



Fuel Quantity Systems Test Set PSD60-1 AF Operaton Manual

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OPERATION MANUAL

PSD60-1AF FUEL QUANTITY SYSTEMS TEST SET

MANUAL NUMBER: E6-0605-0A / 75344
REVISION: B0
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Aeroflex, Operation Manual

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Table of Contents	01		
Section I	02		
Section II	03		
Appendix A	01		



ELECTROSTATIC DISCHARGE GENERAL WARNINGS FOR ALL EQUIPMENT

CAUTION: THIS EQUIPMENT MAY CONTAIN ELECTROSTATIC DISCHARGE (ESD) SENSITIVE COMPONENTS. TO PREVENT ESD SENSITIVE EQUIPMENT FROM POSSIBLE DAMAGE, OBSERVE THE FOLLOWING PRECAUTIONS WHEN HANDLING ANY ESD SENSITIVE COMPONENTS OR UNITS CONTAINING ESD SENSITIVE COMPONENTS.

- a. Maintenance or service personnel must be grounded through a conductive wrist strap or a similar grounding device using a 1 M Ω series resistor for equipment protection against static discharge and personal protection against electrical shock.
- b. All tools must be grounded (including soldering tools) that may come into contact with the equipment. Hand contact provides sufficient grounding for tools that are not otherwise grounded provided the operator is grounded through an acceptable grounding device such as a wrist strap.
- c. Maintenance or service of the Unit must be done at a grounded ESD work station.
- d. Before maintenance or service of the equipment, disconnect all power sources, signal sources and loads connected to the Unit.
- e. If maintenance or service must be performed with power applied, take precautions against accidental disconnection of equipment components. Specifically, do not remove integrated circuits or printed circuit boards from the equipment while the equipment has power applied.
- f. All ESD sensitive components are shipped in protective tubes or electrically conductive foam. The components should be stored using the original container/package when not being used or tested. If the original storage material is not available, use similar or equivalent protective storage material.
- g. When ESD sensitive components are removed from a Unit, the components must be placed on a conductive surface or in an electrically conductive container.
- h. When in storage or not being repaired, all printed circuit boards must be kept in electrically conductive bags or other electrically conductive containers.
- i. Do not unnecessarily pick up, hold or directly carry ESD sensitive devices.

Failure to comply with these precautions may cause permanent damage to ESD sensitive devices. This damage can cause devices to fail immediately or at a later time without apparent cause.

TABLE OF CONTENTS

**SECTION I
GENERAL INFORMATION**

SECTION		PAGE NUMBER
1.1	GENERAL	1-1
1.2	DESCRIPTION.....	1-1

**SECTION II
OPERATION**

2.1	GENERAL INFORMATION	2-1
2.2	CAPACITANCE MEASUREMENT	2-2
2.3	INSULATION RESISTANCE MEASUREMENT	2-3
2.4	CAPACITANCE SIMULATION.....	2-4
2.5	AIRCRAFT ONLY.....	2-5
2.6	MAINTENANCE	2-6
2.7	SHIPMENT.....	2-6

APPENDIX A

A-1	THREE TERMINAL MEGGER.....	A-1
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SECTION I INTRODUCTION

1.1 GENERAL

This manual contains operating procedures for the AC Capacitance Field Calibrations Unit, PSD60-1AF manufactured by Aeroflex. For instructions on how to calibrate or troubleshoot a specific aircraft system, refer to the applicable Technical Order.

1.2 DESCRIPTION

- A. The PSD60-1AF AC Capacitance Field Calibration Unit may be used for functional check or calibration of any capacitive liquid quantity gauging system which uses strictly capacitive probes ("tank units") as sensors. It may not be used to measure or simulate sensors which have diodes or resistive elements integral to the sensor. The Field Calibration Unit provides three basic functions.

It measures capacitance in picofarads (pf)
It measures insulation resistance in megohms
It simulates one or two capacitors as required

The capacitance measuring circuit is auto-ranging up to 1,999 pf in the normal configuration, and up to 19,999 pf when the "Extended Range" switch is pressed. Aeroflex certifies to 10,000 pf. Insulation resistance measurement is auto-ranging up to 19,999 megohms. A "TWO-TERMINAL" switch is provided for isolating system faults reading less than 100K ohms. Aeroflex certifies to 10,000 MΩ. Ref 1.2.E.

Operation requires selection of the desired function with the FUNCT switch, and selections of the specific reading on the SELECT switch. Aircraft-specific interface cables are required for each application. These are not supplied with the tester.

- B. The tester is powered by 18 alkaline "C-cell" batteries which can be replaced without requiring tester recalibration. A low battery condition is indicated on the LCD display as "LO BATT". Rechargeable batteries may not be used in this tester.

- C. Leading particulars:

Housing	Aluminum, Dimensions: +/- 0.3" (as per manf. specifications)
Length	9 inches
Width	12 inches
Height	6 inches
Weight	12 pounds nominal
Display	Liquid Crystal

Standard accessories supplied with unit.

Order code:	Description
57306	Cable PSD60-1AF GENERAL PURPOSE, Hi-Z BNC to two clip (55-0605-13)
57307	Cable PSD60-1AF GENERAL PURPOSE, Lo-Z polarized BNC to alligator (55-0605-14)
57308	Cable PSD60-1AF GENERAL PURPOSE, Hi-Z BNC to BNC (55-0605-15)
57309	Cable PSD60-1AF GENERAL PURPOSE, Polarized BNC to standard BNC (55-0605-16)
58345	Cable GROUND STRAP, (55-7002-00)

D. Measurement Range:

Capacitance reading is 0.1 pf – 1,999 pf in normal range.
Capacitance reading is 1.0 pf – 19,999 pf in extended range.
Insulation resistance reading is 100K ohms – 19,999 megohms.

Over-range is indicated in both the measurement modes by displaying four zeros and flashing three colons: :0:0:0 0. When over-range is indicated in the insulation resistance mode, the reading is over 19,999 megohms.



E. Measurement Accuracy:

- Capacitance: +/-0.1% of reading or .2 pf, to 10,000 pf, whichever is greater, at temperatures of 0 to +50 degrees C.
- Capacitance: +/-0.15% of reading or .3 pf, to 10,000 pf, whichever is greater, at temperatures of -20 to 0 and +50 to +55 degrees C.
- Insulation resistance: +/- 10% of range to 10,000 MΩ from 0 to +50 degrees C.
- Insulation resistance: +/- 15% of range to 10,000 MΩ -20 to 0 and +50 to +55 degrees C.

F. Capacitance Simulation Range:	TANK UNIT	20 pf – 8,000 pf
	COMP	20 pf – 1,000 pf

The capacitance simulators have infinite resolution within range. The “vernier” adds 17-30 pf to the decade value chosen. The tester display indicates the exact value selected. This simulation has the same accuracy as para E, “Measurement Accuracy, capacitance” above.

G. Front panel: Refer to Figure 1-1 for component identification. Refer to Table 1-1 for description of each component’s function.

Aeroflex Operation Manual

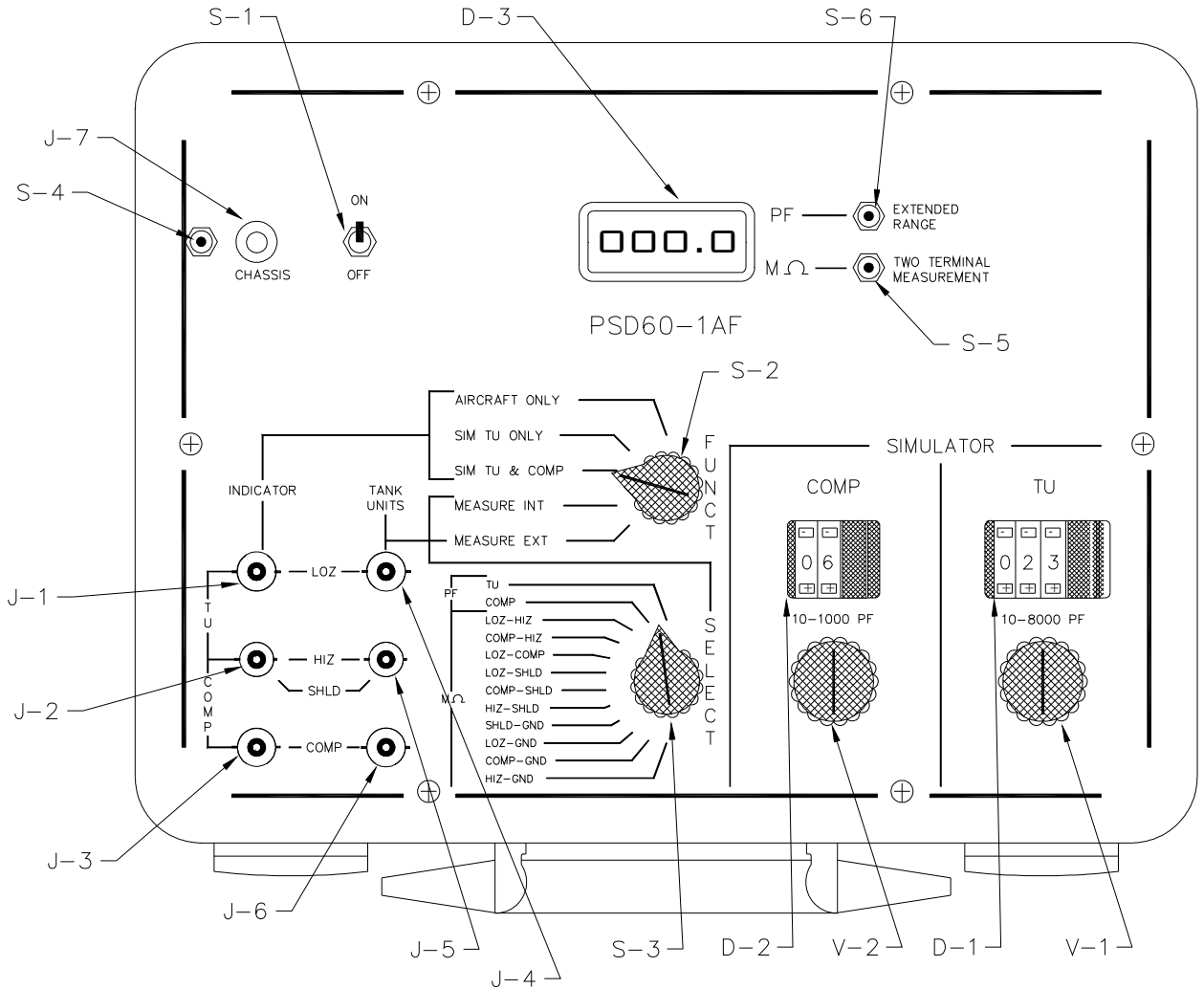


FIGURE 1-1

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>J-1 LoZ output to indicator</p> <p>J-2 HiZ output to indicator</p> <p>J-3 Comp LoZ out to indicator</p> <p>J-4 Tank Units LoZ input</p> <p>J-5 Tank Units HiZ input</p> <p>J-6 Tank Units Comp input</p> <p>J-7 Chassis ground jack</p> <p>D-1 Tank Unit simulator decade</p> <p>D-2 Compensator simulator decade</p> <p>D-1 Liquid Crystal Display (LCD)</p> | <p>S-1 Power ON-OFF switch</p> <p>S-2 Function select switch</p> <p>S-3 Cap-Meg select switch</p> <p>S-4 Lid-close power OFF switch</p> <p>S-5 Press for 2-terminal megger readings</p> <p>S-6 X10 range switch</p> <p>V-1 TU simulator vernier</p> <p>V-2 COMP simulator vernier</p> |
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Aeroflex Operation Manual

ITEM	DESCRIPTION	FUNCTION
S-1	“ON-OFF”	Power switch. Applies battery power to circuit.
S-2	“FUNCT”	Select simulation or measurement function required:
	“AIRCRAFT ONLY”	Disconnects the tester simulated capacitance from J-1, J-2 & J-3.
	“SIM TU ONLY”	Connects “TU” simulators D-1 & V-1 between J-1 & J-2, & Shorts COMP simulators D-2 & V-2 to ground.
	“SIM TU & COMP”	Connects “TU” simulators D-1 & V-1 between J-1 & J-2, & COMP simulators D-2 & V-2 between J-2 & J-3.
	“MEASURE INT”	Connects J-1 & J-2 to measurement circuit and LCD display when “TU” is selected on SELECT switch S-3. Connects J-2 and J-3 to measurement circuit and display when “COMP” is selected on SELECT switch S-3.
	“MEASURE EXT”	Connects J-4 & J-5 to measurement circuit and LCD display when “TU” is selected on SELECT switch S-3. Connects J-5 and J-6 to measurement circuit and display when “COMP” is selected on SELECT switch S-3.
S-3	“SELECT”	Determines the points which a measurement is made, either internal or external, depending on the position of S-2. Position is irrelevant in SIM TU ONLY, SIM TU & COMP and AC ONLY positions of FUNCT switch S-2.
S-4	“POWER SW” (not marked)	Turns power OFF when lid is closed, regardless of position of switch S-1.
S-5	“TWO TERMINAL MEASUREMENT”	Changes the insulation resistance measurement from the normal 3-terminal mode to the 2-terminal mode. Used when resistance is less than 100K ohms.
S-6	“EXTENDED RANGE”	Moves decimal point on LCD one pace to the right and multiplies range X 10. Use when adjusting TU simulator or measuring EXT capacitance over 1,999 pf.
J-1	“INDICATOR LOZ”	Current-limited AC from aircraft system under test applied to TU capacitance in tester.
J-2	“INDICATOR HIZ-SHIELD”	High impedance or coaxial side of TU & COMP, or TU ONLY, capacitance in SIM modes. Capacitance output to aircraft system.

TABLE 1-1

Aeroflex Operation Manual

ITEM	DESCRIPTION	FUNCTION
J-3	"INDICATOR COMP"	Current-limited AC from aircraft system under test applied to COMP capacitor in tester. Used in SIM TU & COMP mode only.
J-4	"TANK UNITS LOZ"	Current-limited AC from tester to "LOZ" side of capacitance sensor (s) in aircraft system under test in MEAS EXT (TU or COMP) mode. Current-limited AC from tester to "LOZ" side of aircraft sensors, and wiring, in MEAS EXT, with SELECT switch in positions relating to LOZ.
J-5	"TANK UNITS HIZ-SHIELD"	High impedance or coaxial side of capacitive sensor (s) and wiring in MEAS EXT mode. Return signal to tester in both the cap measurement, and insulation resistance modes.
J-6	"TANK UNITS COMP"	Current-limited AC from tester to "Comp Loz" side of compensator (reference capacitor) in MEAS EXT (COMP) mode. Current-limited DC from tester to compensator & aircraft wiring with SELECT switch in insulation resistance position referring to "COMP".
J-7	"CHASSIS JACK"	Access to tester "chassis" or "case" ground. Normally required to connect tester to aircraft ground. All MEAS EXT measurements with SELECT switch in GND position refer to J-7.
D-1	"TU DECADE"	Adds fixed capacitors in units of 10, 100, & 1000 pf in parallel with vernier V-1. Reads 10-30 pf less than value shown on LCD display, depending on V-1 setting. Ref Note 1.
D-2	"COMP DECADE"	Adds fixed capacitors in units of 10, 100 in parallel with vernier V-2. Normally 10-30 pf less than reading on LCD display.
D-3	"LIQUID CRYSTAL DISPLAY"	Display numeric value of capacitor under test (EXT or INT) in picofarads (PF). Displays insulation resistance of system wiring or unit under test in megohms (MEG).
V-1	"SIMULATOR-TU" "10-8000"	Continuously variable 10-30 pf air capacitor in parallel with TU decade D-1. Ref note 2.
V-2	"SIMULATOR-TU" "10-1000"	Continuously variable 10-30 pf air capacitor in parallel with COMP decade D-2. Ref note 2.

TABLE 1-1

Aeroflex Operation Manual

- Note 1. Since decades D-1 and D-2 are always in parallel with verniers V-1 and V-2 respectively, the digits on the decade will always read 10-30 pf less than the LCD display.
- Note 2. “Verniers”, V-1 and V-2 are infinitely variable air capacitors with no end “stops”. Therefore, they will vary from min-to-max-to-min in either the clockwise or counterclockwise direction.

SECTION II OPERATION

2.1 GENERAL INFORMATION

The PSD60-1AF is a general purpose test set which can be used to troubleshoot and calibrate any capacitive liquid gauging system which does not have diodes integral to the sensors. A set of general-purpose cables is supplied with the tester for connecting directly to the sensors (also called “probes” or “tank units”). Aircraft-specific interface cables are required to test fuel quantity, oil quantity, and liquid oxygen systems on the aircraft. The PSD60-1AF will accommodate all such interface cables designed for the tester it is replacing. However, there are important differences in the PSD60-1AF design which change and simplify the operating procedures.

- The PSD60-1AF is battery-powered and current-limited. It is approved as safe for use in all operating modes, with fuel in the tank or with the tank open. Voltage checks between the tester chassis and ground are not required when using the PSD60-1AF tester.
- The PSD60-1AF should always be connected to airframe ground during system test to permit insulation resistance checks and to insure accurate measurements. However lack of such grounds does not constitute a safety hazard.
- The PSD60-1AF is designed to be used with interface cables with either two or three test leads, i.e. true “T” cables. Cables with six leads (not “T” cables) can be used, but the procedure cannot require three leads connected to the TANK UNITS terminals, and three to the INDICATOR terminals at the same time. The tester will not operate in this configuration.
- The PSD60-1AF isolates the HiZ (coax) lead shield (“SHLD”) from CHASSIS ground (“GND”). The interface cable used should not connect HiZ shield and CHASSIS ground (“GND”) together.
- The PSD60-1AF automatically grounds the TANK UNITS COMP terminal when measuring between TANK UNITS HIZ and LOZ, and grounds the TANK UNITS LOZ terminal when measuring the COMP

2.2 CAPACITANCE MEASUREMENT

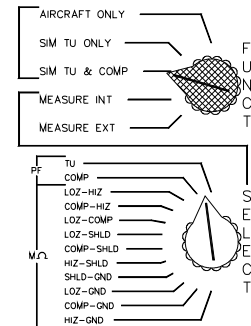
- A. Connect CHASSIS jack J-7 to airframe ground (or the mounting flange of a tank unit removed from the tank).
- B. Turn ON-OFF switch S-1 to ON and allow 3-minute warm-up.

Note: Some testers have “lift-to-unlock” type toggle switches. DO NOT FORCE AGAINST LOCK.

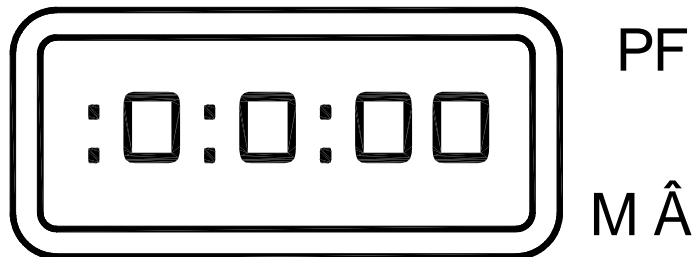
Note: If “LO BATT” appears on LCD display D-3 when power is turned ON, replace batteries per para 2.6.

- C. Connect interface cable HIZ (COAX) lead to TANK UNITS HIZ-SHLD terminal J-5. Connect cable LOZ (UNSH) lead to TANK UNITS LOZ terminal J-4. If the system under test has a compensator (reference capacitor), connect the COMP lead to TANK UNITS COPM terminal.

- D. Rotate FUNCT switch S-2 to MEASURE EXT position.
- E. Rotate SELECT switch S-3 to TU position to measure capacitance between J-4 & J-5.
- F. Rotate SELECT switch S-3 to COMP position to measure capacitance between J-5 & J-6.
- G. Capacitance in pf (UUF) is displayed on the LCD display D-3.



Note: If the capacitance being measured is in excess of normal range (0-1,999 pf), LCD display will indicate



Press EXTENDED RANGE switch S-6 to read high values.

- H. To measure a sensor (probe) removed from the tank, connect universal HIZ (COAX) lead between TANK UNITS HIZ terminal J-5 and HIZ terminal on sensor. Connect unshielded lead between TANK UNITS LOZ terminal J-4, and LOZ terminal on sensor. If sensor has a mounting flange, connect flange to CHASSIS ground terminal using ground lead supplied. DO NOT touch outer tube or terminals of probe during measurement.
- I. If the unit under test has a compensator (reference) capacitor, connect another unshielded lead between TANK UNITS COMP terminal J-6 and sensor COMP terminal.

2.3 INSULATION RESISTANCE MEASUREMENT

- A. Connect CHASSIS jack J-7 to airframe ground (or the mounting flange of a tank unit removed from tank).
- B. Turn ON-OFF switch S-1 to ON and allow 3-minutes to warm-up.

Note: If "LO BATT" appears on LCD display D-3 when power is turned ON, replace per para 2.6.

- C. Connect interface cable HIZ (COAX) lead to TANK UNITS HIZ-SHLD terminal J-5. Connect cable LOZ (UNSH) lead to TANK UNITS LOZ terminal J-4. If the system under test has a compensator (reference capacitor), connect the COMP lead to TANK UNITS COMP terminal J-6.

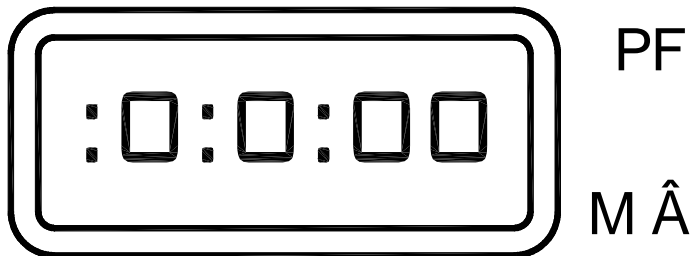
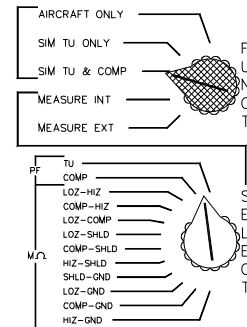
- D. Rotate FUNCT switch S-2 to MEASURE EXT position.

- E. Rotate SELECT switch S-3 to LOZ-HIZ. Allow 5 seconds for LCD readout to stabilize.

- F. Repeat for each position thru HIZ-GND.

- G. Insulation resistance in megohms is displayed on LCD display D-3.

Note: If the insulation resistance being measured is in excess of 19,999 megohms, LCD display will indicate as follows with three colons flashing:



Note: "GND" indicates measurement to CHASSIS ground J-7.

- H. If more than one position of the insulation resistance measurement indicates a short circuit "000.1", depress TWO-TERMINAL MEASUREMENT switch S-5. Repeat steps E-F above. Ref APPENDIX A for a description of 3-terminal measurement.
- I. To measure a sensor removed from tank, connect universal HIZ (COAX) lead between TANK UNITS HIZ terminal J-5 and HIZ terminal on sensor. Connect unshielded lead between TANK UNITS LOZ terminal J-4 and LOZ terminal on sensor.
- J. If sensor under test has a compensator (reference) capacitor, connect another unshielded lead between TANK UNITS COMP terminal J-6 and sensor COMP terminal.

2.4 CAPACITANCE SIMULATION

- A. Connect CHASSIS jack J-7 to airframe ground.
- B. Turn ON-OFF switch S-1 ON and allow 3-minute warm-up.

Note: Some testers have “lift-to-unlock” type toggle switches. DO NOT FORCE AGAINST LOCK.

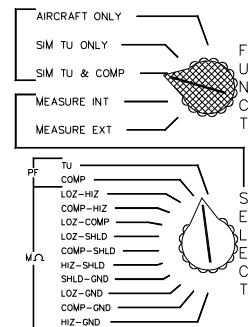
Note: If “LO BATT” appears on LCD display D-3 when power is turned ON, replace batteries per para 2.6.

- C. Connect interface cable HIZ (COAX) lead to INDICATOR HIZ-SHLD terminal J-2. Connect cable LOZ (UNSH) lead to INDICATOR LOZ terminal J-1. Connect COMP lead (if interface cable has one) to INDICATOR COMP terminal J-3.

Note: Verify that interface cable leads are connected to INDICATOR terminals on left side of tester whenever capacitance simulators are adjusted. If leads are connected to TANK UNITS terminals when simulators are adjusted, LCD will read simulators plus any capacitance connected to TANK UNITS terminals.

Note: Properly designed and constructed interface cables introduce minimal capacitance to the circuit. The cable capacitance should be measured per para 2-2, however, to insure its integrity. Any capacitance measured in TU or COMP positions should be subtracted from capacitance value being simulated.

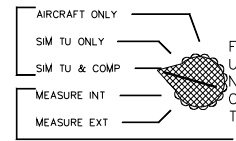
- D. Rotate FUNCT switch S-2 to MEASURE INT position.
- E. Rotate SELECT switch S-3 to TU position.
- F. Adjust TU decade D-1 to 10-20 pf lower than tank capacitance required.
- G. Adjust TU vernier V-1 to read exact capacitance required on LCD display.
- H. Rotate SELECT switch S-3 to COMP position.
- I. Adjust COMP decade D-2 to 10-20 pf lower than comp capacitance required.
- J. Adjust COMP vernier V-2 to read exact compensator capacitance required on LCD displayed.
- K. To simulate TU capacitance only, rotate FUNCT switch S-2 to SIM TU ONLY position. To simulate both TU and COMP, rotate FUNCT switch S-2 to SIM TU & COMP position.



2.5 AIRCRAFT ONLY

The PSD60-1AF tester makes provision to switch the simulated TU and COMP capacitance out during “dry tank” calibration. The purpose is to allow the “0 lb” or “empty” adjustment on the gauge to be set to the actual empty tank with no capacitance being added by the tester. The “full” adjustment is then made by switching in the “added” capacitance value using “SIM TU ONLY”. To complete such a calibration:

- A. Adjust the TU decade and vernier to “cap added” value using para 2.4. “Cap added” is the difference between the “empty” and “full” capacitance values.
- B. If system under test has a compensator or reference capacitor, adjust the COMP decade and vernier to the difference between a dry compensator and a wet compensator.
- C. Rotate FUNCT switch S-2 to AIRCRAFT ONLY position to adjust “empty” setting.
- D. Rotate FUNCT switch S-2 to SIM TU ONLY position to adjust “full” setting if system under test had no compensator. If system under test has a compensator, rotate FUNCT switch S-2 to SIM TU & COMP position.



Note: In order to utilize the AIRCRAFT ONLY function, the aircraft system interface cables must be true “T” cables. Cables which depend on the tester switching to interconnect the tank leads to the indicator signal input cannot utilize this function of the PSD60-1AF.

2.6 MAINTENANCE

CAUTION: THE PSD60-1AF TESTER CONTAINS ESD SENSITIVE DEVICES. IF FRONT PANEL IS REMOVED IN NON-ESD PROTECTED AREA, DO NOT TOUCH PC BOARD.

- A. Battery replacement: LCD display D-3 will indicate "LO BATT" when batteries require replacement. Remove six screws from perimeter of front panel and replace 18 batteries with alkaline "C-cell" batteries. Recalibration not required.
- B. Calibration: The manufacture's recommended calibration interval is annually. Calibration and recertification are available from:

Aeroflex
10200 West York
Wichita, KS 67215
(800) 835-2350

2.6 SHIPMENT

The PSD60-1AF is designed to withstand normal handling during shipment. However, if operational considerations permit, ship tester in protective packaging. If tester is being returned for battery replacement and/or recertification, remove front panel and carefully remove "C-cell" batteries prior to shipment.

APPENDIX A THREE TERMINAL MEGGER

A.1 PSD60-1AF THREE TERMINAL MEGGER

The PSD60-1AF incorporates a three terminal megger in order to accurately measure the insulation resistance of each element. This method is required due to the complexity of the network to be measured. An equivalent circuit for a two terminal megger is shown in Figure A-1.

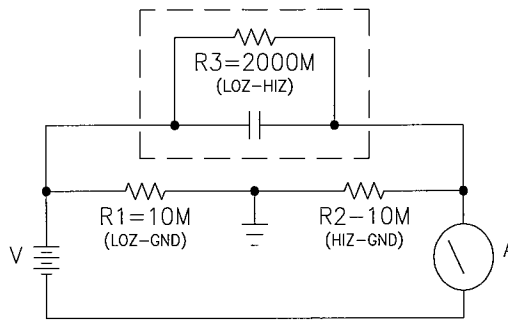


FIGURE A-1

In Figure A-1, the insulation resistance reading would be approximately 20 MΩ, which is unacceptable. This is because the main current is through R1 and R2 not the tank unit.

The three terminal measurement used in the PSD60-1AF measures the current through the element under test. (Figure A-2) As you can see, the resistance in the ammeter is infinitely smaller than R1 or R2. By using this method we can accurately measure the tank unit insulation resistance.

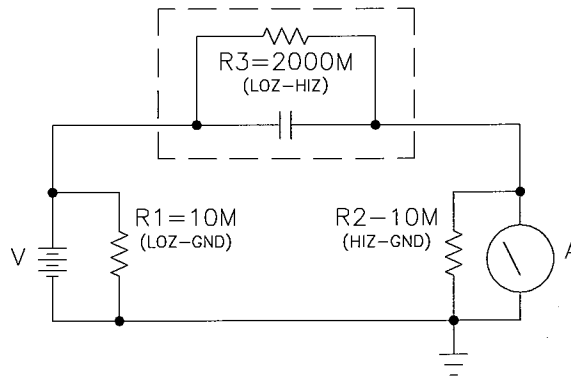


FIGURE A-2

The three terminal measurement as described above works well in identifying problems except when a direct short is in the system. For example, if R1 is shorted no current will reach R3 and it shows infinite resistance or if R2 is shorted no current will reach the current sensing device also indicating an incorrect reading. When connected to an entire system, this will cause erroneous readings on many portions of the select switch. Table A-1 shows a typical result.

<u>SELECT POSITION</u>	<u>NORMAL READING</u>	<u>SHORT FROM LoZ TO HiZ</u>
LoZ - HiZ	0 Ω	0 Ω
Comp - HiZ	10 M Ω	INFINITY
LoZ - Comp	10 M Ω	INDETERMINATE
LoZ - Shield	10 M Ω	INDETERMINATE
Comp - Shield	10 M Ω	10 M Ω
HiZ - Shield	10 M Ω	INDETERMINATE
Shield - GND	10 M Ω	10 M Ω
LoZ - GND	10 M Ω	INDETERMINATE
Comp - GND	10 M Ω	10 M Ω
HiZ - GND	10 M Ω	INDETERMINATE

TABLE A-1

Of the five points measured (LoZ, HiZ, Comp, Shield, GND) only four of the readings are correct. The "TWO TERMINAL MEASUREMENT" switch is provided to help eliminate this confusion by lifting the third leg of the megger so it will act as a two terminal device. This method of testing will provide the best of both three and two terminal measurements by allowing accurate measurement of system parameters while allowing for quick identification of a direct short.

As we are always seeking to improve our products, the information in this document gives only a general indication of the product capacity, performance and suitability, none of which shall form part of any contract. We reserve the right to make design changes without notice.

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GERMANY	Tel: [+49] 8131 2926-0	Fax: [+49] 8131 2926-130
HONG KONG	Tel: [+852] 2832 7988	Fax: [+852] 2834 5364
INDIA	Tel: [+91] (0) 80 4115 4501	Fax: [+91] (0) 80 4115 4502
JAPAN	Tel: [+81] 3 3500 5591	Fax: [+81] 3 3500 5592
KOREA	Tel: [+82] (2) 3424 2719	Fax: [+82] (2) 3424 8620
SCANDINAVIA	Tel: [+45] 9614 0045	Fax: [+45] 9614 0047
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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven, customer-focused.