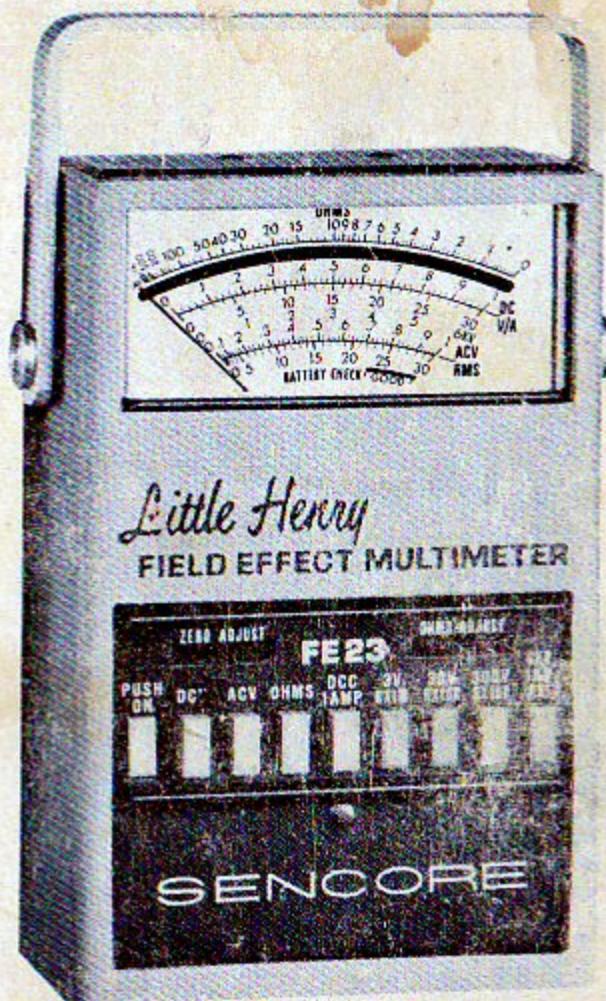


**FE 23**

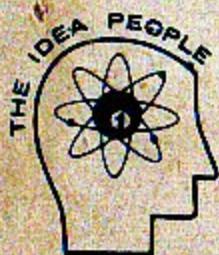
*Little Henry*

**SERVICE MANUAL**



**SENCORE**

**"the all american line"**



**SENCORE**

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

# FE23 SCHEMATIC AND PARTS LIST [PanamasBus.com](http://PanamasBus.com)

SCHEMATIC REFERENCE	DESCRIPTION	PART NO.	PRICE
<b>RESISTORS</b>			
R11	100K, 1/2W, 1%	14C29-1005	.75
R12	1 Meg., 1/2W, 1%	14C29-1006	.75
R14	10 Meg., 1/2W, 2%	14C30-1007	.75
R15	100K, 1/2W, 1%	14C29-1005	.75
R16	1K, 1/2W, 1%	14C29-1003	.75
R17	9 ohm, 1/2W, 1%	14C29-9000	.75
R18	1 Meg., 1/2W, 1%	14C29-1006	.75
R19	75 Meg., 2W, 2%	14C36-7507	1.25
R20	.2 Ohm resistance wire shunt	42E11	.75
R22	8 Meg., 1/2W, 1%	14C29-8006	.75
R23	4.5 Meg., 1/2W, 1/2%	14C28-4506	1.25
R24	450K, 1/2W, 1/2%	14C28-4505	1.25
R25	35K, 1/2W, 1/2%	14C28-3504	1.25
R26	15K, 1/2W, 1/2%	14C28-1504	1.25
<b>CONTROLS</b>			
R4	5K Vert. P. C. Mtg. (AC Cal)	15C7-14	.50
R6	10K Horiz. P. C. Mtg. (Zero Adj.)	15C7-22	.50
R9	10K Horiz. P. C. Mtg. (Ohms Adj.)	15C7-22	.50
R13	10K Vert. P.C. Mtg. (DC Cal)	15C7-2	.75
<b>TRANSISTORS</b>			
TR1, TR2	Matched pair 2N5457 FET	19A11-1	3.50/pr
<b>DIODES</b>			
CR1,2,3,4	1N456	50C5-1	.50
CR5, 6	1N34	50C3-1	.25
CR 7,8,9,10	1 amp, 400 volt rectifier	16S10	.50
CR11, 12	1N4148	50C5-2	.25
<b>MISCELLANEOUS</b>			
Case wrap, complete		110B270	10.50
Meter M1	(Front Meter Zero, Runs 10 and 11)	23B44A	15.00
	(Rear Meter Zero, Run 12 and later)	23B44B	15.00
F1	Fuse 1.5A	44G10	.25
I1	131 Pilot bulb	20G11	.25
Test leads		39G40	3.75

NOTE: Prices are in effect at time of printing, and are subject to change without notice. When ordering parts, please specify model number, run number, part number and description.

Minimum Billing \$2.00

Form 753

## SENCORE

3200 SENCORE DRIVE, SIOUX FALLS, SOUTH DAKOTA 57107

Printed U.S.A

# SENCORE SAFETY REMINDERS

When testing electronic equipment, there is always a danger present. Unexpected high voltages can be present at unusual locations in defective equipment. The technician should become familiar with the device he is working on and observe the following precautions.

1. An isolation transformer should always be used on equipment having one side of the AC line tied to the chassis. If an isolation transformer is not used, a severe shock hazard can result if the chassis of the equipment being serviced is tied to the "hot" side of the AC line.
2. When making test lead connections to high voltage points, remove the power. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket as a safety precaution and stand on an insulated floor to reduce the possibility of shock.
3. Discharge filter capacitors before connecting test leads to them. Capacitors can store a charge that could be dangerous to the technician.
4. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose the technician to dangerous potentials.
5. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

6. Do not work alone when working on hazardous circuits. Always have another person close by in case of accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with higher voltages.

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## **DESCRIPTION**

The demand in electronics equipment today is for smaller, more portable testers. The technician with more equipment to carry and less space to carry it in wants a smaller, more reliable, high input impedance meter than currently available. The same Sencore engineering knowhow that pro-

duced the first FET meter has answered the challenge for a truly portable tester with the FE23. Battery operated, with an automatic shutoff to save battery power, the FE23 takes approximately the same tube caddy space as two 6JE6 tubes. Push-button selection of range and function make the FE23 fast and simple to operate. Just compare these features and see why the FE23 is a must for an on-the-go technician.

- \* 1.5 DC Accuracy - 3% AC
- \* Fully protected to 500 times overload
- \* Minimum circuit loading with 15 megohm DC input impedance
- \* Automatic shut off to prevent battery run-down
- \* Compartment for storing leads has snap action cover to prevent loss of leads
- \* Fully protected and illuminated meter with exclusive slide cover
- \* Simple pushbutton operation

## SPECIFICATIONS

### DC VOLTS

Ranges: 0 to 3, 30, 300, 1000 and 6000 volts full scale

Input resistance: 15 megohms shunted by 27pf

Accuracy:  $\pm 1.5\%$  full scale at  $25^{\circ}\text{C}$  ( $\pm 3\%$  6KV range)

De rate accuracy :  $\pm 3\%$  0 -  $40^{\circ}\text{C}$

AC rejection: 30db minimum

**AC VOLTS (RMS)**

Ranges: 0 to 3, 30, 300, and 1000 volts full scale

Input resistance: 900 kilohms shunted by 27 pf

Accuracy:  $\pm 3\%$  full scale at  $25^{\circ}\text{C}$

De rate accuracy:  $\pm 6\%$  5 -  $40^{\circ}\text{C}$

Frequency response:  $\pm 1\text{db}$  30Hz to 1KHz  
 $\pm 3\text{db}$  15Hz to 3KHz

**OHMMETER**

Ranges: 0 to 1,000, 100K, 10 meg, 1000 meg with 10 ohms center scale.

Accuracy:  $\pm 2$  degrees arc

Applied voltage: 1.5V

**DC CURRENT**

Range: 0 to 1 amp

Accuracy:  $\pm 3\%$  full scale

Internal voltage drop: 300 millivolts

**GENERAL SPECIFICATIONS**

Meter:  $3\frac{1}{2}$  inch, 100 microamp, 2%

Multiplier resistors:  $\frac{1}{2}\%$  deposited carbon type

Semiconductor complement: Transistor: 2-2N5457

Diodes: 4-1N456, 1-1N34, 2-1N4148, 5-500ma, 600V Rectifier

Power supply: One 9 volt transistor radio battery, Eveready 222 or equivalent.

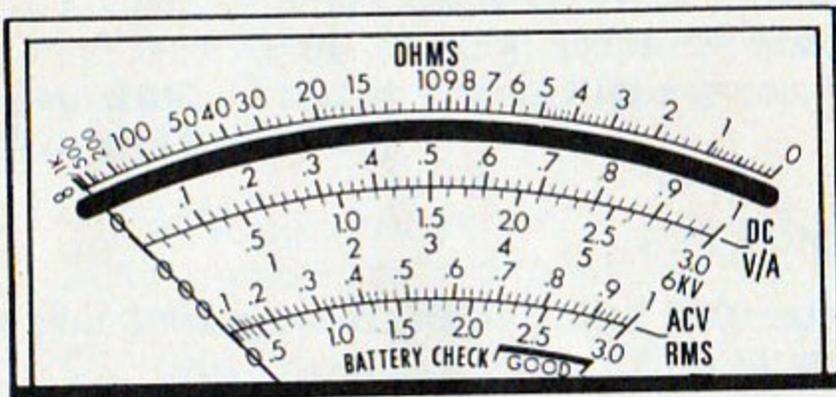
Ohms battery: Two AA Penlight, Eveready E91 or equivalent.

Meter light battery: One AA Penlight, Eveready E91 or equivalent (Batteries not included)

Weight:  $2\frac{1}{2}$  pounds

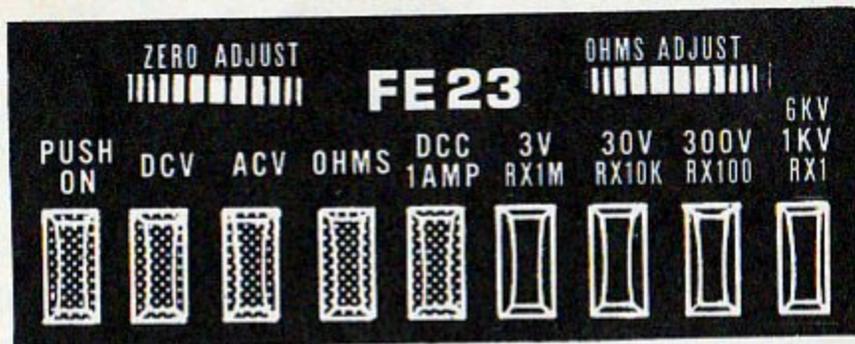
Dimensions:  $7\frac{3}{4}$  inches long,  $4\frac{3}{4}$  inches wide,  $2\frac{3}{8}$  inches deep.

## CONTROLS



*Little Henry*

**FIELD EFFECT MULTIMETER**



*Fig. 1, FE23 Front Panel*

**ON-OFF SWITCH:** The gray pushbutton on the extreme left of the pushbutton assembly is the ON-OFF switch. This switch controls the 9 volt battery power to the meter amplifier as well as the 1.5 volt supply for the meter light. The in position of this button is ON and the out position is OFF.

**FUNCTION SWITCH:** The four gray pushbuttons to the right of the ON-OFF switch are used to select the function, either DC Volts, AC Volts, Ohms, or DC Current. These four switches are provided with a mechanical lockout so that only one function button may be pressed (selected) at one time.

**RANGE SWITCH:** The four red pushbuttons control the range switching for the FE23, and are provided with a mechanical lock out so that only one range button may be pushed (selected) at one time. A safety factor has been built into the range switching so that if all buttons are out the 1KV range is selected.

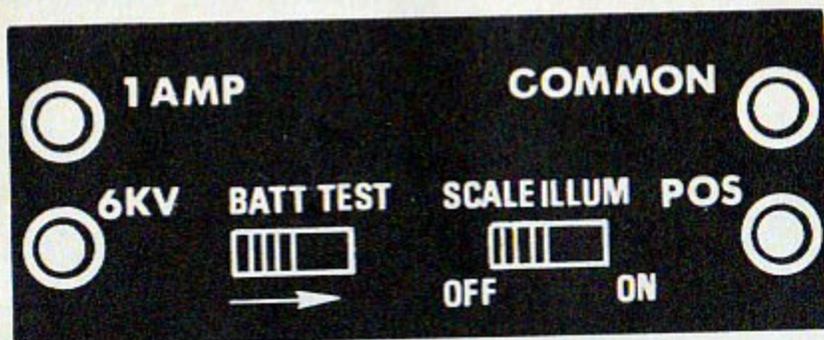
**ZERO ADJUST:** This thumb wheel control is used to position the meter pointer to zero on the extreme left edge of the meter scale. It should be adjusted with the power on, in either ACV or DCV function, with the leads shorted together.

**OHMS ADJUST:** This thumb wheel control is used to compensate for lead resistance and changing ohms battery voltage, and is adjusted in the OHMS function with the leads shorted together. Adjust this control to position the meter pointer to the OHMS zero on the extreme right edge of the meter scale.

**Automatic shut off:** This specially designed leaf switch provides automatic turn off for the 9 volt meter amplifier battery, the 1.5 volt ohms supply batteries, and the 1.5 volt meter light battery. Shut off occurs when the lead compartment door is closed.

**BATT TEST:** This spring return slide switch is used to test the condition of the 9 volt amplifier battery. To test, depress the ON pushbutton, and slide the BATT TEST switch to the right. Read the BATTERY GOOD scale on the meter.

**SCALE ILLUM:** This slide switch and the ON push button switch must both be in the ON position to supply 1.5 volt power to the meter light. This scale illumination feature should be used only when necessary, as the size of the battery for Scale Illum. limits its life to approximately 10 hours.



*Fig. 2, FE23 Input Connections*

## INPUT CONNECTIONS

**COMMON** - This black banana jack is the common input connection for all functions and ranges.

**POS.** - This red banana jack is the second input connection for all functions and ranges except 6KV DC voltage and 1 Amp DC current.

**6KV** - This yellow banana jack is the positive input connection for the 6,000 volt DC voltage range.

**1 AMP** - This blue banana jack is the positive input connection for the one amp DC current function.

# OPERATION

## BATTERY INSTALLATION

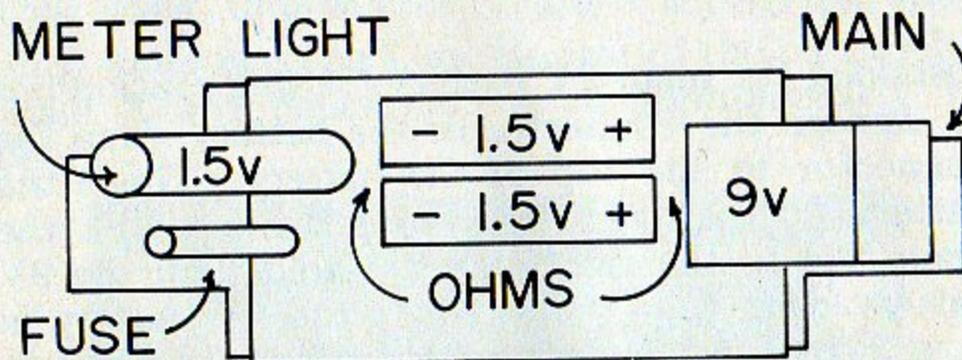
**Removing the battery/fuse compartment:** Remove the two screws from the top rear of the case, and slide the compartment from the case. Note that the connecting cable is dressed across the top of the meter barrel.

**Installing the main 9V battery:** Using caution not to damage the connector or the battery, snap the connector to the top of the battery. Grasp the battery compartment in your left hand with the open side to the right, and the holder for the 9V battery nearest to you. Grasp the 9V battery in your right hand, and dress the wires from the connector through the holder. Slide the battery connection end first into the holder until the connector just clears the holder. Hold the battery into the holder, and turn the battery one quarter turn until it snaps into the holder. Slide the battery the rest of the way into the holder.

**Removing the 9V battery:** Grasp the battery holder in your left hand, and the battery with your right hand. Slide the battery from the holder until it clears the holder for the ohms supply batteries, and turn the battery one quarter turn to remove it from its holder.

**Installing the OHMS batteries:** Insert two AA batteries side by side for the ohms supply. It is recommended that a premium alkaline such as the Eveready E91 be used to insure long trouble free service. Be sure to observe proper polarity.

**Installing the scale illumination battery:** Insert one AA battery into the holder near the fuse. A premium alkaline such as the Eveready E91 will provide more light output over a longer period of time than a standard zinc-carbon battery. It is recommended that the scale illumination be used only when necessary to conserve battery life. The scale illumination battery has a life of approximately 10 hours continuous operation.



*Fig. 3, Installing the batteries in the FE23*

**Replacing the battery compartment:** Dress the connection cable over the top of the meter barrel, and slide the compartment back into the case. Be sure that the lip of the chassis goes inside the battery compartment. Replace the two screws to hold the battery compartment in position.

## GENERAL

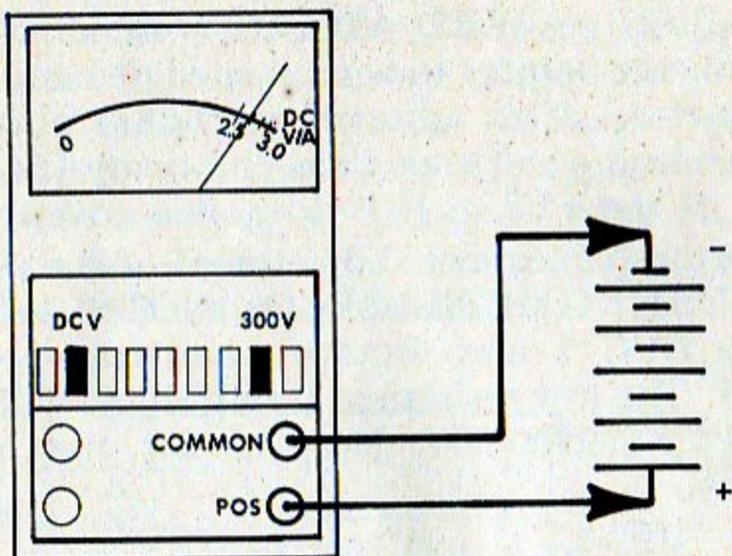
Slide the meter cover down to expose the meter face. Pull down on the lip of the lead compartment door (away from the switch assembly) to unlatch the door and slide the door down into the case to gain access to the input leads and connections. Push the ON switch to apply power to the FE23, and test the condition of the 9 volt battery with the BATT. TEST switch. If the battery

condition indicated is below the BATTERY CHECK GOOD area on the meter, replace the 9 volt battery. Adjust the ZERO ADJUST control to position the meter pointer to zero at the left hand edge of the meter. This adjustment should not vary more than one small scale division on any function or range of the FE23. If it does, it is advisable to check the mechanical zero adjustment of the meter. (see ADJUSTING METER ZERO). NOTE: Always press the DCC 1 amp button when transporting the FE23. The low resistance 1 amp shunt will provide electro-mechanical damping for the meter movement.

## MEASURING DC VOLTAGE

**1,000 volts or less:** Push the DCV pushbutton, plug the black test lead into the COMMON input jack, and the red test lead into the POS. input jack. Determine what voltage you expect to measure, and select a range pushbutton that will give a reading as close to full scale as possible. If the voltage to be measured is unknown, start with the 1KV range, and work toward the 3V range. Determine the polarity of the voltage being measured, and connect the black test lead to the negative point. Touch the red test lead to the positive point, and read the DC voltage on the black DC V/A scales directly below the mirror on the meter.

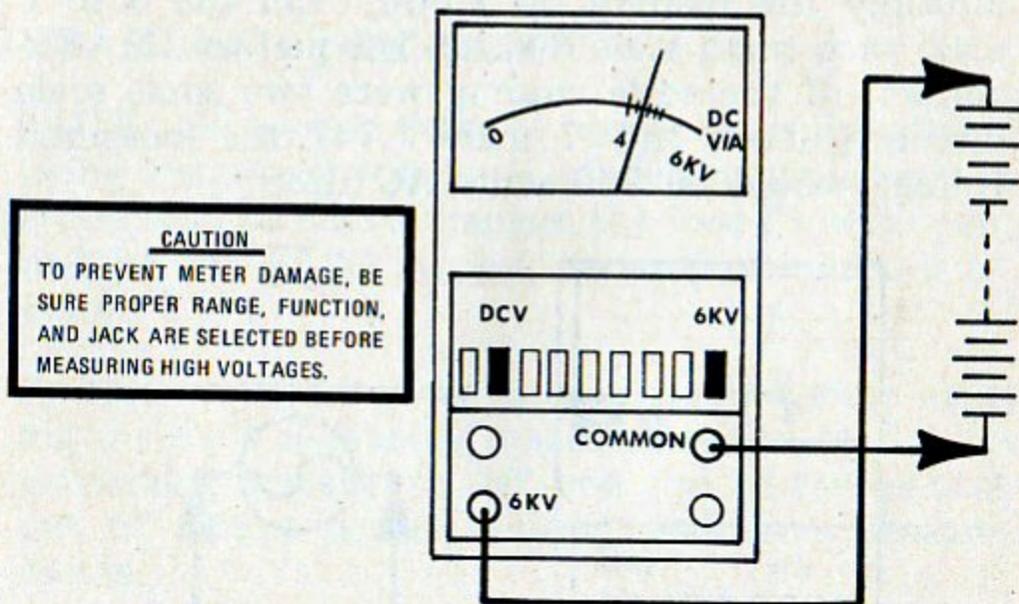
On the 1KV range, use the 0 - 1 scale and multiply the reading by 1,000. Each small scale division of the 0 to 1 scale equals .02. Example: If the meter pointer indicated one small scale division above the .4 mark, the scale reading would be .42. The .42 scale reading multiplied by 1,000 would mean that the measured voltage was 420 volts DC.



*Fig. 4, Measuring DC volts (1,000 volts or less)*  
 For the 3V range, read the 0 to 3.0 scale directly. When using the 30V range, read the 0 to 3.0 scale, and multiply the reading by 10. For the 300V range, read the 0 to 3.0 scale, and multiply the reading by 100. Each small scale division on the 0 to 3.0 scale is equal to .1. Example: If the meter indication were one small scale division above the 2.5 mark, the scale reading would be 2.6. If the 300V range were being used, the measured voltage would be 2.6 times 100, or 260 volts DC.

**NOTE:** When measuring DC voltages in critical circuits such as the grid of an oscillator, or in circuits with a high level AC signal such as the grid of a horizontal output tube, it is suggested that you connect a 100K resistor in series with the positive input lead to minimize circuit loading and maintain accuracy.

**1,000 to 6,000 volts:** Plug the red lead into the yellow 6KV jack, the black lead into the COMMON jack, and push the DCV and 6KV buttons. Determine the polarity of the voltage to be measured, and observing proper precautions, connect the black input lead to the negative point.



*Fig. 5, Measuring DC volts (1,000 to 6,000 volts)*

Touch the red lead to the positive point, and read the 0 to 6KV scale directly. Each small scale division is equal to .2KV or 200 volts. Example: If the meter indication is 2 small scale divisions above the 4 mark on the 0 to 6KV scale, the scale indication would be 4.4KV or 4,400 volts.

## MEASURING AC VOLTS

Push the ACV pushbutton, plug the black test lead into the COMMON input jack, and the red test lead into the POS. input jack. Determine what voltage you expect to measure, and select a range pushbutton that will give a reading as close to full scale as possible. If you are in doubt as to the voltage

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expected, start with the 1KV range and work toward the 3V range. Connect the black lead to the common or ground test point, touch the red lead to the point you wish to measure, and observe the meter indication.

For the 1KV range, read the 0 to 1 scale, and multiply the reading by 1,000. On the 0 to 1 scale each small scale division is equal to .02. Example: If the scale reading were two small scale divisions above the .7 mark (.74), the measured voltage would be 740 volts AC RMS.

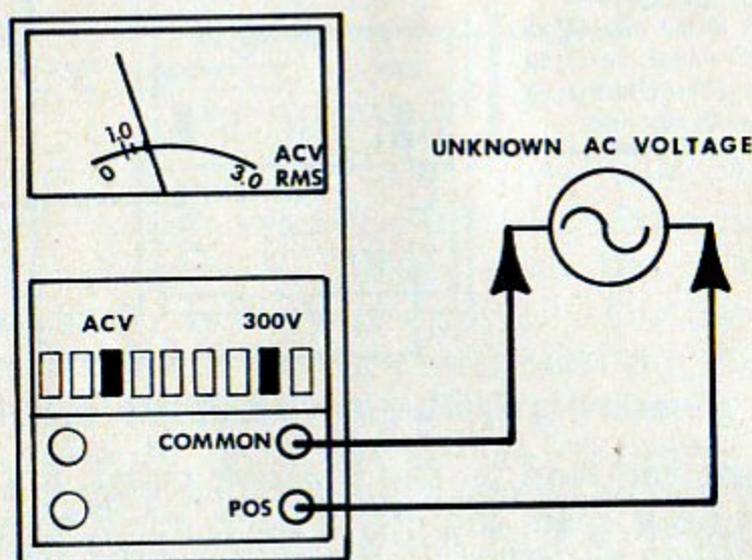


Fig. 6, Measuring AC volts

For the 3V range, read the 0 to 3.0 scale directly. When using the 30V range, read the 0 to 3.0 scale, and multiply the reading by 10. For the 300V range, read the 0 to 3.0 scale, and multiply the reading by 100. On the 0 to 3.0 scale, each small scale division is equal to .1. Example: If the scale reading were two small scale divisions above the 1.0 mark (1.2) and the 300V range being used, the measured voltage would be 120 volts AC RMS.

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**NOTE:** The FE23 is an RMS reading meter as compared to peak to peak detection used on other Sen-core meters. On a pure sine wave input both meters will read the same. With distortion of the waveform present, there will be a difference in readings due to the different types of detection.

## MEASURING RESISTANCE

**NOTE:** Be sure to remove power from the circuit being tested. If voltage is applied to the inputs in either RX1 or RX100 ranges, the fuse F1 will open, making the FE23 inoperative until the fuse is replaced.

Be sure to discharge all filter capacitors when making incircuit resistance measurements. In circuits containing transistors, lift one end of the resistor out of circuit before making resistance measurements.

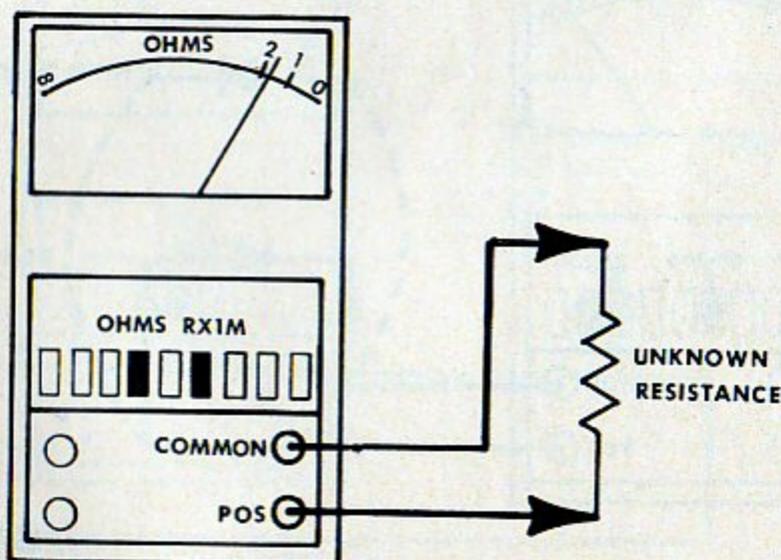


Fig. 7, Measuring resistance

Press the OHMS function pushbutton, and a range pushbutton that will allow a reading as close to mid-scale as possible. Plug the black test lead into the COMMON input jack, and the red test lead into the POS. input jack. Short the leads together, and adjust the OHMS ADJUST control to position the meter pointer to the ohms zero at the right edge of the meter scale. Unshort the leads, and connect them to the resistance being measured.

Read the top scale of the meter directly for the RX1 range or multiply by the appropriate multiplier for the RX100, RX10K or RX1M range. Example: If the scale reading were 1.8, and the range RX1M, the measured resistance would be 1.8 meg, or 1,800,000 ohms.

## CHECKING DIODES

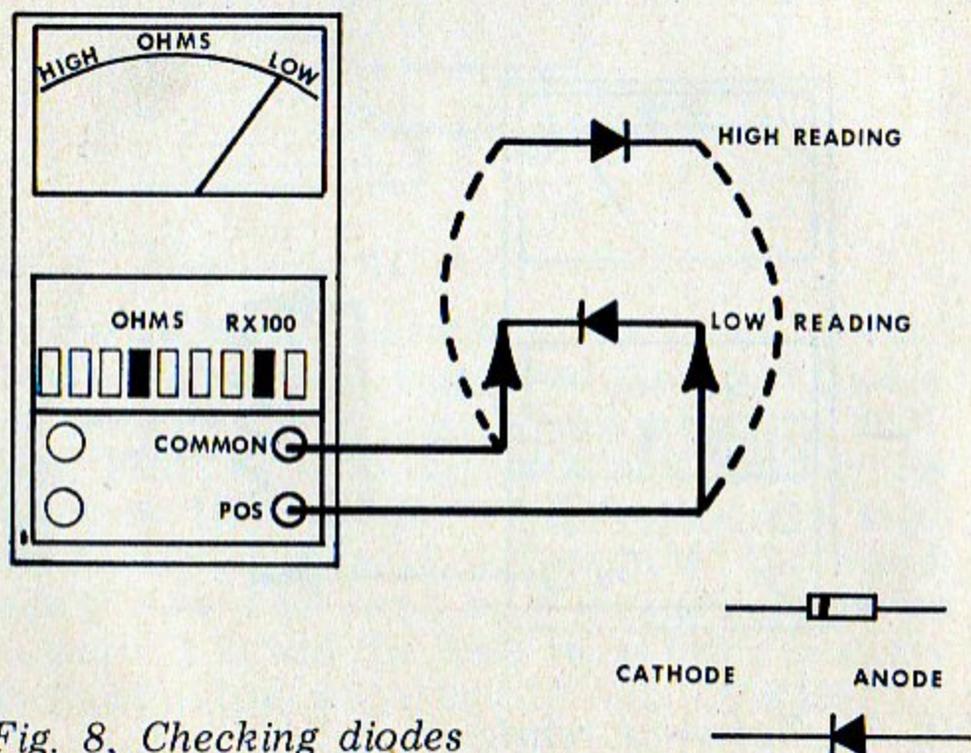


Fig. 8, Checking diodes

The front to back ratio of transistors and diodes may also be tested with the FE23 using the RX100 ohms range. With the black (negative) lead connected to the cathode of the diode, the resistance reading should be low. The resistance reading should be high with the red (positive) lead connected to the cathode of the diode. The ratio between the high and low readings should be at least 100:1 for a small germanium diode, and 1,000:1 for a silicon diode.

## MEASURING DC CURRENT

Push the DCC 1 AMP button, plug the black lead into the COMMON input jack, and the red lead into the blue 1 AMP jack. Turn off the power supply to the circuit being measured. Connect the FE23 in series with the circuit to be measured. Be sure to observe proper polarity when making connections.

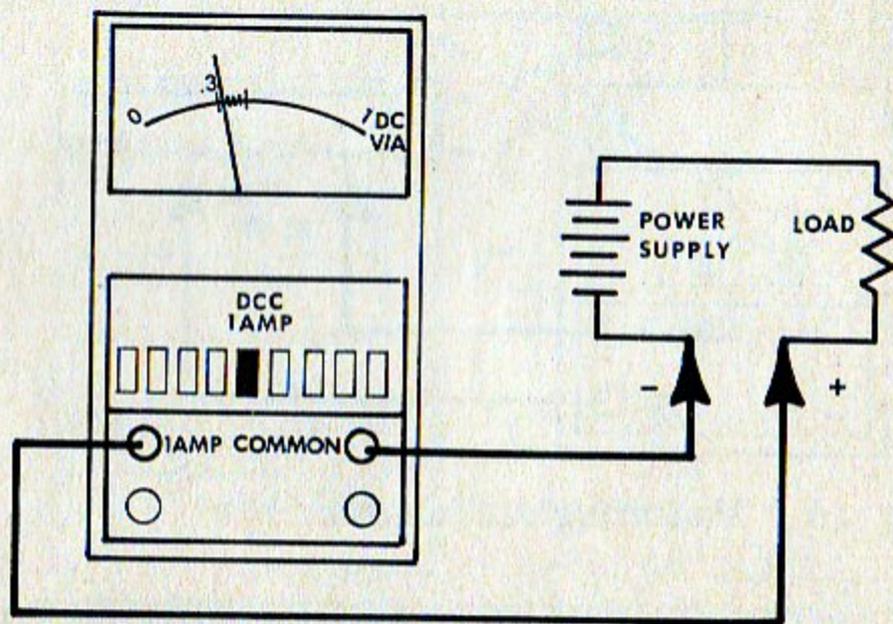


Fig. 9, Measuring DC Current

Turn the power supply back on, and read the 0 to 1 DC V/A scale directly. Each small scale division

is equal to .02 amps. Example: If the meter pointer indicates one small scale division above the .3 mark on the scale the reading would be .32 amps, or 320mA. NOTE: The DCC 1 AMP button is used to select both function and range for the 1 AMP DCC range. All other buttons are not functional when the DCC 1 AMP button is depressed.

## MEASURING AC CURRENT

The FE23 can also be used to measure AC current with the addition of the circuit shown below. The resistor (1 ohm, 1% 10W Sencore part number 14A68-A) is connected in series with the AC line, and the FE23 is used to measure the voltage across the resistor. Use the ACV function, the 3V range, and read the 0 to 3.0 scale directly as 0 to 3 amps.

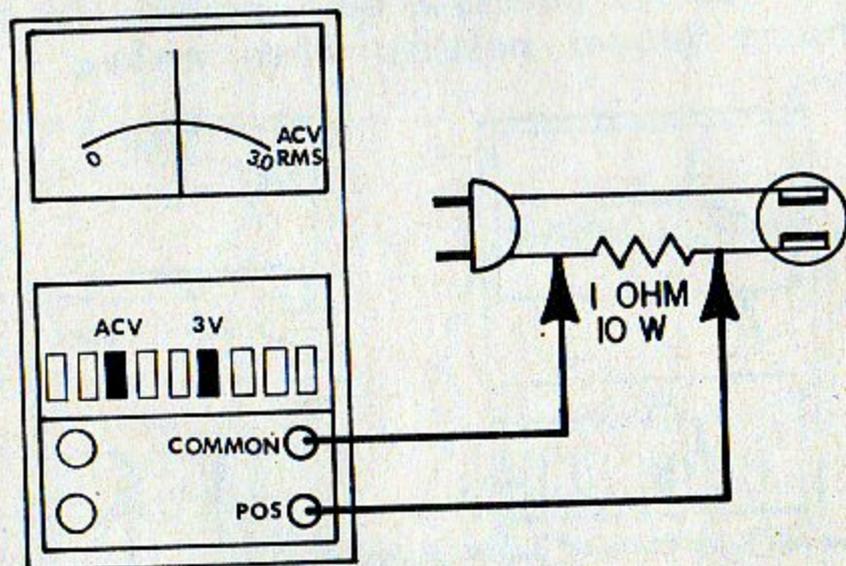


Fig. 10, Measuring AC Current

## MEASURING HIGH VOLTAGE WITH THE 39A30 PROBE (OPTIONAL)

Push the DCV and 300V pushbuttons, plug the black

test lead into the COMMON input jack and the red test lead into the POS input jack. Assemble the 39A30 high voltage probe, making sure the two parts are firmly seated together. Insert the red FE23 test probe into the small hole in the high voltage probe handle. Be sure that the tip of the test probe and the tip jack inside the handle of the 39A30 are properly aligned, and push the test probe firmly into the handle of the 39A30 to insure a good connection. Remove power to the equipment being measured, and connect the black lead to an appropriate ground point in the equipment being measured. Use the hook on the end of the 39A30 to connect the probe to the high voltage test point, and apply power to the equipment being measured.

**CAUTION:** High voltage is dangerous. Be sure to follow proper precautions, and do not work alone when working on high voltage circuits.

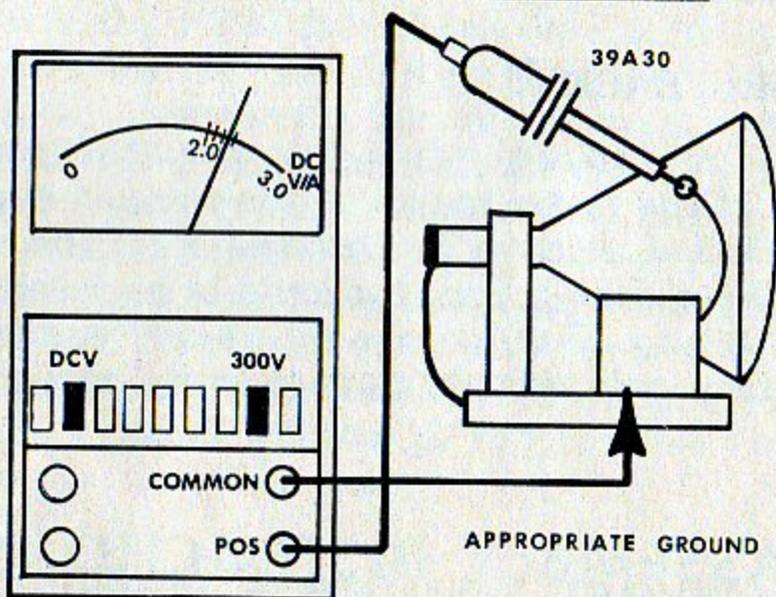


Fig. 11, Measuring High Voltage With the 39A30 probe (optional)

Read the 0 to 3.0 scale, and multiply the scale reading by 10,000. Each small scale division on the 0 to 3.0 scale is equal to 1,000 volts. Example, if the scale reading were two and one half divisions above the 2.0 mark on the meter, the measured voltage would be 22.5KV.

## **OVERLOAD PROTECTION**

Your FE23 is protected against accidental overloads on all ranges and functions. The voltage ranges are protected by the high input impedance. This limits the amount of current that can flow into the meter to safe levels. On the resistance and current functions, the fuse F1 protects both the meter movement and the circuitry. This fuse should be replaced with one of the same type so the protection feature and accuracy of the FE23 are not affected. The meter and internal resistors are further protected by the action of diodes CR7-CR12.

## **FUSE REPLACEMENT**

A quick check for the fuse is to short the leads on ohms. If the meter moves to the right, the fuse is good. If not, remove the battery holder and check fuse. When fuse is bad, it should be replaced with 3AG 1.5 amp. Do not use a slow blow type fuse as inaccuracy and possible damage to the meter may result.

## **DISASSEMBLY INSTRUCTIONS**

### **REMOVING THE BATTERY/FUSE HOLDER**

Remove the two screws from the rear top of the

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chassis and using a rocking motion, slide the holder from case. Before replacing the holder, dress the connecting wires so that they do not become pinched or interfere with reassembly. Position the sides of the holder on the rails inside the chassis, and slide the holder back into the base. Replace the two screws.

## REMOVING THE CASE

With the lead compartment door closed, remove the four recessed head screws from the sides of the case. Spread the bottom edges of the case slightly, and lift it off the chassis. The calibration adjustments (R4 and R13) are now accessible directly behind FE23 on the panel. To replace the case, reverse the above procedure.

## REMOVING THE CHASSIS

Remove the battery/fuse compartment and the case. Place the FE23 face down on a soft cloth, and remove the nut and bolt holding the cable clamp in place. Remove the four remaining screws from the rear of the FE23, and lift the chassis off the meter and function assemblies. You may now do all troubleshooting and testing from either side of the PC boards using the board layouts provided. To replace the chassis, start with the two screws to the function assembly. Next replace the meter and the cable clamp. Finally, replace the battery/fuse holder and the case.

## REPLACING THE SCALE ILLUMINATION BULB

Remove the case and the battery/fuse holder. Re-

move the screw from the rear of the FE23 that holds the scale illumination assembly in place. Pull the assembly down and away from the meter. Replace the bulb with a 131 pilot lamp. Do not substitute any other lamp as decreased life of the scale illumination battery, and or reduced light output will result. Reinstall the scale illumination assembly, using the screw to hold it in position.

## CALIBRATION ADJUSTMENTS

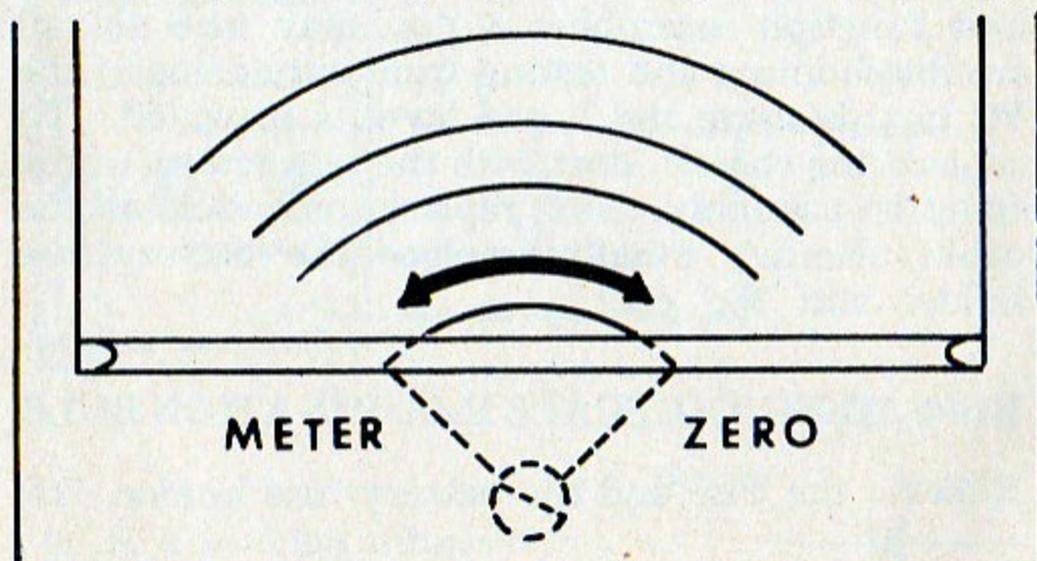
**NOTE:** Calibration adjustments must be done in proper sequence for accurate results.

An accurate 3V AC & DC source is necessary for proper calibration of the FE23.

### ADJUSTING METER ZERO

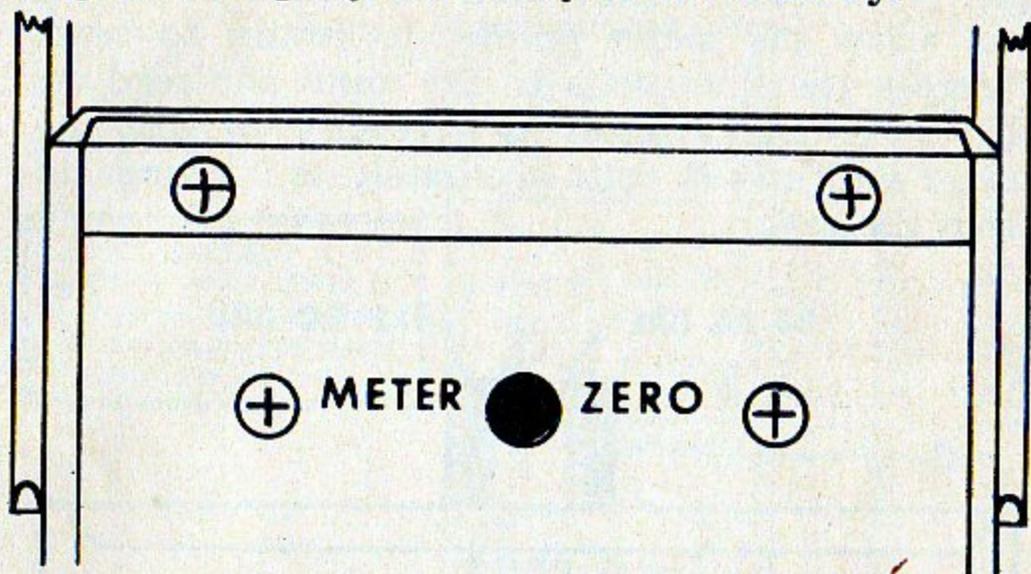
(Runs 10 and 11)

Slide meter cover fully open to expose meter zero disc. Rotate meter zero disc with fingertips to adjust meter pointer over the zero on left edge of scale. Tap meter lightly and readjust as necessary.



(Runs 12 and up)

The mechanical meter zero adjust is located at the center of the back of the FE23. Using a small screwdriver, adjust meter zero until meter pointer rests over the zero on the left edge of the scale. Tap meter lightly and readjust as necessary.



## CALIBRATION

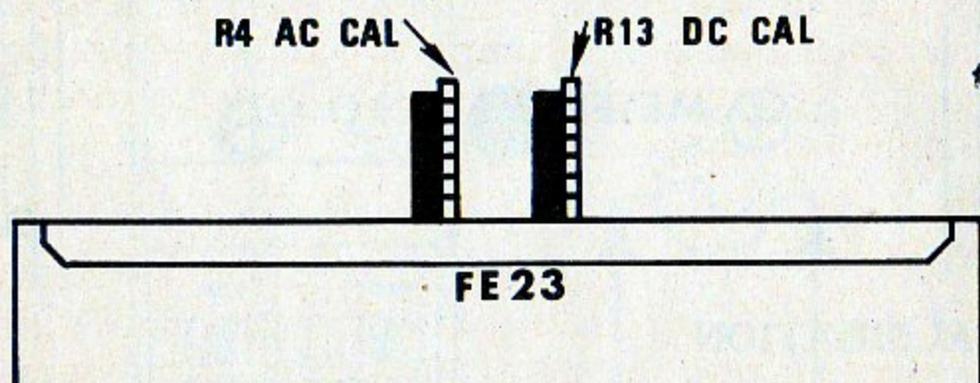
**NOTE:** A slight change in calibration is caused by the removal of the case. This change results from the effect of the sliding meter cover on the magnetic field generated by the meter movement. The following calibration procedure has been designed to allow for the change caused by removal of the case.

### DC VOLTS CALIBRATION

1. Remove the case from the FE23 but leave the battery/fuse holder in place, as removal of the battery/fuse holder will affect calibration.
2. Press the DCC 1 AMP pushbutton, and ad-

just the mechanical meter zero to position the meter pointer to left hand edge of the meter.

3. Press the DCV and 3V pushbuttons, and adjust the ZERO ADJUST control to position the meter pointer to the zero on the left hand edge of the meter scale. Apply 2.95 volts from the input, and allow the meter pointer to return to zero. Reapply the 2.95 volts to the input and readjust the DCV CAL control as necessary so that the meter indicates 3 volts accurately as it swings up from the zero.



*Fig. 12, FE23 Calibration Adjustments*

## AC VOLTS CALIBRATION

1. Press the ACV and 3V pushbuttons, and adjust the ZERO ADJUST control to position the meter pointer to the zero on the left edge of the meter. Apply 2.95 volts AC to the input and adjust R4 for a full scale reading of 3.0 volts. Remove the 2.95 volts from the input and allow the meter pointer to return to zero. Reapply the 2.95 volts to the input, and readjust the ACV CAL control as necessary so that the meter indicates 3 volts accurately as it swings up from zero.

2. Replace the case on the FE23, and check the calibration by applying exactly 3.0 volts, DC and AC. If any error is indicated, remove the case and readjust R13 and R4 as necessary so that the FE23 indicates accurately with the case in position.

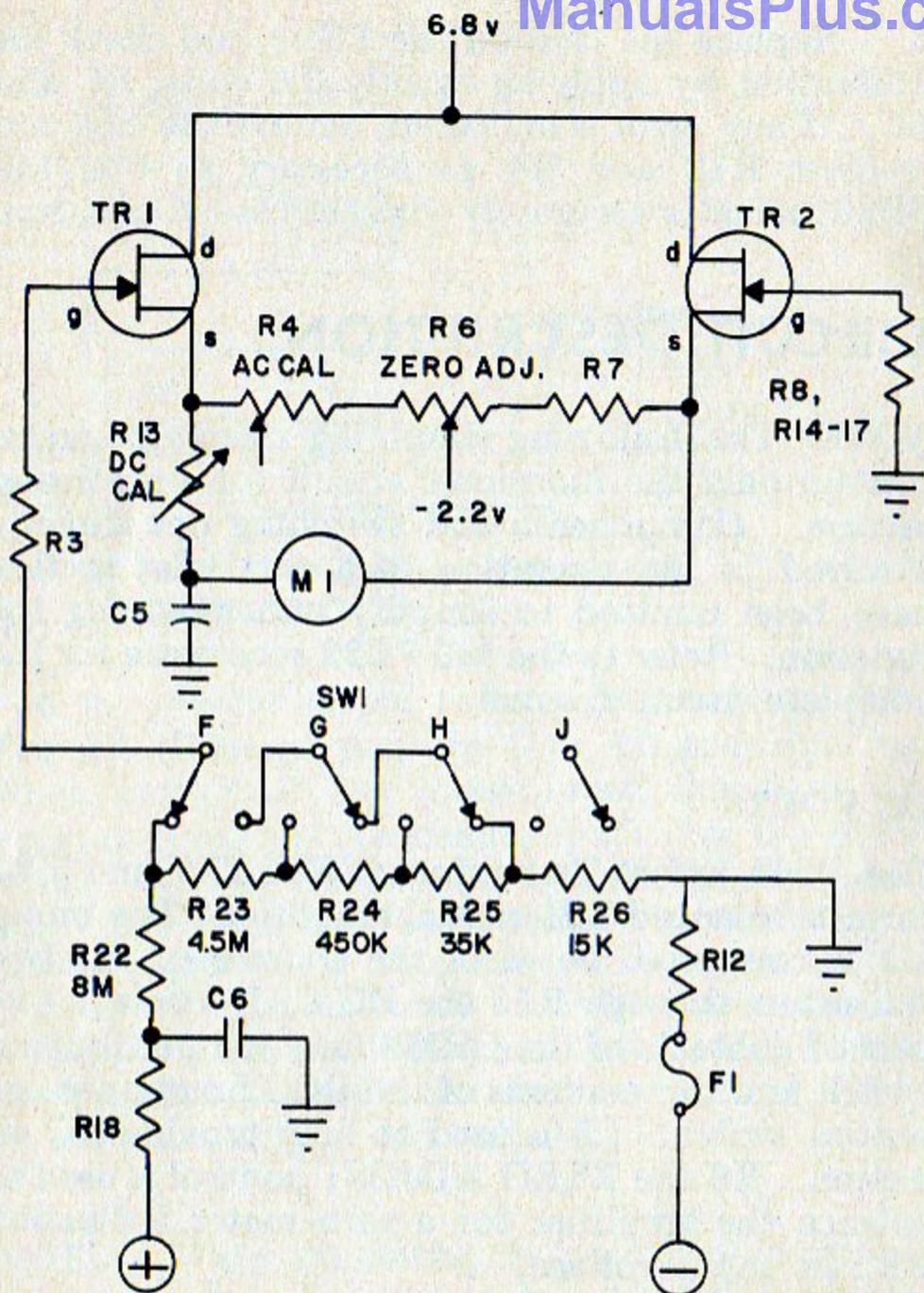
## CIRCUIT DESCRIPTION

**NOTE:** The following simplified circuit diagrams contain only the functional circuit for a particular section. Components and switching not directly involved in the operation of a particular section have been omitted to simplify understanding the function. Refer to the full FE23 schematic for the complete circuit diagram.

### DC VOLTS

The Field Effect Transistors (FET) TR1 and TR2 form a balanced differential amplifier. The meter M1 is connected between the sources of the two transistors through R13 the DC CAL. control, one pair of contacts of the OHMS function pushbutton switch and the contacts of the DCC function pushbutton switch. C5 is used to help provide AC rejection. R6 the ZERO ADJUST control is used to balance the amplifier for a zero meter indication with no input voltage.

The positive input from either the POS or 6KV input jacks is coupled through one pair of contacts of the DCV function pushbutton switch, R18, and R22 to the top of the voltage divider (R23-R26). R18 and C6 form a low pass filter with one end of C6 connected to ground through the ACV pushbutton function switch. The negative input is coupled from



*Fig. 13, Simplified Diagram of DC Volts Function*

the COMMON input jack through F1, R12, and one pair of contacts of the DCV pushbutton function switch to ground.

One set of contacts on each of the range push-

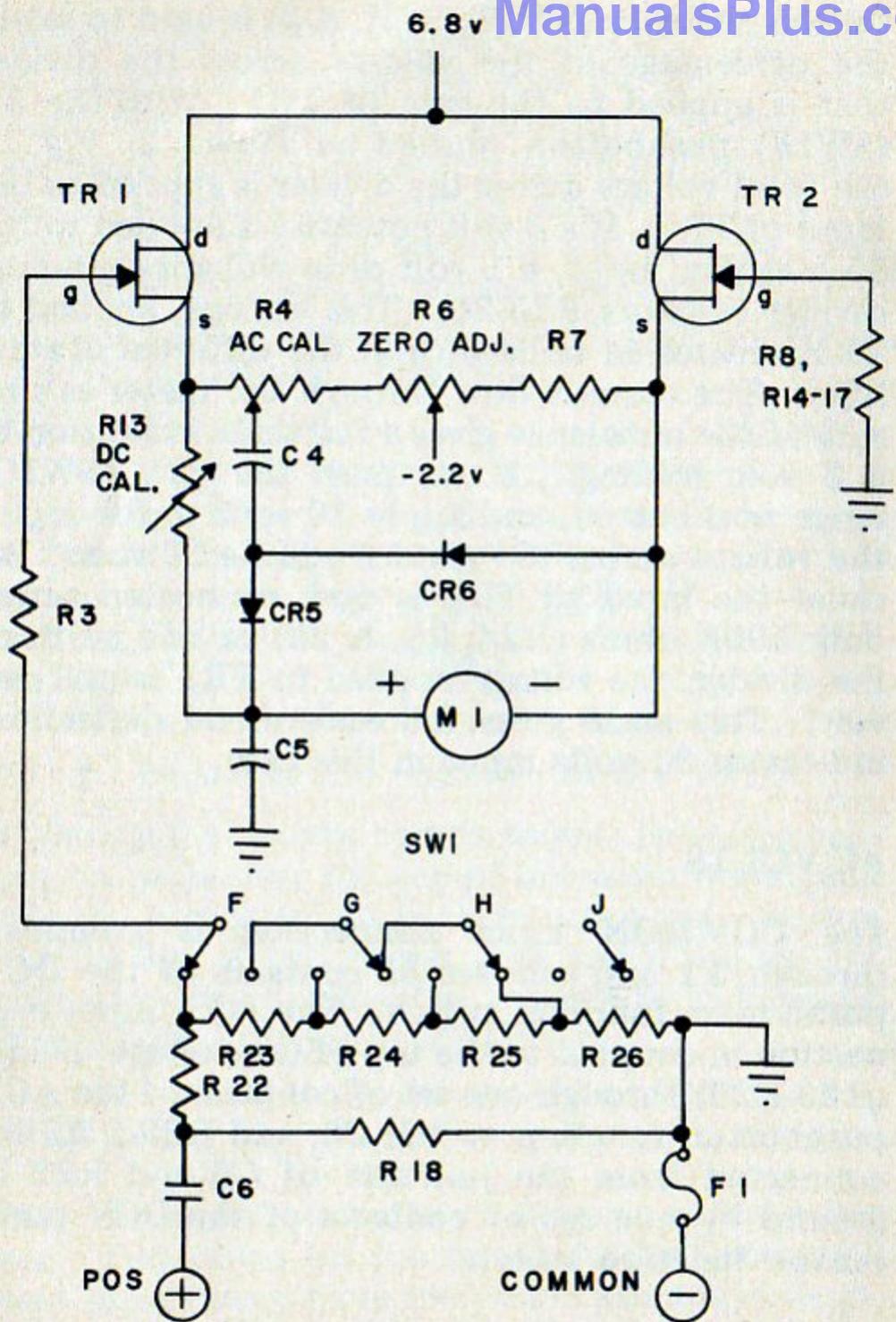
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button switches (SW1F, G, H, & J) is used to select the percentage of the voltage across the divider that is applied to the gate of TR1. With the 3V (SW1F) pushbutton pushed as shown in Fig. 13 the total voltage across the divider is applied to the input of TR1. If a 3 volt potential is applied to the 15 megohm input, a 1 volt drop will appear across divider resistors R23-26. This voltage, applied to TR1, creates an unbalance in the differential amplifier. The current flow through the meter as a result of the unbalance gives a full scale indication or a 3 volt reading. If we push the 30V (SW1G) range pushbutton, and apply 30 volts to the input, the voltage across the divider will be 10 volts. Because the input to TR1 is now connected across only 500K ohms (R24, 25, & 26) or one tenth of the divider, the voltage applied to TR1 is still one volt. This again gives full scale meter deflection, indicating 30 volts input in this case.

## AC VOLTS

The COMMON input connection is grounded through F1 and one set of contacts of the DCV pushbutton function switch. The POS. input connection is coupled to the top of the voltage divider (R23-R26) through one set of contacts of the ACV pushbutton function switch C6, and R22. R18 is connected from the junction of C6 and R22 to ground by one set of contacts of the DCV pushbutton function switch.

The range pushbutton switches (SW1F, G, H, & J) select the percentage of the input voltage that is applied to the input of TR1. TR1 acts as a source follower to provide a low impedance drive for the meter circuit. From the source of TR1, the AC

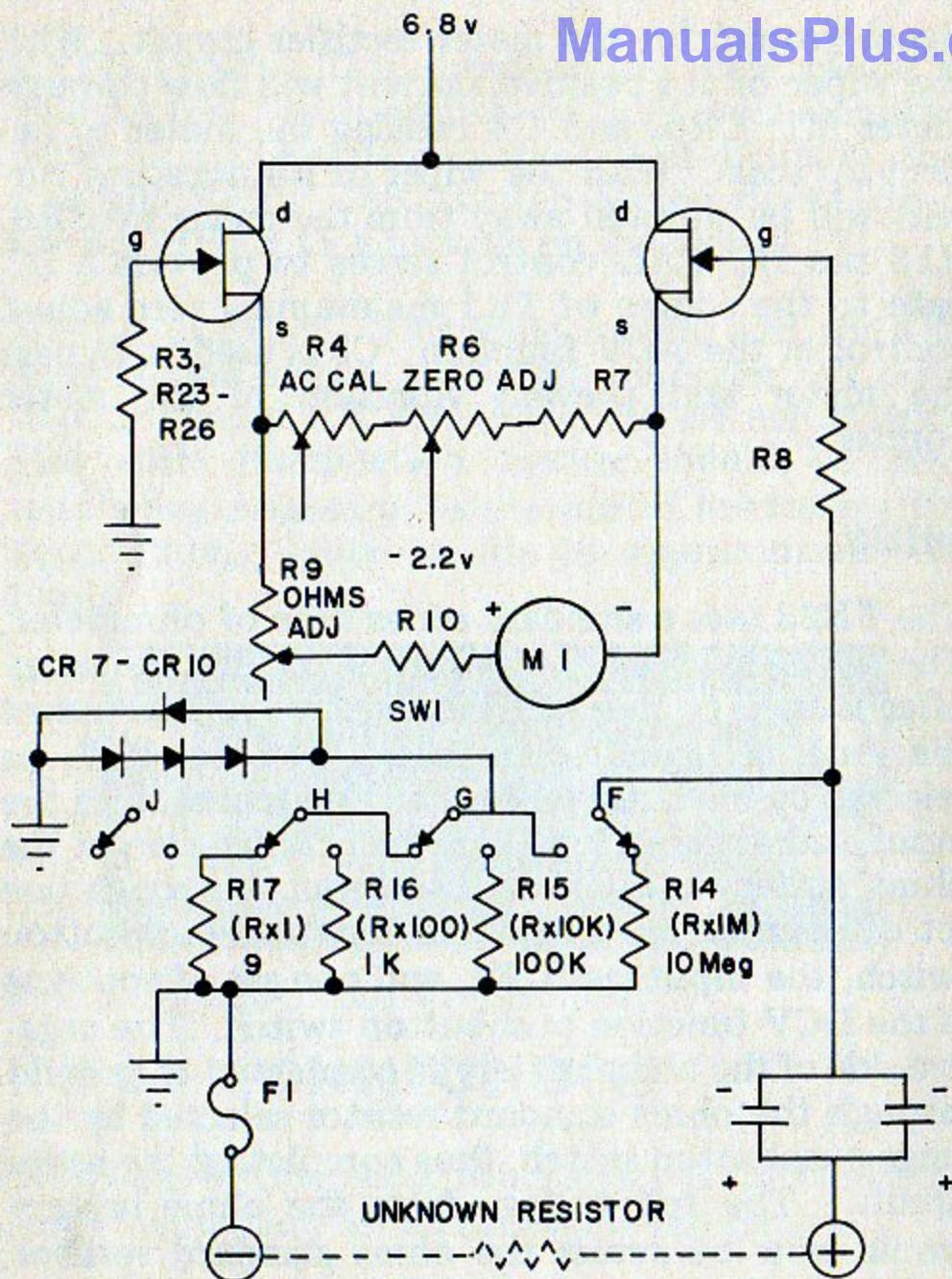


**Fig. 14, Simplified Diagram of AC Volts Function**  
signal is coupled through R4 (the AC CAL control) C4, and one set of contacts of the ACV pushbutton function switch to the meter rectifiers CR5 and CR6. The source of TR2 forms a low impedance

signal ground for the meter rectifier circuit. With the wiper of R4 positive, current will flow through meter M1, CR5, and C4 causing the meter to deflect up scale. With the wiper of R4 negative, current will be shunted away from the meter by CR6. R13 the DC CAL control serves to provide a DC path to the source of TR1 maintaining zero adjust control in the ACV function. C5 is used to bypass the meter and prevent vibration of the meter pointer.

## OHMS

The FE23 uses a standard series type of ohmmeter. The TR2 input of the balanced differential amplifier is used to measure the negative voltage across the internal standard resistor, R14 to R17, as selected by the range pushbutton switches. With the input leads shorted together, the positive side of the ohms battery is connected to ground through one set of contacts of the OHMS function pushbutton switch, the input leads, F1, and one set of contacts of the DCV function pushbutton switch. The negative side of the ohms battery is connected to ground through the ohms standard resistor selected by the range pushbutton switch, thus completing the series circuit. The full voltage from the ohms battery would now be across the ohms standard resistor, and applied to the gate of TR2 through R8. The negative voltage applied to the gate of TR2 will cause an up scale deflection of the meter. R9, the front panel OHMS ADJUST control, is adjusted for a full scale zero ohms reading. If a 10 Meg resistor is connected between the input leads, and range pushbutton switch SW1F (RX10M) is pushed, the series circuit would consist of R14 (the 10 Meg



**Fig. 15, Simplified Diagram of Ohms Function**  
 standard resistor) and the 10 Meg resistor between the input leads. One half of the voltage from the ohms battery would then be across the standard resistor, and the other half across the resistor being measured. The voltage across the standard resistor would be applied to the gate of TR2 causing a half

scale indication, which corresponds to a resistance measurement of 10 Meg ohms.

## DC CURRENT

The FE23 operates as a standard series ammeter for the DCC function. The positive input from the 1 AMP jack is connected to ground through R20, the .2 ohm shunt. The negative input from the COMM jack is connected to ground through F1 and one set of contacts of the DCV function push-button switch. The positive meter terminal is connected to the positive side of the shunt through series protection resistor R21, and one set of contacts of the DCC pushbutton function switch. The negative terminal of M1 is connected to the negative side of the shunt (ground) through the other set of contacts of the DCC pushbutton function switch. Diodes CR11 and CR12 are connected across the meter to limit the maximum overload voltage applied to the meter to .6 volts. This serves as meter protection during overload until fuse F1 opens.

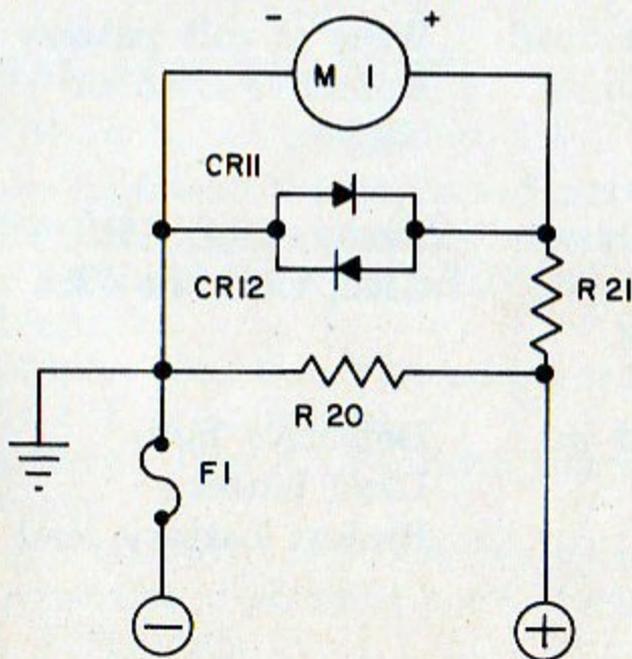


Fig. 16, Simplified Diagram of DC Current Function

# TROUBLE CHART

SYMPTOM	PROBABLE CAUSE
Unit dead, meter does not read.	Dead battery Poor battery contact Broken battery lead Blown fuse
Ohms function inoperative	Dead ohms battery Poor battery contact Broken ohms battery lead
Will not zero on RX1, RX100	Weak ohms battery Leaky CR7, 8 or 9
AC voltage readings inaccurate	Weak 9 volt battery Defective CR5 or CR6
Meter reads up scale 3V and RX1M	Leaky TR1, TR2, CR1 CR2, CR3, or CR4
Meter light inoperative	Defective bulb Dead battery Broken battery lead

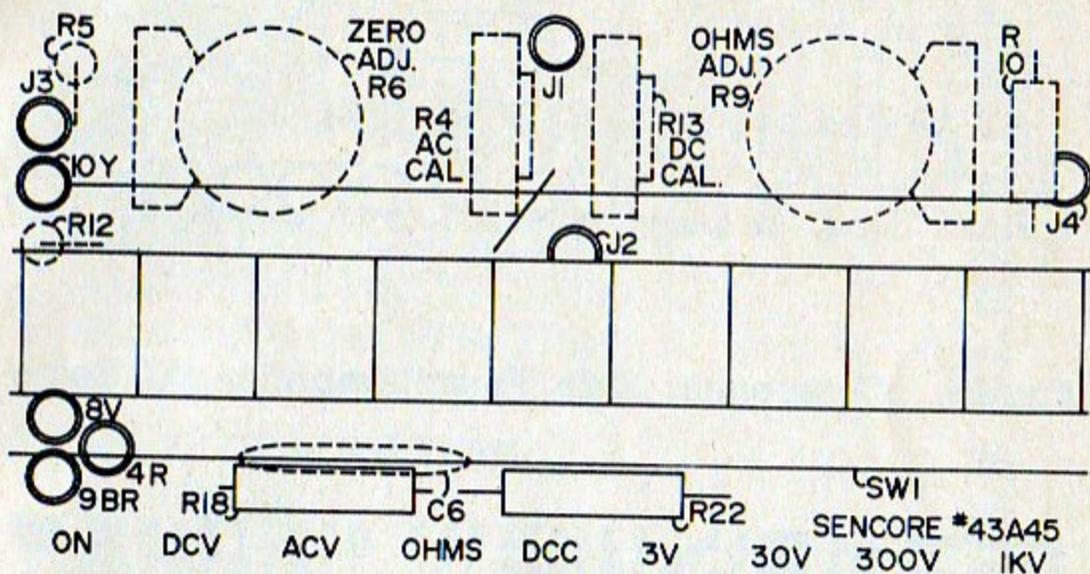


Fig. 17, Component Side View, Switch PC Board

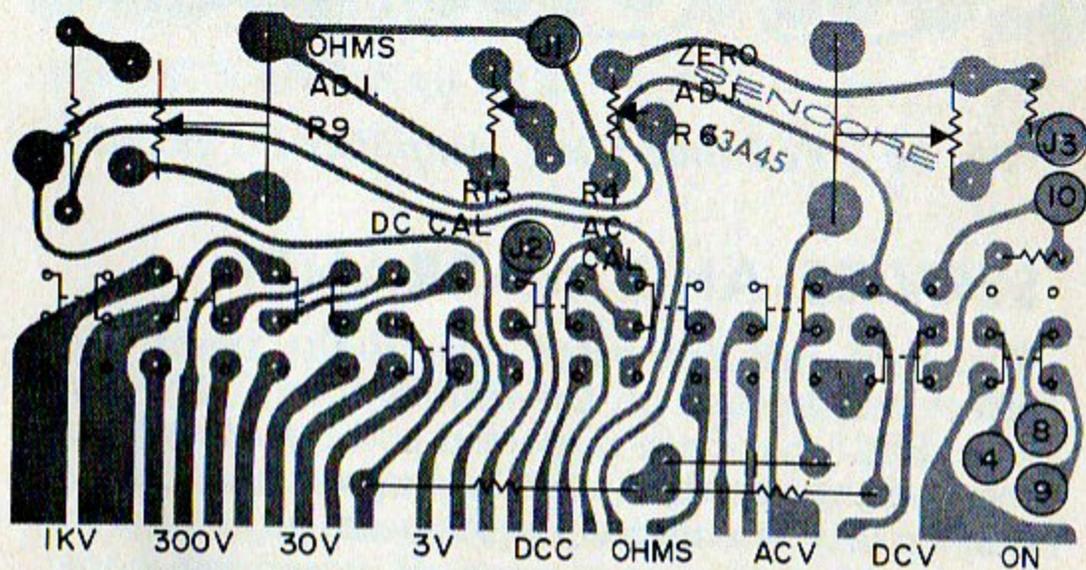
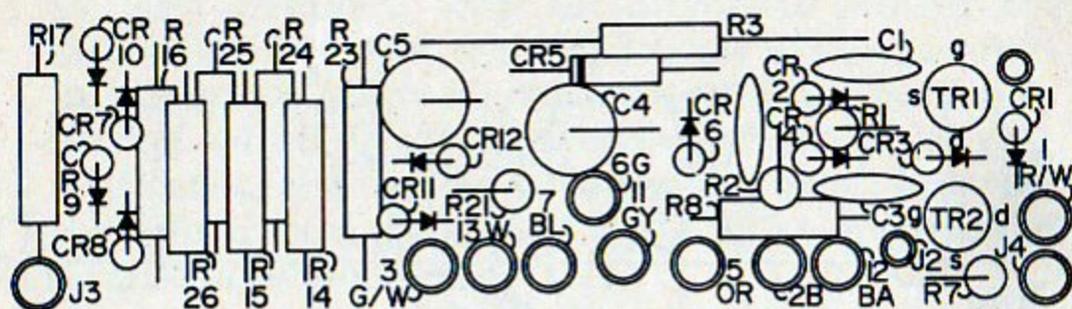
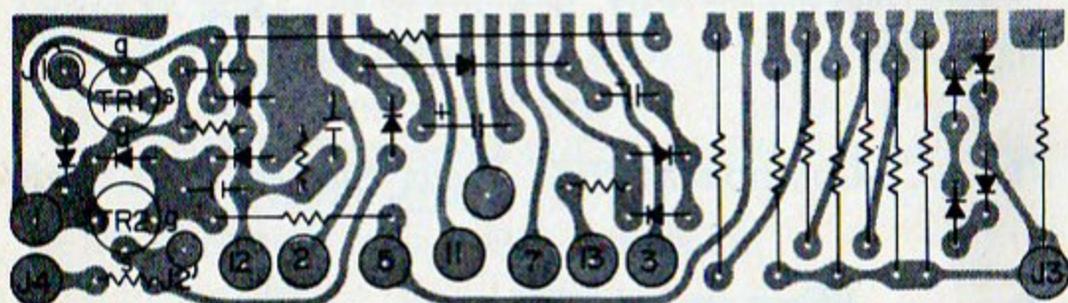


Fig. 18, Foil Side View, Switch PC Board



*Fig. 19, Component Side View, Amplifier PC Board*



*Fig. 20, Foil Side View, Amplifier PC Board*

## SERVICE AND WARRANTY

You have just purchased one of the finest field effect multimeters on the market today. The Sen-core FE23 has been inspected and tested twice at the factory and has passed a rugged use test, by our Quality Assurance Department, to insure the best quality instrument to you. If something should happen, the FE23 is covered by a standard 90 day warranty as explained on the warranty policy enclosed with your instrument.

Sencore has three regional offices to serve you. Instruments to be serviced should be returned to the nearest regional office, by UPS if possible. Parcel post should only be used as a last resort. Instruments should be packed with the original packing materials or equivalent, and double boxed to insure safe arrival at the regional office. The blue and white display carton IS NOT an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own FE23 Field Effect Meter, we have included a schematic, trouble chart, and parts list. Any of these parts may be ordered directly from the regional office nearest you.

We reserve the right to examine defective components before an in warranty replacement is issued.

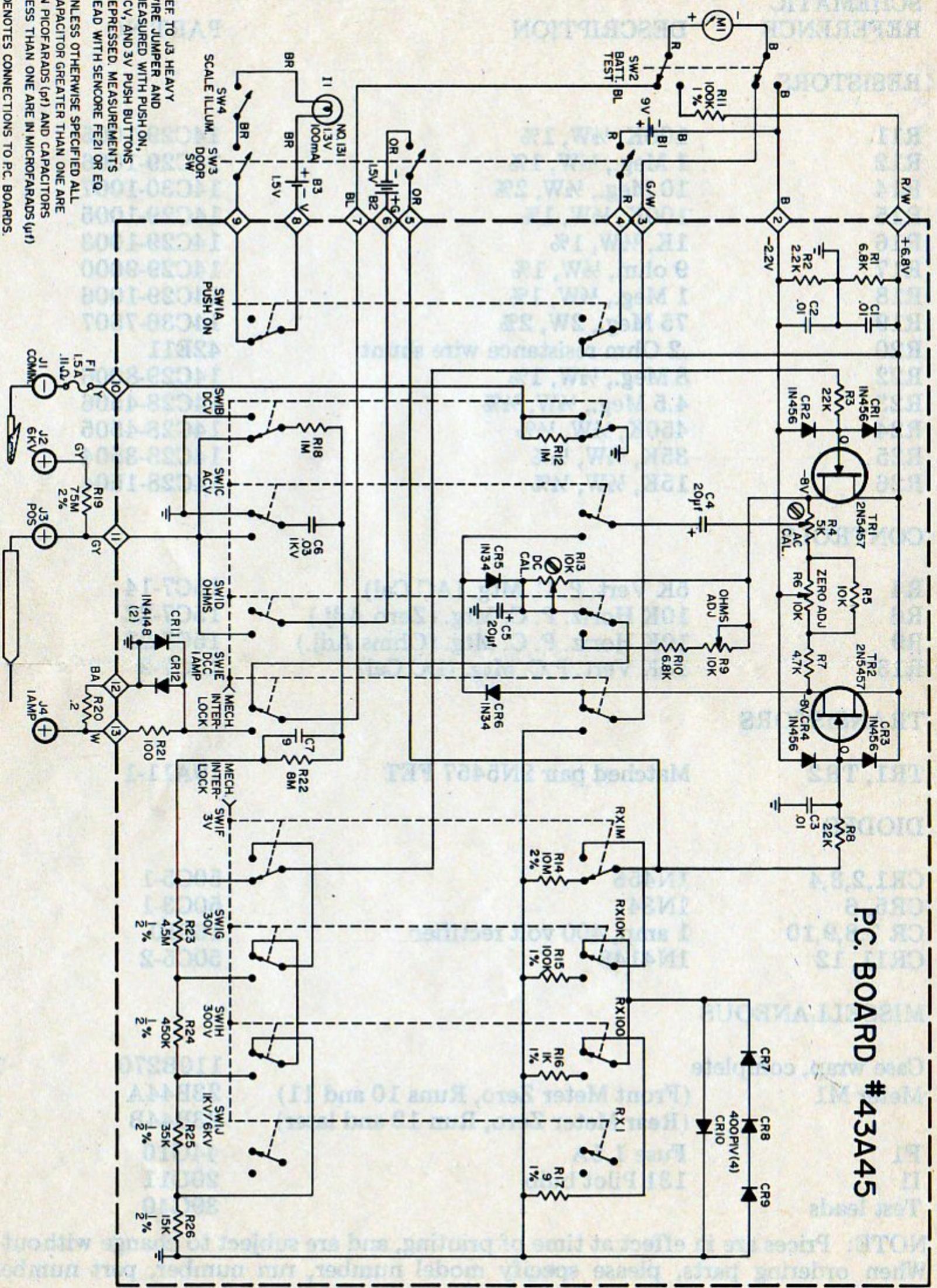
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SCHEMATIC DIAGRAM FE23