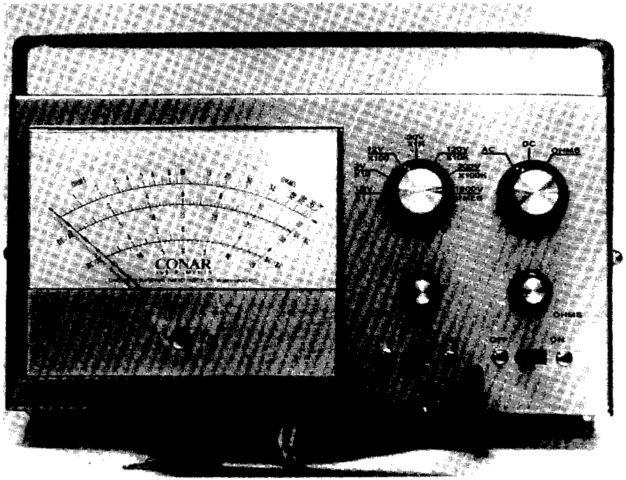


Table of Contents

The Model 212 TVOM

Whether you're an electronics hobbyist, an experienced technician, or just getting started in the field of electronics you'll find the CONAR Model 212 Transistor Volt/Ohmmeter (tvom) one of the handiest tools on your workbench. With it you can directly measure voltage and resistance values over a range that covers practically every electronic servicing or testing need. Battery operation of the meter offers the added convenience of total portability. Complete specifications for the Model 212 are listed in Table I.

Like any other fine instrument, the Model 212 must be properly used and cared for if it is to deliver the topnotch performance and long service life designed into it. If you purchased your tvom assembled, turn to Page 24 and read the operating instructions carefully before you begin using your new meter. If yours was the kit version, you're probably anxious to begin construction, so let's get started.

TABLE 1

MODEL 212 SPECIFICATIONS

7 DC Voltage Ranges:
0 – 1.2, 0 – 3, 0 – 12, 0 – 30, 0 – 120, 0 – 300, 0 – 1200
7 AC Voltage Ranges:
0 – 1.2, 0 – 3, 0 – 12, 0 – 30, 0 – 120, 0 – 300, 0 – 1200
7 Ohms Ranges:
RX1, RX10, RX100, RX1k, RX10k, RX100k, RX1 megohm
Accuracy:
3% of Full Scale, AC and DC.
AC Frequency Response:
±3 db – 10 Hz to 6 MHz. Umble to 15 MHz.
DC Input resistance:
12.2 megohms shunted by approximately 50 pf
Meter:
6", 200 microampere jeweled D'Arsonval movement
Semiconductor Complement:
2 N Channel Field Effect transistors, 4 germanium diodes
Power Requirements:
9 Volts dc - transistor radio battery; 1.5 volt "C" cell
Dimensions:
5-3/4" H × 10-3/4" W × 2-3/4" D
Weight:
3 puunds, 3 ounces

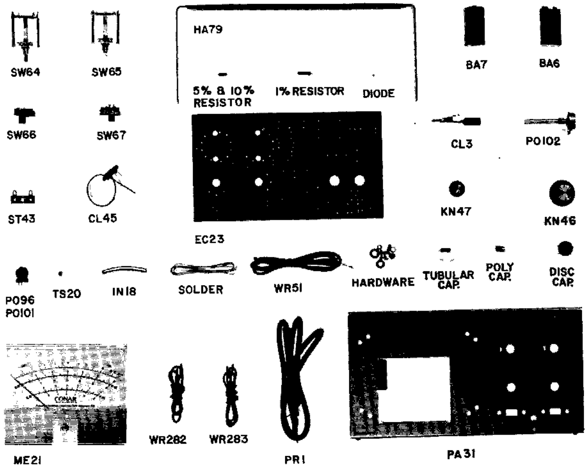


Fig. 1. Parts identification photo.

QUAN.	PART NO.	DESCRIPTION	PRICE EACH
1	BA6	9 volt transistor battery (NEDA 1604)	.68
1	BA7	1.5 volt C cell	.23
1	CB23	Cabinet*	2.95
1	CL3	Alligator clip w/insulated handle	.14
1	CL45	9 volt battery connector clip	.26
1	CN82	.01 mfd 2 kV disc capacitor	.22
1	CN104	.1 mfd disc capacitor	.36
5	CN111	5 mfd electrolytic capacitor	.35
1	CN151	56 pf disc capacitor	.03
1	CN227	120 pf disc ceramic capacitor	.15
1	CN263	22 pf polystyrene capacitor	.12
1	CN264	27 pf polystyrene capacitor	.12
1	CN265	200 pf polystyrene capacitor	.12
1	CN266	390 pf polystyrene capacitor	.12
1	CN267	2000 pf polystyrene capacitor	.15
1	CN268	3900 pf polystyrene capacitor	.18
1	CN269	.012 mfd tubular capacitor	.25
4	CR4	1N60 diode	.45
1	EC23	Etched circuit board	4.17
1	HA8	Rosin core solder	.08
1	HA79	Handle	2.18
1	IN18	4″ length spaghetti tubing	.20

QUAN.	PART NO.	DESCRIPTION	PRICE EACH
2	KN46	Large knob with pointer	.40
2	KN47	Small round knob	.32
1	ME21	6″ D'Arsonval meter, 200 microampere	11.54
5	NU1	6-32 hex nut	12/.15
2	NU12	8-32 cap nut	12/.25
1	PA31	Front Panel	3.00
1	PO96	10k-ohm trimmer potentiometer	.45
2	PO101	100k-ohm trimmer potentiometer	.23
2	PO102	10k-ohm potentiometer	.48
1	PR1	Test probe and cable	1.05
1	RE1	10 ohm, 1/2 watt, 5% resistor	.24
1	RE3	100 ohm, 1/2 watt, 5% resistor	.24
1	RE9	51k-ohm, 1/2 watt, 5% resistor	.24
1	RE10	100k-ohm, 1/2 watt, 5% resistor	.24
1	RE25	10 meg, 1/2 watt, 5% resistor	.24
1	RE33	22k-ohm, 1/2 watt, 10% resistor	.15
1	RE34	27k-ohm, 1/2 watt, 10% resistor	.15
2	RE39	1 meg, 1/2 watt, 10% resistor	.15
1	RE48	2.7k-ohm, 1/2 watt, 10% resistor	.15
2	RE50	6.8k-ohm, 1/2 watt, 10% resistor	.15
1	RE73	1 meg, 1/2 watt, 5% resistor	.24
1	RE74	10k-ohm, 1/2 watt, 5% resistor	.24
1	RE94	10k-ohm, 1/2 watt, 1% resistor	.78
1	RE95	30K-ohm, 1/2 watt, 1% resistor	.78
1	RE96	60k-ohm, 1/2 watt, 1% resistor	.78
1	RE97	300k-ohm, 1/2 watt, 1% resistor	.78
1	RE98	600k-ohm, 1/2 watt, 1% resistor	.78
1	RE99	3 meg, 1/2 watt, 1% resistor	.78
1	RE162	6 meg, 1/2 watt, 1% resistor	.78
1	RE163	2.2 meg, 1/2 watt, 1% resistor	.78
1	RE164	1k-ohm, 1/2 watt, 5% resistor	.24
2	SC4	8-32 × 3/8″ machine screw	12/.15
5	SC42	6-32 × 3/8″ Phillips head machine screw	12/.25
4	SC58	6-32 × 3/8″ self-threading machine screw	12/.25
1	ST43	2 lng terminal strip	.06
1	SW64	7 position rotary switch w/control nut	1.63
1	SW65	3 position rotary switch w/control nut	1.76
1	SW66	DPDT slide switch	.16
1	SW67	SPST slide switch	.21
2	TS20	N channel junction FET 2N5457	1.00
2	WA5	No. 8 flat washer	12/.15
2	WA14	Flat control washer	12/.15
5	WA15	No. 6 lockwasher	12/.15
2	WA16	No. 8 lockwasher	12/.15
4	WA18	No. 10 flat washer	12/.15
1	WR51	Flexible ground wire	.30
1	WR48	1′ length orange hookup wire*	12′/.25
1	WR282	2′ length black stranded HV wire	.15
1	WR283	2′ length red stranded HV wire	.15

*NOT SHOWN

Place one No. 10 flat washer on each meter stud . . . . ( )

Now carefully rotate the etched circuit board into position so that the two switch shafts will come through the upper holes in the panel and the two potentiometer shafts will come through the lower holes in the panel. The two meter studs should pass through the two large holes of the etched circuit board. Make certain that the wires from the two slide switches on the panel are free and not pinched between the switch bushings and the panel. The locating lugs of the two switches should pass through the small slots in the panels.

When you are sure the switches are correctly seated, place a large flat washer over each of the switch bushings and lightly fasten the switches with the two large control nuts. Tighten these nuts only "finger-tight" for now . . . . ( )

Now sight along the etched circuit board from the end near the meter. The board should be straight and resting on the two washers on the meter studs. If the board is "bowed" out or must be pushed in to rest on the washers, adjust the position of the 10-32 nuts on the meter studs so the board rests on the washers without bowing . . ( )

Place the remaining No. 10 flat washers over the meter studs and fasten lightly (finger-tight) with the remaining 10-32 nuts. Be careful not to strike Q_1 or Q_2 as you tighten the nuts . . . . ( )

Now look at the two potentiometer shafts coming from the front of the panel. They should be fairly well centered in the panel holes. If they are not, slightly loosen the two control nuts, which secure the two rotary switches, and the two meter stud nuts. With these four nuts loosened, you can move the etched circuit board around enough to center the potentiometer shafts. With the shafts centered, hold the circuit board in place and tighten securely the two control nuts of the rotary switches . . . . ( )

Now tighten securely the two nuts that fasten the circuit board to the meter studs, being careful not to damage Q_1 or Q_2 . . . . ( )

Now take the 1.5-volt "C" flashlight cell and tin a spot in the center of the bottom of the cell. Also tin the positive terminal of the cell . . . . ( )

Slip the "C" cell into the curved clamp beside the meter barrel, so that the positive terminal is toward the top of the panel . . . . ( )

Now locate the red and black wires which go to the + and $-1.5V$ location on the circuit board. Bring the black wire over to the battery and solder to the negative battery terminal (bottom) . . . . ( )

In a similar manner solder the red wire to the positive battery terminal (top) . . . ( )

Make sure that the SPST slide switch is in the "off" position, then take the battery

clip (connected to the "9V" location on the circuit board) and snap the connector onto the terminals of the 9-volt battery . . . . ( )

If you look into the end of your tvom where the "C" cell is mounted, you will see that there is a small shelf of metal directly below the barrel of the meter. This shelf forms a spring clamp which will hold the 9-volt battery securely. To install the 9-volt battery, lift the shelf up very slightly and slide the 9-volt battery under the shelf so that it rests on one side of the battery, holding it between the shelf and the inside wall of the panel . . . . ( )

Take one of the large knobs, with pointer, and check to see that the setscrew does not protrude into the shaft opening. Place this knob on the shaft of the range switch so that the setscrew will bear on the flat part of the shaft. Tighten the setscrew . . . ( )

In a similar manner install the other pointer knob on the function switch . . . . . ( )

There are no flats on the ZERO adjust and OHMS adjust potentiometer shafts, so install the two small round knobs on these shafts in any position . . . . ( )

This completes the electrical assembly of your tvom. You are now ready to calibrate the instrument.

CALIBRATING THE TVOM

All meter readings referred to in the following adjustment procedures are to be read on the second black scale below the red OHMS scale. This scale reads 0 to 30. Read each adjustment procedure through before you actually begin making the adjustment.

Presetting the Controls. Place the tvom face up on your worktable and preset the front panel controls as follows:

RANGE switch	3V-X10
FUNCTION switch	DC
NORMAL-REVERSE switch	Normal
ON-OFF switch	Off
ZERO adjust	Fully clockwise
OHMS adjust	Fully Counterclockwise

Now set the three potentiometers located on the circuit board as follows. These three potentiometers are accessible through the holes marked AC, BAL, and DC in the bottom of the panel. Make the adjustment by inserting a small screwdriver through each hole to engage the slot on the potentiometer.

AC CALIBRATE	Fully Clockwise
BALANCE	Fully Clockwise
DC CALIBRATE	Fully Counterclockwise

Mechanical Zero Adjustment. With the meter still lying face up on the worktable, check to see that the meter pointer rests squarely over the zero marks at the extreme left-hand edge of the meter face. If it does, the mechanical zero is correctly set and does not require further adjustment. If the pointer reads a little above or a little below the zero marks, proceed as follows.

Select a screwdriver with a blade that fits the plastic screw located in the lower center of the meter face. Using this screwdriver, turn the screw one complete revolution in a clockwise direction. Notice as you turn the screw that the meter pointer at first moves a short distance in one direction, then stops and moves a short distance in the other direction.

Now turn the screw clockwise until the pointer goes below the zero mark. Continue turning the screw slowly clockwise until the pointer is exactly over the zero mark. If you overshoot the zero mark, continue turning the screw clockwise through another complete cycle of pointer movement. The idea is to approach zero with an upward (toward center scale) motion of the pointer.

Balancing Adjustment. Read the following instructions before performing the steps indicated. The balancing adjustment compensates for slight differences in electrical characteristics of the two FET's used in your tvom. To make the adjustment, insert your screwdriver in the BAL control, move the off-on switch to the on position and short-circuit the input to the meter by connecting the ground lead to the tip of the probe. Leave the other controls in their preset positions. When you turn the meter on, the pointer will deflect either upscale or downscale. In either case, quickly adjust the balance potentiometer for a reading of about 10 on the 0 to 30 scale. When you've obtained this reading, turn the ZERO adjust control on the front panel counter-clockwise to obtain a zero reading on the 0 to 30 scale. You may have to readjust the balance control slightly so that a zero reading can be obtained with the zero adjust control. Leave the ZERO adjust control in the position which gives a zero reading on the meter.

DC Calibration Adjustment. The no-load terminal voltage of a new flashlight cell is exactly 1.55 volts. To calibrate the dc portion of your meter, you will connect the meter to measure the voltage of the C cell installed in the tvom and then adjust the dc calibration potentiometer for a 1.55 volt reading on the meter.

With the tvom still turned on and all other controls as previously set, unclip the ground lead from the tip of the probe. Touch the tip of the probe to the positive terminal of the C cell installed in the meter; the meter pointer should deflect upscale. Now adjust the dc calibration potentiometer to make the pointer read in the exact center of the space between the 15 and the first division after the 15 on the 0 to 30 scale. This point, shown in Fig. 15, corresponds to a reading of 1.55 volts.

Check the setting of this adjustment by removing the probe from the C cell and reconnecting it to the ground clip. The meter should still read zero. Reset the ZERO adjust if necessary, then again measure the voltage of the C cell by unclipping the ground lead from the probe tip and touching the probe tip to the positive terminal of the C cell. The dc calibration adjustment is correctly set when the meter reads as shown in Fig. 15, with the probe on the positive battery terminal and reads zero with the probe connected to the ground lead.

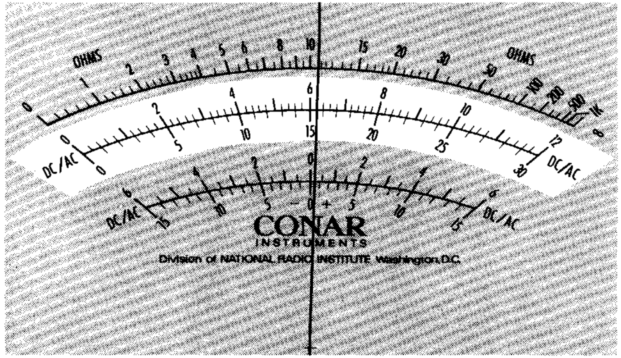


Fig. 15. Meter reading of 1.55 volts.

Now turn the ZERO adjust control fully clockwise and note the scale reading. If it is not indicating between 20 and 30 on the 0 to 30 scale, readjust the balance control to bring it within this range. If you adjust the balance control, you must go through the dc calibration procedure once again.

When you have completed the balancing adjustment on the dc calibration adjustment, record the reading you obtained on the 0 to 30 scale with the zero adjust control fully clockwise here: 29. As the battery ages and its output voltage decreases, the reading you obtain with the ZERO adjust fully clockwise will decrease. When the reading has decreased by 5 units on the 0 to 30 scale (from 25 to 20 for example), it's time to replace the 9-volt battery.

AC Calibration. To calibrate the ac portion of your meter, you will connect the meter to measure the voltage at your wall outlet and adjust the ac calibration potentiometer so that the meter correctly reads the value of this voltage. You can assume the line voltage to be 120 volts for the purpose of this adjustment.

To make the ac calibration adjustment, proceed as follows. With all controls as previously set, move the RANGE switch to the 300V position and the FUNCTION switch to the ac position. Now connect the ground lead from the meter to the screwhead which holds the cover of a wall outlet in place. This screw is at ground potential and therefore the same point electrically as the grounded side of the ac line.

Next, insert the probe tip into one of the openings of the ac outlet. If you get no reading at all on your meter, try the probe in the other opening. Leave the probe in the opening that gives a meter reading and adjust the ac calibration control until the meter pointer indicates two divisions past 10 on the 0 to 30 scale as shown in Fig. 16. This corresponds to a reading of 120 volts on the meter. To insure maximum accuracy, this adjustment should be made during mid-morning, mid-afternoon, or late evening.

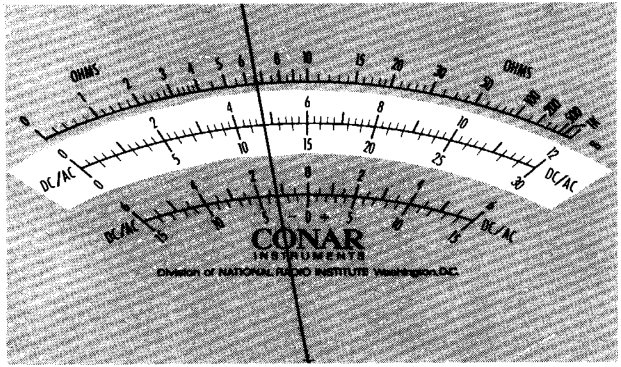


Fig. 16. A meter reading of 120 volts ac.

At these times, the load on the electric power lines is lowest and the line voltage will most probably be at its normal value.

Ohms. The OHMS function does not require calibration. However, to check the operation of the ohms circuit, switch the FUNCTION switch to ohms and adjust the OHMS adjust for a full scale reading. Switch the RANGE switch through all positions while watching the meter pointer. It should remain at full scale for each setting of the RANGE switch.

IN CASE OF DIFFICULTY

If you are not able to calibrate your tvom according to the preceding instructions, there may be an error in the wiring of the instrument, you may have a poor solder connection, or one or more of the parts may be defective.

If you get no meter reading whatever, check to be sure that the two meter terminal nuts are tight. If another 9-volt battery is available, substitute it in place of the one installed in the instrument. Check to be certain you have installed the two transistors correctly as well as the leads from the two slide switches. Check all solder connections. If you are in doubt about any of them, reheat each with your soldering iron and resolder. Beware of letting solder run over from one terminal to another, particularly in the area around the 1% resistors.

After checking your soldered connections, attempt to balance and calibrate the tvom again. If you still have no success, go back to the beginning of the manual and check your work in each assembly stage. Be certain that the correct part was installed in the correct position on the circuit board.

If you still cannot get your tvom to operate satisfactorily, write to us, giving full

details of how the tvom behaves, the results you obtained when you attempted to calibrate the instrument, and the results of any tests you may have made (such as the battery voltage). Be sure to give us complete and detailed information so that we will have a clear picture of your problem. We'll make every effort to help you get your tvom into operating condition.

ASSEMBLING THE CABINET AND HANDLE

You will need the following parts to assemble the cabinet and handle:

1 Cabinet (CB23)
1 Handle (HA79)
2 8-32 cap nuts (NU12)
2 8-32 X 3/8" machine screws (SC4)
4 6-32 X 3/8" self-threading machine screws (SC58)
2 No. 8 flat washers (WA5)
2 No. 8 lockwashers (WA16)

To assemble the handle to the cabinet, first place a No. 8 lockwasher over one of the 8-32 X 3/8" screws. Pass the screw through one of the holes in the center of one end of the cabinet from the ***inside*** to the ***outside***. While holding the screwhead and lockwasher against the inside of the cabinet, place a No. 8 flat metal washer over the screw, then position the handle so that the screw can also pass through one of the holes in the handle. Secure this assembly temporarily with one of the cap nuts. Tighten only finger-tight for now.

Following exactly the same procedure just described, secure the other end of the handle to the cabinet with a 8-32 X 3/8" screw, No. 8 lockwasher, No. 8 flat washer and a cap nut.

With both ends of the handle fastened, tighten both screws as much as possible. This will secure the handle and yet allow you to move it around to serve as a stand for the completed tvom.

To fasten the cabinet and tvom together, lay the tvom face down on a clean, soft surface such as a tablecloth or bedspread. Put the cabinet into place, being sure that the four small holes in the back of the tvom panel line up with the holes in the cabinet. Now fasten the cabinet to the tvom with the four 6-32 X 3/8" thread-cutting screws. **DO NOT OVERTIGHTEN THESE SCREWS.** The tvom panel is aluminum, and if you overtighten the screws they will probably pull out of the aluminum. This completes the assembly of the tvom.

Operating the TVOM

Your CONAR Model 212 tvom can be used to measure ac voltages, dc voltages, and resistances. The operating controls are conveniently arranged for simple switching from one function to another. Only one set of test leads is used to take the readings on all functions. The readings are indicated on an easy-to-read 6" meter. The scale on the meter that indicates the correct reading depends on the function selected and the setting of the range switch. A detailed discussion of the use of the scales is included in these operating instructions. A few minutes spent in studying these operating instructions will be repaid in easier and more pleasant use of this fine instrument.

OPERATING CONTROLS

The operating controls are identified and their functions described by Fig. 17 and the paragraphs which follow:

FUNCTION Switch. (1) Selects the operating mode of the tvom. In the ac position, the meter will read the RMS value of sinusoidal ac voltages. In the dc position, the meter reads the value of dc voltages. The meter reads resistance values when the OHMS position is selected.

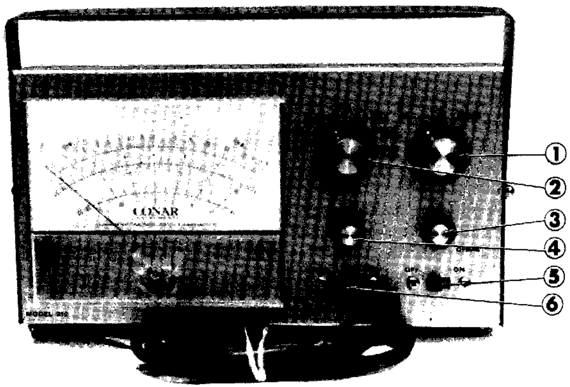


Fig. 17. Identification of panel controls.

RANGE Switch. (2) Selects the operating range of the meter according to the setting of the FUNCTION switch. In the ac or dc positions of the FUNCTION switch, the RANGE switch indicates the scale to be used and the maximum scale reading. In the Ohms position of the FUNCTION switch, the RANGE switch indicates a factor by which the ohms scale reading must be multiplied.

OHMS Adjust. (3) Adjusts the internal circuit so that the meter pointer indicates infinity (∞) when the OHMS function is selected and the meter leads are open-circuited.

ZERO Adjust. (4) Balances the internal circuit so that the meter pointer indicates zero with no input to the meter.

ON-OFF Switch. (5) Supplies or removes power from the internal circuit of the instrument. In the ON position, operating power is applied to the internal meter circuit from a self-contained 9-volt battery. This switch must be in the ON position before voltage or resistance readings can be made. In the OFF position the battery is disconnected from the internal meter circuit.

NORMAL-REVERSE Switch. (6) Reverses the internal connection of the ground lead and probe lead. In the NORMAL position the ground lead is connected to the internal circuit ground and the probe lead is connected to the high side of the meter circuit. In the REVERSE position, the lead connections are reversed.

READING THE METER SCALES

There are five different scales printed on the meter face. The 7 RANGE switch positions, however, give an effective total of 21 scales. For example, any reading on the Ohms scale must be multiplied by the factor selected by the RANGE switch. Thus a reading of 8 on the Ohms scale can indicate 8 ohms in the X1 position of the RANGE switch, 80 ohms in the X10 position, and so on with the remaining positions of the RANGE switch indicating, in order, 8k-ohms, 80k-ohms, 800k-ohm, and 8-megohms.

When you measure ac or dc voltages, the scales printed on the meter face are also modified by the setting of the RANGE switch. The RANGE switch selects the scale to be read and, indirectly, indicates a multiplying factor for the scales. For example, the 1.2V, 12V, 120V, and 1200V positions of the RANGE switch all refer to the 0 to 12 scale on the meter. In each of these positions of the RANGE switch, however, the actual scale reading is multiplied by a factor which makes the maximum scale reading (which is 12) equal the RANGE switch selection. Thus, in the 1.2V position, the actual reading on the 0 to 12 scale is multiplied by .1. Similarly, in the 12V position, the scale reading is multiplied by 1 or the scale may be read directly. In the 120V and 1200V positions of the RANGE switch you must multiply the scale reading by 10 and 100 respectively.

The three remaining positions of the RANGE switch (3V, 30V, and 300V) refer to the 0 to 30 scale on the meter face. Just as with the other switch positions, the 3V, 30V, and 300V positions indicate a multiplying factor for the scale used with them. The multiplying factors for these last three positions are .1, 1, and 10. As before, the multiplying factor to be used is the one which makes the maximum scale reading (which is 30) equal the RANGE switch selection.

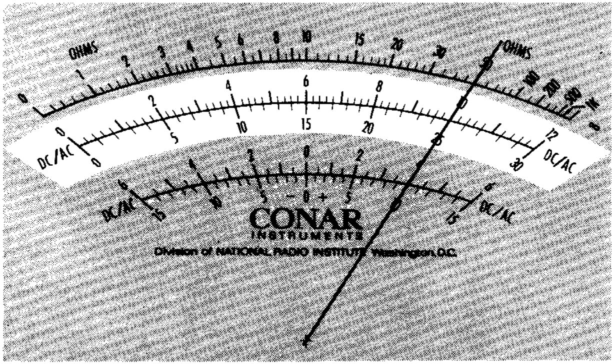


Fig. 18. A meter reading of 25 or 10.

At this time we will concentrate on the 0 to 12 and 0 to 30 volt scales. As you will see, the two scales may often be used together to help you obtain precise readings. These two scales are shown in white in Fig. 18. The 0 to 12 volt scale is the upper scale and has the numbers 0, 2, 4, 6, 8, 10 and 12 printed in black. The 0 to 30 volt scale is the lower scale and has the numbers 0, 5, 10, 15, 20, 25 and 30 printed in black. Notice that the 0 to 12 volt scale has several short marks as well as some longer unnumbered marks. The 0 to 30 volt scale has four short unnumbered marks between each number.

Now look at the meter shown in Fig. 18. In this case the pointer is indicating 10 on the 0 to 12 volt scale and shows 25 on the 0 to 30 volt scale. If the pointer is as shown in Fig. 19, the reading would be 10 on the 0 to 30 volt scale and 4 on the 0 to 12 volt scale. These readings are quite easy to determine, as you can see, but what happens if the pointer is somewhere between the numbers on the scale?

Look at the scale shown in Fig. 20. Now the pointer is over one of the short marks of the 0 to 12 volt scale, but is between two short marks on the 0 to 30 volt scale! To read this value, note that on the 0 to 12 volt scale there are nine marks (or ten spaces) between 6 and 8, eight short marks and one long mark. The long mark represents 7 volts, and each short mark represents 0.2V. The pointer in Fig. 20 is on the third short mark following the 6 volt mark. Since each short mark is 0.2V, the pointer shows a reading of 6.6 volts.

Now, what is the reading of Fig. 20 on the 0 to 30 volt scale? First, notice that between 15 and 20 there are four short marks. Each mark, therefore, represents one volt. The pointer is halfway between the first and second marks following 15 so the reading is 16.5 volts. You can tell that the pointer is ***exactly*** halfway between the two marks by looking at the upper (0 to 12 volt) scale. On this scale, every other mark falls

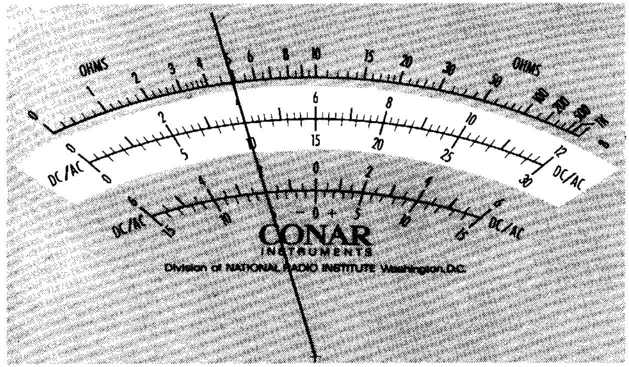


Fig. 19. A meter reading of 10 or 4.

exactly halfway between the one volt marks on the 0 to 30 volt scale. This means that while the 0 to 30 volt scale is marked in one volt steps, you can determine readings to one half a volt by looking at the divisions on the 0 to 12 volt scale.

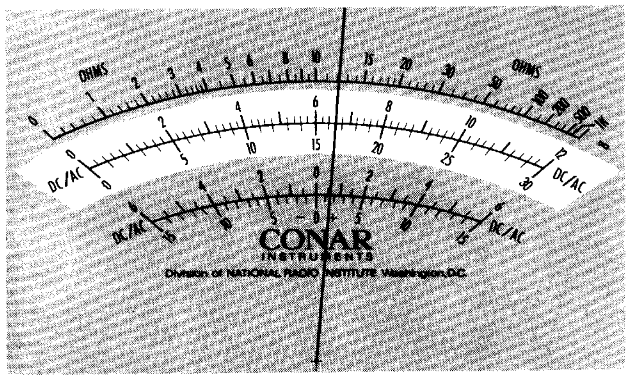


Fig. 20. Another sample meter reading.

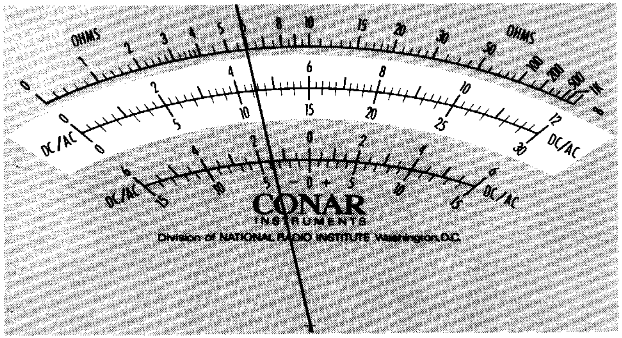


Fig. 21. Here is another meter reading for you to practice on.

There is always the possibility that the pointer will not fall precisely on one of the short marks of the 0 to 12 volt scale. How are these values read? Take a look at Fig. 21. Notice here that the pointer is halfway between the second and third short marks after 4 on the 0 to 12 volt scale. This would be a reading of 4.5 volts. On the 0 to 30 volt scale it is just as easy. The pointer falls one fourth of the way between the first and second mark after 10, so the reading is 11.25 volts.

As a final example, try your hand at reading the two values indicated in Fig. 22. Again, the pointer does not fall on any of the scale marks of either scale. Let us see

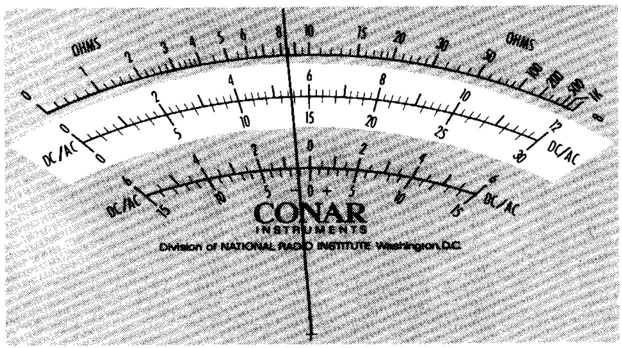


Fig. 22. What is the indication on this meter?

how close we can come to reading the meter by applying what we have already learned. On the 0 to 12 volt scale, the pointer is between 5 and 6. We can be more exact than that; it appears to be halfway between the second and third marks following the (unmarked) 5-volt mark. The first mark is 5.2 volts, the second mark is 5.4 volts and the third mark is 5.6 volts. Therefore the reading is between 5.4 and 5.6 volts. How much, is the question. The pointer falls about halfway between 5.4 and 5.6 volts, so we would call it 5.5 volts. There is, of course, some uncertainty in this reading.

What reading does Fig. 22 represent on the 0 to 30 volt scale? Well, it is somewhere between 10 and 15 volts. Each short mark represents one volt, so the reading would be between 13 and 14 volts. Remember that the short mark on the *upper* scale (0 to 12 volts) is exactly halfway between the 13 and 14 volt marks, or in other words represents 13.5 volts. The pointer falls to the ***right*** of this mark so the reading must be between 13.5 and 14.0 volts. We would probably call this 13.75 volts; any value from 13.7 to 13.8 volts would be sufficient.

Measuring Resistance. To set up your tvom to measure resistance, set the ON-OFF switch to the ON position, the FUNCTION switch to the Ohms position and the NORMAL-REVERSE switch to the NORMAL position. Now short-circuit the meter leads by connecting the ground clip to the tip of the probe and turn the **ZERO** adjust control to obtain a zero reading on the Ohms scale. Next, separate the meter leads and adjust the **OHMS** adjust for a reading of infinity on the Ohms scale. The **ZERO** adjust and **OHMS** adjust controls interact, so recheck the zero setting by again shorting the test leads and readjusting the **ZERO** adjust control as necessary. The **OHMS** adjust will then have to be set once more with the leads open. The two controls are correctly set when the meter indicates zero ohms with the leads shorted and indicates infinity with the leads open. You're now ready to measure the value of an unknown resistor.

Connect the ground lead to one end of the resistor under test and touch the probe tip to the other end. With the two leads connected in this manner, select a position of the RANGE switch which gives a meter reading near the middle of the Ohms scale. Multiply the meter reading by the multiplication factor indicated by the RANGE switch and you have the value of the unknown resistor.

When you measure the value of a resistor with your tvom, current from an internal battery flows, via the test leads, through the resistor under test. With the NORMAL-REVERSE switch in the NORMAL position, the probe lead is positive with respect to the ground lead. The polarity of the test leads may be reversed by moving the normal-reverse switch to the reverse position. This feature is handy when checking polarity sensitive components such as diodes and transistors with the ohmmeter function of your tvom.

WARNING

Never attempt to measure resistance in a "live" circuit. Always turn off the current to any circuit in which you are going to measure resistance. An external voltage applied to the tvom when the FUNCTION switch is in the Ohms position will almost certainly ruin one of the transistors in the meter circuit.

Measuring Positive DC Voltage. To set up your tvom to measure positive dc voltage, set the ON-OFF switch to the ON position, the FUNCTION switch to the DC position, the NORMAL-REVERSE switch to the NORMAL position, and the RANGE switch to the 1200V position. With the meter leads shorted together, set the ZERO adjust control for a zero reading on the meter.

Now connect the ground lead to a ground point in the circuit under test and touch the probe tip to the point where the voltage is to be measured. The RANGE switch may now be set to a lower position, if necessary, so that the meter reads near the mid-portion of a scale. Before switching to a lower voltage range, make sure that the voltage reading obtained will not drive the meter off scale on the next lowest range.

For example, if you obtained a reading of 400V with the meter set to the 1200V range, you could not switch to the next lowest range because it reads a maximum value of only 300V. The 400-volt reading would drive the meter pointer completely off scale if you were to do this. It's a good practice when measuring voltage with your tvom to always start at the highest voltage range, then lower the range once you've determined the approximate value of the voltage being measured. This way you'll avoid meter damage caused by driving the meter off scale.

Measuring Negative DC Voltage. If a negative dc voltage is to be measured, set the meter controls, except the NORMAL-REVERSE switch, the same as for measuring a positive dc voltage. The NORMAL-REVERSE switch should be set to the REVERSE position. As before, connect the ground lead to a ground point in the circuit under test and touch the probe tip to the point where the voltage is to be measured. Select a lower voltage range, if necessary, to obtain a reading near the middle of the scale and read the meter.

Using the Zero Center Scales. The two scales nearest the bottom of the meter face read zero in the center and increasing values to the right and left of center. One use of these scales is in making tests on circuits where the polarity of the voltage being measured may change during an adjustment of the circuit. When using these scales, the meter controls are set the same as for measuring a positive dc voltage. However, the ZERO adjust control is set so that the meter pointer rests on the zero at the center of these scales with the test leads shorted together. To make the measurement, the ground lead, as in all voltage measurements, is connected to the circuit ground and the probe tip touched to the point where the measurement is to be made. Pointer deflection to the left of center indicates a negative voltage on the probe tip, and deflection to the right indicates a positive voltage on the probe tip. The scale marked 6-0-6 is used with the 1.2V, 12V, 120V, and 1200V positions of the range switch. The scale marked 15-0-15 is used with the 3V, 30V, and 300V positions.

Measuring AC Voltages. AC voltage measurements are made with the meter controls set the same as for positive dc voltage measurements except that the FUNCTION switch is set to the AC position. The NORMAL-REVERSE switch must always be set to the NORMAL position when measuring an ac voltage. While the meter will read upscale in either position of the switch, it is only in the NORMAL position that the shielded probe lead is connected to the high side of the input circuit. If the shielded lead is not connected to the high side of the input circuit, the ac voltage readings are likely to be in error due to the stray pickup by the unshielded lead.

HIGH VOLTAGE DC MEASUREMENTS

If you purchased the high voltage probe with your tvom, you can measure dc voltages up to 30,000 volts.

WARNING

To avoid the possibility of a shock, the tvom ground clip must ALWAYS be attached to the negative side of the voltage source you are to measure and you must hold the probe by its black end.

Insert the probe of your tvom into the hollow handle of the high voltage probe so the tvom probe tip is fully engaged. Attach the tvom ground clip to the negative side of the receiver circuit. Set the FUNCTION switch to dc and the RANGE switch to 1200 volts. Holding the high voltage probe so the round flanges are between your hand and the red tip, touch the tip of the probe to the voltage source.

Read the voltage on the 0 to 30 scale and multiply your reading by 1000. A reading of 30 is 30,000 volts, the maximum voltage which can be measured. A reading of 12.5 is 12,500 volts. A meter reading of 11 indicates 11,000 volts.

Just remember when using the high voltage probe to set the RANGE switch to 1200 volts and that the range of the tvom is now 0 to 30,000 volts; read the 0 to 30 scale. If you did not purchase a high voltage probe with your tvom, they are available postpaid from CONAR for $5.50.

Maintenance

Your CONAR Model 212 TVOM has been designed to give many years of service with just minimum care. Occasional replacement of the internal batteries is about all that's necessary to keep the instrument in top operating condition.

Two batteries are used in your tvom: a 1.5-volt C cell and a 9-volt transistor radio type battery. The C cell is used only on the Ohms function of the meter. A weak C cell is indicated when readings on the low resistance ranges of the Ohms scale are in error or the meter pointer cannot be set to infinity using the OHMS adjust control.

The 9-volt battery supplies power to the electronic circuit which makes the meter indicate and is therefore used on all functions of the tvom. This battery should be replaced whenever a reading of 20 or higher on the 0 to 30 scale cannot be obtained with the ZERO adjust control fully clockwise.

To replace a battery, remove the four screws from the back of the meter cabinet. The meter may then be separated from the cabinet, allowing access to the batteries. Now place the tvom face down on a soft cloth to avoid scratching the plastic meter face. If the C cell is to be replaced, unsolder the leads connected to its terminals before sliding the battery from the mounting clip. With the leads unsoldered, slide the battery in a direction away from the 9-volt battery until it is free of the clip. Tin the terminals of the replacement battery, then slide it into the clip moving it toward the 9-volt battery. Now solder the red lead to the positive terminal of the new battery and the black lead to the negative terminal.

To replace the 9-volt battery, spring the mounting shelf slightly to release its grip on the battery. You can use a screwdriver as a lever to spring the shelf away from the battery. The battery may then be pulled from its mounting position, using the leads attached to the battery clip. Once the battery is removed, unsnap the battery clip and reconnect it to the new battery. Insert the new battery into the mounting position by reversing the procedure used for removal.

The complete schematic diagram for the Model 212 tvom is shown in Fig. 23. If your instrument develops a defect which you cannot locate, you may use our free CONAR consultation service for assistance. Write us a letter explaining how the meter behaves and what you have done in an effort to correct the problem. Since the amount of help we're able to give you will depend on how much information you give us, try to be as specific as possible in explaining the nature of your trouble. Include the results of any tests which you may have made.

If you prefer, you may send the completed instrument back to us for repairs. On units returned after the warranty period has elapsed, a minimum charge of $5.00 will be made plus the cost of any parts which must be replaced. Send a separate letter telling us the instrument is on its way, enclosing the $5.00 minimum charge in the form of a check or money order. ***Do not send cash.*** Pack the instrument in a sturdy container surrounded with suitable packing material such as shredded newspaper. Ship by insured parcel post.

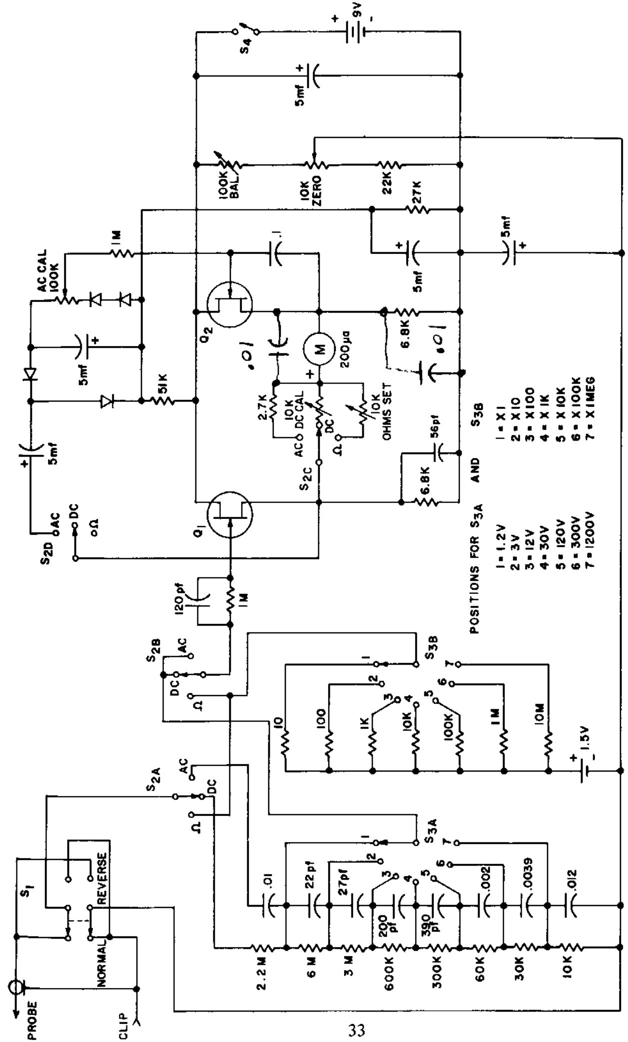
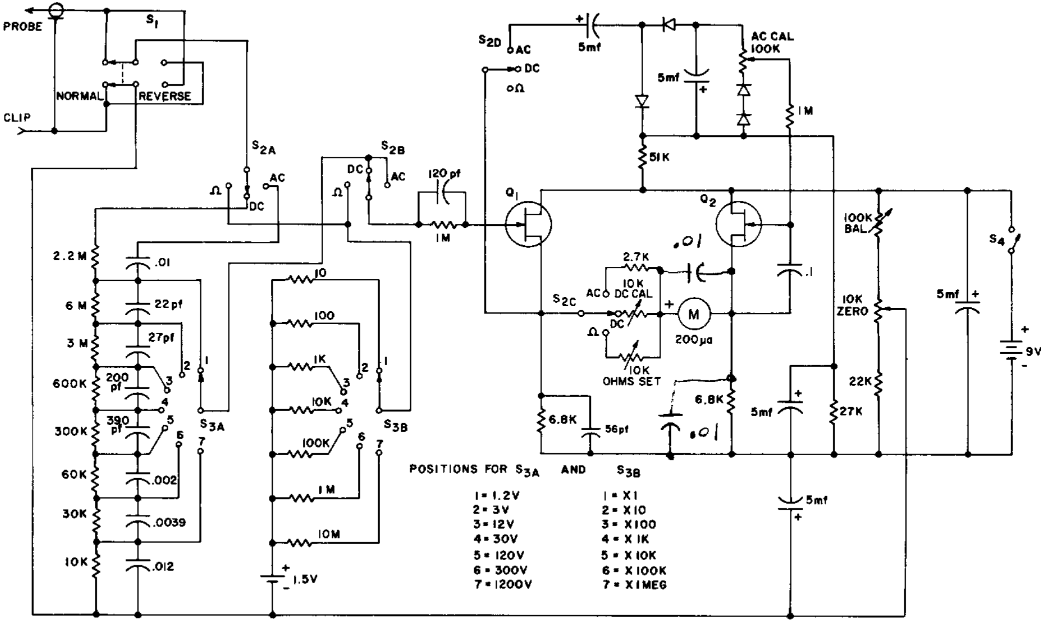


Fig. 23. Schematic of the Model 212 TVOM.



Schematic of the Model 212 TVOM.