GRAVITY PROBE B

PROCEDURE FOR

GMA VERIFICATION

(PTP) MSS 3.2.7 FUNCTIONAL TEST OF THE NON-FLIGHT GMA

Procedure No. P*0907 Rev. -*

1/24/10

Prepared by: *D. Meriwether*

Approvals:

Program Responsibility	Signature	Date
D. Meriwether Test Author		
K. Bower E-Mock GMA creator		
C. Gray GMA REE		
R. Brumley Payload Technical Manager		
R. Pressberg GP-B Quality Assurance		

NOTES:

Level of QA required during performance of this procedure:
___ Stanford QA Representative
___ Government QA Representative

1) The Flight GMA has no valve state indicators.
2) The E-Mock GMA has valve state monitors, indicating an open or closed position. This configuration will allow a confirmation that the ECU EU / ECU3 Test Set correctly commands the valves intended.
3) The MSS 3.2.7 software was created and intended to be used with the previous GMA. The valve commands used in 3.2.7 operate different valves in the E-Mock GMA, as well as the Flight GMA.
4) There shall be NO Flight Hardware used during this test.

Revision Record:

Rev	Rev Date	ECO #	Summary Description

Acronyms and Abbreviations:

Acronym / Abbreviation	Meaning
ECU Monitor Mnemonics	
BE_XXXXX_XXXXXX	Binary Word Monitor
CE_XXXXX_XXXXXX	Current Monitor
DE_XXXXX_XXXXXX	Digital Word Monitor
TE_XXXXX_XXXXXX	Temperature Monitor
TE_XXXXX_X**GT**XXX	GRT TYPE Thermometer
TE_XXXXX_X**PT**XXX	PRT TYPE Thermometer
TE_XXXXX_X**ST**XXX	SDT TYPE Thermometer
TE_XXXXX_XXXXX**D**	Dewer located Thermometer
TE_XXXXX_XXXXX**P**	Probe located Thermometer
TE_XXXXX_XXXXX**Q**	Quartz Block located Thermometer
VE_XXXXX_XXXXXX	Voltage Monitor
AC	Alternate Current
Closed Loop	Hardware Controlled
Command	Software response indicating command sent
Current	Commanded Heater Amperage
DC	Direct Current
Open Loop	Software Controlled
Power	UV Lamp Power Supply readout
Pressure	GMA Pressure Sensor readout
Range	UV Lamp Power Hi Lo Range readout
Signal	UV Lamp Intensity readout
Temperature	Thermometer readout
Voltage	Commanded Heater Voltage

CCCA	Command & Control Computer Assembly
CSTOL	Colorado Spacecraft Test and Operations Language
ECU	Experimental Control Unit
EPS	Electrical Power Subsystem
FEU	Flight Equivalent Unit
FSW	Flight Software
FTP	file transfer protocol
GMA	Gas Management Assembly
GP-B	Gravity Probe B
ICD	Interface Control Document
MOC	Mission Operations Center

MSS	Mission Support Software
OASIS-CC	Operations and Science Instrument Support - Command and Control
ONR	Office of Naval Research
PDU	Power Distribution Unit
QA	Quality Assurance
RTC	Real-Time Commands
SPC	Stored Program Commands
TCP/IP	Transmission Control Protocol over Internet Protocol
Tlm	Telemetry
UPS	Uninteruptable Power System
VAC	Volts AC

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A **Scope**

This procedure operates and verifies the functionality of the E-Mock GMA using the ECU3 Test Set and MSS 3.2.7S. The ECU EU is initialized and it's internal monitors limit checked. ALL GMA monitors are recorded initially and upon change. The E-Mock GMA Heaters are then turned on and off. All GMA valves are closed then each GMA valve is opened, closed and opened. The translation between the MSS 3.2.7 valve commanded, the actual E-Mock valve operated & the MSS 3.2.7 telemetry monitor effected is contained in section B

B **Old GMA Versus New GMA Software & Valve Translation Matrix:**

MSS 3.2.7 Command		GMA Valve Operation		Telemetry result	
Name	State	Name	State	Name	State
SV1	Open	V1	Open	SV1	Open
SV1	Closed	V1	Closed	SV1	Closed
SV2	Open	V2	Open	SV2	Open
SV2	Closed	V2	Closed	SV2	Closed
SV3	Open	V3	Open	SV3	Open
SV3	Closed	V3	Closed	SV3	Closed
SV4	Open	V4	Open	SV4	Open
SV4	Closed	V4	Closed	SV4	Closed
SV5	Open	V5	Open	SV5	Open
SV5	Closed	V5	Closed	SV5	Closed
SV6	Open	V6	Open	SV6	Open
SV6	Closed	V6	Closed	SV6	Closed
SV7	Open	V11	Open	SV7	Open
SV7	Closed	V8	Open	SV19	Open
SV8	Open	V9	Open	SV8	Open
SV8	Closed	V9	Closed	SV8	Closed
SV9	Open	V10	Open	SV9	Open
SV9	Closed	V10	Closed	SV9	Closed
SV10	Open	V11	Closed	SV7	Closed
SV10	Closed	V8	Closed	SV19	Closed

MSS 3.2.7 Command		GMA Valve Operation		Telemetry result	
Name	State	Name	State	Name	State
SV11	Open	V13	Open	SV11	Open
SV11	Closed	V13	Closed	SV11	Closed
SV12	Open	V14	Open	SV12	Open
SV12	Closed	V14	Closed	SV12	Closed
SV13	Open	V15	Open	SV13	Open
SV13	Closed	V20	Open	SV16	Open
SV14	Open	V17	Open	SV14	Open
SV14	Closed	V17	Closed	SV14	Closed
SV15	Open	V18	Open	SV15	Open
SV15	Closed	V18	Closed	SV15	Closed
SV16	Open	V15	Closed	SV13	Closed
SV16	Closed	V20	Closed	SV16	Closed
SV17	Open	V21	Open	SV17	Open
SV17	Closed	V21	Closed	SV17	Closed
SV18	Open	V22	Open	SV18	Open
SV18	Closed	V22	Closed	SV18	Closed
SV19	Open	V23	Open	SV10	Open
SV19	Closed	V28	Open	SV21	Open
SV20	Open	V25	Open	SV20	Open
SV20	Closed	V25	Closed	SV20	Closed
SV21	Open	V26	Open	SV23	Open
SV21	Closed	V26	Closed	SV23	Closed
SV22	Open	V29	Open	SV22	Open
SV22	Closed	V29	Closed	SV22	Closed
SV23	Open	V23	Closed	SV10	Closed
SV23	Closed	V28	Closed	SV21	Closed

MSS 3.2.7 Command		GMA Valve Operation		Telemetry result	
Name	State	Name	State	Name	State
SV24	Open	V30	Open	SV24	Open
SV24	Closed	V30	Closed	SV24	Closed
CV1	Open	V7	Open	CV1	Open
CV1	Closed	V7	Closed	CV1	Closed
CV2	Open	V19	Open	CV2	Open
CV2	Closed	V19	Closed	CV2	Closed
CV3	Open	V27	Open	CV3	Open
CV3	Closed	V27	Closed	CV3	Closed
CV4	Open	V2	Open	SV2	Open
CV4	Closed	V2	Closed	SV2	Closed
CV5	Open	V1	Open	SV1	Open
CV5	Closed	V1	Closed	SV1	Closed
CV1A	Open	V12	Open	CV1A	Open
CV1A	Closed	V12	Closed	CV1A	Closed
CV2A	Open	V16	Open	CV2A	Open
CV2A	Closed	V16	Closed	CV2A	Closed
CV3A	Open	V24	Open	CV3A	Open
CV3A	Closed	V24	Closed	CV3A	Closed

C **Requirements Verification**

C.1 Requirements Cross Reference

C.2 Expected Data for Verification per requirement

C.2.1 All Limits passed as specified within CSTOL procedure.

D **Configuration Requirements**

D.1 The ECU3 Test set shall be connected to the ECU EU via a 1553 data bus, a timing signal (10 Hz) and a 28.0 Volt power supply. Ref: Figure 1, ECU EU Test Set Interconnect diagram

D.2 The ECU Power Supply shall be the sole provider of Heater Power to ECU controlled GMA Heaters. Ref: Figure 1, ECU Test Set Interconnect diagram

D.3 The Aft ECU shall be attached via cables to the GMA. Ref: Drawing 5856124, Payload Cable Interconnect Diagram

D.4 Flight hardware required

Description	Part No.	Finite Lifetime Object	No. Req'd
None			

D.5 Commercial test equipment

Manufacturer	Model	Serial Number	Calibr. Exp. Date
SUN Workstation (Test Set)	Ultra 2	941H2436	

D.6 Mechanical/Electrical Special test equipment

Description	Part No.	Certification Date
Timing & Interrupt Test Supply	001	

D.7 Tools

Description	No. Req'd
8 mm tape drive	1

D.8 Expendables

Description	Quantity
8 mm tape	1

E Software Required

E.1 Flight Software

Flight Software Name	Version No.
MSS (Mission Support Software)	3.2.7S

E.2 CSTOL Scripts

CSTOL Script Name	Version No.
ecu_seg.prc	V 1.2 : 06/26/01
ecu_unsg.prc	V 1.1 : 01/31/01
ecumisc_br.prc	V 1.1 : 01/15/99
fmt_ecu32a.prc	V 1.7 : 02/07/01
gmatemp_br.prc	V 1.1 : 02/10/99
gma1_br.prc	V 1.1 : 02/06/99
gma2_br.prc	V 1.1 : 02/11/99
gma3_br.prc	V 1.1 : 02/11/99
gma_moog.prc	V 1.3 : 06/04/02

E.3 SPC Scripts

SPC Script Name	Version No.
N/A	

E.4 Test Support Software

Test Software Name	Version No.
Oasis (Operating System Software)	V 2.4.5
Framex (front end software)	Framexs

F Procedures Required

Procedure Name	Procedure No.
(PTP) ECU EU Functional Test of the E-Mock GMA	P0907

G Equipment Pretest Requirements

Equipment	Serial No.	Test Required	Proc. No.	Test Performed Date	By
ECU EU	8A01313-ECU GSE	Certification	gma_moog.prc	2/7/01	HDM
E-Mock GMA	1	Certification	S-Doc S0621	1/5/02	KB

H Personnel Requirements

H.1 As a general requirement, all operations involving flight equipment require at least two persons at all times.

H.2 The test leader for this procedure is Dave Meriwether <Cell *650-725-9332 >*, or his appointed representative.

H.3 The GMA REE is Chris Gray <Cell *650-996-5070 >*. The GMA REE is responsible for all GMA tests, and will therefore schedule appropriate times for the performance of this procedure.

H.4 The Test Director for all Gyro Spin Up activities conducted in FIST Ops is Rob Brumley <Cell *650-245-1746 >*, or his appointed representative.

H.5 The Stanford Quality Assurance representative is Dorrene Ross <Beeper *650-317-7922, 1283969 >* or her appointed representative.

H.6 The Office of Naval Research representative is Abe Sabbag < Sabbaga@onr.naVy.mil> or his appointed representative.

H.7 The following personnel are qualified to perform this procedure using the FIST Ops test set:

H.7.1 Dave Meriwether <Cell 650-725-9332>

H.7.2 Thomas Wai <Phone 650-354-5644>

H.7.3 Denys Vanrenen <Phone 725-5769>

H.7.4 Rick Stephenson <Phone 724-3002>

I Safety Requirements

I.1 Standard safety practices to ensure safety of personnel and prevent damage to equipment shall be observed during performance of this test.

I.2 Read the CARD's[1] appropriate to ECU GMA Operations before running this test.

I.3 All connectors used will have connector savers attached. Protect all electrical connections and/or Connector Savers with ESD dust caps when the connectors are not mated.

I.4 Ensure that power is removed from cable assemblies before connecting and disconnecting cable connections.

I.5 Grounded wrist straps are to be worn prior to removal of connector caps or covers and during cable mating/demating operations.

I.6 Examine all mating connections before attempting to mate them. Remove any foreign particles. Look for any damaged pins or sockets. Do not force the coupling action if excessive resistance is encountered. Ensure that key ways are aligned.

[1] Constraints and Restrictions Document

J General Instructions

J.1 Test operators shall read this procedure in its entirety and resolve any apparent ambiguities prior to beginning this test.

J.2 This procedure operates the GMA system for the GP-B satellite. Knowledge of the GMA, caution in it's operation and attention to displayed information must be exercised at all times during these operations or Hardware damaged may result.

J.3 This procedure shall be conducted on a formal basis to its latest approved and released Version.

J.4 Tests will be conducted under the environmental conditions existing in the FIST Ops, HEPL Lab at Stanford University.

J.5 This procedure operates Non-Flight Hardware only.

J.6 In order to expedite test operations, unless specifically noted, the sequence in which major sections or subsections are preformed may be altered at the discretion of the GMA REE or his representative.

J.7 Upon completion of the test, all data on the FIST Ops test set under the /opt/usr6/lab and sub-directories shall be transferred to the data archive on the Payload Server. Upon confirmation that the FIST Ops test set data has been successfully archived, the data in the /opt/usr6/lab/bridge, /snaps, /messages and /oasis_raw_data directories may be deleted.

K References and Applicable Documents

K.1 SCIT-01 System Design, Verification, Integration & Test Plans

K.2 SCSE 06 Command and Telemetry Handbook, App B sw_cmd 3.2.5

K.3 SCSE 16 SECTION 9, Flight Software Design Specification, External Interface Detailed Design, Version Fg

K.4 PLSE-12, Science Payload Specification, Version 4.3

K.5 MSS3.2.7_Report_Excel.xls; GMA Telemetry Monitor List

K.6 ECU Drawings

L **Operations:**

L.1 ECU Test Set Initialization:

L.1.1 Connect the ECU3 Test Set to the ECU EU. Ref: Operating Instructions for ECU Spacecraft Emulator.

L.1.2 Start the MSS 3.2.7 FUNCTIONAL TEST OF THE NON-FLIGHT GMA CSTOL procedure:

WARNING: This procedure will leave the GMA Valves Open for extended periods and thus shall not be used on the Flight GMA once it's Gas bottles are under pressure.

CSTOL ACTIONS:

L.1.2.1 TYPE Go to start gma_moog.prc.

L.1.2.2 Oasis Binary and Message File recording started

L.1.2.3 Load ECU telemetry format (nominal Format ID: F3250ECU32A).

L.1.2.4 Display and Record upon change the ECU state monitors.

L.2 Flight ECU Initialization:

L.2.1.1 Command on the ECU Processing.

CSTOL HOLD

L.2.1.2 Power on the ECU Power Supply

CSTOL ACTIONS:

L.2.1.3 TYPE Go to Initialize and check that all ECU Heaters are Off.

CSTOL HOLD

L.2.1.4 Power on the ECU Heater Power Supply

CSTOL ACTIONS:

L.2.1.5 TYPE Go to limit check internal ECU state monitors.

L.2.1.6 Check for and record timing signal presence.

L.2.1.7 Limit check ECU state and locked ADC monitor (`DE_Ecu_Status`) as displayed in ECU_Critical_1 (nominal = 10000000).

L.2.1.8 Limit check Rollover Counter status (`BE_Failure_A, BE_Failure_B`) as displayed in FSW_SM_DI_10hz_1 (nominal = false).

L.2.1.9 Limit check Active ECU Side (`BC_1553_A_B_Sel`) in VES_IoDirectiVe1 (nominal = Side_A).

CSTOL HOLD:

L.2.1.10 Review the ECU_Critical_1 display and confirm that both ECU Rollover Counters (`DE_Roll_Cntr__A, DE_Roll_Cntr__B`) are in synch and incrementing

L.2.1.11 Review the Startlab xterm window and check for any new errors.

L.2.1.12 Review the Startlab window and check for errors (BC_SEND BC RECEIVE)

CSTOL ACTIONS:

L.2.1.13 Type Go to limit check ECU Calibration, I/O, Gain & Reference monitors[2]

L.2.2 GMA Heater Operation

L.2.2.1 Display and Record upon change the GMA Heater monitors. [3]

L.2.2.2 Type Go to turn on the Side A GMA Heater

L.2.2.2.1 Limit check GMA Heater command confirmation

L.2.2.3 Type Go to turn off the Side A GMA Heater

L.2.2.3.1 Limit check GMA Heater command confirmation

L.2.2.4 Type Go to turn on the Side B GMA Heater

L.2.2.4.1 Limit check GMA Heater command confirmation

L.2.2.5 Type Go to turn off the Side B GMA Heater

L.2.2.5.1 Limit check GMA Heater command confirmation

L.2.3 GMA Valve Initialization

L.2.3.1 Display and Record upon change the GMA Valve monitors. [3]

L.2.3.2 Close Valves V1, V2, V3, V4, V5, V6, V9, V10, V13, V14, V17, V18, V21, V22, V25, V26, V29, V30

L.2.3.3 Open Valves V7, V8, V11, V12, V15, V16, V19, V20, V23, V24, V27, V28

L.2.3.3.1 Limit check Valve status

[2] Ref: ECU3.2.7Report_Excel.xls, ECU Initialization Monitor's & Limits
[3] Ref: ECU3.2.7Report_Excel.xls, GMA Telemetry

L.2.4 GMA Valve Checkout

L.2.4.1 Command Open, Close & Open each GMA Valve {V1-V30}

L.2.4.1.1 Limit check Valve status

L.2.5 GMA Valve Isolation Checkout

L.2.5.1 Close all GMA Valves {V1-V30}

L.2.5.1.1 Limit check Valve status

L.2.5.2 Open, Close each valve & monitor telemetry for additional valve operation

L.2.6 GMA SDT Limit Check

L.2.6.1 Display and limit check each E-Mock GMA SDT

L.2.6.1.1 GMA_SDT1A, 1B, 2A, 2B, 3A, 3B

L.2.7 GMA Pressure Sensor Limit Check

L.2.7.1 Display and limit check each E-Mock GMA Pressure Sensor

L.2.7.2 GMA_SP1, SP2, SP3A, SP3B, SP4, SP5, SP6, SP7, SP8, SP9, CP1, CP2, CP3, CP4

L.2.8 GMA Valve Initialization

L.2.8.1 Close Valves V1, V2, V3, V4, V5, V6, V9, V10, V13, V14, V17, V18, V21, V22, V25, V26, V29, V30

L.2.8.2 Open Valves V7, V8, V11, V12, V15, V16, V19, V20, V23, V24, V27, V28

L.2.8.2.1 Limit check Valve status

L.2.8.3 MSS 3.2.7 FUNCTIONAL TEST OF THE NON-FLIGHT GMA CSTOL procedure completion

L.2.8.4 TYPE: GO to End MSS 3.2.7 FUNCTIONAL TEST OF THE NON-FLIGHT GMA CSTOL procedure.

CSTOL ACTIONS:

L.2.8.5 Snap & Clear Monitors.

L.2.8.6 Command Off ECU.

L.2.8.7 Snap & Clear ECU Monitors.

L.2.8.8 End ECU Message File Recording.

L.2.8.9 End Bridge File Recording.

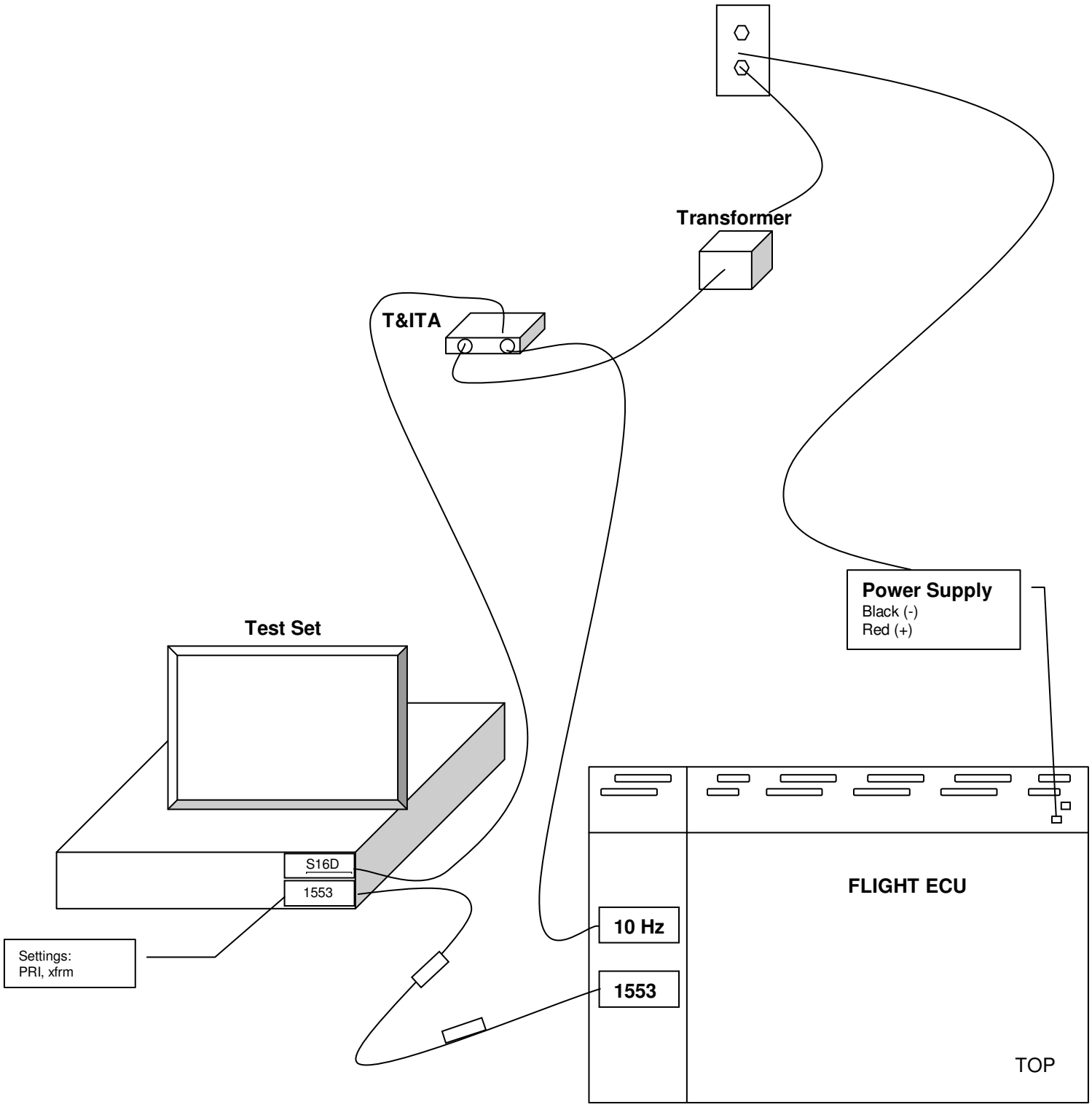
L.2.8.10 End Oasis Binary File Recording.

L.2.8.11 OPERATOR: Power down ECU power supply.

L.2.8.12 Test completed:

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

Quality Engineer: _____
Date: _____
Time: _____


Transformer
T&ITA
Power Supply
Black (-)
Red (+)
Test Set
S16D
1553
Settings:
PRI, xfrm
FLIGHT ECU
10 Hz
1553
TOP