Gravity Probe B

Procedure for *GTU-2* EMI Tests

10 September 1997
P0331 Rev.-

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Approvals:

Program Responsibility	Signature	Date
Rodger Cliff GTU-2 EMI/EMC Test Leader		
P. Ehrensberger TRE IPT Lead		
Jim Lockhart SRE IPT Lead		
John Thatcher ECU REE and IPT Lead		
G. Gutt GSS EU REE		
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Total No. of Pages = 17

Table of Contents

1. Introduction

The External EMI test is one of the series of tests to be performed on Ground Test Unit 2 (GTU-2) in accordance with the Stanford test plan documented in GP-B GTU-2 Test List Table 7-1. Test reference No. 2.8 to 2.13

These tests will be performed in Hansen Experimental Physics Laboratory (HEPL) building of the Stanford University. The Equipment Under Test (EUT) will be GTU-2 hardware configuration as described in the GTU-2 test plan. The EMI test equipment will be provided by EMI laboratory of the Lockheed Martin Missiles and Space (LMMS).

2. Test Objectives

Requirement(s):. Determine EMI field intensity versus frequency for which SQUID operation shows no readily observable degradation.. Determine EMI field intensity versus frequency for which SQUID becomes unstable**.** Determine impact on SQUID low frequency noise of operation at the threshold of readily observable degradation.

Goal(s):. Determine effectiveness of SQUID, instrumentation, and suspension filter connectors. Determine optimum grounding configuration for SRE**.** Determine adequacy of SRE cabling and shielding.

3.0 Reference Documents

TRE Specification.	(PLSE-13, Part 3)
SRE Specification	(PLSE-13, Part 2)
ECU Specification	(PLSE-13, Part 4)
GSS Specification	(PLSE- 13, Part1)
GTU-2 Test Plan	(Unnumbered)

GPB Mission Event Timeline Database
GPB Payload Electronics Units Testing Philosophy EM No. 449
Electrostatic Discharge Procedure as posted in the working area
GP-B Safety, Maint. , & PA Plan F428533 Rev.E

4.0 Test Facilities

Hansen Experimental Physics Laboratory (HEPL) building of the Stanford University.

5.0 General Requirements

5.1 Test will be performed under the environmental conditions existing, at Hansen Experimental Physics Laboratory (HEPL) building of the Stanford University.

5.2 Power supplies, oscilloscope, digital Multi Meters, computers and any other standard test equipment used in this test must have valid calibration decals.

5.3 Red lines to the procedure shall require the approval and initial of any one of the following key contacts or their representatives.

Stanford	*M. Taber*
Stanford	*Jim Lockhart*
Stanford	*Paul Ehrensberger*
Stanford	*B. Muhlfelder*
Stanford	*B. Taller*
LMMS	*Rodger Cliff*
LMMS	*John Thatcher*
LMMS	*Mirza Siddique*
???	*Ed Ingraham*

5.4 In order to expedite test operations, unless specified noted, the sequence in which major sections or subsections are performed may be altered at the discretion of the following people.

Stanford	M. Taber
Stanford	Jim Lockhart
LMMS	Rodger Cliff

5.5 PA or their representative shall be present to witness and verify the test is performed as described in the test procedure, and stamp each page of the procedure as it progresses.

5.6 Test equipment used during this test, their serial numbers shall be recorded in the log book or in section 14.0 “List of Equipment” of this procedure.

5.7 All the disks/tapes used must be labled and referenced in the logbook.

5.8 Test operators shall read this procedure in its entirety and resolve any apparent ambiguities prior to beginning this test.

6.0 Safety / Security Requirement

6.1 Standard safety practices to ensure safety of personnel and prevent damage to equipment shall be observed during performance of this test.

6.2 Ensure that power is removed from cable assemblies before connecting or disconnecting cable connectors.

6.3 Examine all mating connectors before attempting to mate them. Remove any foreign particle. Look for any damaged pins or sockets. Do not force the coupling action if excessive resistance is encountered. Ensure that key ways are aligned.

6.4 Protect all electrical connectors with plastic caps or connector savers when the connectors are not mated.

6.5 Special care shall be exercised as posted in the operations area to prevent damage caused by Electrostatic Discharge.

6.6 Following precautions will be taken to assure personnel safety:

6.6.1 Only the personnel necessary to conduct the test will be allowed in the test area during the application of radiated power.

6.6.2 Level of radiation will not exceed 60 V/m at any frequency.

7.0 Hardware Under Test

Probe B

Fwd ECU

Fwd TRE

Fwd SRE

Fwd GSS

P/L Electronics to Top Hat Cables

8.0 Support Hardware / Software

8.1 The following test equipment, or equivalent, will be used to perform this test.
Write all the equipment and necessary information in the table " List of Equipment" of this procedure.

LMMS Equipment

Oscillators

Power amplifiers and antennas to provide the needed electromagnetic radiation.

Field strength meters

Stanford Equipment

Oscillators, specialized cables for injection (and reception) of signals into (and out of) the suspension and instrumentation probe feed throughs.

4 channel chart recorder

Computer data recorder

R F Spectrum Analyzer

Lo Frequency Spectrum Analyzer

Frequency Counter

8.2 GPB Specialized Equipment

The following test equipment, or equivalent, will be used to perform this test.

Write all the equipment and necessary information in the table " List of Equipment" of this procedure.

SRE Fwd Engineering Unit
SRE aft simulator with software
GSS gyro unit (forward EU and aft simulator)
TRE (forward EU, and GSE)
ECU (forward EU and Aft. EU)
Probe Suspension Connector Caps
Probe Instr. Connector Caps

Dewar Instr. Vonnector Caps
SRE Instr. Connector Caps
Probe EMI cover
Signal injection cable for suspension line
Signal injection cable for gyro heater line
Signal injection cable for telescope heater
SRE tophat cables
Instrumentation cables/filters
Grid dip oscillator
SRE forward caps
Caps for unused ECU ports and I1/I3 lines

9. Test Description

Electromagnetic waves with frequencies ranging from 10 MHz to 10 GHz and field intensities up to 50 V/m will be focused into the neck of the GTU -2 probe through Window # 4. The effect of this electromagnetic interference on P/L electronic operation will be characterized.

10. Test Requirement

Provides test of electrical filter performance (version 2.6 Payload Specification 3.7.3.2.8.1). May provide test of section 3.7.3.2.7.5 (Optical System EMI Filtration). Determines additional shielding which must be provided by window coatings, sunshade, and other absorbers. May allow test of EMI resistance of SQUID control electronics.

11.0 EMI Tests

Test Method - Electronics sensitivity to external EMI, probe closed:

Position EMI antenna over window 4 at distance of 1 m to be used for coupling radiation into probe.

***[Important note**: antenna rigging must be done so as to present no risk to flight dewar.]*

Modulate RF carrier with 1 KHz squarewave, 100% modulation depth (this modulation to be used in all EMI testing).

Place RF-tight cap over window #4 to isolate probe from rediated EMI.. Connect SQUIDs 1 and 3 to SRE A EU as indicated:

Cable Connector	**Tophat Connector**
MSX-1	MR21
SSX-1	SR12
FBX-1	TR51
MSX-3	FR44
SSX-3	SR15
FBX-3	TR52

Affix metallic shield caps to all other probe feedthroughs. Bring up SRE A with both SQUID channels flux locked. Attach SRE FLL channel 1 & 3 analog outputs from breakout box to chart recorder and to computer data recorder. Connect frequency

counter to computer data recorder via IEEE. Start EMI test program on computer. Also connect FLL output channels to lock-in amplifiers referenced to 1 KHz modulation source; set lock-in time constants to 50 ms; connect lockin outputs to chart recorder and computer data recorder.

Set RF field strength to 0.5 V/m at Window #4. Scan from 10 MHz to 10 GHz over a period of no less than 20 minutes with chart recorder and data recorder running.

If disturbances in SQUID output are observed, repeat above step at field strength of 0.2 V/m and 0.1 V/m until no disturbance is obvious on chart recorder.

Repeat process at field strengths of 2 V/m, 10 V/m, and optionally 20 V/m.

Observe data from TRE, GSS position bridge and ECU QBS heater for changes due to RF energy.

Sensitivity to external EMI with probe open

Remove RF-tight cap from window #4 to expose probe to radiated EMI. Arrange RF antenna to beam radiation along probe centerline. Set field strength to 0.5 V/m at Window #4. Sweep RF from 10 MHz to 10 GHz smoothly over period of no less than 20 minutes with chart recorder and data recorder operating as above.

Repeat above process with EMI field strengths of 2 V/m, 10 V/m, and optionally 20 V/m. (if significant effects were observed at 0.5 V/m, repeat test at 0.2 V/m and 0.1 V/m, etc., Until a level is reached at which no significant effects are observed on SQUID output bias and 1 KHz output levels.)

Observe data from TRE, GSS position bridge and ECU QBS heater for changes due to RF Energy.

From data obtained above, determine two principal frequencies at which radiated EMI sensitivity is greatest. At each of these frequencies, find the threshold field strength at which bias offset and 1 KHz indications are observed. At this field strength, accumulate one hour of SQUID data for each of the two SQUID channels using the SRE data acquisition system. Repeat for the other principal frequency. Repeat this process using both half and twice the threshold level as well as with no EMI applied.

Repeat all above steps with the SRE EU connected to SQUID 2 & 4 according to the following cable connection list:

CABLE CONNECTOR	TOPHAT CONNECTOR
MSX-1	BR34
SSX-1	SR18
FBX-1	BR33
MSX-3	FR45
SSX-3	SR14
FBX-3	MR23

OPTIONS:

The effectiveness of the EMI shielding of the SQUID control electronics can be assessed by observing SQUID performance with and without additional metal covering on the electronics units. Tests can be made both with and without the coax ground cable to the probe tophat (cable to be replaced with shorting terminator connector on SRE ground connector). Tests can be made with optional cable grounding jumpers in SRE.

12.0 Completion of Procedure

Test Leader_____ Date_____
Rodger Cliff

Test Director_____ Date_____
M. Taber

TRE IPT Leader_____ Date_____
P. Ehrensberger

SRE IPT Leader_____ Date_____
Jim Lockhart

ECU IPT Leader_____ Date_____
John Thatcher

GSS EU REE_____ Date_____
G. Gutt

This is to certify that the information obtained under this test procedure is as represented and documentation is complete and correct.

Product Assurance_____ Date_____
B. Taller

13.0 Re-Run Documentation

Make copies of the " Re-Run Documentation " Table as required

RE- Run Documentation

No	DR. No.	TP Page No.	TP Para No.	Retest Title	Comments

14.0 List of Equipment

Make copies of the " List of Equipment " Table as required

List of Equipment

No.	Name Description	Manufacturer	Model	Prop./Serial No.	Cal. Due Date

15.0 Data Sheets

Strip Chart Recorders, and Electronics Media are used to record the Test Results, log books are maintained during the tests, Test Data Sheets may be prepared as required, during and after the tests.