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

GMA FUNCTIONAL TEST
SETTING & TESTING OF SPIN UP PARAMETERS

P0586 REV --

20, June 2000

GPB SCIENCE MISSION PROCEDURE

PREPARED: _____ date: _____
D. Avaloff, Test Engineer

APPROVED: _____ date: _____
R. Stephenson, Test Director

APPROVED: _____ date: _____
G. Asher, GMA Manager

APPROVED: _____ date: _____
D. Ross, Quality Assurance

APPROVED: _____ date: _____
B. Muhlfelder, Hardware Manager

TABLE OF CONTENTS

1. GENERAL DESCRIPTION

This procedure describes the adjustment of the regulators and metering valves of the spin up module of the flight GMA. After the parameters are set a functional test will be performed. This procedure assumes a 700 and 500 scc/m flow through the gyroscope circuits as the critical requirement. The pressures that correspond to these flows will be measured and then accepted as requirements under the assumption that the impedance simulation is accurate.

2. TEST INFORMATION

- Proper care should be taken in handling and cleanliness must be preserved.
- Temperature: Room Temperature
- Humidity: not critical

2.1 Safety

The pressure in any part of the GMA must never exceed the rated pressure of any individual component to withstand that pressure. The GSE equipment will incorporate a pressure relief valve to ensure that the pressure in the GMA or GSE will not exceed 3000 psi. See Fig. 1.

2.2 Cleanliness

2.2.1 Normal lab environment when valves are capped and bagged

2.2.2 Class 10 clean room or clean bench in a class 1000 room.

2.3 ESD precautions

2.3.1 None required.

2.4 Use of Connector Savers

2.4.1 Connector savers will be used on all gas and electrical connections.

ONR representative, and QA to be notified 24 hours prior to beginning this procedure

QA Notified:_____ ONR Notified:_____

2.5 Procedure Pass-Fail Criteria

2.5.1 The flow and pressure parameters required for a successful spin up of the gyroscopes must be set. All requirement values have a tolerance of +/- 10% and are laid out in the individual adjustment sections of this procedure. If GMA cannot be set correctly, the test is failed.

2.6 Personnel, QA, and Documentation

2.6.1 The Integration and Test Director (ITD) shall be R. Stephenson 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. The GMA Manager shall also sign off the completed *As-Built* procedure.

2.6.2 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 to be R. Stephenson and D. Avaloff and C Gray.

2.6.3 QA. The test 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 D. Ross shall be present during the procedure (if deemed necessary) and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Manager, D. Ross or her designate, shall certify their 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. If a re-test of any or all of the hardware is necessary, the ITD will determine the appropriate changes in the procedure, with the QA Manager's approval.

2.7 Red-line Authority

Authority to red-line (make minor changes during execution) this procedure is given solely to the ITD or his designate, or the GMA Manager, and shall be approved by QA. 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. DOCUMENTS AND EQUIPMENT

3.1 Applicable Documents

Document number	Rev	Description
Dwg. 25110	B	GMA Assembly
Dwg. 25212	B	Spin Up GMA
Dwg. 25213	C	Regulator
Specs for Flow Meters	N/A	Specifications for Impedances of the Flow Meters used in the GSE
Specs for Metering Valves	N/A	Specifications for the Metering Valves used on the GMA and GSE

3.2 Test Equipment

Equipment	Model and Serial Number	Calibration
Vacuum Pump		
Helium Leak Detector	ASM 180 T (Or equivalent)	G142
Helium 4 Gas @ 4000psi		
Helium 3 Gas @ 3500psi		
Engineering ECU		
Impedance Simulation Manifold	See Fig. 2	
Connector Savers	Electrical and Gamah	
High Pressure Regulator Manifold for Helium 4	See Fig. 1	
*Chart Recorder for Engineering ECU		
Caging GSE		

* If the ECU has an output for a chart recorder.

3.3 Flight Parts

3.3.1 Flight GMA, S/N 001 already in clean room.

4.0 PREPARING SPIN UP GMA FOR TESTING

Started on:

4.1 Connecting Gas Supply to SD1

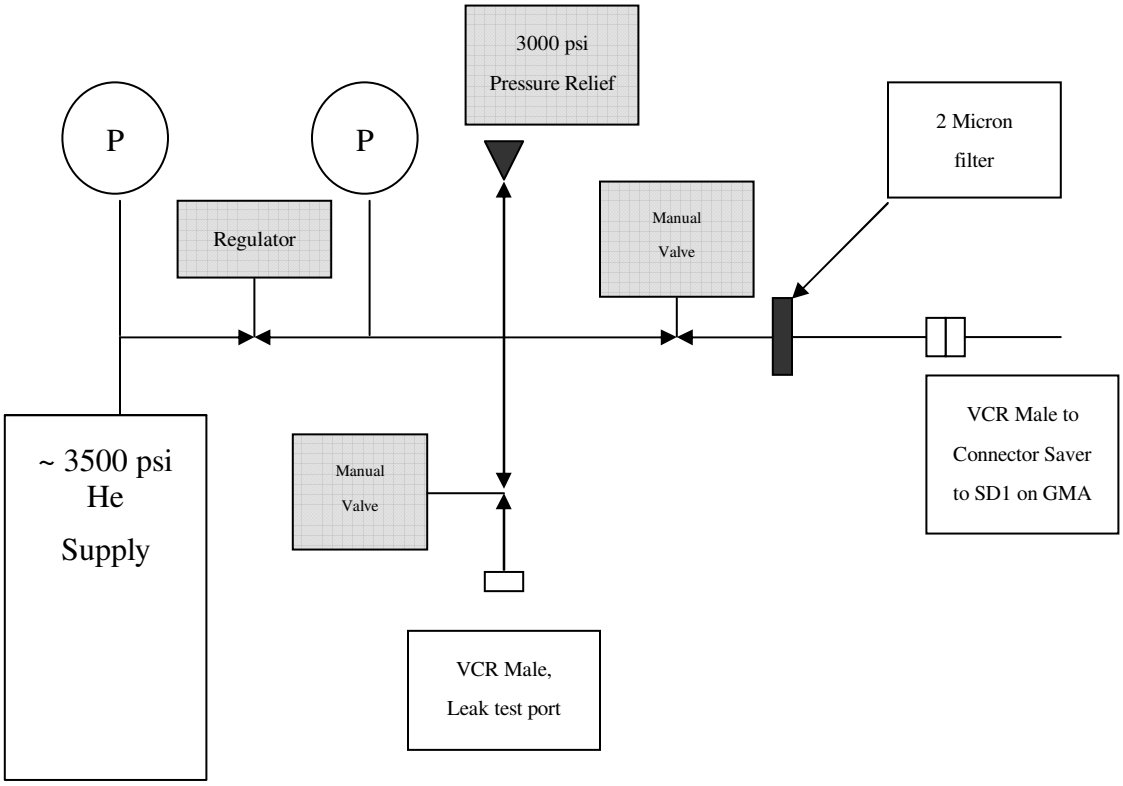

Fig. 1 Schematic of Helium gas supply manifold.

4.1.1 See Fig. 1. Attach regulator to He4 bottle and then attach He4 gas bottle line to SD1 through the connector saver.

4.1.2 Pump out the air between HPM2 and the regulator through the port on the regulator manifold. Pump to a pressure of 1 mTorr or less.

4.1.3 Pressure test connection: With HPM2 closed, open bottle regulator to 1000 psi and apply ethanol to all connections, check for bubbles. Repeat for 2000 and 3000 psi. Leave regulator set to deliver 1000 psi.

4.2 Connecting External Vacuum Pump and Impedance Simulation Manifold to GMA.

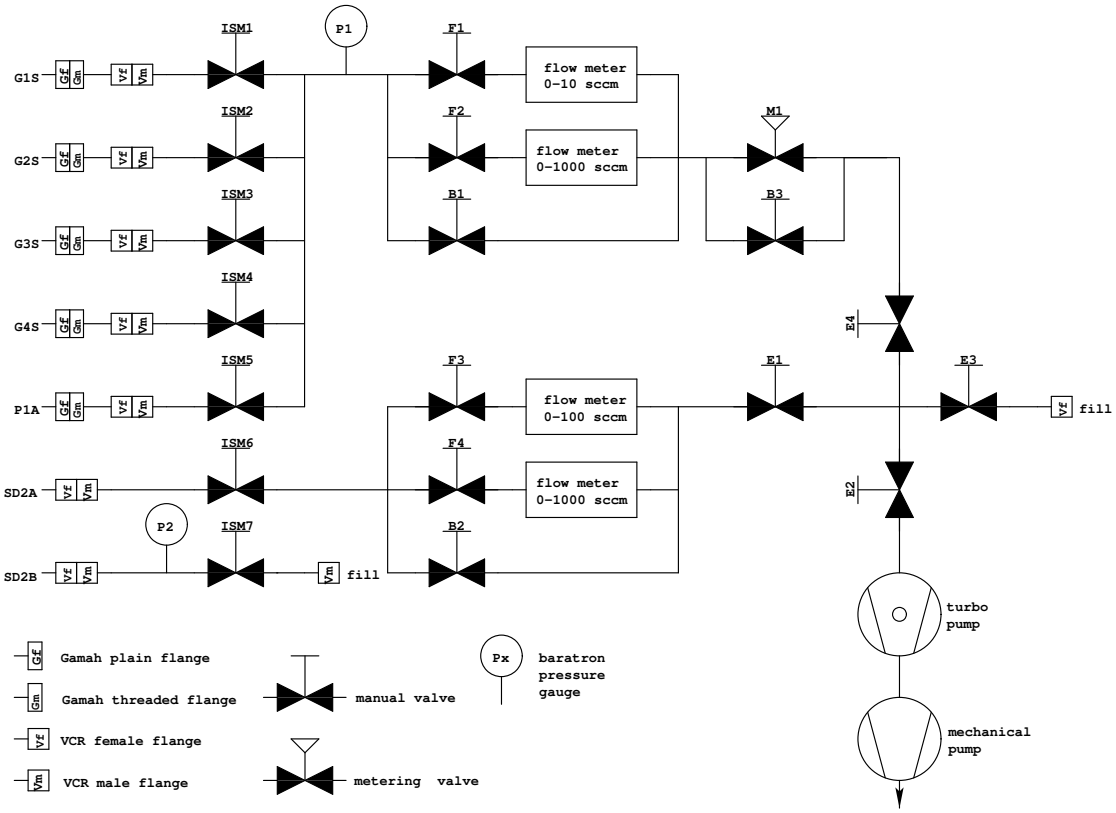

Fig.2 Schematic of Impedance Simulation Manifold (ISM) connected to Spin Up GMA

4.2.1 See Fig. 2. Attach manifold to G1S-G4S and P1A through the connector savers. Then attach manifold to SD2A and SD2B through the connector savers. Leak test all the connections made to the GMA through the ISM7 and/or the E3 valve on the manifold.

4.2.2 Valve off leak detector and start the manifold pump. Open all of the manual valves on the ISM except for ISM7, F1-F4, and E3. Open HPM3. Pump the ISM to a pressure of 0.5 mTorr or less. This is the starting configuration for the ISM.

4.3 Connecting Engineering ECU to GMA

4.3.1 Verify that the pressure transducer cables are connected to SP1-SP9 through connector savers. Verify that the pressure transducer cables are connected to CP1-CP4 through connector savers.

4.3.2 Verify that the solenoid cables are connected to SV1-24 through connector savers. Verify that the solenoid cables are connected to CV1-5 through connector savers.

4.3.3 Verify that SP1-SP9 and CP1-CP4 are being correctly read by the engineering ECU.

4.3.4 Verify that SV1 - SV24 and CV1-CV5 can be activated from the engineering ECU.

4.3.5 Connect chart recorder to engineering ECU to monitor SP1-9.

4.3.6 Verify that all GMA thermometers and heaters are connected to the engineering ECU.

4.4 Configuration of GMA before Functional test

4.4.1 Open all spinup and regulator assembly solenoid valves in order to evacuate the assemblies to <0.5 mTorr. Then close the appropriate solenoids.

4.4.2 The configuration of the spin up module of the GMA should now be a vacuum between HPM2 and the gyro circuits and SV22/SV23. All SV's should be closed except those marked as N/O. There is a pressure of 1000 psi of He4 in the regulator manifold and in the line up to HPM2. There is a vacuum in the impedance simulation manifold and up to the gyro circuits as well as to the bypass circuit. The configuration of the caging module of the GMA should be all solenoid valves CV1-CV5 are closed.

5. TESTING & SETTING PRESSURE AND FLOW

Started on:

5.1 Testing & Setting I: Pressure in R1 at 1000 psia Inlet Pressure

5.1.1 R1 is defined as the regulating arm containing REG1 and REG3. R2 is defined as the regulating arm containing REG2 and REG4.

5.1.2 Open HPM2 and then HPM1. Record SP1.

5.1.3 Open SV1, SV3 and SV5. Record the pressure readings in Table 1 below. Adjust high pressure REG1 and then low pressure REG3 as needed. Vent lines through the bypass (i.e. open SV23) if necessary.

Table 1 Pressure Readings from R1 at 1000 psia Inlet Pressure

Pressure Sensor	Requirement psia	Initial Reading psia Final Adjusted Reading psia	Verify	Comments
SP1	1000			
SP2	450			
SP3A	7			
SP4	0-1			

5.2 Testing & Setting I: Pressure in R2 at 1000 psia Inlet Pressure

5.2.1 Open SV2, SV4, and SV6.

5.2.2 Record the pressure readings in Table 2 below. Adjust REG2 and REG4 as needed. Vent through the bypass if necessary.

5.2.3 Close SV2, SV4 and SV6.

Table 2 Pressure Readings from R2 at 1000 psia Inlet Pressure

Pressure Sensor	Requirement psia	Initial Reading psia Final Adjusted Reading psia	Verify	Comments
SP1	1000			
SP2	450			
SP3A	7			
SP4	0-1			

5.3 Testing & Setting I: Pressure in R1 at 2000 psia Inlet Pressure

5.3.1 Adjust regulator on Helium supply bottle to deliver 2000 psia. Open SV1, SV3 and SV5.

5.3.2 Record the pressure readings in Table 3 below. Adjust REG2 and REG4 as needed. Vent through the bypass if necessary.

5.3.3 Close SV1, SV3 and SV5.

Table 3 Pressure Readings from R1 at 2000 psia Inlet Pressure

Pressure Sensor	Requirement psia	Initial Reading psia Final Adjusted Reading psia	Verify	Comments
SP1	2000			
SP2	450			
SP3A	7			
SP4	0-1			

5.4 Testing & Setting I: Pressure in R2 at 2000 psia Inlet Pressure

5.4.1 Open SV2, SV4 and SV6.

5.4.2 Record the pressure readings in Table 4 below. Adjust REG2 and REG4 as needed. Vent through the bypass if necessary.

5.4.3 Close SV2, SV4 and SV6.

Table 4 Pressure Readings from R2 at 2000 psia Inlet Pressure.

Pressure Sensor	Requirement psia	Initial Reading psia Final Adjusted Reading psia	Verify	Comments
SP1	2000			
SP2	450			
SP3B	7			
SP4	0-1			

5.5 Testing & Setting I: Pressure in R1 at 3000 psia Inlet Pressure

5.5.1 Adjust regulator on Helium supply bottle to deliver 3000 psia. Open SV1, SV3 and SV5.

5.5.2 Record the pressure readings in Table 5 below. Adjust REG2 and REG4 as needed. Vent through the bypass if necessary.

5.5.3 Close SV1, SV3 and SV5.

Table 5 Pressure Readings from R1 at 3000 psia Inlet Pressure.

Pressure Sensor	Requirement Psia	Initial Reading psia Final Adjusted Reading psia	Verify	Comments
SP1	3000			
SP2	450			
SP3A	7			
SP4	0-1			

5.6 Testing & Setting I: Pressure in R2 at 3000 psia Inlet Pressure

5.6.1 Open SV2, SV4 and SV6.

5.6.2 Record the pressure readings in Table 6 below. Adjust REG2 and REG4 as needed. Vent through the bypass if necessary.

5.6.3 Close SV2, SV4 and SV6.

Table 6 Pressure Readings from R2 at 3000 psia inlet pressure.

Pressure Sensor	Requirement psia	Initial Reading Psia / Final Adjusted Reading Psia	Verify	Comments
SP1	3000			
SP2	450			
SP3B	7			
SP4	0-1			

5.7 Testing & Setting II: Setting Impedance Simulation Metering Valve for Gyros

5.7.1 Open SV1, SV3 and SV5. Open SV7. Open MTR1 halfway i.e. 7 turns from fully opened or fully closed.

5.7.2 Close B1 and B3 on the ISM. Open F2. Open M1 fully, 15 turns from fully closed.

5.7.3 The pressure at P1 should now be very low (close to zero). Adjust MTR1 so that the flow is about 750 scc/m (950 scc/m for 0.9 psia drop according to Mike Tabor tests with prototype GMA). Turn M1 clockwise (closing) until either the pressure at P1 is about 60 Torr or the flow rate falls below 700 scc/m.

Note: The flow gauges have an impedance of their own. According to the manufacturers spec.'s the 0-1000 scc/m meter has an impedance of 5Torr/100 scc/m so that should be an approximately 38 Torr drop at 750 scc/m. In effect the gyro impedance will be simulated by the series impedance of the 0-1000 scc/m flow meter and the metering valve M1. This also implies that for the 0-10 scc/m flow meter the impedance will not be correct i.e. the

flow rate from MTR1 will be as desired but the measured flow rate at the 0-10 scc/m flow meter will be incorrect. In the low flow condition the pressure at P1 should be around 6 Torr for 7.50 scc/m (1% of full flow). Assuming a spec of 5T/1 scc/m gives a flow meter pressure drop of 3.75 Torr.

5.7.4 If the flow rate falls below 700 scc/m, open MTR1 until it is at 750 scc/m again. Then close M1 until the pressure increases to 60 Torr or the flow rate falls below 700 scc/m. The correct impedance will be achieved when P1 is roughly 60 Torr and the flow rate is 750 scc/m, +/- 10% for either parameter. (From Doron's calculations)

5.7.5 When the correct impedance has been achieved, close MTR1 so that the flow rate is 700 scc/m.

5.7.6 Note the metering valve setting for MTR1 (i.e. turns from fully open or closed): _____. Note the ambient temperature: _____.

5.7.7 Note the metering valve setting for M1 (i.e. turns from fully open or closed): _____. Note the ambient temperature: _____.

5.7.8 Close SV7. Close SV1, SV3 and SV5. Leave the ISM as it is for the next step.

5.8 Testing & Setting II: Flow Rates through Gyro Simulation From R1 (3000 psia inlet pressure)

5.8.1 Open SV1, SV3 and SV5.

5.8.2 Open SV7 (SV9 N/O). Verify metering valve on ISM is set to correct value. Record pressure at SP5 in Table 7. Record flow rate through ISM flow gauge in Table 7. Adjust MTR1 as needed while monitoring the flow rate through the ISM flow gauge.

5.8.3 Close SV7 and open SV8. Record pressure at SP5 and flow rate in Table 7.

5.8.4 Close SV8 and open SV10. Record SP6 and flow rate.

5.8.5 Close SV10 and open SV11. Record SP6 and flow rate.

5.8.6 Close SV11 and open SV13. Record SP7 and flow rate.

5.8.7 Close SV13 and open SV14. Record SP7 and flow rate

5.8.8 Close SV14 and open SV16. Record SP8 and flow rate.

5.8.9 Close SV16 and open SV17. Record SP8 and flow rate.

5.8.10 Close SV17. Evaluate results.

5.8.11 Close SV1, SV3 and SV5.

Table 7 Flow and Pressure in the Gyroscope Circuits from R1, inlet pressure 3000 psia.

Solenoid Valve	Requirement Flow scc/m	Initial Flow scc/m	Final Adjusted Flow Scc/m	Comments
Pressure Sensor	**Requirement Pressure Torr**	**Initial Pressure Torr**	**Final Adjusted Pressure Torr**	**Verify**
SV7	700			
SP5				
SV8	700			
SP5				
SV10	700			
SP6				
SV11	700			
SP6				
SV13	700			
SP7				
SV14	700			
SP7				
SV16	700			
SP8				
SV17	700			
SP8				

5.9 Testing & Setting II: Flow Rates through Gyro Simulation from R2 (3000 psia inlet pressure)

5.9.1 Open SV2, SV4 and SV6.

5.9.2 Open SV7 (SV9 N/O). Set the value of M1 to correspond to the lower pressure drop across the flow meter at 500 scc/m. This can be done by calculating the gyro impedance and using this impedance to calculate the total pressure drop across flow meter and M1 (abour 40 Torr). See Section 5.7 and proceed in a similar manner to set M1 and MTR2. Record pressure at SP5 in Table 8. Record flow rate through ISM flow gauge in Table 8.

5.9.3 Close SV7 and open SV8. Record pressure at SP5 and flow rate in Table2.

5.9.4 Close SV8 and open SV10. Record SP6 and flow rate.

5.9.5 Close SV10 and open SV11. Record SP6 and flow rate.

5.9.6 Close SV11 and open SV13. Record SP7 and flow rate.

5.9.7 Close SV13 and open SV14. Record SP7 and flow rate

5.9.8 Close SV14 and open SV16. Record SP8 and flow rate.

5.9.9 Close SV16 and open SV17. Record SP8 and flow rate.

5.9.10 Close SV17. Evaluate results.

5.9.11 Close SV2, SV4 and SV6.

5.9.12 Note the metering valve setting for MTR2 (i.e. turns from fully open or closed): _____. Note the ambient temperature: _____.

5.9.13 Note the metering valve setting for M1 (i.e. turns from fully open or closed): _____. Note the ambient temperature: _____.

Table 8 Flow and Pressure in the Gyroscope Circuits from R1, inlet pressure 3000 psia.

Solenoid Valve	Requirement Flow scc/m	Initial Flow scc/m	Final Adjusted Flow scc/m	Comments
Pressure Sensor	**Requirement Pressure Torr**	**Initial Pressure Torr**	**Final Adjusted Pressure Torr**	**Verify**
SV7	500			
SP5				
SV8	500			
SP5				
SV10	500			
SP6				
SV11	500			
SP6				
SV13	500			
SP7				
SV14	500			
SP7				
SV16	500			
SP8				
SV17	500			
SP8				

5.10 Testing & Setting II: Flow and Pressure at the Bypass, Low Flow Rates to Gyro

5.10.1 Open SV1, SV3 and SV5. Open SV23, close B2 valve and open F4 valve on ISM at SD2A. Record SP9 pressure and flow rate.

Note: This flow rate will correspond to the characteristic impedance of the flow meter.

Bypass flow, from R1.

SP9: _____ Flow Rate: _____

5.10.2 Close F2 and open F1 on ISM.

5.10.3 Open SV7, record SP5 and flow rate. Close SV7.

Note: The low flow rate measured here through the 0-10 scc/m flow meter is not completely accurate since the impedance of this flow meter is not equivalent to the impedance of the gyroscope. The measured flow should be approximately 1% of the high flow rate. The requirement states 1-50 scc/m as acceptable. If the requirement is not met then M1 needs to be adjusted, i.e. impedance calculated, pressure drop calculated etc. See Section 5.7 and 5.9.

Gyro flow, from R1.

SP5: _____ Flow Rate: _____

5.10.4 Close SV1, SV3 and SV5. Open SV2, SV4 and SV6. Record SP9 and flow rate.

Bypass flow, from R2.

SP9: _____ Flow Rate: _____

5.10.5 Open SV7, record SP5 and flow rate. Close SV7 and SV23. Close SV2, SV4 and SV6.

Gyro flow, from R2.

SP5: _____ Flow Rate: _____

5.11 Testing and Setting III: Flow through P9

5.11.1 Open SV1, SV3 and SV5. ISM still set to measure low flow.

5.11.2 SV21 N/O. Open SV19 and record flow through the low flow meter on ISM in Table 9.

5.11.3 Adjust MTR3 to achieve required flow. Record metering valve setting: _____.

Note the ambient temperature: _____.

5.11.4 Close SV19 and open SV20. Verify that flow is still nominal (+/- 10%).

5.11.5 Close SV1, SV3 and SV5 and open SV2, SV4 and SV6.

5.11.6 Close SV19 and open SV20. Verify that flow is nominal.

5.11.7 Close SV20.

5.11.8 Evaluate results.

5.11.9 Return spin up GMA module to baseline configuration. Return ISM to baseline configuration.

Table 9 Flow through P9 from R1

P9 Valve	Nominal Flow Rate	Initial Reading / Final Adjusted Reading	Verify	Comments
SV19 Open	2 scc/m			
SV20 Open	2 scc/m			

Table 10 Flow through P9 from R2

P9 Valve	Nominal Flow Rate	Initial Reading / Final Adjusted Reading	Verify	Comments
SV19 Open	1.4 scc/m			
SV20 Open	1.4 scc/m			

6.0 FUNCTIONAL TEST; SPACE VEHICLE GMA COMMAND SEQUENCE

Started on:

6.1 Launch Pad Configuration

6.1.1 The launch pad configuration is to minimize the leakage of air into the gyroscopes while the Space Vehicle is on the launch pad. It consists of closing the normally open SV9, SV12, SV15 and SV18. These valves have been reversed so that the leakage will occur into the GMA rather than into the gyros. SV7, SV10, SV13 and SV16 are open so that the leakage will go to the ballast volume. All other SV's are closed. This implies a vacuum between SV5, SV6, SV9, SV12, SV15, SV18, SV19, SV20 and SV22, SV23.

6.1.2 Close SV1 and SV2. Close SV9, SV12, SV15, and SV18. Open SV7, SV10, SV13 and SV16.

6.1.3 Verify that the ISM is in its starting configuration. Open SV23 and pump the resulting configuration to a pressure of 1mTorr or less. Close SV23. This is the launch pad configuration. Verify the configuration with the engineering ECU.

6.2 Baseline Configuration

6.2.1 Close SV7, SV10, SV13 and SV16 and wait one minute. Open SV9, SV12, SV15, and SV18. All other valves closed except those N/O. The GMA is now in its baseline configuration. Verify the configuration.

6.3 Space Spin Up Functional Test

6.3.1 Allow a 1 second delay between the opening of valves. Open SV1, SV3, SV5 and then SV23. Telemeter SP1, SP2, SP3A, SP4 and SP9 and verify that they are nominal (+/- 10 % of previously set values) in 1 second intervals for 1 minute. Record the final readings in Table 11. (How long should bypass be open for purging the lines? TBD)

6.3.2 Close SV23. Close B1 and B3 on the ISM and open F2. Verify that the metering valve M1 on the ISM is at the correct setting for gyro impedance at 700 scc/m. Open SV7. Telemeter SP5 for 10 seconds at 1 second intervals. Verify that pressure and flow are nominal. Record readings in Table 13. Close SV7.

6.3.3 Open SV8. Verify parameters. Close SV8.

6.3.4 Open SV10. Verify parameters. Close SV10.

6.3.5 Open SV11. Verify parameters. Close SV11.

6.3.6 Open SV13. Verify parameters. Close SV13.

6.3.7 Open SV14. Verify parameters. Close SV14.

6.3.8 Open SV16. Verify parameters. Close SV16.

6.3.9 Open SV17. Verify parameters. Close SV17.

Table 11 Pressure Readings from R1.

Pressure Sensor	Requirement Psia	Final Reading Psia	Verify	Comments
SP1	3000			
SP2	450			
SP3A	7			
SP4	0-1			
SP9 (Torr)				

Table 12 Pressure Readings from R2.

Pressure Sensor	Requirement Psia	Final Reading Psia	Verify	Comments
SP1	3000			
SP2	450			
SP3A	7			
SP4	0-1			

SP9 (Torr)				

6.3.10 Close SV1, SV3 and SV5. Open SV23. Open SV2, SV4 and SV6. Telemeter SP1, SP2, SP3A, SP4 and SP9 and verify that they are nominal (+/- 10 % of previously set values) in 1 second intervals for 1 minute. Adjust M1 to the correct value for 500 scc/m. Record the final readings in Table 12. (How long should bypass be open for purging the lines? TBD)

Table 13 Flow and Pressure in the Gyroscope Circuits from R1, inlet pressure 3000 psi

Solenoid Valve	**Requirement Flow scc/m**	**Flow Reading scc/m**	**Comments**
Pressure Sensor	**Requirement Pressure Torr**	**Pressure Reading Torr**	**Verify**
SV7	700		
SP5			
SV8	700		
SP5			
SV10	700		
SP6			
SV11	700		
SP6			
SV13	700		
SP7			
SV14	700		
SP7			
SV16	700		
SP8			
SV17	700		

SP8			

6.3.11 Close SV23. Open SV7. Telemeter SP5 for 10 seconds at 1 second intervals. Verify that pressure and flow are nominal. Record readings in table 14. Close SV7.

6.3.12 Open SV8. Verify parameters. Close SV8.

6.3.13 Open SV10. Verify parameters. Close SV10.

6.3.14 Open SV11. Verify parameters. Close SV11.

6.3.15 Open SV13. Verify parameters. Close SV13.

Table 14 Flow and Pressure in the Gyroscope Circuits from R2, inlet pressure 3000 psi

Solenoid Valve	**Requirement Flow scc/m**	**Flow Reading scc/m**	**Comments**
Pressure Sensor	**Requirement Pressure Torr**	**Pressure Reading Torr**	**Verify**
SV7	500		
SP5			
SV8	500		
SP5			
SV10	500		
SP6			
SV11	500		
SP6			
SV13	500		
SP7			
SV14	500		
SP7			
SV16	500		
SP8			

SV17	500		
SP8			

6.3.16 Open SV14. Verify parameters. Close SV14.

6.3.17 Open SV16. Verify parameters. Close SV16.

6.3.18 Open SV17. Verify parameters. Close SV17.

6.3.19 Open SV23. Close SV2, SV4 and SV6 in 10 second intervals. Close SV23.

6.3.20 Return ISM to starting configuration.

7.0 TEMPERATURE CYCLING

7.1 Place the GMA into the environmental control chamber. Attach the GSE manifolds as outlined in section 4. There should be enough He gas in the GMA bottles to run this test without re-charging them from the external supply bottle.

7.2 Set the GMA into the launch pad configuration as described in section 6.1.

7.3 Raise the temperature in the chamber to 51 C at approximately 5 C/minute. Verify the GMA temperature with the Silicon diode thermometers on the metering valves. Allow the GMA to stay at this temperature for one hour. Note temperature: _____ and elapsed time: _____.

7.4 Cool the GMA to –49 C at approximately 5 C/minute. Again verify the temperature on the GMA itself. Keep the GMA at this temperature for one hour. Note temperature: _____ and elapsed time: _____.

7.5 Repeat 7.3. Note temperature: _____ and elapsed time: _____.

7.6 Repeat 7.4. Note temperature: _____ and elapsed time: _____.

7.7 Repeat 7.3. Note temperature: _____ and elapsed time: _____.

7.8 Repeat 7.4. Note temperature: _____ and elapsed time: _____.

8.0 FLOW VERIFICATION

8.1 Raise the temperature of the GMA to 20 C. Verify the temperature with the engineering ECU.

8.2 Allow a 1 second delay between the opening of valves. Open SV1, SV3, SV5 and then SV23. Telemeter SP1, SP2, SP3A, SP4 and SP9 and verify that they are nominal (+/- 10 % of previously set values) in 1 second intervals for 1 minute. Record the final readings in Table 15. (How long should bypass be open for purging the lines? TBD)

8.3 Close SV23. Close B1 and B3 on the ISM and open F2. Verify that the metering valve M1 on the ISM is at the correct setting for gyro impedance. Adjust M1 to the correct value for 700 scc/m. Open SV7. Telemeter SP5 for 10 seconds at 1-second intervals. Verify that pressure and flow are nominal. Record readings in Table 17. Close SV7.

8.4 Open SV8. Verify parameters. Close SV8.

8.5 Open SV10. Verify parameters. Close SV10.

8.6 Open SV11. Verify parameters. Close SV11.

8.7 Open SV13. Verify parameters. Close SV13.

8.8 Open SV14. Verify parameters. Close SV14.

8.9 Open SV16. Verify parameters. Close SV16.

8.10 Open SV17. Verify parameters. Close SV17.

Table 15 Pressure Readings from R1.

Pressure Sensor	Requirement Psia	Final Reading Psia	Verify	Comments
SP1	3000			
SP2	450			
SP3A	7			
SP4	0-1			
SP9 (Torr)				

Table 16 Pressure Readings from R2.

Pressure Sensor	Requirement Psia	Final Reading Psia	Verify	Comments
SP1	3000			

SP2	450			
SP3A	7			
SP4	0-1			
SP9 (Torr)				

8.11 Close SV1, SV3 and SV5. Open SV23. Open SV2, SV4 and SV6. Telemeter SP1, SP2, SP3A, SP4 and SP9 and verify that they are nominal (+/- 10 % of previously set values) in 1 second intervals for 1 minute. Adjust M1 to the correct value for 500 scc/m. Record the final readings in Table 16. (How long should bypass be open for purging the lines? TBD)

Table 17 Flow and Pressure in the Gyroscope Circuits from R1, inlet pressure 3000 psi

Solenoid Valve	**Requirement Flow scc/m**	**Flow Reading scc/m**	**Comments**
Pressure Sensor	**Requirement Pressure Torr**	**Pressure Reading Torr**	**Verify**
SV7	700		
SP5			
SV8	700		
SP5			
SV10	700		
SP6			
SV11	700		
SP6			
SV13	700		

SP7			
SV14	700		
SP7			
SV16	700		
SP8			
SV17	700		
SP8			

8.12 Close SV23. Open SV7. Telemeter SP5 for 10 seconds at 1-second intervals. Verify that pressure and flow are nominal. Record readings in Table 17. Close SV7.

8.13 Open SV8. Verify parameters. Close SV8.

8.14 Open SV10. Verify parameters. Close SV10.

8.15 Open SV11. Verify parameters. Close SV11.

8.16 Open SV13. Verify parameters. Close SV13.

Table 18 Flow and Pressure in the Gyroscope Circuits from R2, inlet pressure 3000 psi

Solenoid Valve	**Requirement Flow scc/m**	**Flow Reading scc/m**	**Comments**
Pressure Sensor	**Requirement Pressure Torr**	**Pressure Reading Torr**	**Verify**
SV7	500		
SP5			
SV8	500		
SP5			
SV10	500		
SP6			

SV11	500		
SP6			
SV13	500		
SP7			
SV14	500		
SP7			
SV16	500		
SP8			
SV17	500		
SP8			

8.17 Open SV14. Verify parameters. Close SV14.

8.18 Open SV16. Verify parameters. Close SV16.

8.19 Open SV17. Verify parameters. Close SV17.

8.20 Open SV23. Close SV2, SV4 and SV6 in 10-second intervals. Close SV23.

9.0 TEMPERATURE STABILITY TEST

9.1 Lower the temperature of the GMA to 0 C. Use the ECU and GMA heaters to change the GMA temperature. Verify the temperature of the metering valves with the ECU. All temperatures measured during the following steps should be from the Silicon diode thermometers on the metering valves. Verify that M1 is set for a flow of 700 scc/m.

9.2 Raise GMA/MTR1 temperature to 10 C. Open SV1, SV3 and SV5. Open SV23. Open SV7 and then close SV23. (700 scc/m flow.)

9.3 Record flow rate: _____ and MTR1 temperature: _____.

9.4 Raise GMA/MTR1 temperature to 15 C.

9.5 Record flow rate: _____ and MTR1 temperature: _____.

9.6 Raise GMA/MTR1 temperature to 20 C.

9.7 Record flow rate: _____ and MTR1 temperature: _____.

9.8 Raise GMA/MTR1 temperature to 25 C.

9.9 Record flow rate: _____ and MTR1 temperature: _____.

9.10 Raise GMA/MTR1 temperature to 30 C.

9.11 Record flow rate: _____ and MTR1 temperature: _____.

9.12 Lower GMA/MTR1 temperature to 25 C.

9.13 Record flow rate: _____ and MTR1 temperature: _____.

9.14 Lower GMA/MTR1 temperature to 20 C.

9.15 Record flow rate: _____ and MTR1 temperature: _____.

9.16 Lower GMA/MTR1 temperature to 15 C.

9.17 Record flow rate: _____ and MTR1 temperature: _____.

9.18 Lower GMA/MTR1 temperature to 10 C.

9.19 Record flow rate: _____ and MTR1 temperature: _____.

9.20 Raise GMA/MTR1 temperature to 15 C.

9.21 Record flow rate: _____ and MTR1 temperature: _____.

9.22 Raise GMA/MTR1 temperature to 20 C.

9.23 Record flow rate: _____ and MTR1 temperature: _____.

9.24 Raise GMA/MTR1 temperature to 25 C.

9.25 Record flow rate: _____ and MTR1 temperature: _____.

9.26 Raise GMA/MTR1 temperature to 30 C.

9.27 Record flow rate: _____ and MTR1 temperature: _____.

9.28 Lower GMA/MTR1 temperature to 25 C.

9.29 Record flow rate: _____ and MTR1 temperature: _____.

9.30 Lower GMA/MTR1 temperature to 20 C.

9.31 Record flow rate: _____ and MTR1 temperature: _____.

9.32 Lower GMA/MTR1 temperature to 15 C.

9.33 Record flow rate: _____ and MTR1 temperature: _____.

9.34 Lower GMA/MTR1 temperature to 10 C.

9.35 Record flow rate: _____ and MTR1 temperature: _____.

9.36 Close SV7.Close SV1, SV3 and SV5. Open SV23. Open SV2, SV4 and SV6. Open SV7 and then close SV23. Verify that M1 is set for a flow of 500 scc/m.

9.37 Record flow rate: _____ and MTR2 temperature: _____.

9.38 Raise GMA/MTR2 temperature to 15 C.

9.39 Record flow rate: _____ and MTR2 temperature: _____.

9.40 Raise GMA/MTR2 temperature to 20 C.

9.41 Record flow rate: _____ and MTR2 temperature: _____.

9.42 Raise GMA/MTR2 temperature to 25 C.

9.43 Record flow rate: _____ and MTR2 temperature: _____.

9.44 Raise GMA/MTR2 temperature to 30 C.

9.45 Record flow rate: _____ and MTR2 temperature: _____.

9.46 Lower GMA/MTR2 temperature to 25 C.

9.47 Record flow rate: _____ and MTR2 temperature: _____.

9.48 Lower GMA/MTR2 temperature to 20 C.

9.49 Record flow rate: _____ and MTR2 temperature: _____.

9.50 Lower GMA/MTR2 temperature to 15 C.

9.51 Record flow rate: _____ and MTR2 temperature: _____.

9.52 Lower GMA/MTR2 temperature to 10 C.

9.53 Record flow rate: _____ and MTR2 temperature: _____.

9.54 Raise GMA/MTR2 temperature to 15 C.

9.55 Record flow rate: _____ and MTR2 temperature: _____.

9.56 Raise GMA/MTR2 temperature to 20 C.

9.57 Record flow rate: _____ and MTR2 temperature: _____.

9.58 Raise GMA/MTR2 temperature to 25 C.

9.59 Record flow rate: _____ and MTR2 temperature: _____.

9.60 Raise GMA/MTR2 temperature to 30 C.

9.61 Record flow rate: _____ and MTR2 temperature: _____.

9.62 Lower GMA/MTR2 temperature to 25 C.

9.63 Record flow rate: _____ and MTR2 temperature: _____.

9.64 Lower GMA/MTR2 temperature to 20 C.

9.65 Record flow rate: _____ and MTR2 temperature: _____.

9.66 Lower GMA/MTR2 temperature to 15 C.

9.67 Record flow rate: _____ and MTR2 temperature: _____.

9.68 Lower GMA/MTR2 temperature to 10 C.

9.69 Record flow rate: _____ and MTR2 temperature: _____.

9.70 Close SV7. Close SV2, SV4, and SV6. Raise the temperature of the GMA to room temperature.

9.71 Put the GMA into the launch pad configuration as described in section 6.1.

10.0 CAGING GMA FUNCTIONAL TEST

Started on:

10.1 Connect Helium supply to the CD1 port on GMA. Connect plugs to G1C, G2C and G3C/G4C ports. Leak test all connections through the CD2 port on the GMA by opening CV1, CV2, CV3 and CV4. After the leak test is completed CV1, CV2, CV3 and CV4 should be closed.

10.2 CP1-4 should now read close to zero. Set the delivery pressure on the Helium supply to 200 psi. All of the following valve actions should be confirmed with the engineering ECU.

10.3 Open CV5, record pressure at CP4: _____.

10.4 Open CV1, record pressure at CP1: _____. Close CV1.

10.5 Open CV2, record pressure at CP2: _____. Close CV2.

10.6 Open CV3, record pressure at CP3: _____. Close CV3.

10.7 Measure the leak rate through CV4 for 10 minutes. Record the final number _____. This should not go about 10^{-5} sccs.

10.8 Close CV5. Open CV4. CP5 should drop to about 15 psi.

10.9 Open CV1A, CP1 should drop to about 15 psi. Close CV1A.

10.10 Open CV2A, CP2 should drop to about 15 psi. Close CV2A.

10.11 Open CV2A, CP3 should drop to about 15 psi. Close CV3A.

10.12 Close CV4. Disconnect caging GSE from GMA.

11.0 CLEANLINESS TEST

Started on:

11.1 Refer to Procedure 00710 by Aharon Halevy.

11.2 Sampling point or points TBD.

12.0 PRESSURIZE GMA FOR STANDBY

Started on:

12.1 Close all N/O valves. Open all valves except SV6.

12.2 Close HPM2. Record SP1-SP4 in a logbook.

12.3 Once a week check SP1-SP4 for deviations from nominal.

12.0 PROCEDURE COMPLETION

The results obtained in the performance of this procedure are acceptable:

_____ ___ date: _____
Integration Engineer

Discrepancies if any:

Approved: _____ date: _____
Test Director

Approved: _____ date: _____
GMA REE

Approved: _____ date: _____
QA