No

If Yes Explain: