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

CALIBRATING THE G-MOCK PRESSURE SENSORS AND THE ECU ENGINEERING UNIT

GP-B ENGINEERING PROCEDURE

P0912 Rev –

22 April, 2002

PREPARED _____ _____
R. Stephenson, GMA Engineer Date

APPROVED _____ _____
B. Farley, Electronics Engineer Date

APPROVED _____ _____
C. Gray, GMA REE Date

APPROVED _____ _____
D. Ross, Quality Assurance Date

APPROVED _____ _____
R. Brumley, Hardware Manager Date

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A SCOPE

This procedure calibrates the ECU Engineering unit for use with the G-Mock pressure sensors. It requires cables from the ECU to the G-Mock that have 101k resistors loading the low outputs of the pressure sensors. The G-Mock will be first be evacuated and the zero data point taken. Readings will then be taken at different pressures in order to determine the calibration coefficients for each sensor. These calibrations will be input to the ECU EU test set via CSTOL so that it can be used to read out actual pressures during flow testing of the G-Mock. All data should be recorded in Table 1.

B SAFETY

The G-Mock is a gas pressure vessel. Under normal operations, the G-Mock requires no safety measures or equipment beyond those required for the use of a supply gas cylinder. When any of the systems are pressurized and connected to the leak detector, be cautious not to vent high pressure through the pumping portions of either system. Only allow high pressure to vent through approved ports (such as leak detector vent) and make sure that these are open at time of venting.

C QUALITY ASSURANCE

C.1 QA Notification

This test will be conducted on a formal basis to approved and released procedures. **The QA program office and ONR representative shall be notified 24 hours prior to of the start of this procedure**. A Quality Assurance Representative, designated by D. Ross shall be present during the procedure and shall review any discrepancies noted and approve their disposition. Upon completion of this procedure, the QA Program Engineer, D. Ross or her designate, will certify her 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.

C.2 Red-line Authority

Authority to redline (make minor changes during execution) this procedure is given solely to the Test Engineer or his designate and shall be approved by the QA Representative.

C.3 Discrepancies

Discrepancies will be recorded in a D-log or as a DR per Quality Plan P0108.

D TEST PERSONNEL

The Test Engineer shall be Rick Stephenson or an alternate that he shall designate. The Engineer has overall responsibility for the implementation of this procedure and shall sign off the completed procedure and relevant sections within it.

E REQUIREMENTS

E.1. Electrostatic Discharge Requirements

N/A

E.2. Lifting Operation Requirements

N/A

E.3. Hardware/Software Requirements

ECU Flight Equivalent Unit (GMA)

Interface cables from ECU to G-Mock

Appropriate software for controlling G-Mock

G-Mock

G-Mock Outlet Manifold

Clean, regulated, inert gas supply, > 2000 psi

Baratron pressure gauge, 1000 torr head

Baratron power supply

500 psig pressure sensor, calibrated

4000 psig pressure sensor, calibrated

Plumbing lines, cleaned consistently with Class 100 practices

Leak detector

0.5 micron or better filters

Gas supply, 70 psig or greater, for pneumatic valve operation

E.4. Instrument Pretest Requirements

All test equipment used in taking data shall be "in calibration" at time of test.

E.5. Configuration Requirements

N/A

E.6. Optional Non-flight Configurations

N/A

E.7. Verification/ Success Criteria

Calibrations will be verified in G-Mock ATP, P0909 Rev –

E.8. Constraints and Restrictions

Be cautious to take the leak detector out of test mode before venting gas through it.

F REFERENCE DOCUMENTS

F.1. Drawings

G-Mock Drawing

GMA Schematic, Dwg. Number 26273

F.2. Supporting documentation

MKS Baratron Type 622A/626A/627A/628A/629A Absolute Pressure Transducer Manual

F.3. Additional Procedures

N/A

G OPERATIONS

G.1. Verify Appropriate QA Notification

QA Notified_____ ONR Notified_____

G.2. Verify Configuration Requirements

N/A

G.3 Setup of G-Mock

Started on: _____

Note: Mark off each step of procedure as it is completed.

3.1 Verify that Section G.8 of P0909 Rev – has been performed. This section sets the G-Mock regulators to 20 psia. If this has **not** yet been performed, fully open the G-Mock regulators (full clockwise).

3.2 Verify leak detector is started and warmed up.

3.3 Verify that MMV1, MMV4, and all Outlet Manifold manual valves are closed.

3.4 Verify that 0.5 micron or better filters are connected to the G-Mock Service and Inlet Ports.

3.5 Connect a valve and the Baratron pressure gauge to the G-Mock Service port (see Diagrams 1 and 2).

3.6 Connect the 500 psig pressure gauge to the G-Mock Service port (see Diagram 1 and 2).

3.7 Connect the 4000 psig pressure gauge to the G-Mock Inlet Port (see Diagram 1 and 2).

3.8 Connect the >70 psig gas supply to the pneumatic valve supply manifold.

3.9 Connect the gas supply plumbing to the gas supply (see Diagram 1).

3.10 Open the gas bottle and Plumbing Valves 1 and 2.

3.11 Open the regulator a small amount to purge the plumbing lines.

3.12 Connect the gas supply to the G-Mock per Diagram 1.

3.13 Close Plumbing Valve 1.

3.14 Connect the leak detector to the Vent Port of the Outlet Manifold (see Diagram 2).

3.15 Connect the ECU to the G-Mock and start up the ECU and all necessary software.

3.16 Verify that MMV2 and MMV3 are open.

3.17 Leak check the plumbing from the leak detector to the Outlet Manifold.

3.18 Open the Outlet Manifold Vent valve.

3.19 Open V28, V30, and MMV4.

3.20 Leak check the supply gas plumbing up to Plumbing Valve 1.

3.21 Open all G-Mock solenoid valves and evacuate G-Mock completely.

3.22 Close the Outlet Manifold Vent valve.

G.4 G-Mock Downstream Pressure Transducer Calibration

Started on: _____

Note: Mark off each step of procedure as it is completed.

4.1 Verify that the G-Mock is prepared per section G.3.

4.2 Verify G-Mock pressure is <0.5 psia on the GSE pressure gauges.

4.3 Record in Table 1 the number of counts on each pressure sensor (should be less than 200). Record the pressure as 0 psia.

4.4 Quickly crack open and close Plumbing Valve 1 to raise the pressure in the G-Mock a small amount.

4.5 Repeat until the counts on GP7 – GP14 are between 5000 and 8000. Note: the pressure transducers may not have the same gains, so the following steps may have to be done separately for different sensors at the Test Engineer's discretion.

4.6 Record in Table 1 the pressure from the Baratron gauge and the number of counts on GP7-GP14.

4.7 Slowly raise the pressure in the G-Mock as per step 4.4 until the counts at GP7–GP14 reach 17000–21000.

4.8 Record in Table 1 the pressure from the Baratron gauge and the number of counts on GP7–GP14.

4.9 Slowly raise the pressure in the G-Mock as per step 4.4 until the counts at GP7 – GP14 reach 28000–32700.

4.10 Record in Table 1 the pressure from the Baratron gauge and the number of counts on GP7–GP14.

G.5 G-Mock Mid-Range Pressure Transducer Calibration

Started on: _____

Note: Mark off each step of procedure as it is completed.

5.1 Verify that section G.4 has just been completed.

5.2 Using the same method as above, set the pressure such that the counts at GP4 – GP6 are from 5000–8000. This may require opening the Outlet Manifold Vent valve to lower the pressure using the leak detector. Once again, the gains may be different, so the pressure readings can be separated out at the Test Engineer's discretion.

5.3 Record in Table 1 the pressure from the Baratron gauge and the number of counts on GP4–GP6.

5.4 Slowly increase the pressure until the counts on GP4 – GP6 reach 17000–21000. If pressure increases to over 15 psia, close off the valve to the Baratron gauge and read the 500 psig gauge.

5.5 Record in Table 1 the pressure from the GSE gauge (Baratron or 500 psig gauge) and the number of counts on GP4–GP6. If reading from the 500 psig gauge, subtract 14.8 from the reading to record the pressure in psia.

5.6 Slowly increase the pressure until the counts on GP4 – GP6 reach 28000–32700. If pressure increases to over 15 psia, close off the valve to the Baratron gauge and read the 500 psig gauge.

5.7 Record in Table 1 the pressure from the GSE gauge (Baratron or 500 psig gauge) and the number of counts on GP4–GP6. If reading from the 500 psig gauge, subtract 14.8 from the reading to record the pressure in psia.

5.8 Close V1, V2, and Plumbing Valve 2.

5.9 Open Outlet Manifold P1A valve to vent G-Mock low pressure side to the atmosphere.

5.10 Close Outlet Manifold P1A valve when pressure at Service Port reaches less than 5 psig (20 psia).

5.11 Close V3, V4, V5, and V6. Open V2 and V1.

5.12 Open Plumbing Valve 1 and use the supply regulator to slowly raise the pressure and take readings from GP3, GP2, and GP1. As the gains on these three transducers are different, take readings in any sequence. Data points should be taken at 5000–8000 counts, 17000-21000 counts, and 28000–32700 counts on each transducer.

5.13 Record the pressure and counts for GP3, GP2, and GP1 in Table 1.

G.6 G-Mock Final Configuration

Started on: _____

Note: Mark off each step of procedure as it is completed.

6.1 Verify that Table 1 is completely filled out.

6.2 Verify all Outlet Manifold manual valves are closed.

6.3 Close MMV1. Open all G-Mock solenoid valves.

6.4 Verify pressure at Service Port is between 20 and 27 psia (5 – 12 psig).

6.5 Close MMV4 and all G-Mock solenoid valves.

6.6 Close gas bottle valve and carefully disconnect the gas supply plumbing from the G-Mock.

6.7 Shut down leak detector and disconnect from the Outlet Manifold.

6.8 Shut down the ECU, and disconnect from the G-Mock.

6.9 Close pneumatic gas supply and disconnect from G-Mock.

G.7 Diagrams

Diagram 1: Supply Gas Setup

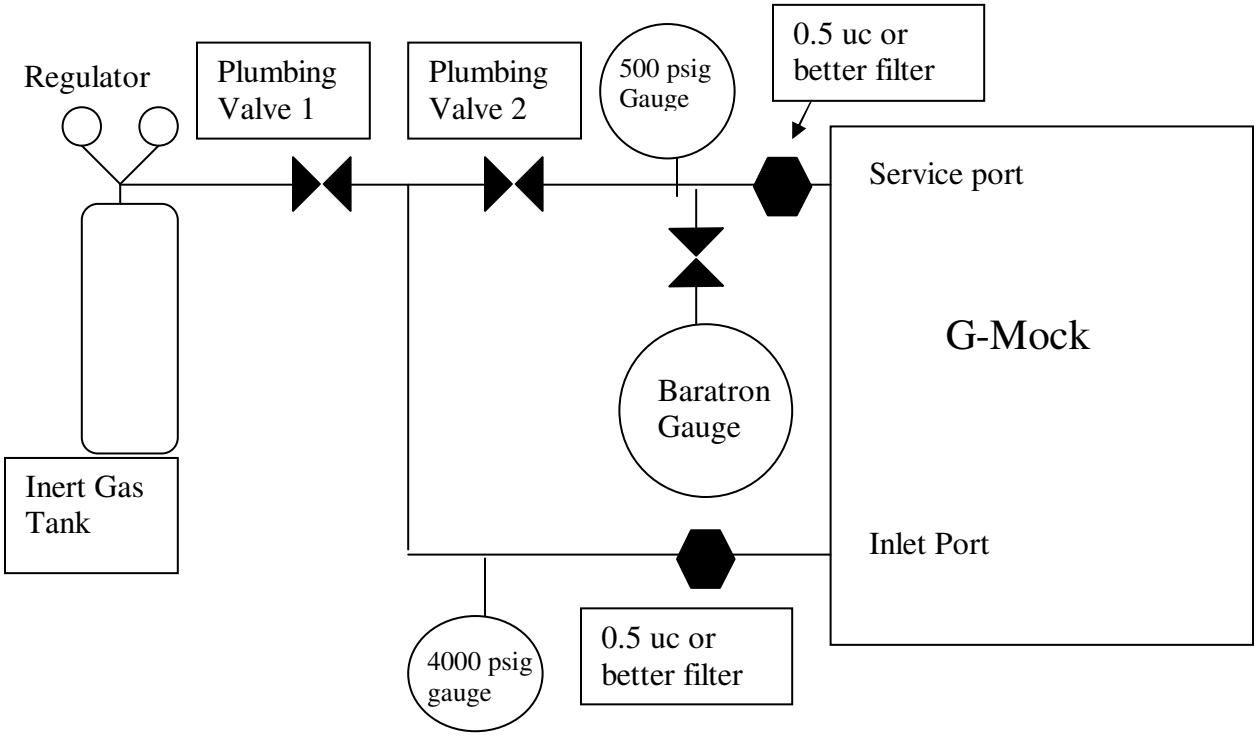
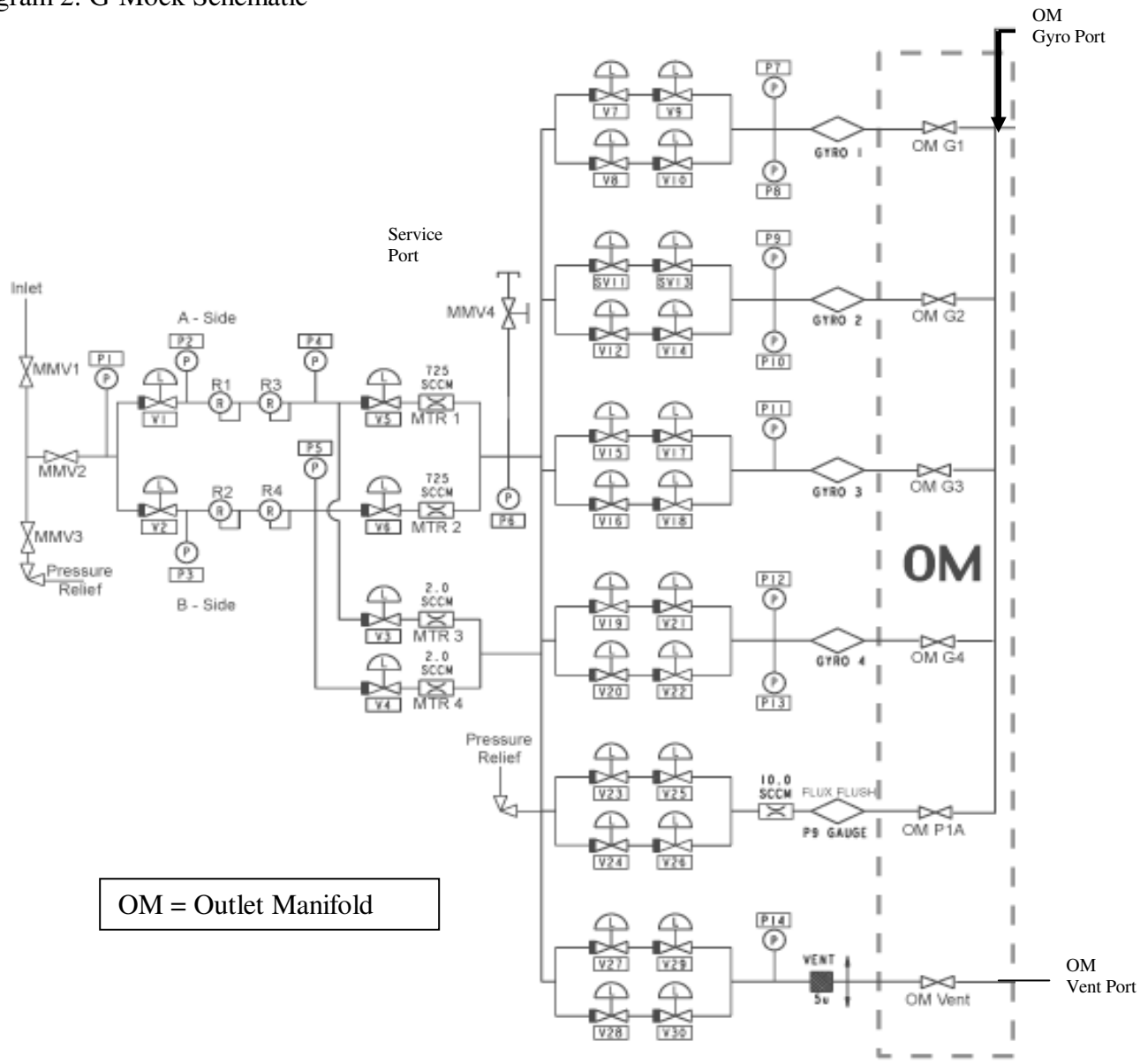


Diagram 2: G-Mock Schematic



OM = Outlet Manifold

G.8 Tables

Table 1: Pressure and Counts Data

Engineering Evaluation of ECU / G-Mock Pressure Gage Readouts

ECU Identification: _____

**Connect the G-Mock Pressure Gages to the ECU by connecting the ECU to the G-Mock electronics box.
Reduce the pressure to zero psia.
Observe the ECU output. It should be less than
200 counts, Record the pressure reading and the displayed counts. Adjust the pressure to obtain a count level between
5000 and 8000 counts, and record the values. Record two more sets of pressure readings, at approximately 17000 to 21000 counts and
28000 to 23700 counts. Pressure readings should be on scale between 0 psia and at least 80% of the Max P value. The order of sequencing
through the gages and monitors may be altered as convenient.**

				<200			5000-8000		17000-21000			28000-32700		
Pressure Monitor	Gage S/N	Max P psia	Pressure	DN		Pressure	DN		Pressure	DN		Pressure	DN		Time
GP7	_____	5													
GP8	_____	4													
GP9	_____	5													
GP10	_____	4													
GP11	_____	5													
GP12	_____	5													
GP13	_____	10													
GP14	_____	4													
GP4	_____	33													
GP5	_____	33													
GP6	_____	17													
GP3	_____	3333													
GP2	_____	3030													
GP1	_____	3333													
		Data collected by:					Date:								

H PROCEDURE SIGN OFF

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

_____ date: _____
Test Engineer

Discrepancies if any:

Approved: _____ date: _____
C. Gray, GMA REE

Approved: _____ date: _____
QA Representative

Approved: _____ date: _____
D. Ross, QA