GRAVITY PROBE B

PROCEDURE FOR

PAYLOAD VERIFICATION

AC SHIELDING TEST PROCEDURE

P0860 Rev.-
July 17, 2001

Prepared by: B. Muhlfelder

Approvals:

Program Responsibility	Signature	Date
B. Muhlfelder Readout Physicist		
B. Clarke SQUID REE		
M. Taber Cryogenics Manager		
R. Whelan Systems Eng.		
D. Ross GP-B Quality Assurance		
R. Brumley Payload Technical Manager		

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

All redlines must be approved by QA

Revision Record:

Rev	Rev Date	ECO #	Summary Description

Table of Contents

A Scope

This is a procedure to operate the hardware required to measure the ac attenuation of external transverse magnetic fields into the science gyroscopes. The external field is applied by a fixed 12-ft. diameter hexagonal field coil set in the Helmholtz configuration, and the internal field is measured by the flight SQUIDs. The nominal roll frequency is 5.55 mHz. It is advantageous, however, to use as high a frequency as possible in order to minimize SQUID noise. Since the attenuation factor can be frequency-dependent because of eddy current fields, this test is run at two frequencies to demonstrate that eddy current damping is understood and that the ac attenuation at roll meets spec. While the magnetic field is being applied, the science magnetometers will be operated by the flight ECU to collect engineering data.

B Requirements Verification and Success Criteria

B.1 Requirements Cross Reference: Payload Spec. 3.2.1.3.2

B.2 Expected Data for verification per requirement: attenuation shall be better than 2e-12.

B.3 The success criteria is meeting the requirement as quoted above.

C Configuration Requirements

The 12-ft. diameter hexagonal field coil set has been installed around the SMD per engineering instruction. The flight magnetometers have been installed onto the payload and the flight SQUIDS are fluxlocked.

C.1 General requirements:

D Hardware Required

D.1 Commercial and Flight test equipment

Manufacturer / Descrip.	Model	Serial Number	Calibr. Exp. Date
Flight Payload with SQUIDS and Gyroscopes	-	-	-
Flight Magnetometers			
HP Function Generator	33120A		
Kepco Bipolar Operational Power Supply / Amplifier	BOP 50-8M		
Keithley 196 DVM (or next line)	196		
HP multimeter	34401A		
APS Fluxgate Magnetometer			
HP Dynamic Signal Analyzer	35607A		NR
SQUID data acquisition system	-	-	-
Soltec Chart Recorder (opt.)	DS6404	24116	NR

D.2 Mechanical/Electrical Special test equipment

Description	Part No.	Rev. no.	Serial No.	Certification Date
Rev C SQUID Electronics	-	C	-	-
Data Acq. System	-	-	-	-
12' dia. Hexagonal vertical-field Helmholtz coil set	-	-	-	-

D.3 Tools

Description	No. Req'd
Tape measure	1

D.4 Expendables: None

E Software Required

E.1 Test Support Software: Strawberry Tree

F Procedures Required

None

G Equipment Pretest Requirements

Equipment	Serial No.	Test Required	Proc. No.	Test Performed	
				Date	By
Hexagonal lower coil	-	field/current ratio	Op #903a	11/17/98	D. Murray
Hexagonal upper coil	-	field/current ratio	Op #910	11/24/98	D. Murray

H Personnel Requirements

This test to be conducted only by B. Clarke, B. Muhlfelder, D. Meriwether, M. Taber, and D. Murray.

I Safety Requirements

I.1 Emergencies: In case of medical emergency or fire, **CALL 9-911**

I.2 Refer to FIST Emergency Procedures SU/GPB P0141 for other types of emergency situations which may occur in the FIST Lab. A copy of this document can be found in the SMD Operations binder. Refer also to the GP-B (FIST) Safety Plan, LMSC F-314447 and the GP-B (FIST) Preliminary Hazards Analysis, LMSC F- 314446 for details concerning hazards and safe operation of Lockheed-supplied equipment.

I.3 Crane operations: The FIST Crane may be operated only by a certified operator.

J General Instructions

J.1 Redlines can be initiated by B. Clarke, B. Muhlfelder, D. Meriwether, M. Taber, or D. Murray and must be reviewed and approved by QA.

J.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.

J.3 Only the following persons have the authority to exit/terminate this test or perform a retest: B. Clarke, B. Muhlfelder, D. Meriwether, M. Taber, or D. Murray.

K **References and Applicable Documents:** None

L **Operations**

Date:
Time:

L.1 Before connection of the power supply to the field coils, perform the following power supply setup to prevent the application of excessive current and verify proper programming:

L.1.1 Review section D to ensure all required hardware is available. Fill in any missing serial numbers and calibration due dates.

L.1.2 Connect the power supply output terminal to the current (I) input of the multimeter and the power supply common terminal to the multimeter LO input. (The multimeter current input will effectively short the power supply.).

L.1.3 Place the Mode switch into the current programming mode (to the right).

L.1.4 Set the current programming control pot to zero output (5.00 on the turns counting dial).

L.1.5 Plug in and turn on the power supply and multimeter.

L.1.6 Turn on the current control switch (on the right side of the panel) and turn up the current control pot until the multimeter reads +3.0 A. (Note: This is the maximum current rating for the multimeter.)

L.1.7 Using a small screwdriver, adjust the positive current limiting pot downward until the current limit indicator lights.

L.1.8 Turn the current control pot downward until the multimeter reads -3.0 A.

L.1.9 Adjust the negative current limiting pot upward until the current limit indicator lights.

L.1.10 Turn the current control pot up and down once more to verify that the current is limited at ±3.0 amps.

L.1.11 Set the current control pot to center (5.00) and turn off the current control switch.

L.1.12 Turn off the power supply.

L.1.13 Connect the HP function generator output to the current programming terminals of the power supply. (Note: the programming ratio is approximatey -0.806 A/V.)

L.1.14 Turn on the function generator, select the square wave function, and set the frequency to 0.05 Hz.

L.1.15 Turn on the power supply.

NOTE:

In using the HP 33120A Function Generator, be aware of two idiosyncrasies: 1) The numbers displayed with units "V_{PP}" are really the peak <u>amplitude</u> volts. 2) The offset voltage is in reality twice the voltage displayed.

L.1.16 Set the function generator ac amplitude to 1.072 V_{PP} and the dc offset to -0.690 V.

(This corresponds to a dc voltage of 1.38 V.) Verify that the output current varies between +0.24 and +1.98 A. Make adjustments as necessary to the offset voltage such that the average current is 1.11 A (corresponding to a dc field of 0.320 G needed to cancel the vertical component of the earth's field) and adjustments in the ac amplitude until the ac current amplitude (one-half of the peak-to-peak difference) is 0.87 A (corresponding to a peak amplitude of 0.25 G).

L.1.17 When satisfied with the offset and amplitude, change from a square to a sine waveform and increase the frequency to 0.1 Hz. Verify that the offset and amplitude have not been accidentally changed.

L.1.18 Store the function generator setup parameters as record 1. These setup parameters may be recalled even after the power to the function generator has been cycled.

L.1.19 In case the record the function generator becomes altered record the ac amplitude:_____V_{pp}, and dc offset:_____V.

L.1.20 Turn off the function generator and the power supply.

L.2 Verify that the ECU is collecting magnetometer data. The data may be found in _____ _____.

L.3 Field coil setup:

L.3.1 Verify that the two halves of the hexagonal Helmholtz are connected in series so that the current will be flowing in the same direction in each coil. (This will be reverified below.)

L.3.2 Connect the coil set, operational power supply, digital multimeter, and function generator per Fig. 1. Note: The output shunting capacitor is necessary to prevent oscillation of the power supply when connect to the field coils.

L.3.3 Verify that the power supply mode switch is set to the current programming mode and that the current programming pot is set to zero output (5.00).

L.3.4 Turn on the digital multimeter and the power supply.

L.3.5 Turn on the current control switch and turn up the current control pot to +2 amps.

L.3.6 Verify that both coils are producing field in the same direction by holding the fluxgate probe a few inches inside each coil.

L.3.7 Note the direction of the field for a positive current.

L.3.8 Turn the current programming pot to zero output, turn off the current control switch, and turn off the power supply. If the field direction was determined to be downward for a positive current, reverse the leads to the field coils.

L.3.9 Mount the fluxgate magnetometer probe midway between the coils and 3" from the OD of the dewar with the fluxgate +Z axis aligned with the SMD +Z axis. At this location (1.15 m from the center), the field is 0.88 of the central field value. (Central field is .289 G/A and .254 G/A at the fluxgate.)

L.3.10 Turn on the power supply and function generator. Restore the function generator parameters stored in section L.2. Verify that the fluxgate Z axis readout alternates between -0.22 and +0.22 gauss to within ~10%. If necessary, temporarily reduce the

function generator frequency to allow the peak field levels to be easily read. If the average of the applied field is more than 0.05 G adjust the offset voltage and record: _____V.

L.3.11 Run the ECU procedure P0544 to operate the flight magnetometers. Ensure that the timing between the ECU test set and the data acquistion system for the SQUIDs is documented in
here_____
_____
_____.

L.3.12 Set/verify set the function generator to 0.1 Hz with a sine waveform. If the offset has been changed, store the function generator setup parameters as record 1.

L.3.13 Turn off the power supply and the function generator.

L.4 SQUID set up and health check:

L.4.1 If the flight SQUIDs are off, turn SQUIDs on and flux lock per P0510.

L.4.2 Record the gain, range, and volts per flux quantum for each SQUID in Table 1 below.

L.5 Electronics setup:

L.5.1 Connect the data acquistion system, SQUIDs, Signal Analyzer, and Function Generator as shown in Fig. 3. If desired, connect one of the squids to one of the Soltec chart recorder channels with the gain set to 10 V f.s. The Signal Analyzer is useful for diagnostics (e.g. harmonic generation, signal / noise estimation). Record setup parameters in Table 1.

L.6 Attenuation Measurements

L.6.1 Turn on / verify turned on all electronics except the power supply.

L.6.2 Turn on the power supply and verify operation with the fluxgate.

NOTE:

Any significant dc offset from the SQUID is undesirable because it reduces dynamic reserve. Be sure to reset the SQUID before starting any measurements. If a flux jump occurs during a measurement, the SQUID should be reset and the settling process should be started over again.

L.6.3 Collect data for a minimum of 4 hours. Indicate the amplitude of the detected signal in the SQUID and the equivalent shielding factor in Table 1.

L.6.4 Repeat the above measurements for an ac field frequency of 50 mHz.

L.6.5 If the results at 50 mHz and 100 do not agree, repeat test at 17 mHz.

L.7 Termination of ac attenuation measurements

L.7.1 Copy all data files to a server. Data file name and directory path:
_____

L.7.2 Shut down and disconnect all electronic instrumentation.

L.7.3 Remove top coil from payload.

Test completed.

Completed by: _____
Witnessed by: _____
Date: _____
Time: _____

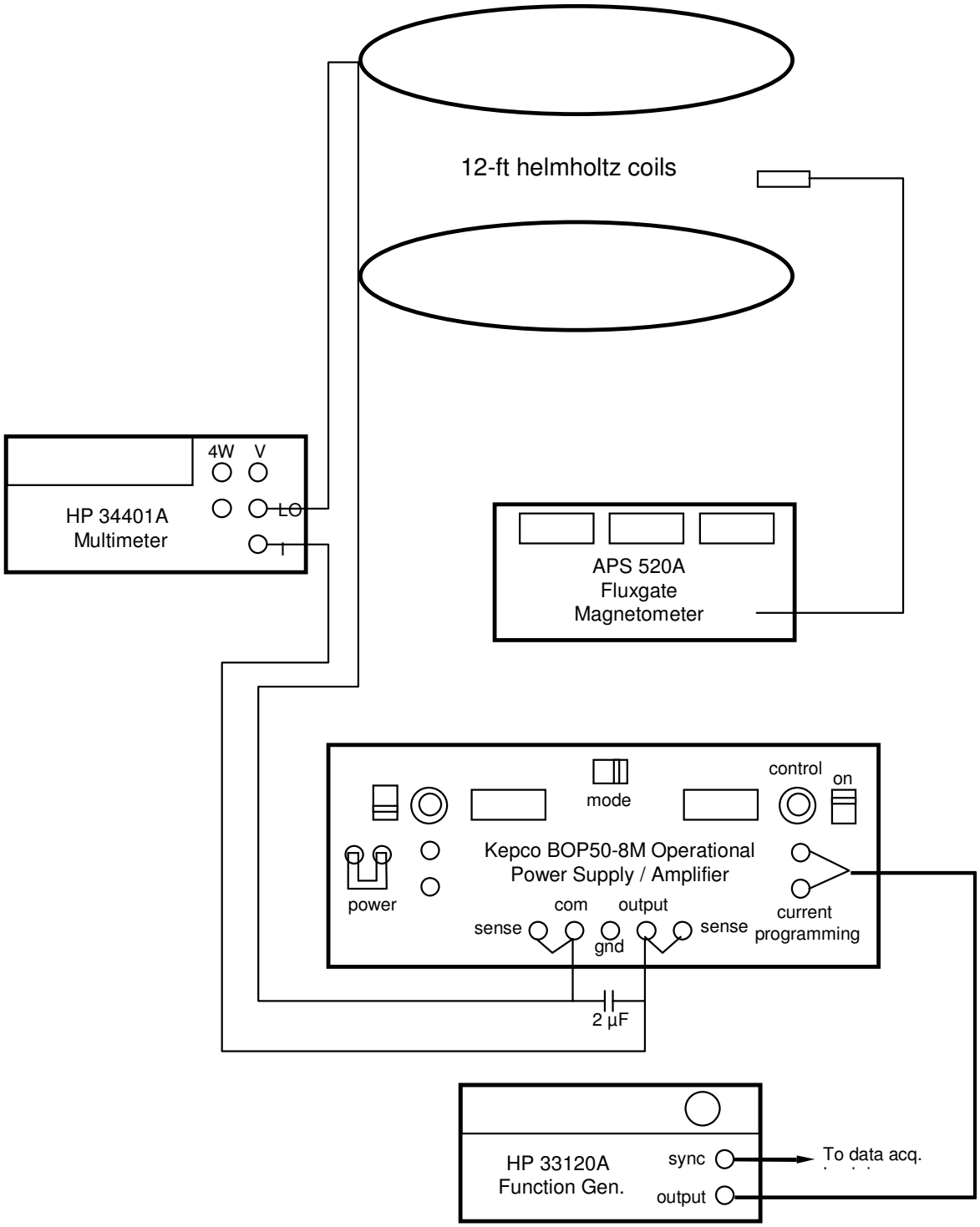

Fig. 1 Field Coil setup. Flight magnetometers and flight SQUIDs are not shown.

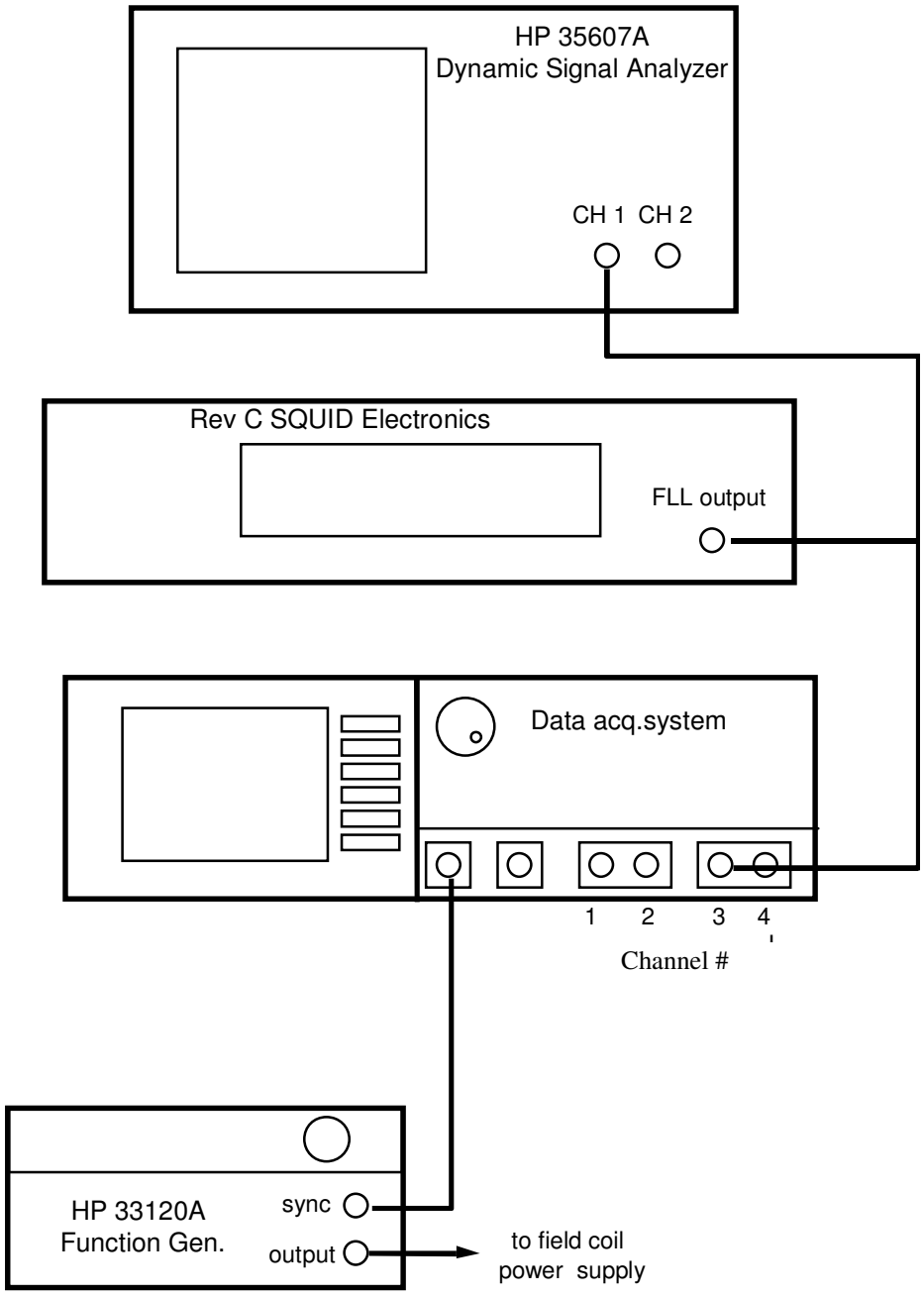

Fig. 3 Instrumentation block diagram. One (of 4) SQUID shown for clarity. Also not shown (for clarity): Low pass filter located between FLL output and Data Acq. System input.

Table 1

SQUID DATA File Name and sample rate	ECU MAG. DATA File Name	Start of data acquistion time	 date	Oscillator frequency (mHz)	SQUID Information SQUID #	 Low pass freq. & gain	 SQUID Range	 SQUID Gain	 Detected Sig. Amplitude (volts)	 Shielding factor