PRICE ONE DOLLAR

RCA SENIOR VOLTOHMYST®

Type WV-98A

- Specifications
- Operation
- Applications
- Maintenance

RADIO CORPORATION of AMERICA
ELECTRON TUBE DIVISION
HARRISON, N. J.

ITEMS
Supplied with the WV-98A

1 DC/AC-OHMS Probe and Cable.....Type WG-299C
1 1.5-Volt Battery.....Type VS036
1 Slip-on Alligator Clip — 1 Insulator
1 RCA-6AL5 Tube — 1 RCA-12AU7 Tube
1 Instruction Booklet for WV-98A
1 Registration Card

ACCESSORIES
Available on Separate Order

For measuring AC Voltages at Frequencies from 50 Kc to 250 Mc:
Crystal-Diode Probe.....Type WG-301A
For increasing DC Voltage Range to 50,000 Volts:
High-Voltage Probe.....Type WG-289
Multiplier Resistor.....Type WG-206

> NOTE
> The types WG-299A, WG-299B, WG-299C, and WG-299D DC/AC-OHMS Probe and Cables can be used interchangeably with the WV-98A.

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TEST AND MEASURING EQUIPMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

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Senior VoltOhmyst
Type WV-98A

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Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit. For proper operation, the ground terminal of the instrument should always be connected to the ground of the equipment under test. The WG-299C DC/AC-OHMS Probe and Cable has a shield throughout its entire length which is connected to the instrument ground and case. Always handle the WG-299C by the insulated probe housing.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be *especially careful* to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

General Description

The WV-98A Senior VoltOhmyst* is an all electronic voltmeter designed to measure dc voltages, resistance, rms values of sine waves, and peak-to-peak values of complex waves. Both rms ac and dc voltages up to 1500 volts may be measured in seven ranges with an accuracy of ±3% of full scale. Resistance values up to 1000 megohms, and complex waveforms having peak-to-peak values up to 4200 volts may also be measured. All measurements are made on a 6½ inch burn-out-proof meter. Separate scales for each function provide improved visibility and permit more accurate readings between scale divisions.

An input resistance of 11 megohms on all dc-voltage ranges allows the WV-98A to be used in circuits where instruments with a lower impedance would result in loading of the circuit under test and a resultant error in reading the operating voltage. The 11-megohm input resistance also has the advantage of not being so high as to impair the stability of the instrument.

The WV-98A is frequency compensated for ac-voltage ranges up to and including the 500-volt range (500 rms volts or 1400 peak-to-peak volts) and can be used at frequencies up to approximately 3 megacycles, depending upon the impedance of the source voltage. (The extended frequency range of the Senior VoltOhmyst, coupled with its high sensitivity, makes it a convenient and reliable device for use in rf applications.) The impedance on ac measurements is a minimum of 0.83 megohm.

Calibration of the Senior VoltOhmyst in peak-to-peak voltage values as well as rms voltage values is a desirable feature for applications such as television, radar, and other pulsed electronic systems where complex waveforms are encountered. Because the meter reading is proportional to the full peak-to-peak value of the waveform, a better indication of the true value of the voltage is given than is possible with voltmeters which respond only to the positive or negative peak of the waveshape. Peak-to-peak voltage values are measured directly on separate meter scales.

When used to measure resistance, the WV-98A will read from 0.2 ohm to 1000 megohms in seven ranges. Convenient mid-scale values are set at 10, 100, 1000, 10,000, and 100,000 ohms and at 1 and 10 megohms.

All measurements are made with a new single-unit probe, the WG-299C DC/AC-OHMS Probe and Cable. The probe is quickly adapted to either dc measurements, or ac and resistance measurements by means of a built-in switch. A fixed ground lead connected to the chassis of the WV-98A insures good grounding of the circuit under test.

The WV-98A is housed in a smartly-styled diecast aluminum case. The light-

*Trade Mark "VoltOhmyst" Reg. U. S. Pat. Off.

weight probe and cable supplied with the WV-98A has been designed to match the mechanical and electrical characteristics of the instrument.

Additional features of the WV-98A include provision for zero-centering of the meter pointer, a useful feature for checking FM discriminator alignment; two separate scales for low-voltage ac measurements; a pilot light; and circuit design which permits measurements of the ac component of a dc voltage or the dc component of an ac signal. Circuit design also prevents any dc-loading effect when the WV-98A is used to measure ac voltages.

For measurement of ac voltages at frequencies up to 250 megacycles, the auxiliary WG-301A Crystal-Diode Probe may be used. The WG-301A slips on the front end of the WG-299C to form a sturdy, insulated rf probe without the addition of an extra cable. When the auxiliary WG-289 High-Voltage Probe is connected to the input terminal of the Senior VoltOhmyst, dc voltages up to 50,000 volts may be measured.

The RCA WV-98A Senior VoltOhmyst is a versatile instrument, designed to give quality performance. A reliable measuring device, it enables the user to make a wide variety of accurate electrical measurements in many kinds of electrical equipment.

Specifications

Electrical

NOTE: Performance figures are for line voltage of 117 volts, 60 cps.

DC Voltmeter:

Ranges ..... 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance (With switch on WG-299C set to "DC"):
All Ranges ..... 11 Megohms
Sensitivity on 1.5-V Range ..... 7.3 megohms/volt
Over-all Accuracy ..... ±3% of full scale

AC Voltmeter:

Ranges:
RMS Values of Sine Waves ..... 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Peak-to-Peak Values of Sine Waves & Complex Waves ..... 0 to 4, 14, 42, 140, 420, 1400, 4200 volts
Over-all Accuracy ..... ±3% of full scale
Input Resistance and Capacitance
(With switch on WG-299C set to "AC-OHMS"):
1.5, 5, 50, 150-V Ranges ..... 0.83 meg. shunted by 70 $\mu\mu f$
500-V Range ..... 1.3 meg. shunted by 60 $\mu\mu f$
1500-V Range ..... 1.5 meg. shunted by 60 $\mu\mu f$

Frequency Response:
NOTE: The response data below are for the 1.5, 5, 15, 50, 150, and 500 volt ranges. The 1500-volt range is flat at power-line frequencies.
(With switch on WG-299C set to "AC-OHMS"):
For source impedance of approximately 100 ohms ..... 30 cps to 3 Mc□
For source impedance of approximately 1000 ohms ..... 30 cps to 500 Kc△
For source impedance of approximately 5000 ohms ..... 30 cps to 270 Kc○
For source impedance of approximately 10,000 ohms ..... 30 cps to 80 Kc◆
With Crystal Probe WG-301A● ..... within 10% from 50 Kc to 250 Mc

Maximum Input Voltages:

DC Voltages with no ac voltage present: ..... 1500 volts
AC Voltages with no dc voltage present:
RMS for Sine Waves ..... 1500 volts
Peak-to-Peak for Sine Waves ..... 4200 volts
Peak-to-Peak for Complex Waves ..... 2000 volts
Combined AC and DC Voltages:
Sum of DC Voltage and AC Peak Voltage ..... 2000 volts

Ohmmeter:

Ranges, Seven ..... 0 to 1000 megohms

Meter Movement:

DC Current for Full-Scale Deflection ..... 200μ amperes

Power Supply:

Voltage Rating ..... 105-125 volts
Frequency Rating ..... 50/60 cps
Power Consumption (Approx.) ..... 6 watts
Battery (1.5-volt cell) 1 RCA-VS036

Tube Complement: 1 RCA-6AL5, 1 RCA-12AU7

Mechanical

Over-all Dimensions:

Height ..... 6½ inches
Width ..... 7 inches
Depth ..... 3¾ inches

Weight: ..... 6 pounds

Finish: ..... Blue-grey hammeroid case—satin aluminum panel

□ Response is up about 10% at 3 Mc.
△ Response is up about 10% at 500 Kc.
○ Response is down about 10% at 270 Kc.
◆ Response is down about 10% at 80 Kc.
● Available on separate order.

Functions of Controls

FUNCTION SELECTOR—Applies power to the instrument when this control is turned clockwise from the "OFF-TRANSIT" position and selects the measurement function of the instrument. When this switch is set to the "OFF-TRANSIT" position, power is removed and, a short is placed across the meter terminals to lock meter pointer electrically in the zero position, thereby reducing the possibility of damage to the meter movement when the instrument is being transported.

RANGE SELECTOR—Selects the ac- or dc-voltage range or the resistance range on which the measurement is to be made.

ZERO control—Used to position the meter pointer at either the left-hand "0" position or, when function selector is set to "+DC VOLTS", to the zero-center "0" position.

OHMS control—Used to position the meter pointer at the extreme right line on the "R" scale when the function selector is set to "R OHMS". NOTE: The WG-299C DC/AC-OHMS Probe and Cable is used for all measurements. The cable connector attaches to the front-panel connector of the WV-98A. The ground cable, which is permanently attached to the instrument, is connected directly to the chassis and serves as a common return point for all resistance and ac- and dc-voltage measurements.

Operation and Application

Use of WG-299C Probe and Cable:

The WG-299C DC/AC-OHMS Probe and Cable, supplied with the WV-98A, is constructed as a single-unit probe and cable and is equipped with a sliding switch in the probe body to permit changing the probe characteristics to suit the type of measurement being made. When the sliding switch is set forward to the "DC" position, a built-in 1-megohm resistor is placed in series with the probe tip and the input to the WV-98A. This resistor acts to isolate the instrument from the circuit under test when dc-voltage measurements are made and is a part of the over-all input resistance of the voltmeter. The switch should always be set to the "DC" position when dc-voltage measurements are made and when the WG-301A Crystal-Diode Probe is used.

When the sliding switch is set to the rear or "AC-OHMS" position, the isolating resistor is shorted out and the signal or test voltage is fed directly from the probe tip to the input of the WV-98A. The switch should always be set to the "AC-OHMS" position when resistance or ac-voltage measurements are made.

Preliminary Adjustments:

To prepare the WV-98A for use, make the following connections and adjustments:

1. Connect the WG-299C DC/AC-OHMS Probe and Cable to the front-panel connector.

2. Plug the power cord into an ac outlet supplying 105-125 volts at 50-60 cps and adjust the controls as follows:

a. Set the function selector to "+DC VOLTS" and allow a few minutes for the instrument to warm up.

b. Adjust the ZERO control to position the meter pointer at the left-hand zero on the scales.

c. Turn the function selector to "R OHMS". The pointer should deflect to approximately full scale.

d. Rotate the OHMS control to position the pointer at the last line on the "R" (ohms) scale.

e. Turn the function selector to the "AC" position, and set the range switch to the "1.5V" position. The pointer should deflect back to the left-hand zero. The instrument is now ready for use.

Use of Range Switch and Meter Scales:

The meter scales on the WV-98A have been designed to provide ease of operation and quick readability over a wide range of measurements. Scales have been grouped according to the type of measurement for which they are used. The "R" scale, at the top of the scale plate, is used only for resistance measurements, and all resistance measurements are read from this one scale. All dc voltages are read from the two scales marked "A" and "B" in Figure 1. The eight remaining scales are used only for ac-voltage measurements. The rms values of sine-wave voltages are read from scales marked "C", "D", "E", and "F". The corresponding peak-to-peak values are read from scales marked "G", "H", "J", and "K". The particular scale which is used for any given function is determined by the setting of the range switch.

Table I has been prepared as an aid in selection of ranges, scales, and multiplying factors for all measurements which can be made with the WV-98A.

Because of the wide number of measurement ranges provided on the WV-98A, it is often possible to take voltage or resistance reading on two ranges and scales. For greatest accuracy in voltage measurements, always use the range which will provide an on-scale reading which is nearest to the full-scale point. For example, 48 dc volts can be read from either the 50-volt or the 150-volt range. Because the

(continued on page 12)

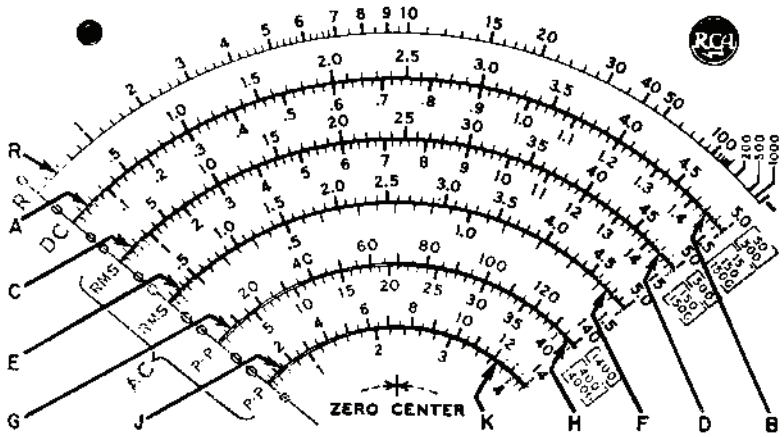

Figure 1. WV-98A meter scales

TABLE 1
RESISTANCE MEASUREMENTS

(Set Function switch to "R OHMS" and set WG-299C switch to "AC-OHMS".)

Resistance to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.2 to 1000Ω	R X 1	R	1
1000 to 10000Ω	R X 10	R	10
10000 to 100000Ω	R X 100	R	100
100000Ω to 1 MEG	R X 1000	R	1000
1 MEG to 10 MEG	R X 10K	R	10000
10 MEG to 100 MEG	R X 100K	R	100000
100 MEG to 1000 MEG	R X 1 MEG	R	1 MEG

DC VOLTAGE MEASUREMENTS

(Set Function switch to "—DC VOLTS" or "+DC VOLTS" and set WG-299C switch to "DC".)

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.02 to 1.5V	1.5V	B	1
1.5V to 5V	5V	A	1
5 to 15V	15V	B	10
15 to 50V	50V	A	10
50 to 150V	150V	B	100
150 to 500V	500V	A	100
500 to 1500V	1500V	B	1000

AC RMS VOLTAGE MEASUREMENTS

(Set Function switch to "AC" and set WG-299C switch to "AC-OHMS".)

RMS voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent peak-to-peak value: Use Scale	Multiply by
0.1 to 1.5V	1.5V	F	1	K	1
1.5V to 5V	5V	E	1	J	1
5 to 15V	15V	D	1	H	1
15 to 50V	50V	C	1	G	1
50 to 150V	150V	D	10	H	10
150 to 500V	500V	C	10	G	10
500 to 1500V	1500V	D	100	H	100

AC PEAK-TO-PEAK VOLTAGE MEASUREMENTS

(Set Function switch to "AC" and set WG-299C switch to "AC-OHMS".)

Peak-to-peak voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent RMS value: Use Scale	Multiply by
0.2 to 4V	4.0V	K	1	F	1
4 to 14V	14V	J	1	E	1
14 to 40V	40V	H	1	D	1
40 to 140V	140V	G	1	C	1
140 to 400V	400V	H	10	D	10
400 to 1400V	1400V	G	10	C	10
1400 to 4200V	4000V	H	100	D	100

NULL INDICATIONS (DC VOLTS)

(Set Function switch to "+DC VOLTS" and set WG-299C switch to "DC".)

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
—.75 to +.75V	1.5V	B	1
—2.5 to +2.5V	5V	A	1
—7.5 to +7.5V	15V	B	10
—25 to +25V	50V	A	10
—75 to +75V	150V	B	100
—250 to +250V	500V	A	100
—750 to +750V	1500V	B	1000

50-volt range will provide a reading nearest the full-scale point, the 50-volt range only should be used if a reading of best accuracy is to be obtained. This general rule applies to all ac- and dc-voltage ranges. For ohms measurements, however, the range selected should be the one which provides a reading nearest the *center* of the scale because the VoltOhmyst provides the most accurate readings at mid-scale points.

For some measurements it will be necessary to use a multiplying factor with the scale reading to obtain the correct reading. The required multiplier is indicated by the setting of the range switch. These ranges correspond to the full-scale values shown on the right side of the meter scales. For example, when the range switch is set to the 500-volt position for a dc-voltage measurement, the "A" scale (Figure 1) is used. Because this scale has a full scale value of "5", it is necessary to multiply any readings on this scale by 100 to obtain the correct value.

DC-Voltage Measurements:

NOTE: The sliding switch on the WG-299C should be set to "DC" for all dc-voltage measurements. Maximum input voltages must not be exceeded. See "Specifications" and "Safety Precautions".

The WV-98A has seven dc-voltage ranges: 0 to 1.5, 5, 15, 50, 150, 500, and 1500 volts. Although the meter is protected against burn-out under ordinary overloads, it is good practice to make a trial measurement at a range setting higher than the voltage expected. Continued or repeated overloads may impair the accuracy of the movement. To measure dc voltages, proceed as follows:

1. Set the function selector to "+DC VOLTS" or to "—DC VOLTS", as required.
2. Connect the clip of the ground cable to ground.
3. Set the range selector to a range position higher than the voltage to be measured.
4. Touch or connect the probe tip to the high side of the source voltage.
5. Reset range selector to a position which gives a reading nearest to full scale.
6. Read the dc voltage from the scale corresponding to the range selector setting.

Zero-Center Indication:

Zero-center indication is frequently useful because it allows observation of either positive or negative dc-voltage excursions without the necessity of resetting the function selector.

1. Set the function selector to "+DC VOLTS".
2. Rotate the ZERO control to position the pointer at the center "→|←", which is located near the bottom center of the meter dial. If the ZERO control does not have sufficient range to center the pointer, switch the function selector to "—DC VOLTS".
3. Set the range selector to a position at least twice the voltage to be measured.
4. After a test reading has been made, the range control may be set to the lowest position which allows the pointer to remain on the scale.

Resistance Measurements:

NOTE: The sliding switch on the WG-299C probe should always be set to "AC-OHMS" when resistance measurements are to be made. Before resistance measurements are made, the power should be removed from the equipment under test, and any capacitors should be discharged so that no voltages are present on them.

1. Set the function selector to the "R OHMS" position.
2. Set the range selector to the "R x 10" position.
3. Short the probe tip to the ground cable and adjust the ZERO control to position the pointer at the left-hand "0", if necessary.
4. Separate the probe tip from the ground cable. The meter pointer should deflect to full scale. If the meter pointer does not deflect to exactly full scale, use the OHMS control to obtain full deflection.
5. Connect the clip of the ground cable to one terminal of the resistance to be measured.
6. Touch or connect the probe tip to the other terminal of the resistance to be measured.
7. Reset the range control to give a convenient deflection on the "R" (ohms) scale.
8. Multiply the reading on the "R" scale by the factor indicated by the range control setting.

CAUTION: Low-current, low-resistance devices, such as thermocouples and meter movements, may be damaged unless a range higher than "R x 10" is used because the WV-98A applies up to 1.5 volts across the resistance under measurement when the range control is set at "R x 1" or "R x 10".

Measurement of Resistance Values Above 1000 Megohms.

The leakage resistance of small mica and paper capacitors is usually above 1000 megohms. The circuit shown in Figure 2 can be used to measure resistance values above 1000 megohms. An external dc-voltage source between 20 and 500

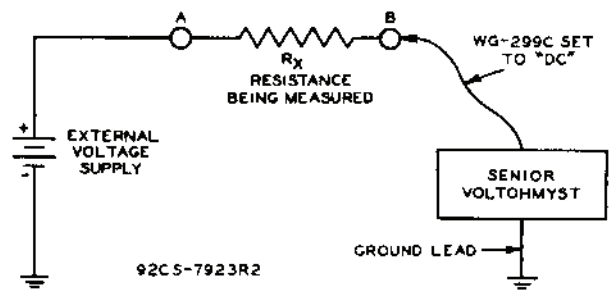

Figure 2. Circuit for resistance measurements above 1000 megohms

volts is utilized to obtain a measurable pointer deflection. Make circuit connections as shown in Figure 2 and proceed as follows:

1. Set function selector to "+| DC VOLTS" and measure the voltage at point B.
2. Measure the voltage at point A.
3. Compute the unknown resistance from the following formula:

$$\text{Rx (megohms)} = \frac{11\,[(\text{Volts at "A"}) - (\text{Volts at "B"})]}{(\text{Volts at "B"})}$$

EXAMPLE: The value of an unknown resistance is to be determined with the circuit of Figure 2. An external voltage of 500 volts is applied. The WV-98A measures 2.5 volts at "B", and 500 volts at "A". Then,

$$\text{Rx} = \frac{11\,(500\text{-}2.5)}{2.5} = 2200 \text{ megohms (approx.)}$$

AC-Voltage Measurements:

CAUTION: Maximum input voltages must not be exceeded. The accuracy of meter indications is dependent upon the frequency of the ac voltage being measured, the waveshape, repetition rate, and the impedance of the voltage source. See "Specifications", page 6, and the section below for additional information.

The switch on the WG-299C Probe should be set to "AC-OHMS" for all ac-voltage measurements.

1. Set the function selector to "AC".
2. Adjust the ZERO control if necessary to position the meter pointer at the left-hand "0".
3. Set the range control to a position considerably higher than the voltage to be measured.
4. Connect the ground cable to the ground side of the voltage to be measured.

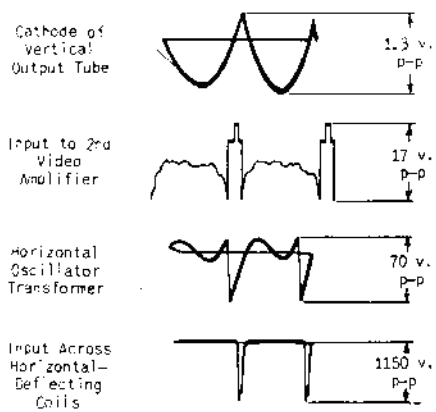

Figure 3. Typical television waveforms

5. Touch or connect the probe tip to the high side of the source voltage.
6. Reset the range control for a convenient deflection.
7. Read the ac voltage from the scale corresponding to the range control setting.

The meter scales of the WV-98A are calibrated in both rms and peak-to-peak voltages. Peak-to-peak voltage values are read from the red scales marked "P-P"; rms values of sine waves are read from the black scales marked "RMS".

NOTE: When it is desired to know which peak-to-peak scale is used, the indication is taken from the markings on the range-switch positions. Position 1, for example, is labeled "1.5V" and "4.0V". These figures correspond to the full-scale values of the corresponding rms and peak-to-peak scales. (Scales "F" and "K" in Figure 1.)

Examples of typical voltage waveforms found in television circuits are shown in Figure 3. Examples of other types of basic waveforms which can be measured by the WV-98A are shown in Figure 4.

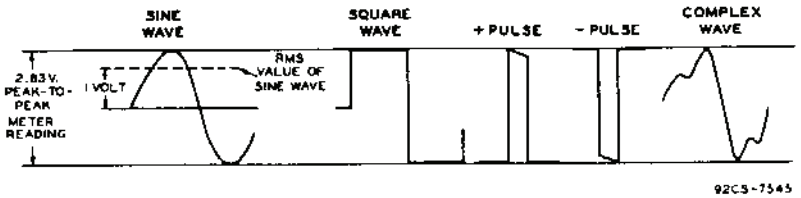

Figure 4. Typical voltage waveforms

The instrument has a maximum rated input for non-symmetrical waveforms of 2000 peak-to-peak volts. Sine waves and symmetrical complex waves up to 4200 peak-to-peak volts can be measured with somewhat reduced frequency response. (See Maximum Input Voltages and Footnote under "Specifications".)

Reliable ac voltmeter readings can be assured only if the characteristics of the voltmeter are compatible with the characteristics of the circuit under test. When the WV-98A is used to measured ac voltages, the "Specifications" on page 6 should be considered. Information on input resistance and capacitance, frequency response, and pulse response is given.

It should be remembered that when the instrument is connected to any voltage source it may cause a loading effect on the circuit and result in a reduced voltage at the test point. When the instrument is not used in accordance with the conditions given under "Specifications", the normal operating voltages of the circuit may change, resulting in an erroneous reading of normal operating voltages.

When any voltmeter is used to measure ac voltages, certain precautions in the interpretation of readings are necessary because connection of the meter to the

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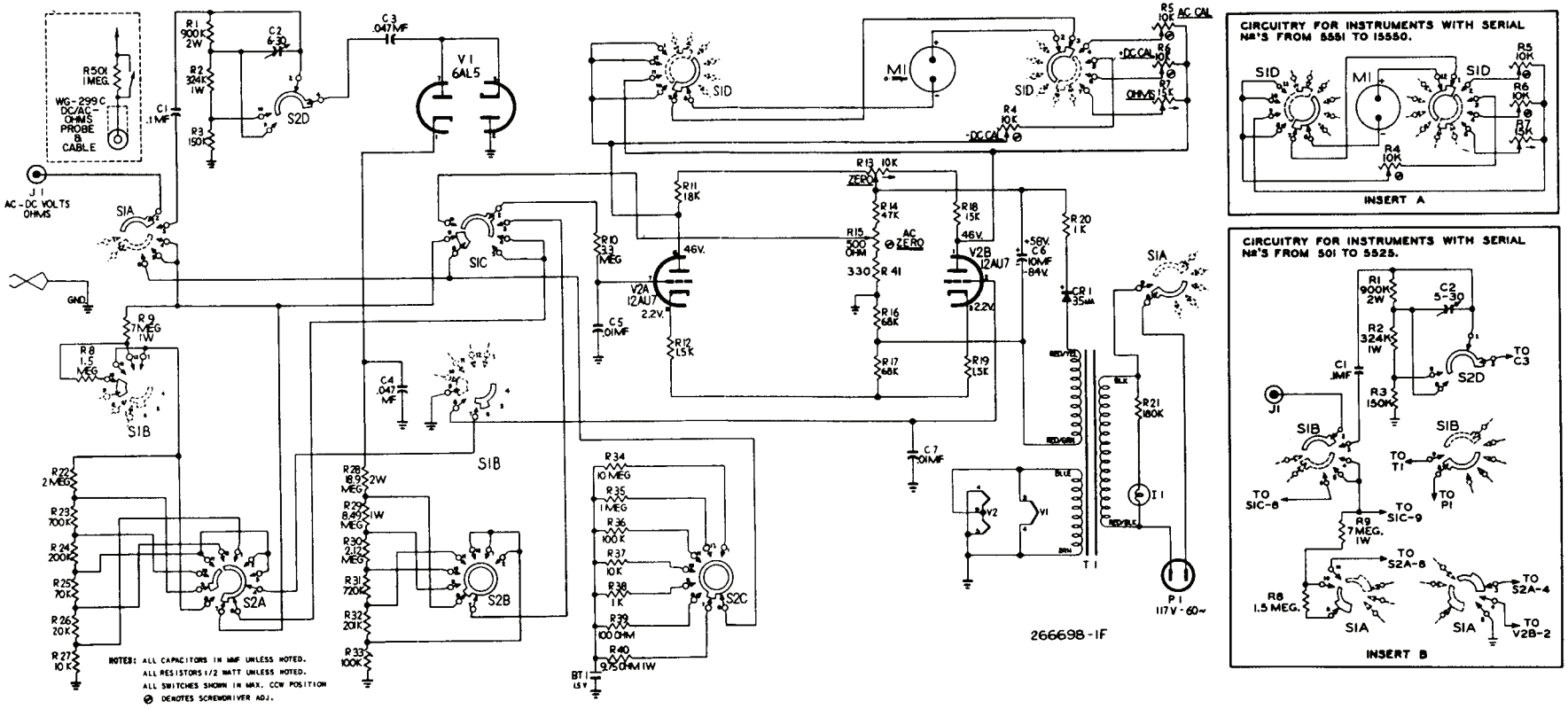

Figure 6. Schematic diagram of the WV-98A.
For differences in switch wiring for instruments with serial numbers below 15600, see inserts A and B.

Replacement Parts List

WV-98A Senior VoltOhmyst

When ordering replacement parts, include the stock number and description of the part, as well as the serial number and code number of instrument. Parts should be ordered through a local RCA tube and parts distributor.

Symbol No.	Description	Stock No.
	Capacitors	
C1	Special tubular: 0.1 μf ±20%, 1000 volts	210098
C2	Trimmer: 6.0-30 μμf, 500 volts	210097
C3, C4	Paper, molded: 0.047 μf ±20%, 400 volts	
C5	Paper, molded: 0.01 μf ±20%, 400 volts	
C6	Electrolytic, dry: 10 μf-10% +100%, 150 volts	217681
C7	Same as C5	
CR1	Rectifier: selenium, 35 ma.	210109
I1	Lamp: neon	48474
J1	Connector: chassis mounting type	210110
M1	Meter	210092-A
P1	Cord: power cord, 78" long with plug	70392
	Resistors	
R1	Carbon film: 900,000 ohms ±1%, 2 watts	210103
R2	Carbon film: 324,000 ohms ±1%, 1 watt	210105
R3	Carbon film: 150,000 ohms ±1%, ½ watt	56483-A
R4, R5 R6	Variable: 10,000 ohms ±20%, ¼ watt	210099
R7	Variable: 15,000 ohms ±20%, ¼ watt	210100
R8	Composition: 1.5 meg ±5%, ½ watt	
R9	Carbon film: 7 meg ±1%, 1 watt	59538
R10	Composition: 3.3 meg ±10%, ½ watt	
R11	Composition: 18,000 ohms ±5%, ½ watt	
R12	Composition: 1500 ohms ±5%, ½ watt	
R13	Variable: 10,000 ohms ±10%, ¼ watt	210101
R14	Composition: 47,000 ohms ±5%, ½ watt	
R15	Variable: 500 ohms ±20%, ¼ watt	210102
R16 R17	Composition: 68,000 ohms ±5%, ½ watt	
R18	Composition: 15,000 ohms ±5%, ½ watt	
R19	Same as R12	
R20	Composition: 1000 ohms ±5%, ½ watt	
R21	Composition: 180,000 ohms ±10%, ½ watt	
R22	Carbon film: 2 meg ±1%, ½ watt	59540
R23	Carbon film: 700,000 ohms ±1%, ½ watt	59541
R24	Carbon film: 200,000 ohms ±1%, ½ watt	56733
R25	Carbon film: 70,000 ohms ±1%, ½ watt	59542
R26	Carbon film: 20,000 ohms ±1%, ½ watt	213657
R27	Carbon film: 10,000 ohms ±1%, ½ watt	218277
R28	Carbon film: 18.9 meg ±1%, 2 watts	210104
R29	Carbon film: 8.49 meg ±1%, 1 watt	94010
R30	Carbon film: 2.12 meg ±1%, ½ watt	94011
R31	Carbon film: 720,000 ohms ±1%, ½ watt	94012
R32	Carbon film: 201,000 ohms ±1%, ½ watt	94013
R33	Carbon film: 100,000 ohms ±1%, ½ watt	72893
R34	Composition: 10 meg ±5%, ½ watt	
R35	Composition: 1 meg ±5%, ½ watt	
R36	Composition: 100,000 ohms ±5%, ½ watt	
R37	Composition: 10,000 ohms ±5%, ½ watt	
R38	Same as R20	
R39	Composition: 100 ohms ±5%, ½ watt	
R40	Carbon film: 9.75 ohms ±1%, 1 watt	96613
R41	Composition: 330 ohms ±10%, ½ watt	
	Switches	
S1	Switch: rotary, wafer type, 5 positions, 2 sections, 8 circuits	219613
S2	Switch: rotary, wafer type, 7 position, 4 section, 5 circuit	210096
T1	Transformer: power, 117 v., 60 cps	210094
	Miscellaneous	
	Clip: alligator	35262
	Clip: alligator slide fit for 0.080 dia. probe tip terminal and must be slide fit for 0.080 dia. probe tip	210088
	Clip: battery	210108
	Ground Lead: includes alligator clip	48996

Symbol No.	Description	Stock No.
	Handle: case carrying handle, black	210093
	Insulator	204717
	Knob: control, blue	212148
	Knob: black rubber	94878
	Meter case: front, plastic	210287
	Socket: tube, 7 pin miniature	210106
	Socket: tube, 9 pin miniature	210107
	WG-299C DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing	213257
	Connector: internal, brass, for cable	210190-A
	Connector, cable: female, with set screw	203574
	Shell: front end, blue	210195-A
	Shell: middle section, with shield, bushing, and insulator	213664
	Shell: rear section, blue	210202-A
	Spring, coil: for front end	210197
	Spring, switch: with insulator	213665
	Tip, probe: with switch slide and 1-meg. resistor	212160
	Washer, tip	213271
	WG-299B DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing	213257
	Connector: internal, brass, for cable	210190-A
	Connector, cable: female, with set screw	203574
	Shell: front end, blue	210195
	Shell: middle section, with shield, bushing, and insulator	212159
	Shell: rear section, blue	210202-A
	Spring, coil: for front end	210197
	Spring, switch: with insulator	212162
	Tip, probe: with switch slide and 1-meg. resistor	219424
	Washer, tip	212163
	WG-299A DC/AC-Ohms Probe and Cable	
	Subassembly: consisting of: probe shell, shield, bushing and insulator, probe tip, switch, and 1-meg. resistor	211400
	Bushing: for probe tip	210196
	Shell: front molding	210195-A
	Shell: rear molding	210202
	Spring: for probe tip	210197
	Connector, cable: female	203574
	Connector, internal: for cable	210190

circuit may cause some disturbance. This is also true of the vacuum-tube voltmeter but its high input impedance minimizes such disturbances. The amount of circuit disturbance caused by the voltmeter is usually reflected in a decreased circuit voltage, the amount of decrease being dependent upon the characteristics of both the voltmeter and the test circuit.

For example, inaccurate readings of normal circuit conditions can be obtained from any one or a combination of the following conditions:

1. If measurements are made in high-impedance circuits, the instrument will cause loading of the circuit to a degree dependent upon the ratio of the circuit impedance to the voltmeter impedance. As this ratio increases, the loading effect of the voltmeter is increased with a corresponding change in the normal operating conditions of the circuit.
2. If the capacitance of the circuit is low in relation to the input capacitance of the voltmeter.
3. If the frequency of the source voltage is higher than the upper frequency rating of the voltmeter.
4. If the voltage waveform in the test circuit consists of narrow pulses with a low repetition rate.

The last of these four conditions needs careful consideration in order to interpret correctly the peak-to-peak readings of the Senior VoltOhmyst. The values of the circuit capacitors and resistors used in the peak-to-peak rectifier circuit of the WV-98A have been chosen to give a discharge time which will provide a reliable

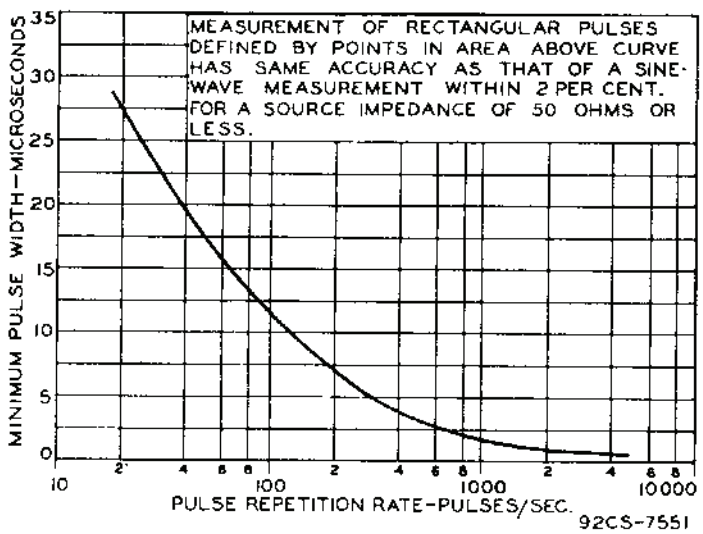

Figure 5. Pulse response capability of the WV-98A

peak-to-peak reading over its specified frequency range. If pulses of extremely short duration are applied to the rectifier circuit, the capacitors may not charge to the peak-voltage value of the pulse. If pulses with a low repetition rate are applied to the rectifier circuit, the capacitors will dissipate an appreciable part of the charge by the time the next pulse is applied. As a result, the capacitors are not charged to the full peak-to-peak value of the voltage. Therefore, both the rms and peak-to-peak voltage indications will be lower than the true value of the applied voltage.

Special Applications

In addition to maintenance and service applications of the WV-98A in ac, dc, af, and pulsed electronic and electro-mechanical equipment, the instrument may be used with versatility in numerous special applications. The special applications described below will help to illustrate the wide range of usefulness of the instrument.

Oscillator Grid-Bias Measurement. The negative dc voltage developed at the grid of an oscillator tube is proportional to the amplitude of oscillation. The impedance of these circuits is usually high and any test instrument inserted into the oscillator must be of sufficiently high impedance so as not to change appreciably the total value of the circuit impedance. The WV-98A is well suited to measurements of this nature. To measure grid bias, the instrument should be set up on the appropriate dc-voltage range and the switch on the WG-299C Probe set to "DC".

Comparative voltage readings should be taken on each band of a multiband receiver and the main tuning capacitor should be rotated through each band while the bias is being measured.

AGC/AVC Voltage Measurements. The WV-98A can be used to measure agc or avc voltage at the diode-load resistor, along the bias buses, or at the grids of the controlled tubes.

Output Indication. The Senior VoltOhmyst is a useful instrument for measuring output in the alignment of radio and television receivers. In these applications, the switch on the WG-299C Probe is set to "DC" and the probe connected to the load resistor of the second detector in AM and TV receivers while the circuit components are adjusted for optimum output. In an FM receiver, the probe is connected to the limiter load resistor. The zero-center feature of the WV-98A is particularly useful in alignment of FM discriminators.

Bias-Cell Voltage Measurements. These small voltages can be measured accurately by the WV-98A. The expanded voltage scales 0 to 1.5 and 0 to 5 volts provide easy-to-read indications of small voltages, an important feature where bias voltages are critical.

Detection of Gassy Tubes. Gassy tubes frequently may pass the check of an ordinary tube tester but cause improper functioning of equipment in which they are installed. The presence of gas in an output tube or avc-control tube, for example, can impair the function of the entire receiver. In an RC-coupled circuit, the presence of a positive voltage at the grid of a tube usually indicates a gassy tube or a defective coupling capacitor. Check the socket grid-pin voltage with the tube removed. If no positive voltage is present, the tube is probably defective

Insulation-Resistance Measurements. Current leakage through the dielectric of capacitors and insulation of coils, transformers, cables, and other com-

ponents can be measured with the WV-98A in terms of resistance. Values of leakage resistance above 1000 megohms can be measured with the circuit shown in Figure 2.

When resistance measurements are made, the probe of the WV-98A is always positive with respect to the ground cable. This arrangement facilitates the measurement of leakage resistance in components such as electrolytic capacitors where polarity must be observed.

DBM Measurements. The graph on page 23 can be used to determine dbm values corresponding to rms ac-voltage values across a 600-ohm resistive load. A dbm value is defined as the number of decibels above or below a reference level of 1 milliwatt in 600 ohms at 1000 cycles. Zero dbm, therefore, would indicate a power level of 1 milliwatt; 10 dbm, 10 milliwatts; and 20 dbm, 100 milliwatts.

The graph makes possible rapid conversion of rms voltages to corresponding dbm values. Associated power levels can be read along the top of the graph. If the rms voltage is measured across a resistive load other than 600 ohms, the correction factors given below must be added algebraically to the dbm values read from the graph in Figure 7. For resistive loads not given in the table, the following formula should be used for determining the correction factor:

$$\text{Correction Factor} = 10 \log \frac{600}{R}$$

where R is the load in ohms. If R is greater than 600 ohms, the correction factor is negative.

Because dbm are defined with respect to a 600-ohm load, power levels correspond to voltage values. DBM can be measured in terms of rms voltages across a 600-ohm resistive load. For example, 0.775 rms volt indicates 0 dbm and 7.75 rms volts indicate 20 dbm. While these measurements must be made with a sine waveform to avoid waveform error, any frequency can be used which is within the range of the WV-98A. The decibel and ear-response curves have their closest correlation at 1000 cycles.

Resistive Load at 1000 cps	DBM*
600	0
500	+0.8
300	+3.0
250	+3.8
150	+6.0
50	+10.8
15	+16.0
8	+18.8
3.2	+22.7

*DBM is the increment to be added algebraically to the dbm value read from Figure 7.

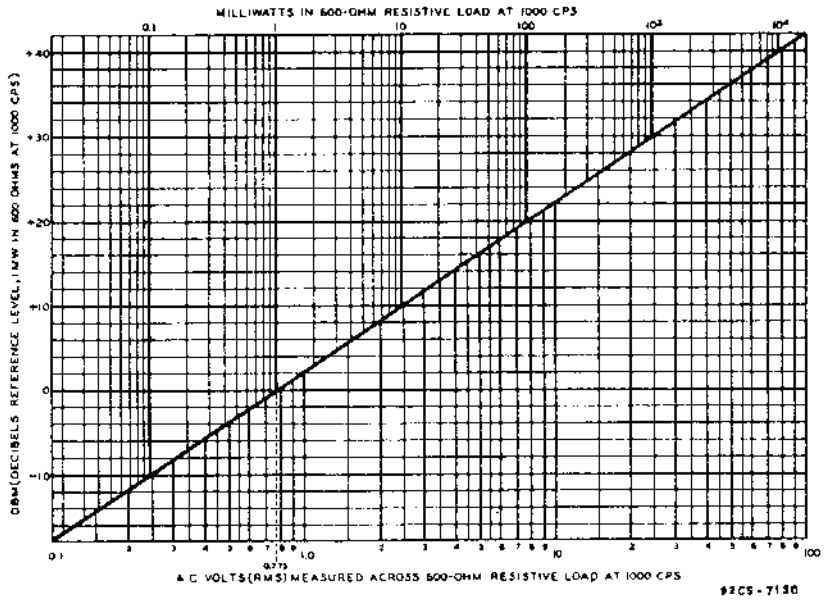

Figure 7. Graph for conversion of rms voltages to dbm values

Accessories

Available on Separate Order

When the WG-301A Crystal-Diode Probe is used with the Senior VoltOhmyst, the usable frequency range is extended to 250 megacycles. This probe consists of a germanium rectifier and an RC network in a polystyrene housing. The probe, which slips onto the front of the WG-299C Probe and Cable, eliminates the need for an extra cable.

The WG-301A may be used in rf circuits to measure sine-wave voltage values up to 20 rms volts in the presence of dc voltage as high as 250 volts. The over-all frequency range of the probe is from 50 Kc to 250 Mc. All rf voltages are read from the dc scales in terms of rms volts for sine waves. For example: A reading of 5 volts dc indicates that the sine wave being measured has an rms value of 5 volts. The all-over accuracy of the WV-98A when used with the WG-301A is ±10%.

DC voltages as high as 50,000 volts can be measured directly by the WV-98A when the WG-289 High-Voltage Probe is used. The probe uses the WG-206 Multiplier Resistor, having a value of 1090 megohms, to present an over-all voltmeter input resistance of 1100 megohms. With a multiplying factor of 100, the Senior VoltOhmyst provides six full-scale positions of 150, 500, 1500, 5000, 15,000, and 50,000 volts. Do not measure voltages higher than 50,000 volts, because the maximum voltage rating of the probe may be exceeded. The extremely high

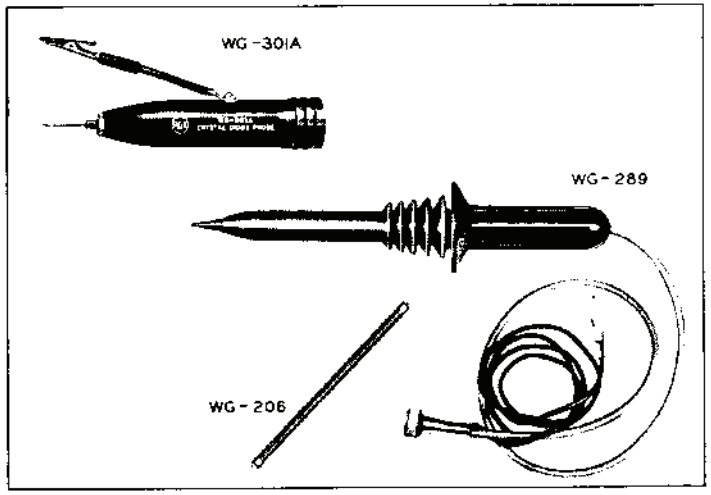

Figure 8. Accessories available on separate order

impedance of the WG-289 is especially desirable when it is necessary to measure voltages found in phototubes, Geiger-Counter tubes, television, and other high-impedance circuits which would not function properly if loaded down by a low-impedance voltmeter.

The WG-289 High-Voltage Probe offers distinct advantages in high-voltage circuits as well as low-voltage circuits characterized by high impedance or poor regulation.

Circuit Description

The operation of the Senior VoltOhmyst centers around a vacuum-tube bridge circuit using a 12AU7 twin-triode. (See schematic diagram, page 18.) When this bridge is properly balanced, the voltages at the two plates will be equal and the 200-microampere meter, connected between the plates, will read zero.

When a positive voltage is applied to the grid of triode section 1, the current through the left half of the bridge is increased, causing the voltage at the plate of this section to decrease. This current also flows through the common cathode resistor, increasing the voltage drop across it, and biasing the grid of triode section 2 in a negative direction. This causes a voltage increase at the plate of triode section 2. The difference in potential across the meter causes current to flow through the meter from the plate of section 2 to the plate of section 1.

When the WV-98A is used to measure ac voltage, the voltage is first rectified by an RCA-6AL5 twin-diode which serves as a full-wave peak-to-peak rectifier. This tube, shown as V 1 on the schematic diagram, has associated components chosen to give the circuit a long time constant. When the ac signal swings negative, C 3 is charged through the left-hand diode section to the negative peak value of the voltage. As the voltage starts in a positive direction, this diode section becomes nonconducting and the charge on C 3 is prevented from discharging. As the ac signal swings positive, the positive peak is added in series with the charge on C 3 and is applied to the plate of the right-hand diode section. C4 charges to a value equal to the sum of the positive and negative peaks. Because of the relatively long time constant of the circuit, the voltage across C 4 will be maintained at the peak-to-peak value of the applied ac voltage. A portion of this voltage is then applied as a dc voltage to the grid of triode section 1 of the 12AU7 bridge tube and the circuit action is the same as described above.

When the ac-signal rectifier is connected, however, contact potential within the tube causes a small amount of voltage to appear at the left-hand grid of the 12AU7, resulting in a slight unbalance of the bridge and a small meter deflection. To counteract this effect, a small voltage, taken from the AC ZERO control, is fed back to the grid of triode section 2 of the 12AU7. This voltage is used to correct for the contact potential of the ac-signal rectifier.

When the instrument is set up to measure resistance, ac voltage, or dc voltage, it is impossible for any voltage applied to the test probes to be applied directly to the meter itself. As shown in the schematic diagram, the meter is isolated from the source voltage by the 12AU7 bridge tube. This current limitation provided by the 12AU7 and its associated components decreases the danger of overloading the meter.

Maintenance

(See "Safety Precautions", page 4)

The WV-98A Senior VoltOhmyst is manufactured, tested, and calibrated under strict engineering supervision. If the instrument should require adjustment or repairs, the procedures outlined below should be followed.

The schematic diagram of the WV-98A is shown in Figure 6. Locations of calibration controls are shown in Figure 9. If it becomes necessary to replace any of the component parts, only RCA replacement parts or their equivalents should be used. Replacement parts should be ordered from a local RCA tube and parts distributor and the code and serial numbers of the instrument, as well as the stock number of the replacement parts, should be specified in the order. Stock numbers and descriptions should be obtained from the Replacement Parts List on pages 20 and 21.

Mechanical Zero Adjustment:

The meter pointer should rest at the left-hand zero mark when the function selector is turned to the "OFF" position. If the pointer should come to rest at a deflected position, the position may be corrected mechanically as follows:

1. Remove the moisture-proof meter-adjustment plug.
2. Insert a scriber or similar tool to engage the zero-adjustment lever, and move the lever laterally as required to bring the pointer to "0".

CAUTION: Extreme care must be taken to prevent insertion of the tool to a depth which will injure the pointer spring. The meter warranty does not cover such damage.

3. Replace the meter-adjustment plug.

Anti-Static Solution:

The inside of the plastic meter case has been coated with a special anti-static solution to eliminate static effects on the action of the pointer. If the meter-pointer action becomes erratic, the condition of the coating may be checked by vigorously wiping the outside of the meter window with a clean, soft, dry cloth. If the anti-static coating has lost its effectiveness, the meter pointer will move off zero and remain there for several minutes. VoltOhmyst owners whose registration cards are on file at the RCA Camden, N. J. office may obtain a free 1-ounce bottle of coating by writing to RCA, Order Service, Building 60, Camden, N. J.

Electrical Balance Check:

1. Set the function selector to "+DC VOLTS" and allow the WV-98A to warm up for 15 minutes.
2. Rotate the ZERO ADJ control. It should be possible to set the meter pointer at either zero or 60% of full-scale deflection on any range.
3. Set the SELECTOR control to "—DC VOLTS".
4. Rotate the ZERO ADJ control. It should be possible to set the meter pointer at either zero or 10% of full-scale deflection on any range.

5. If the conditions given in steps 2 and 4 above cannot be satisfied, there is an unbalance between the two triode sections of the 12AU7 bridge tube and it should be replaced. See the section on Tube Replacement below.

Calibration

The calibration of the WV-98A should be checked after any internal adjustments are made or after any of the component parts are replaced. If recalibration is necessary, the instrument should first be recalibrated on dc voltage as follows:

NOTE: The accuracy of calibration cannot exceed the accuracy of the standards employed.

DC-Voltage Calibration:

1. Check the mechanical zero position of the pointer. If necessary, zero the pointer as described above.
2. Turn the function selector to "+VOLTS" and allow the WV-98A to warm up for at least 30 minutes.
3. Check the line voltage. The WV-98A should be calibrated at 117 volts, 60 cycles.
4. Rotate the ZERO ADJ control to bring the pointer exactly to zero. This control should not be readjusted during the rest of the calibrating procedure.
5. Set the range control at "50V".
6. Connect the Ground Cable clip to the negative terminal of a dc voltage source supplying exactly 50 volts. The switch on the WG-299C should be set to "DC". Connect the probe to the positive terminal of the source voltage.
7. With a screw driver, adjust the "+DC CAL" potentiometer R6 to bring the pointer exactly to the 50-volt mark on the scale. (See Figure 9 for location of calibration controls.)

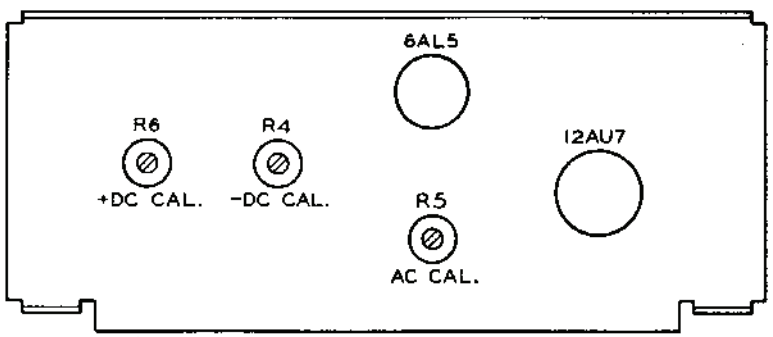

Figure 9. Locations of calibrating controls

8. Reverse the test lead connections at the voltage source.
9. Set the function selector to "—VOLTS".
10. With a screw driver, adjust the "—DC CAL" potentiometer R4 to bring the pointer exactly to the 50-volt mark on the scale.
11. Check the remaining dc-voltage ranges against other dc sources of known accuracy which provides full-scale deflection.

AC-Voltage Calibration:

To calibrate for ac voltage, proceed as follows:

1. Set the switch on the WG-299C to "AC-OHMS".
2. Set the function selector to "AC VOLTS".
3. Set the range selector to "1.5 VOLTS".
4. Short the WG-299C probe to the ground clip and adjust the AC ZERO potentiometer, R15 so that the pointer rests exactly at zero. If a zero meter reading cannot be obtained, replace the 6AL5. See "Tube Replacement", below.
5. Set the range control to "50V".
6. Apply 50 volts, 60 cps between the ground lead and the tip of the probe. The meter reading should be within ±3%. If the accuracy is not within this figure, adjust the AC CAL control, R5, (See Figure 9 for locations of calibrating controls) to give full scale deflection of the meter pointer.

AC Compensation Adjustment.

1. Set the switch on the WG-299C to "AC-OHMS".
2. Set the function selector to "AC VOLTS".
3. Set the range selector at the 500-volt range.
4. Set meter pointer at zero.
5. Set the range selector at the 150-volt range and apply an ac signal of 150 volts at a frequency of approximately 100 Kc to the test leads. With the 150-volt 100 Kc signal applied, adjust C2 with a screw driver for a reading of exactly 150 volts (C2 is located on the rear apron of the chassis).

Ohms Adjustment

NOTE: The battery must be installed for all resistance measurements.

1. Set the function selector to "+VOLTS" and make certain the pointer is at zero.
2. Turn the function selector to the "OHMS" position.
3. Set the range control to "RX1".
4. Adjust the OHMS ADJ control for full-scale deflection.
5. Turn the range switch to the "RXIMEG" position. The meter pointer should read above 1000 on the resistance scale. If the pointer indicates a lower value, there is excessive leakage in the ohmmeter circuit.

If it is necessary to readjust the OHMS ADJ control when changing from a low-range position to the "RXIMEG" position, refer to the section on TUBE REPLACEMENT below. If it is impossible to obtain full-scale setting of the pointer with the OHMS ADJ control and correct ac and dc voltage readings can be obtained, the battery should be replaced.

Tube Replacement

All tubes supplied originally with WV-98A have been thoroughly aged by operating them for several hours before installation in the instrument. This preliminary conditioning of a new tube helps to insure stability and dependable performance.

If a new tube is installed without prior aging, it may be necessary to rezero the instrument when it is switched from the lowest to the highest dc-voltage range. This operating inconvenience may be corrected by aging the tube as follows.

A suggested preaging method for the 12AU7 is to operate the plates at 115 volts dc with the grids and cathodes connected to the B— source. Heaters should be operated at 6.3 volts, 60 cps. The tube should be aged for approximately 12 hours before it is installed in the instrument. The calibration should then be checked.

An alternate, and usually satisfactory, aging procedure consists of operating the new tube in the WV-98A for approximately 36 hours, after which time the instrument may be recalibrated. If this procedure is unsatisfactory, the first aging procedure should be followed.

If it becomes necessary to replace the 6AL5, the tube can be aged for a minimum period of 36 hours by operating it in the instrument. After this period of time, the calibration should be checked according to the procedure outlined under "AC Calibration Check".

Battery Testing

CAUTION: Do not allow exhausted cells to remain inside the case of the WV-98A as chemicals from deteriorated cells may damage the instrument.

The battery should be tested frequently to insure accuracy of resistance measurements. It may be tested as follows.

1. Turn function selector to "OHMS".
2. Set range control to "RX1" position.
3. Rotate the OHMS ADJ control to bring the pointer to full-scale deflection.
4. Short the Ohms Cable to the Ground Cable for about 10 seconds.
5. Open the short circuit and observe the scale indication. Any appreciable deviation from full-scale deflection indicates weak cells which should be replaced.

RCA Repair Service

RCA maintains a complete repair service for the adjustment, calibration, and maintenance of RCA test equipment. If it becomes necessary to service this equipment, the report forms enclosed in this booklet should be filled out as described. It is important that:

1. Test equipment be packed carefully.
2. A full description of the trouble be included in the report.
3. All probes, cables, and test leads used with the equipment be included in the shipment.

Attention to these details will help prevent damage in transit and delay in repairs.

Warranty

Radio Corporation of America warrants its test and measuring equipment, when properly registered, against defects in workmanship, materials, and construction under normal use and service for a period of one year from the date of sale to the original purchaser. Under this warranty, RCA's obligation is limited to repairing or replacing any defective parts except fuses which are not covered by this warranty. Secondary damage, caused by battery leakage, is not covered by this warranty.

This warranty does not apply to any instrument which has been altered in any unauthorized manner, or which has been misused or damaged by accident or negligence, or which has had the serial number removed, altered, or effaced.

RCA tubes and RCA batteries used in such equipment are covered by our standard tube or battery warranty.

This warranty is valid only when the card enclosed with the instrument is properly filled in and returned for registration.

Electron Tube Division
RADIO CORPORATION OF AMERICA
Harrison, New Jersey