

CAPACITANCE FUEL SYSTEM TEST BOX

GENERAL.

APPLICATIONS.

The Field Calibration Test Box is a universal unit designed to be used for complete maintenance, troubleshooting and calibration of the capacitance fuel quantity gauging systems. When properly used, the Field Calibration Test Box will enable the technician to perform the following functions:

1. Measure capacitance of the complete system or of individual components.
2. Substitute the appropriate capacitance into the system to simulate the tank sensors or the fuel in the tanks for calibration.
3. Check the insulation breakdown resistance of the complete system as well as the individual components.
4. Test the indicator and signal conditioner for operation.

The Field Calibration Test Box is entirely portable, and self-contained. Power is supplied by standard type dry cell batteries.

RANGE.

Capacitance Measurement	0 - 150 picofarads
Capacitance Substitution	5 - 150 picofarads
Insulation Resistance	0 - Infinity
Meter	0 - 1000 microamperes conversion

ACCURACY.

Capacitance measurement and substitution	1%
Insulation Resistance	5%
Meter	1%

DESCRIPTION OF CAPACITANCE FUEL GAUGING SYSTEM.

A Capacitance Fuel Gauging System used on aircraft consists of tank sensing units immersed in the fuel (usually one in each tank), a signal conditioner and a follow-up

display indicator. The fundamental signal upon which the whole system is dependent is furnished by the tank sensing units which are excited by the bridge contained in the signal conditioner. The signal conditioner's function is to transmit a current to the indicator which is a function of usable fuel in the selected tank. The tank sensing unit is basically a level sensing device. The capacitance measured, at any particular level of fuel, is a function of the electrode spacing and the dielectric constant of the medium between the electrodes, thus, as fuel is consumed, air and fuel vapor fills the space vacated by the fuel and the dielectric constant in this portion of the tank sensing unit drops from a nominal value of $K=2$ (approximately for fuel) to a value of $K=1$ (for air). The resulting change in total capacitance measured at the terminals results in a corresponding change in indicator reading. The fuel volume contained in the tank is a more or less complex function of level, therefore, the tank sensing units are located and profiled so that the incremental change of capacitance measured at the tank sensing unit is proportional to the corresponding incremental volume change.

SYSTEMS RELIABILITY.

The inherent accuracy and reliability of the capacitance fuel gauging system is highly dependent upon the following three basic factors:

1. Indicator accuracy (normally 2%).
2. Installation and interconnection of components.
3. Calibration and maintenance of the system.

The accuracy of the system is spelled out in the applicable service manual for the particular aircraft.

OPERATIONAL PROCEDURE.

The normal recommended calibration or troubleshooting procedure is to be accomplished per the following steps (in this order):

1. Check insulation resistance to insure a good insulation breakdown value per Table I (Page 4).
2. Check capacitance values to insure that the system is complete and not in excess of its allowed capacitance per Table III (Page 16).
3. Calibrate system per procedures for the particular model (Page 13 thru Page 31).

TO MEASURE INSULATION BREAKDOWN RESISTANCE.

The insulation resistance check must be made for the following:

HiZ to LoZ
HiZ to Shield
LoZ to Shield
HiZ to Ground
LoZ to Ground
Shield to Ground

All insulation resistance readings must be equal to or greater than the resistance values noted in Table I.

Refer to the appropriate wiring diagram in the aircraft service manual for proper connections. The HiZ Lead is always the shielded wire and the LoZ Lead is the unshielded wire in all capacitance gauging systems covered by this test box.

The insulation resistance should be checked for the entire system (LH and RH, Main and Aux) when the entire system is calibrated.

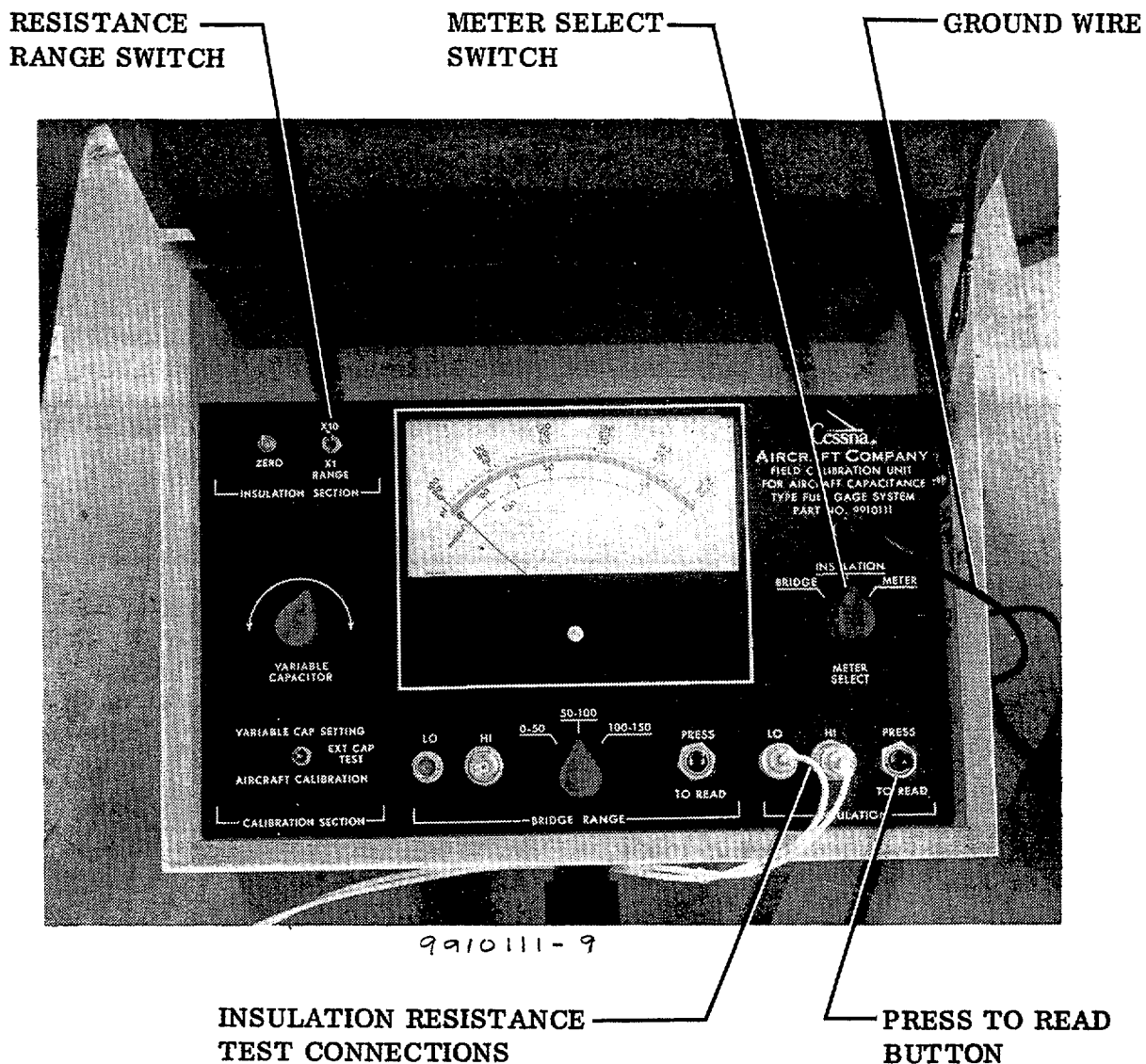


Figure 1. Measuring Insulation Resistance

NOTE

The insulation resistance values noted on Table I are the minimum acceptable values. Normally a new system will indicate infinite resistance.

TEST BOX SETTING (See Figure 1).

1. Turn "Meter Select" to "Insulation."
2. Connect test leads to test box "Insulation Section."
3. See Table I, for resistance value and select appropriate resistance range (1X or 10X).
4. Short the test leads together and press "Press to Read" insulation button. The resistance reading should be zero. If the meter is not zeroed, adjust the "Zero Adjust" to zero on the meter (Zero Adjust is located in upper LH corner of test box).
5. DO NOT ATTACH GROUND JUMPER FROM TEST BOX GROUND TO AIRFRAME GROUND for resistance testing.
6. Remove connector from Signal Conditioner and attach HiZ Lead (Red) to HiZ pin in the wire bundle connector and attach LoZ Lead (Black) to LoZ pin in the wire bundle connector.
7. Press insulation "Press to Read" button and read insulation resistance on megohm scale on meter. See Table I, for minimum acceptable resistance value (HiZ to LoZ).
8. Remove LoZ Lead (Black) from LoZ pin and connect to the shielding pin of connector. Press the "Press to Read" button and read insulation resistance from HiZ to shield. See Table I, for minimum acceptable resistance value (HiZ to shield).

TABLE I

IN CIRCUIT RESISTANCE VALUE IN MEGOHMS			
Connections for Left and Right Main and Auxiliary* Tanks	210	401B0001 thru B0300	310Q0001 & On, 310R0001 & On
	337	402B0001 thru B0300	340-0001 & On, 340A0001 & On
		414-0001 thru -0350	402B0301 & On, 402C0001 & On
			414-0351 & On, 414A0001 & On 421B0001 & On, 421C0001 & On 404-0001 & On
Shield to Structure Ground	1000	0	1000
HiZ to LoZ	1000	1500	1000
HiZ to Shield	1000	100	1000
LoZ to Shield	1000	100	1000
HiZ to Structure Ground	1000	100	1000
LoZ to Structure Ground	1000	100	1000

9. Return LoZ Lead (Black) to LoZ Pin of connector and move HiZ Lead (Red) from HiZ Pin of connector to the shielding pin of connector. Press the "Press to Read" button and read insulation resistance from LoZ to shield. See Table I, for Minimum acceptable resistance value (LoZ to shield).

*Auxiliary tanks are not applicable to Models 402C, 404, 414A and 421C.

10. Remove HiZ Lead (Red) from shielding pin and using alligator clip, connect to structure ground. Press the "Press to Read" button and read insulation resistance from LoZ to structure ground. See Table I, for minimum acceptable resistance value (LoZ to Structure Ground).

11. Move LoZ Lead (Black) from LoZ Pin to HiZ Pin of connector. Press the "Press to Read" button and read insulation resistance from HiZ to structure ground. See Table I, for minimum acceptable resistance value (HiZ to Structure Ground).

12. Remove HiZ Lead (Red) from HiZ Pin and connect to shield pin of connector. Press the "Press to Read" button and read insulation resistance from Shield to Structure Ground. See Table I, for minimum acceptable resistance value (Shield to Structure Ground).

TO MEASURE CAPACITANCE (See Figure 2).

Capacitance of individual probes or the complete system should be measured to verify that the capacitance values are within the specified limits per Table III (Page 16).

1. Turn "Meter Select" to "Bridge."
2. Switch "Calibration Section" switch to "Ext Cap Test" position.
3. Turn "Bridge Range" switch to the appropriate range.
4. Connect the individual test leads (provided with Test Box) to the Test Box - Bridge Range Connectors (Red Lead to "Hi," Black Lead to "Lo" and jumper to ground).

The Test Box is now ready to measure the capacitance of either the individual probe or any other system capacitance.

To measure the system capacitance with the test leads, the signal conditioner connector must be disconnected and the appropriate wiring diagram in the aircraft service manual must be used to determine the proper pins in the wire bundle connector for HiZ, LoZ Main, LoZ Aux and Shield for HiZ. The appropriate Test Harness (Page 33) should be used for measuring the system capacitance more accurately.

To measure the individual probe and cable assembly capacitance, the individual probe connectors must be removed from the wire bundle and disconnected thereby exposing the HiZ, LoZ and Shield pins of the probe wires.

1. Connect the HiZ Lead (Red) to the HiZ pin, the LoZ Lead (Black) to the LoZ Pin and connect the jumper from the ground pin on the Test Box to the shield pin and Airframe Ground.
2. Press the "Press to Read" button on the Test Box and read the capacitance on the 0-50 pf scale. If the needle overruns the end of the 0-50 pf scale, turn the "Bridge Range" switch to the to-100 pf scale or then to the 100-150 pf scale and read the capacitance by pressing the "Press to Read" button.

To measure capacitance of certain aircraft main and auxiliary systems, it is necessary to use the correct harness assembly that will connect into the signal conditioner connector. Refer to the appropriate wiring diagram in the aircraft service manual to determine the necessity of switching the fuel select valve to the appropriate position for measuring capacitance of the Main and Aux Systems at the signal conditioner connector.

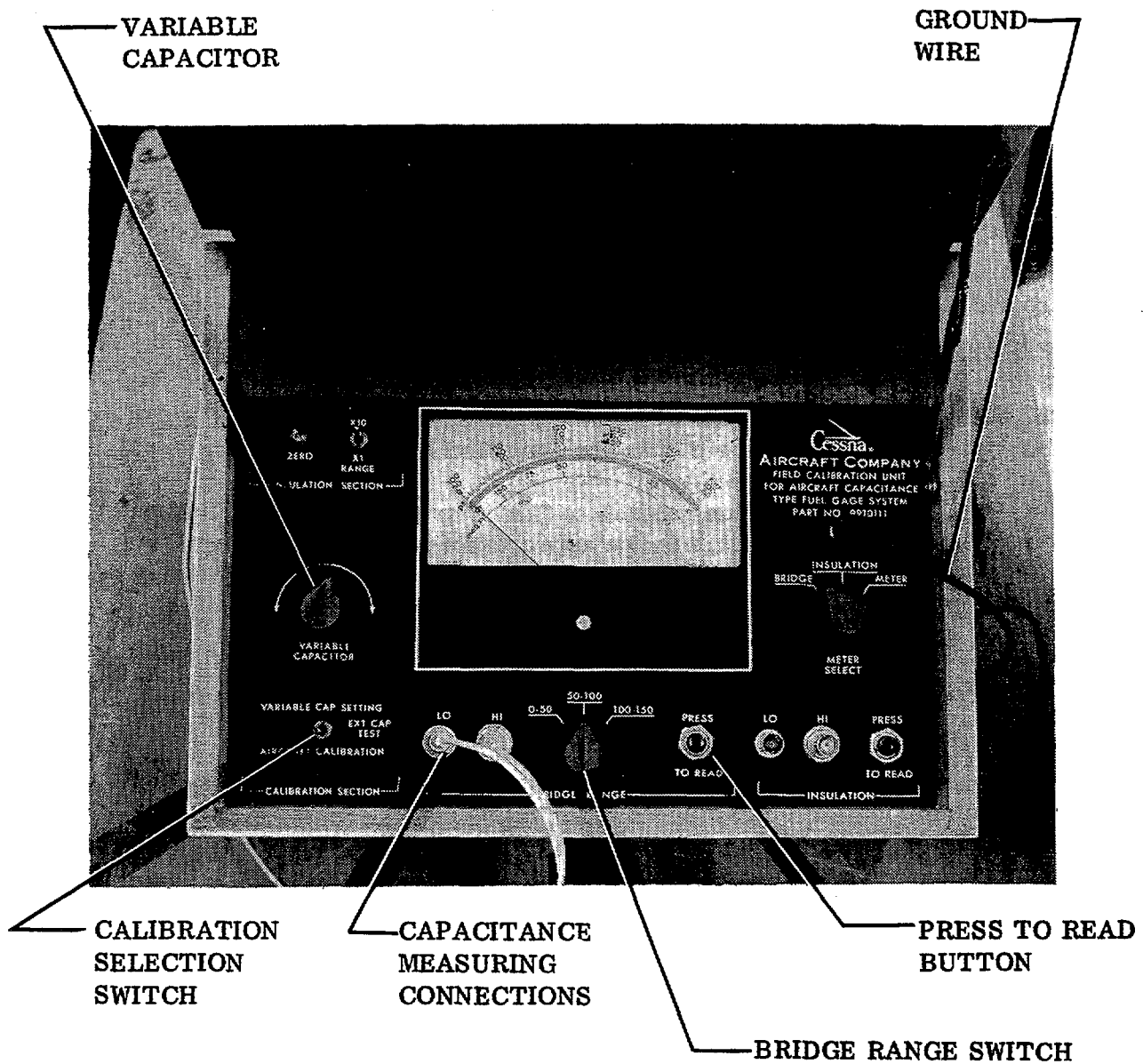


Figure 2. Measuring Capacitance

NOTE

The harness assembly must be connected to the aircraft fuel quantity system wire bundle plug and must be disconnected from the signal conditioner to measure system capacitance.

TO SUBSTITUTE CAPACITANCE.

Capacitance substitutions are fed into the main or auxiliary system to simulate a particular probe capacitance or to simulate a particular value for a full fuel indication. The appropriate harness assembly should be used for substituting capacitance into the system.

TEST BOX SETTING (See Figure 2).

1. Turn "Meter Select" switch to "Bridge."
2. Switch "Calibration Section" switch to "Variable Cap Setting" position.
3. Turn "Bridge Range" switch to desired range for the substitution capacitance value.
4. Press "Press to Read" button and turn "Variable Capacitor" knob to desired capacitance on meter scale. (Reading will stabilize in approximately 5 to 10 seconds.)
5. Disconnect the signal conditioner connector.
6. Connect the appropriate harness assembly to the wire bundle plug and to signal conditioner.
7. Connect appropriate HiZ and LoZ Leads of the harness assembly to the Test Box.
8. Attach ground jumper from Test Box Ground to Airframe ground and insure there is a good ground.
9. Before you go further recheck the capacitance setting.
10. Switch "Calibration Section" switch to "Aircraft Calibration" position.

If the substitution capacitance is used for full fuel indication, both harness connectors should be connected; one to signal conditioner and the other to the wire bundle plug. If the substitution capacitance is used for empty indication (wet calibration), both harness connectors should be connected and the probes disconnected at the main and auxiliary tank disconnects.

TO TEST THE INDICATOR AND SIGNAL CONDITIONER.

To troubleshoot a fuel gauging system that will not respond to a normal calibration, it is sometimes necessary to check the indicator and signal conditioner to insure that they are functioning properly.

The Test Box has been equipped with a test function for measuring the output of the signal conditioner and the input requirements of the indicator.

NOTE

Test harnesses to accomplish testing of the indicator and signal conditioner have not been furnished with the test box. The harnesses to accomplish the testing can be fabricated from standard shop wire without difficulty. Reference Figure 3 and Figure 4 for wiring. Use 20 or 22 gauge wire for fabricating harness. HiZ Leads must be shielded wire.

CAUTION

Do not press "Press to Read" button in insulation section when the test box is connected per Figure 3 or 4. This may cause damage to the indicator or signal conditioner.

TEST BOX SETTING (See Figure 3).

1. Turn "Meter Select" to "Meter" position.
2. Connect test leads to the test box - insulation plugs Hi and Lo. ("Red" to Hi, "Black" to Lo).

The Test Box Meter may now be used as a full scale 1000 microampere meter. The following conversion chart is used to convert 0 to 50 pf scale to 0 to 1000 microamperes:

Pf	uA
0	0
10	200
20	400
30	600
40	800
50	1000

Conversion formula: MICROAMPERES = 20.00 X (pf reading)

INDICATOR TEST.

To test the Indicator, a check of the milliampere input versus indication in pounds should be made. The following test setup may be used per the schematic on Figure 3.

1. Connect the Test Box to the Indicator and the 1 milliamp Power Supply per the schematic shown on Figure 3.
2. Vary the input to the indicator smoothly and slowly from zero to full scale and back to zero. There shall be no observable pointer stickiness.

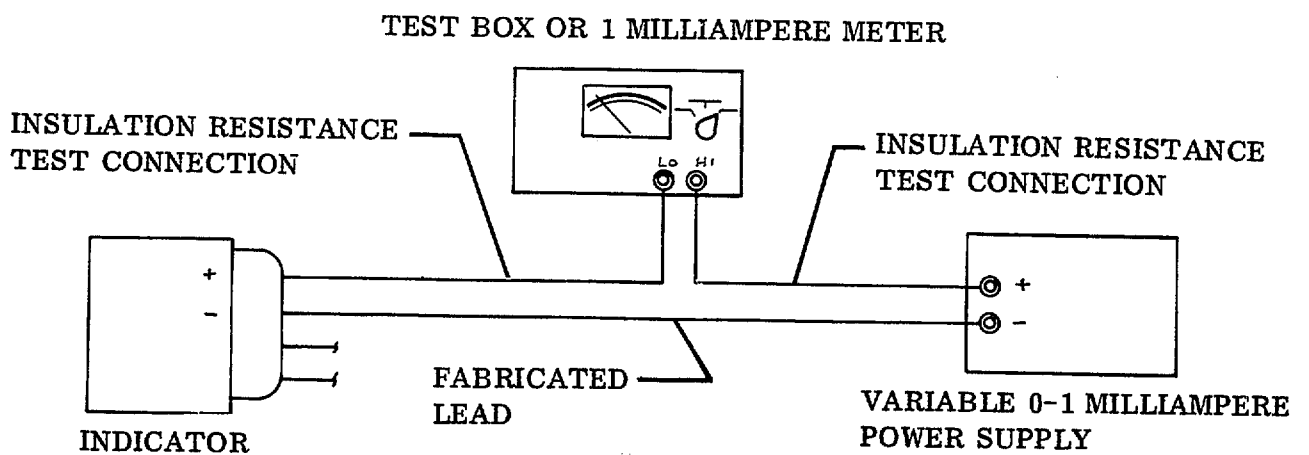


Figure 3. Checking Indicator

Vary the input and record the microampere input required for indicator readings 0, 50, 100, 150, 200, 250, 300 and 310 pounds.

NOTE

Always tap the indicator before taking a reading to overcome any damping effect of the indicator.

4. Refer to Table II, to compare the results of pounds indication versus microamperes input. The indicator should fall within the ± 20 microamperes of the nominal.

SIGNAL CONDITIONER TEST (See Figure 4).

To test the Signal Conditioner, a harness assembly must be fabricated per the schematic shown in Figure 4.

1. Connect Signal Conditioner to Test Box with the fabricated test harness as shown on Figure 4.
2. Turn "Meter Select" to "Bridge."
3. Turn "Bridge Range" to desired range (0-50, 0-100 or 0-150). See Table II for capacitance values.
4. Switch "Calibration Section" switch to "Variable Cap Setting" position.
5. Press "Press to Read" button in Bridge Range and adjust "Variable Capacitor" to desired capacitance reading on scale.
6. Switch "Calibration Section" switch to "Aircraft Calibration" position.
7. Turn "Meter Select" to "Meter."
8. Obtain pf reading from 0-50 pf scale and convert to MICROAMPERES using the conversion chart.

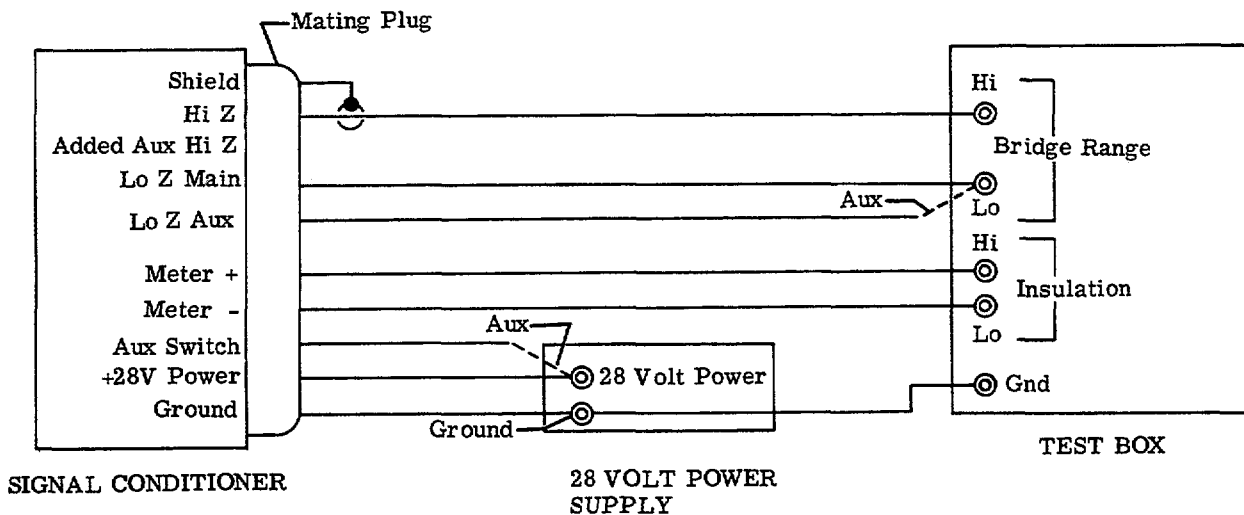


Figure 4. Checking Signal Conditioner

TABLE II
INDICATOR AND SIGNAL CONDITIONER TESTING

PF Fed into Signal Conditioner After Adjusting Empty & Full at Increment Shown	Indicator Reading (Pounds)	Microamperes Nominal (+ 20 uA) for Checking Indicators and Signal Conditioners	NOTE Values on this Table are for Indicator and Signal Conditioner Testing only and are not Necessarily Calibration Setting Values.
(Set Empty) 35.0 pf	0	34	421B0301 To 421C0001 414-0351 To 414A0001 402B0301 & On 335-0001 & On 340-0151 & On, 340A0001 & On 310Q060a & On, 310R0001 & On
40.6	50	157	
46.2	100	279	
51.9	150	402	
57.6	200	524	
63.2	250	647	
68.9	300	770	
(Set Full) 70.0 pf	310	795	
(Set Empty) 61.29 pf	0	34	402C0001 & On 414A0001 & On 421C0001 & On
70.45	100	153	
79.61	200	273	
88.77	300	392	
97.93	400	511	
107.09	500	636	
116.25	600		
(Set Full) 117.15 pf	620	774	
(Set Empty) 47.12 pf	0	34	404-0001 & On
56.78	200	165	
64.96	400	296	
71.50	550	394	
77.23	700	492	
85.41	900	623	
(Set Full) 93.63 pf	1100	754	
(Set Empty) 50.0 pf	0	27	401B0001 thru 401B0300 402B0001 thru 402B0300 414-0001 thru 414-0350
57.3	50	184	
64.5	100	341	
71.8	150	497	
79.0	200	654	
86.3	250	811	
93.5	300	968	
(Set Full) 95.0 pf	310	1000	
(Set Empty) 35.0 pf	0	47	421B0001 thru 421B0300 340-0001 thru 340-0150
40.6	50	214	
46.2	100	381	
51.9	150	548	
57.6	200	716	
(Set at 250#) 63.2	250	883	
68.9	300	1050	
70.0 pf	310	1083	
(Set Empty) 38.0 pf	0		310Q0001 thru 310Q0600
43.5	50		
49.0	100		
54.5	150		
60.0	200		
(Set Full) 71.0 pf	300		

TABLE II (CONTINUED)
INDICATOR AND SIGNAL CONDITIONER TESTING

PF Fed into Signal Conditioner After Adjusting Empty & Full at Increment Shown	Indicator Reading (Pounds)	Microamperes Nominal (+ 20 uA) for Checking Indicators and Signal Conditioners	NOTE Values on this Table are for Indicator and Signal Conditioner Testing only and are not Necessarily Calibration Setting Values.
(Set Empty) 40.0 pf	0 gal	50	P337-0001 Thru P337-0194 337-01528 Thru 337-1607
45.5	10	213	
51.1	20	375	
56.6	30	538	
62.1	40	700	
(Set at 50 gal) 67.6	50	863	P337-0194 & On 337-1607 & On Long Range Tanks
(Set Empty) 41.8 pf	0 gal	105	
47.0	10	260	
53.0	20	435	
56.2	30	530	
59.3	40	620	
63.3	50	735	
66.2	60	825	
71.3	70	970	
(Set Full) 74.2	74	1055	
(Set Empty) 40.0 pf	0 gal	50	337-01195 Thru 337-01528
47.4	10	267	
54.8	20	485	
62.2	30	702	
(Set at 40 gal) 74.0 pf	46	1050	210-59200 Thru 210-62273
(Set Empty) 54.0 pf	0 gal	50	
64.9	10	272	
75.8	20	494	
86.7	30	717	
(Set at 40 gal) 103.0 pf	45	1050	

The Signal Conditioner Test is used only as a functional test for troubleshooting and is not intended to be used for determining the accuracy of the output of the signal conditioner.

The functional test may be used to determine that the potentiometers for Main Empty, Aux Empty and Main Full adjustments are operating smoothly.

Refer to Table II for information on input capacitance versus output microamperes for the Signal Conditioner.

Refer to the applicable service manual wiring diagram to determine an adequate schematic to fabricate a harness assembly.

CALIBRATION PROCEDURE.

Dry calibration, utilizing the capacitance fuel system test box, provides the only accurate method of adjusting the fuel quantity indicator.

Dry calibration uses the actual tank units for zero calibration, this takes into account the tank sensor unit and wiring harness tolerances. A fixed capacitance is added in parallel with the actual dry tank unit to represent the fuel in the tank for calibration to the full condition.

CAUTION

During all defueling and tank calibrations, the airplane must be located a safe distance from other airplanes and buildings. Fire fighting equipment must be available. Two ground wires from different points on the airplane to separate grounding stakes shall be used to prevent accidental disconnecting of one grounding wire. Refer to aircraft service manual for defueling procedure.

NOTE

Always tap the indicator when reading, this will help overcome friction of the needle when the indicator is in a static condition.

DRY CALIBRATION.

Models 402C, 404, 414A and 421C

Serial Effectivity: 402C0001 & On
404-0001 & On
414A-0001 & On
421C0001 & On

System Preparation for Calibration.

1. Defuel airplane in accordance with the applicable Service Manual.
2. Drain the remaining fuel from each tank by removing the drain valves from the bottom side of the fuel sump.
3. Remove the signal conditioner access panel located on the underside of the wing just outboard of the main gear.

NOTE

The fuel quantity indicator visually displays fuel quantity for each wing separately. Therefore, calibration is accomplished on each wing individually.

Dry Tank Calibration.

NOTE

Use 5190508-7 Test Harness for 421C0001 Thru 421C0113
Airplanes.

1. Interconnect 5190508-9 Test Harness as shown in Figure 1A. Measure and record the empty capacitance of the fuel level sensing unit. Reading should be 61.29 \pm 1.5 pf (402C, 414A, 421C) or 47.12 \pm 1.5 pf (404).

2. Using the test box as a resistance meter, measure and record insulation resistance on the main tanks. They should be as noted on Table I.

3. Make capacitance measurements on MAIN tank circuits. Net gain capacitance on the circuit and probe combination should not exceed 2.00 pf of that of the probes noted on Table III. The 2.00 pf allowance is for additional capacitance induced by the system wiring.

NOTE

Any discrepancies found should be checked out completely and corrected before proceeding further with the calibration procedures.

4. Disconnect test harness from the airplane harness and connect P1 of the test harness to the signal conditioner as shown in Figure 1B.

5. Set the capacitance decade section of the test box to 62.19 \pm 1.5 pf (402C, 414A, and 421C) or 48.2 \pm 1.5 pf (404). This includes .90 pf to account for the 3.7 gallons of unusable fuel.

6. Apply electrical power to the airplane system. If airplane battery is used, assure battery voltage is 22 volts or greater.

7. Adjust the empty Adjust Potentiometer "E" of the signal conditioner so that the corresponding fuel quantity indicator reads exactly zero pounds.

NOTE

Tap the indicator slightly when reading the indicator. This will help overcome the friction of the needle when the indicator is in a static condition.

8. Interconnect the test harness with the fuel level sensing unit and the signal conditioner as shown in Figure 2.

9. Reset capacitance substitution decade section of the test box to read 55.86 pf (402C, 414A, 421C) or 45.03 pf (404) for 100 grade (formerly 100/130) fuel calibration and 57.10 pf (402C, 414A, 421C) or 46.20 pf (404) when calibrating for 100 octane low lead fuel.

Added capacitance 55.86 pf = 620 pounds 402C/414A/421C 100/130 Octane Fuel
57.10 pf = 620 pounds 402C/414A/421C 100 Octane Low-Lead Fuel
Added capacitance 44.03 pf = 1100 pounds 404 100/130 Octane Fuel
46.20 pf = 1100 pounds 404 100 Octane Low-Lead Fuel

10. Adjust the signal conditioner full Adjust Potentiometer "F" so that the corresponding fuel quantity indicator reads 620 lbs. (402C, 414A, 421C) or 1100 lbs. (404).

NOTE

Tap indicator when reading the indicator.

11. Recheck zero indication per Steps 5, 6, and 7.

NOTE

If the zero indication has changed, readjust zero and full indication until no change is evident by the adjustment setting of the other.

12. Turn electrical power off and remove test harness and tester.

13. Repeat procedure for opposite main tank.

14. Reconnect airplane wiring and reinstall access panels.

Models 310Q, 310R, 335, 340, 340A, 402B, 414 and 421B

Serial Effectivity:

310Q0601 & On	4140351 To 414A0001
310R0001 & On	421B0301 To 421C0001
335-0001 & On	
340-0151 & On	
340A0001 & On	
402B0301 & On	

System Preparation for Calibration.

1. Defuel airplane in accordance with the applicable service manual.
2. Check insulation breakdown resistance on LH and RH Aux and Main circuits; they should be as noted on Table I.
3. Interconnect test box into circuit as shown on Figure 5 using the 9910111-11 harness assembly.
4. Make capacitance measurements on LH and RH main and auxiliary circuits. Net gain capacitance on the circuit and probe combinations should not exceed 2.00 pf of that of the probes noted on Table III. The 2.00 pf allowance is for additional capacitance induced by the system wiring.

NOTE

Any discrepancies found in Steps 2 and 4 should be checked out completely and corrected before proceeding further with the calibration.

5. Restore the circuits to original configuration.

Dry Tank Calibration.

1. Apply airplane power and assure battery is adequately charged; voltage should never be less than 22 volts when calibrating.
2. Place fuel selector valve to "Main" position and adjust the signal conditioner "Main Empty" potentiometer to read exact "Zero" pounds on the indicator.
3. Place the fuel selector valve to "Aux" position and adjust the signal conditioner "Aux Empty" potentiometer to read exact zero pounds on the indicator.

NOTE

Slight tapping on the indicator may be required to overcome friction when meter is in static condition.

4. Place fuel selector valve to "Main" position and interconnect test box using 9910111-11 harness assembly and adjust variable capacitance for added capacitance value of 32.64 pf in parallel with dry tank unit.

Added Capacitance 32.64 pf = 50 gallon 100/130 Octane Fuel
Added Capacitance 35.25 pf = 310 pounds indication 100 Octane Low-Lead Fuel

- 5 Adjust signal conditioner "Main Full" potentiometer to read 50 gallons on the indicator. Tap indicator slightly to insure that pointer has stabilized in final position.
6. Disconnect Test Box and 9910111-11 harness assembly and restore circuit to original configuration.
7. With airplane power on and fuel selector valve in "Main" position, check main empty for any shift. It may be necessary to readjust main and auxiliary potentiometers, by switching back and forth to "Main" and "Aux" positions respectively, until no deviation in zero reading is noticed.
8. Recheck "Main Full" per steps 4 and 5. If calibration has changed, readjust "Full Main" until a "full" indication without a change in both main and auxiliary zero indication is obtained.
9. Repeat Steps 1 through 8 for opposite side.
10. After both LH and RH sides have been restored to original configuration, select Aux tanks by actuating the override switch located below the fuel quantity indicator on the instrument panel and verify that Aux zero corresponds to that of the main.

Models 340 and 421B

Serial Effectivity:

340-0001 thru 340-0150
 421B0001 thru 421B0300

System Preparation for Calibration.

1. Defuel airplane in accordance with the applicable service manual.
2. Check insulation breakdown resistance on LH and RH Aux and Main circuits; they should be as noted on Table I.

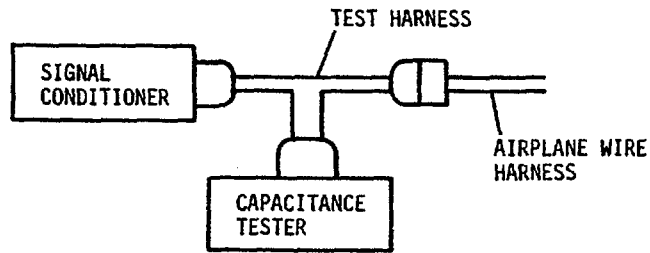
3. Interconnect Test Box into circuit as shown on Figure 5 using either 9910111-7 or 9910111-11 Harness Assembly. Either harness assembly may be used for these serials because the pin locations in the signal conditioner plug are compatible for proper calibration.

4. Make capacitance measurements on LH and RH main and auxiliary circuits. Net gain capacitance on the circuit and probe combinations should not exceed 2.00 pf of that of the probes noted on Table III. The 2.00 pf allowance is for additional capacitance induced by the system wiring.

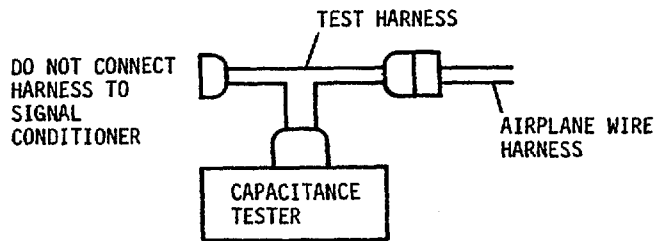
NOTE

Any discrepancies found in steps 2 and 4, should be checked out completely and corrected before proceeding further with the calibration.

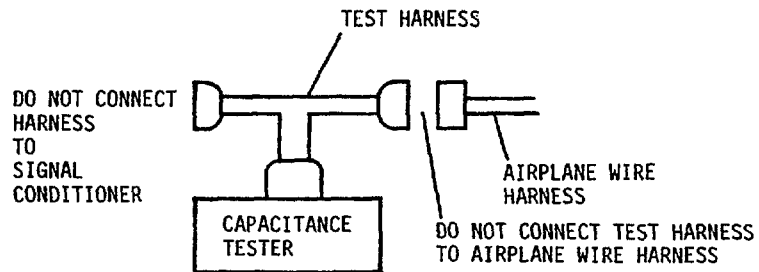
5. Restore the circuits to original configuration.



FUEL QUANTITY CAPACITANCE TEST



EMPTY CAPACITANCE TEST



INSULATION RESISTANCE TEST

5198013

Figure 5. Harness and Test Box Interconnection

TABLE III

Airplane Serialization	Main Tank Unit	CAPACITANCE VALUES					Dry Calibration Values	
		Inboard	Auxiliary Middle	Tank Units Outboard	Total	Added Capacitance	Full Indicator Setting	
402C0001 & On		22.65±0.5	22.22±0.5	14.42±0.5	61.29±1.5	**57.10 pf	620 lbs.	
414A0001 & On		22.65±0.5	22.22±0.5	14.42±0.5	61.29±1.5	**57.10 pf	620 lbs.	
421C0001 & On		22.65±0.5	22.22±0.5	14.42±0.5	61.29±1.5	**57.10 pf	620 lbs.	
421B0301 & On	*35.00±0.5	15.52±0.5	11.63±0.5	7.55±0.5	34.70±1.5	32.64 pf	50 gal.	
414-0351 To 414A0001	*35.00±0.5	13.68±0.5	2.62±0.5	7.55±0.5	23.85±1.5	32.64 pf	50 gal.	
402B0301 & On						35.25 pf	**310 lbs. indication	
340-0151 & On								
340A0001 & On								
335-0001 & On								
310Q0601 & On								
310R0001 & On								
421B0001 thru B0300	*35.00±0.5	15.52±0.5	11.63±0.5	7.55±0.5	34.70±1.5	32.21 pf	310 lbs.	
414-0001 thru -0350	49.50±0.5	20.80±0.5			20.80±0.5	44.50 pf	310 lbs.	
402B0001 thru B0300								
401B0001 thru B0300								
404-0001 & On		16.85±0.5	18.83±0.5	9.44±0.5	47.12±1.5	45.03 pf	1100 lbs.	
340-0001 thru -0150	*37.04±0.5	15.18±0.5			15.18±0.5	**46.20 pf	50 gal.	
310Q0001 thru Q0600	37.04±0.5	15.18±0.5			15.18±0.5	32.65 pf	300 lbs.	
P337-0001 thru -0193								
& 337-01528 thru	Inboard	21.71±0.5				34.30 pf	61.5 gal.	
01606 Long Range	Outboard	17.69±0.5						
Long Range Opt								
337-01195 thru		21.71±0.5				34.30 pf	46 gal.	
337-01606 Std								
P337-0194 & On		21.71±0.5				34.30 pf	74 gal. usable	
Long Range &								
337-01672 & On								
Long Range Opt								
337-01607 & On Std								
337-01195 thru	Aux Opt	16.82±0.5			16.82±0.5	17.20 pf	18 gal.	
-01527								
210-59200 thru								
-62273		28.75±0.5				45.0 pf	40 gal.	

*2.00 pf Allowance for Additional System Wiring Capacitance on Main & Auxiliary Systems.

**When 100 Octane Low-Lead Fuel Is Used.

Dry Tank Calibration.

1. Apply airplane power and assure battery is adequately charged; voltage should never be less than 22 volts when calibrating.
2. Place fuel selector valve to "Main" position and adjust the signal conditioner "Main Empty" potentiometer to read exact zero pounds on the indicator.
3. Place fuel selector valve to "Main" position and adjust the signal conditioner "Aux Empty" potentiometer to read exact zero pounds on the indicator.

NOTE

Slight tapping of the indicator may be required to overcome friction when meter is in static condition.

4. Place fuel selector valve to "Main" position and interconnect Test Box using 9910111-7 or 9910111-11 Harness Assembly and adjust variable capacitance for added capacitance value of:

Added Capacitance 31.62 pf = 50 gallons 340

Added Capacitance 33.21 pf = 310 pounds 421B

5. Adjust signal conditioner "Main Full" potentiometer to read 50 gallons (340) or 310 pounds (421B) on the indicator. Tap indicator slightly to insure that pointer has stabilized in final position.
6. Disconnect test box and harness assembly and restore circuit to original configuration.
7. With airplane power on and fuel selector valve in "Main" position, check main empty for any shift. It may be necessary to readjust main and auxiliary empty potentiometer by switching back and forth to "Main" and "Aux" positions respectively until no deviation in zero reading is noticed.
8. Recheck "Main Full" per steps 4 and 5. If calibration has changed, readjust "Full Main" until a "full" indication without a change in both main and auxiliary zero indication is obtained.

9. Repeat steps 1 through 8 for opposite side.
10. After both LH and RH sides have been restored to original configuration, select auxiliary tanks by actuating the override switch located below the indicator on the instrument panel and verify that auxiliary zero corresponds to that of the main.

Models 401B, 402B and 414

Serial Effectivity:

- 401B0001 thru 401B0300
- 402B0001 thru 402B0300
- 414-0001 thru 414-0350

System Preparation for Calibration.

1. Defuel aircraft in accordance with applicable service manual.
2. Check insulation breakdown resistance on LH and RH Aux and Main circuits; they should be as noted on Table I.
3. Interconnect Test Box into circuit as shown on Figure 5, using 9910111-4 harness assembly.
4. Make capacitance measurements on LH and RH main and auxiliary circuits. Net gain capacitance on the circuit and probe combination should not exceed 1.00 of that of the probe noted on Table III. The 1.00 pf allowance is for additional capacitance induced by the system wiring.

NOTE

Any discrepancies found in steps 2 and 4 should be checked out completely and corrected before proceeding further with the calibration.

Dry Tank Calibration.

1. Apply aircraft power and assure battery is adequately charged; voltage should never be less than 22 volts when calibrating.
2. Place fuel selector valve to "Main" position.
3. Adjust signal conditioner "Main Empty" potentiometer to read exact zero pounds on the indicator.

NOTE

Slight tapping of the indicator may be required to overcome friction when meter is in static condition.

4. Adjust variable capacitance for added capacitance value of 44.5 pf in parallel with actual dry tank unit.

Added Capacitance 44.5 pf - 310 pounds

5. Adjust signal conditioner "Main Full" potentiometer to read 310 pounds on the indicator. Tap indicator slightly to insure that pointer has stabilized in final position.
6. Disconnect Test Box and 9910111-4 harness assembly and restore circuit to original configuration.

NOTE

On this system "Aux Zero" is automatically adjusted when "Main Empty" is adjusted. "Aux Zero" can be + 9.30 pounds off from zero.

7. Recheck "Main Empty." If calibration has changed, readjust "Main Empty" and "Full" until a "full" indication without a change in "Zero" indication is obtained.
8. Repeat steps 1 through 7, for opposite side.
9. After both LH and RH sides have been restored to original configuration, select auxiliary tanks by actuating the override switch located below the fuel quantity indicator on the instrument panel and verify that auxiliary zero corresponds to that of the main within + 9.3 pounds.

Model 310Q

Serial Effectivity:

310Q0001 thru 310Q0600

NOTE

On these affected Model 310Q's, the signal conditioner is a part of and located in the aft portion of the fuel quantity indicator.

System Preparation for Calibration.

1. Defuel aircraft in accordance with the applicable service manual.
2. Check insulation breakdown resistance on LH and RH Aux and Main circuits; they should be as noted on Table I.
3. Interconnect Test Box into circuit on backside of indicator using 9910111-6 harness assembly.
4. Make capacitance measurements on LH and RH main and auxiliary circuits. Net gain capacitance on the circuit and probe combination should not exceed 1.50 pf of that of the probe noted on Table III. The 1.50 pf allowance is for additional capacitance induced by the system wiring.

NOTE

Any discrepancies found in steps 2 and 4, should be checked out completely and corrected before proceeding further with the calibration.

5. Restore the circuits to original configuration.

Dry Tank Calibration.

1. Apply aircraft power and assure battery is adequately charged; voltage should never be less than 22 volts.
2. Place fuel selector valve to "Main" position and adjust indicator "Main Empty Adjust" to read exact zero pounds on the indicator.
3. Place fuel selector valve to "Aux" position and adjust indicator "Aux Empty Adjust" to read exact zero pounds on the indicator.

NOTE

Slight tapping of indicator may be required to overcome friction when meter is in static condition.

4. Interconnect Test Box using 9910111-6 harness assembly and adjust variable capacitance for added capacitance value of 32.65 pf in parallel with actual dry tank unit.

Added Capacitance 32.65 pf = 300 pounds

5. Indicator should read 300 ± 6 pounds. If necessary, remove rear nameplate and adjust "Left" or "Right" "Full Adjust" for 300 pounds. Tap indicator slightly to insure that pointer has stabilized in final configuration.
6. Disconnect Test Box and 9910111-6 harness assembly and restore circuit to original configuration.
7. With aircraft power on and fuel selector valve in "Main" position, check "Main Empty" for any shift. It may be necessary to readjust "Main" and "Aux Empty" potentiometers by switching back and forth to "Main" and "Aux" positions respectively until no deviation in zero reading is noticed.
8. Recheck "Main Full" per steps 4 and 5. If calibration has changed, readjust "Full Main" until a "full" indication 300 pounds without a change in both main and auxiliary zero indication is obtained.
9. Repeat steps 1 through 8, for opposite side.
10. After both LH and RH sides have been restored to original configuration select auxiliary tank by actuating the override switch located below the fuel quantity indicator on the instrument panel and verify that auxiliary zero corresponds to that of the main.

Model 337

Serial Effectivity:

- 337-01195 thru 337-01671 (Std) 46 gals.
- 337-01195 thru 337-01527 (Aux-Opt) 18 gals.
- 337-01528 thru 337-01606 (Long Range Opt) 61.5 gals.
- 337-01607 and On (Std) 44 gals.
- 337-01672 and On (Long Range Opt) 74 gals.
- P337-0001 thru P337-00193 (Long Range Std) 61.5 gals.
- P337-00194 and On (Long Range Std) 74 gals.

System Preparation for Calibration.

1. Defuel aircraft in accordance with applicable service manual.
2. Check insulation breakdown resistance on LH and RH main and auxiliary circuits; they should be noted on Table I.
3. Interconnect Test Box into circuit as shown on Figure 5 using 9910111-5 harness assembly.
4. Make capacitance measurements on LH and RH main and auxiliary circuits. Net gain capacitance on the circuit and probe combination should not exceed 1.00 pf of that of the probes noted on Table III. The 1.00 allowance is for additional capacitance induced by system wiring.

NOTE

Any discrepancies found in steps 2 and 4 should be checked out completely and corrected before proceeding further with the calibration.

5. Restore the circuits to original configuration.

Dry Tank Calibration.

1. Apply aircraft power and assure battery is adequately charged; voltage should never be less than 22 volts when calibrating.
2. Place fuel selector to "Main" position.
3. Adjust "Main" signal conditioner LH and RH potentiometers to exact "Zero" indication LH and RH.

NOTE

Slight tapping of the indicator may be required to overcome friction when meter is in static condition.

4. Interconnect Test Box using 9910111-5 harness assembly and adjust variable capacitance for added capacitance value of 34.30 pf in parallel with actual dry tank unit. (Add capacitance to LH and RH side separately.)

Added Capacitance 34.30 pf = 46 gallons (Standard)

Added Capacitance 34.30 pf = 44 gallons (Standard)

Added Capacitance 34.30 pf = 61.5 gallons (Long Range)

Added Capacitance 34.30 pf = 74.0 gallons (Long Range Std)

5. Adjust "Main" signal conditioner "full" potentiometer to "full indication" on the indicator. Tap indicator slightly to insure that pointer has stabilized in final position. (Adjust LH and RH side separately.)

6. Disconnect Test Box and 9910111-5 harness assembly and restore circuit to original configuration.

7. Recheck for exact "Zero" indication and readjust "Main" signal conditioner "Empty" potentiometer if necessary.

8. Recheck full indication per steps 4 and 5. If calibration has changed, readjust "Full" potentiometer until a full indication (46 gallons of 61.5 gallons)/(44 gallons of 74.0 gallons) without a change in zero indication is obtained. (Adjust LH and RH sides separately.)

9. Disconnect Test Box and Harness Assembly and restore circuit to original configuration.

Dry Tank Calibration (Auxiliary) (Optional).

Serial Effectivity:

337-01195 thru 337-01527 with Auxiliary Optional

This procedure is to be used after the "Main Tank" calibration is completed and used only with aircraft having the auxiliary fuel tank option.

1. Place fuel selector to "Aux" position.
2. Adjust "Aux" signal conditioner LH and RH potentiometers to exact "Zero" indication.

NOTE

Slight tapping of indicator may be required to overcome friction when meter is in the static condition.

3. Interconnect Test Box using 9910111-5 harness assembly and adjust variable capacitance for a capacitance value of 17.20 pf in parallel with actual dry tank unit. (Adjust LH and RH sides separately.)

Added Capacitance 17.20 pf = 18 gallons (Optional) (Auxiliary)

4. Adjust "Aux" signal conditioner "full" potentiometer to "18 gallons" on the indicator. Tap indicator slightly to insure that pointer has stabilized in final position. (Adjust LH and RH sides separately.)

5. Disconnect Test Box and 9910111-5 harness assembly and restore to original configuration.

6. Recheck for exact "Zero" indication and readjust "Aux" signal conditioner

"Empty" potentiometer if necessary.

7. Recheck full indication per steps 3 and 4. If calibration has changed, readjust "full" potentiometer until a full indication (18 gallons) without a change in "Zero" indication is obtained. (Adjust LH and RH sides separately.)

8. Disconnect Test Box and Harness Assembly and restore circuit to original configuration.

Model 210

Serial Effectivity:

210-59200 thru 210-62273

Circuit Checkout.

1. Defuel aircraft in accordance with the applicable service manual.
2. Check insulation breakdown resistance on LH and RH main circuits; they should be noted on Table I.
3. Interconnect Test Box into circuit as shown on Figure 5 using 9910000-5 harness assembly.
4. Make capacitance measurements on LH and RH main circuits. Net gain capacitance on the circuit and probe combination should not exceed 0.75 pf of that of the probe noted on Table III. The .75 pf allowance is for additional capacitance induced by the system wiring.

NOTE

Any discrepancies found in steps 2 and 4 should be checked out completely and corrected before proceeding further with the calibration.

5. Restore circuit to original configuration.

Dry Tank Calibration.

1. Apply aircraft power and assure battery is adequately charged; voltage should not be less than 11.5 volts when calibrating (11.5 volts 210-59200 thru 210-59502; 22 volts 210-59503 thru 210-62273).
2. Adjust signal conditioner "Empty" potentiometer to exact zero pounds indication.

NOTE

Slight tapping of indicator may be required to overcome friction when meter is in static condition.

3. Interconnect Test Box using 9910111-5 harness assembly and adjust variable

capacitance for added capacitance value of 45.50 pf in parallel with actual dry tank units.

Added Capacitance 45.50 pf = 40 gallons

4. Adjust signal conditioner "full" potentiometer to "40 gallons" indication on the indicator. Tap indicator slightly to insure that pointer has stabilized in final configuration.
5. Disconnect Test Box and 9910111-5 harness assembly and restore circuit to original configuration.
6. Recheck for exact "Zero" indication and readjust signal conditioner "Empty" potentiometer if necessary.
7. Recheck full indication per steps 3 and 4. If calibration has changed, readjust "full" potentiometer until a full indication (40 gallons) without a change in zero indication is obtained.
8. Repeat steps 1 through 7 for opposite side.

System Preparation for Calibration.

1. Inspect all wiring for any breaks and open or shorted shield wires.
2. Disconenct connector at main fuel tank.
3. Disconnect quick-disconnect connectors on inboard auxiliary tank going to signal conditioner.
4. Insure that disconnected wires are not shorting to ground at any time during the calibration.
5. Correct any discrepancies found in the wiring before proceeding further with this calibration.

CALIBRATION VERIFICATION

If for some reason there is some question whether the system is indicating correctly, a fairly accurate indication can be calculated by using Temperature Conversion Chart. Example below is for 100/130 octane fuel. Procedures are same for 100 octane fuel except use 100 octane low-lead fuel line on temperature conversion chart.

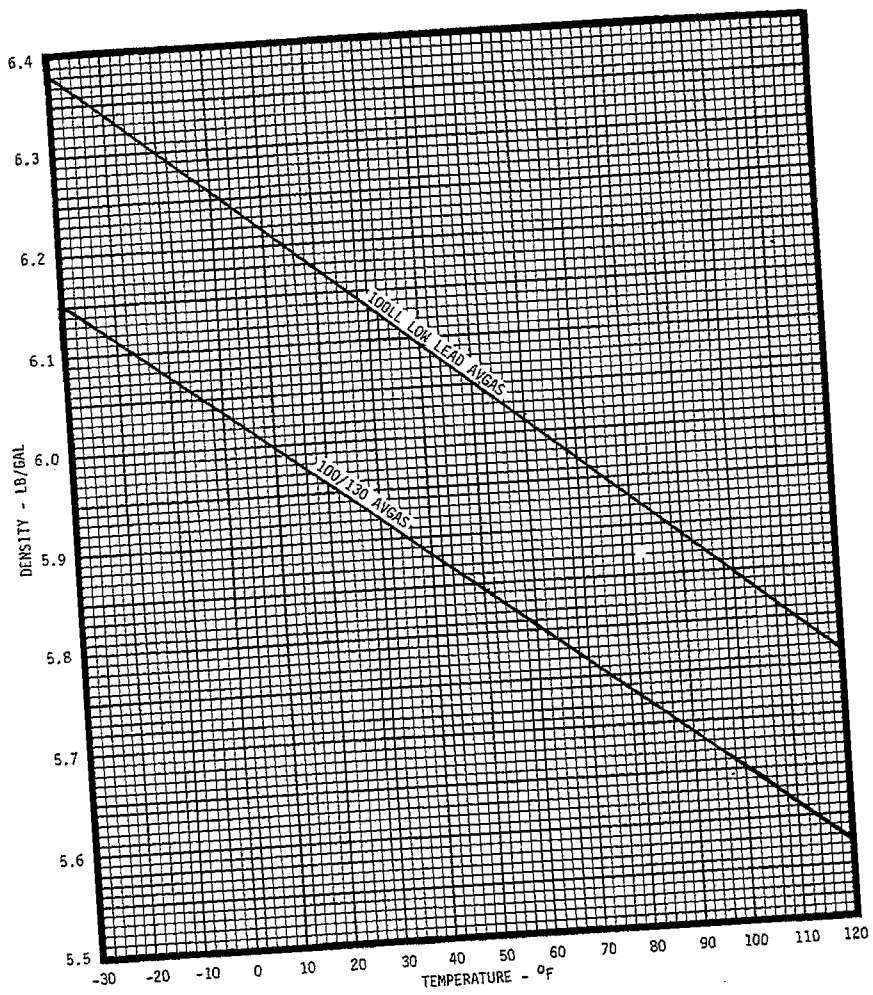
Example:

Temperature of Fuel	78°F
Number of Gallons put in the Tank As Noted	51 Gal.
on Tank Meter. (Note: It is assumed that the tanks were empty and dry)	
Unmeasured Fuel at Bottom of Tank	1 Gal <u>+1/4 Gal.</u>
Specific Weight of the Fuel per Temperature Conversion Chart	5.73 Lbs/Gal.

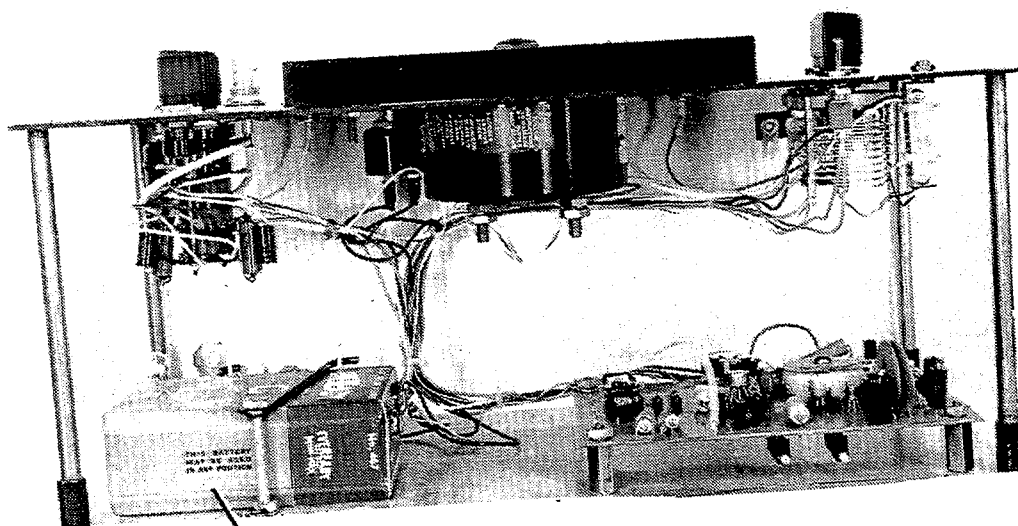
Indicated Fuel Should Be:

Fuel In Tank	51 Gal.
(Times) Weight Per Gal	<u>5.73 Lbs/Gal.</u>
Total Weight	292.23 Lbs.
(Minus) Unmeasured Fuel at the Bottom	-5.80 Lbs.
Approximate Gauged Fuel	286.50
Approximate Indication	286.50 <u>+*8.6 Lbs.</u>

*Includes 3% Indicator Tolerance.



Temperature Conversion Chart



"B" BATTERY

Figure 6. Replacing Battery

MAINTENANCE.

1. Maintenance of the Field Calibration Unit Test Box is limited to the replacement of vacuum tube and battery. Should additional maintenance be required, the complete Test Box must be returned to the manufacturer for repair.

2. (See Figure 6.) To replace battery, remove screws on bottom of Test Box and lower screw on door brace and lift unit straight up and out of box.

Part Number	Nomenclature	Usage
9910111-4	Harness	401B0001 thru 401B0300 402B0001 thru 402B0300 414-0001 thru 414-0350
9910111-5	Harness	210 337
9910111-6	Harness	310Q0001 thru 310Q0600
9910111-7	Harness	340-0001 thru 340-0150 421B0001 thru 421B0300
9910111-11	Harness	310Q0601 To 310R0001 310R0001 and On 335-0001 and On 340-0001 and On 340A0001 and On 402B0301 To 402C0001 414-0351 To 414A0001 421B0001 To 421C0001
5190508-7	Harness	421C0001 To 421C0099
5190508-9	Harness	402C0001 And On 404-0001 And On 414A0001 And On 421C0099 And On

SELF TESTING.

The Field Calibration Unit Test Box may be tested for operation and accuracy as follows:

1. Insulation Resistance:
 - a. Connect test leads as shown in Figure 1.
 - b. Short the test leads together and read resistance.
 - c. Resistance should be approximately 0.
 - d. If insulation resistance throughout the meter range must be checked, it will be necessary to use several standard megohm resistors of known value.
2. Bridge:
 - a. Connect test lead as shown in Figure 2.
 - b. Connect 1%, 5% or 10% capacitors of known value and measure capacitance of each.
 - c. Check bridge throughout range for accuracy.

NOTE

Tolerance of each capacitor must be taken into account when measuring capacitors.

- d. Refer to Substituting Capacitance and check the bridge for accuracy using the variable capacitor in the Test Box.