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HAM SHACK TROUBLE-SHOOTER

Practical Applications of the Versatile RCA VoltOhmyst

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This feature concludes the two-part article covering the use of vacuum-tube voltmeters in the ham shack and covers a few of the many applications in which *VoltOhmysts*® can be used. The examples shown below serve to illustrate the measurement principles and techniques utilized for specific equipment, but they can be applied, in general, to similar types of equipment.

Checking Oscillators

The VoltOhmyst* can be used to check all operating voltages under key-up or key-down conditions in both types of oscillator circuits shown in Figure 1. The measurement principles involved in these representative circuits can be applied to any type of oscillator.

A complete check of the operating voltages includes measurement of ac heater voltage, control-grid voltage, screen-grid voltage, and plate voltage. To measure the heater voltage, connect the ground cable to the chassis (ground) if one end of the heater supply is grounded, or to one side of the heater and connect the probe to the other side of the heater. Always make heater-voltage measurements directly at the tube pins. Faulty solder connections or IR drop in heater-lead wiring can cause insufficient voltage at the tube

socket, although normal voltage can be measured at the transformer.

In tetrode and pentode oscillators, screen voltage influences overall performance of the stage. In keyed oscillators, measure the plate and screen voltages under both key-up and key-down conditions. Unless a voltage-regulated power supply is used, the key-down voltage will be less than the key-up voltage.

If the oscillator delivers much power, measure the plate voltage at point D in either of the circuits of Figure 1, rather than at point E, to prevent the strong rf signal from affecting the voltage reading. The capacitor from point D to ground serves to keep rf energy from getting into the supply lead and permits the measurement to be made. Because no dropping resistor is used in the plate circuit, the dc voltage measured at point D should be the same as at point E. Plate current will increase with off-resonance tuning and cause a change in the dc voltage at the tube.

Measure the screen voltage at point C, which is at rf ground potential because of the screen bypass capacitor. If a considerable amount of power is being drawn from the oscillator, make sure that screen voltage does not exceed the permissible rating for the tube when the key is up. The degree of voltage change under keying depends upon power-supply regulation.

The amount of developed grid bias is a good indication of how the stage is function-

*"VoltOhmyst" is a registered trademark of the Radio Corporation of America.

ing; the amount of bias voltage will increase with the strength of oscillation. The dc probe can be used to check bias at point A. This voltage is negative with respect to the cathode and is measured between the control grid and cathode of the oscillator stage. Bias will decrease as the plate load is increased.

Amplifier and Multiplier Stages

It is equally important that the operating voltages of amplifier and frequency-multiplier stages be set correctly to prevent damage to tubes and to minimize generation of harmonics and parasitics. The typical amplifier stages shown in Figure 2 differ in their input-coupling arrangements and plate-feed methods. Plate-circuit tuning in both these amplifiers will affect the grid, screen, and plate-current flow and will generally affect the voltage levels at the tube. The bias voltage measured at point A in both circuits, for example, will depend upon the amount of drive and, in triode amplifiers, upon plate-circuit tuning. Grid-circuit tuning will also affect the amount of measured bias. Bias voltage will increase with excitation and will be greatest at grid-circuit resonance.

In amplifier stages, measure operating voltages under both key-up and key-down conditions. If an appreciable amount of current is drawn by the amplifier tube, the plate, screen, and bias voltages can change over a relatively wide range. Under these conditions, it is important to prevent the screen voltage from rising to a value which exceeds the screen-dissipation rating of the tube, especially in circuit 2B. The VoltOhmyst can be used to measure the dc voltages at points C in both circuits under key-up and key-down conditions.

DC-voltage measurements at point A will provide an exact indication of the total bias. Plate voltages should be measured at point D in the circuit. Because different amplifier arrangements utilize different types of bias circuits, no single method of measuring bias will suffice for all arrangements.

Adjustment of High-Power Amplifiers

Measurement of operating voltages in high-power amplifiers deserves special consideration for several reasons. For example, the high plate and screen voltages employed are hazardous, and measurement techniques must take into account the possibility that high voltages may appear at unexpected points because of insulation breakdown in the transmitter. Also, misadjustment of tuning controls or operating voltages may damage costly tubes

and components, especially when newly constructed equipment is first tested.

While the transmitter circuit shown in Figure 3 may differ considerably in design from those found in many ham rigs, the measurement techniques and precautions described for it apply to all transmitter amplifiers. In all high-power equipment, checking and adjustment of ac filament voltages is especially important to tube life and performance. Grid-bias voltages are equally important because they have a direct effect upon the screen and plate dissipation of the tube under key-up conditions. The value of the grid-bias voltage also affects drive requirements and sets the operating level (class of operation) of the amplifier. In tetrodes, screen voltages should be carefully adjusted to insure that screen dissipation is kept within proper limits under both key-up and key-down conditions. Plate voltages, as well as plate current, should be determined exactly when the operating level borders on the legal input-power limit or the maximum permissible ratings for the tube type.

Preliminary Checks

In setting up an rf amplifier for the first time, use the VoltOhmyst to make precautionary measurements before applying plate and screen voltages. When checking out a high-power amplifier, such as that shown in Figure 3, use the following procedure: (1) Apply filament and grid-bias voltages. Remove excitation. (2) Set up the VoltOhmyst for ac-voltage measurements. Check the filament voltage of each tube directly at the filament pins (xx) and (yy) by connecting the ground cable to one pin and the ac probe to the other pin at the same tube socket. Filament voltage should be within at least $\pm 5\%$ of the recommended voltage for the tube type. (3) If the voltage measured at either filament is off by more than $\pm 5\%$, measure the line voltage on the primary side of the filament transformers. If line voltage is correct, IR drop in the filament wiring may be responsible. In this event, replace the wiring with heavier conductors. It is also possible that one of the filament transformers may need replacement because of improper turns ratio. (4) Check the fixed grid bias by setting up the VoltOhmyst for "—DC" voltage measurements and read the voltage directly at the grid pins of both tubes. This is a wise precaution, especially in equipment which is not protected against grid-bias failure. If proper voltage is measured for both tubes, the wiring is correct and the fixed-bias supply is functioning properly.



When connected to a wavemeter circuit, the VoltOhmyst makes an excellent rf-tuning indicator. Here, W2IYG uses the WV-77C and WG-301A Crystal-Diode Probe during neutralizing of final amplifier.

The separate bias-supply leads feeding the two halves of the grid circuit in Figure 3 are provided as a means of checking the balance of the push-pull circuit. Do not attempt to measure total grid voltage at the grid pins when excitation is applied because of the high rf grid voltage. (5) Adjust the grid-tank tuning and the coupling to obtain the required amount of grid current in both grid-circuit legs. Remove excitation. (6) The amplifier can now be checked for plate-current cutoff or, if it is to be operated class AB or B, for the required amount of static plate current. With fixed bias applied and excitation removed, apply plate and screen voltages. Note the plate current flow, if any, and adjust the bias voltage from the supply to give the required cutoff or static current. Remove the high voltage. (7) The plate and screen circuits can now be checked with excitation applied and with the amplifier under dummy load. In circuits which employ high-perveance tubes, take care to prevent excessive plate and screen current flow while tuning. Unless dial settings of plate-tank resonant points are first established by

means of a grid-dip oscillator, use a considerably reduced plate voltage for tuning. Measure the plate voltage at point C and the screen voltage at point D. The rf choke and capacitor C5 will keep rf out of the VoltOhmyst at point D. Point C is likewise at rf ground potential because of the rf choke and bypass capacitor.

The basic measurement procedures just described should provide a thorough and reliable check of equipment operating conditions and adjustments. When voltage measurements indicate improper operation or component failure, the VoltOhmyst can be set up quickly for resistance measurements and for conventional trouble-shooting.

Miscellaneous Applications

The filtering action of power-supply filters may be determined easily by measuring the ac component at the output of the filter. The VoltOhmysts are well suited to this application because of their ability to measure ac in the presence of dc voltages.

Ripple is measured by setting up the VoltOhmyst for ac-voltage measurements on a

low-range scale, connecting the ground cable to the negative side of the power-supply filter section, and connecting the probe to the positive side. Figure 4 shows the setup and a representation of the ripple and dc components of the output voltage. The VoltOhmyst will indicate only the rms value of the ripple component.

The effectiveness of the filter can be expressed in terms of percent of ripple, which is the ratio of the rms value of the ripple voltage to the value of the dc voltage multiplied by 100. For example, if the dc voltage is 250 v and the measured ripple voltage is 1.25 v, the percentage of ripple is 0.5.

Power-supply regulation can be determined simply by measuring the dc output voltage under load (E_{minimum}) and no-load (E_{maximum}) conditions. Percentage of regulation is equal to:

$$\frac{E_{\text{maximum}} - E_{\text{minimum}}}{E_{\text{maximum}}} \times 100$$

Neutralization Indicator

When used in conjunction with the WG-301A crystal-diode probe, the VoltOhmyst can be employed as a neutralizing indicator in power-amplifier stages. Amplifier neutralization is normally accomplished with plate voltage removed and with excitation applied. If the amplifier is not properly neutralized, some rf energy will appear in the plate-tank circuit. Proper adjustment of the neutralizing capacitors in the amplifier will eliminate the rf from the plate circuit.

A neutralizing setup which employs the VoltOhmyst as an rf indicator is shown in

Figure 5. Set the VoltOhmyst to its lowest dc-voltage range and attach a small wire loop to the tip of the WG-301A probe. Make sure the amplifier plate voltage is off. Couple the loop tightly to the plate-tank coil. Apply excitation and tune the plate-tank capacitor near the resonant point until a reading is obtained on the VoltOhmyst. Adjust the neutralizing capacitors equally until no reading or a minimum reading is obtained on the VoltOhmyst. It is usually necessary to retune slightly to maintain a reading on the VoltOhmyst because adjustment of the neutralizing capacitors changes the tuning point at which the rf indication occurs.

Wavemeter—Field-Strength Meter

The VoltOhmyst and WG-301A probe can also be used in combination with a tuned circuit as a wavemeter and field-strength meter, as shown in Figure 6. This arrangement is especially useful in determining the frequency of an output signal, in checking for radiation from transmitters, and in plotting the radiation patterns of antenna systems.

The tuned circuit consists simply of a coil and capacitor which can be adjusted to the operating frequency. The coil is tapped about one-third of the length along its turns. Set up the VoltOhmyst on its lowest dc-voltage scale and connect the WG-301A crystal-diode probe to the coil tap. Adjust the tuned circuit for maximum reading on the meter. It may be necessary to experiment somewhat with the length of the pick-up lead used on the wavemeter to obtain a suitable meter indication. In these applications, the readings obtained will be relative but useful, nevertheless, in making adjustments and checks.

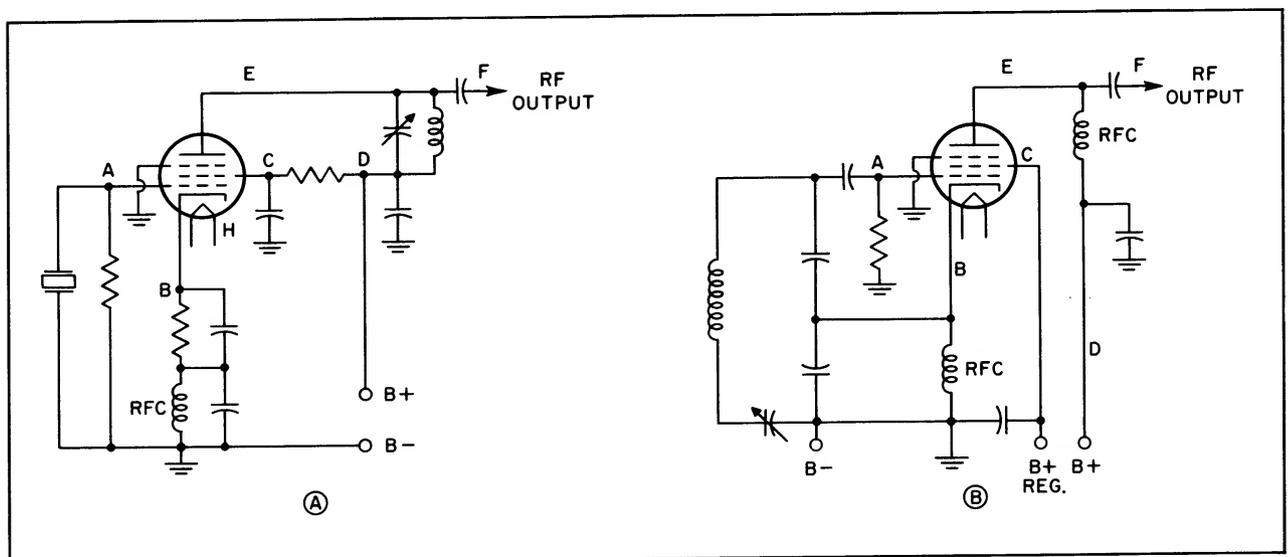


Figure 1. Typical oscillator circuits.

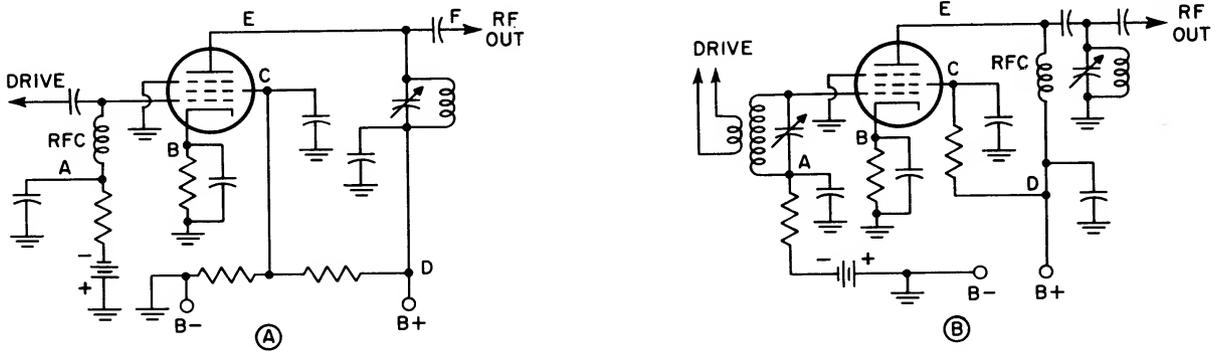


Figure 2. Typical amplifier stages.

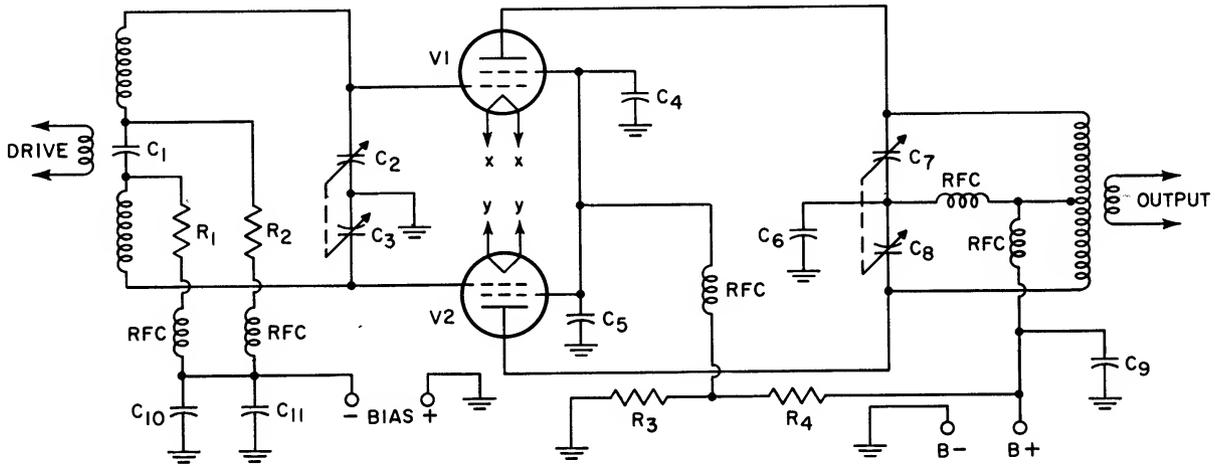


Figure 3. A transmitter final amplifier circuit.

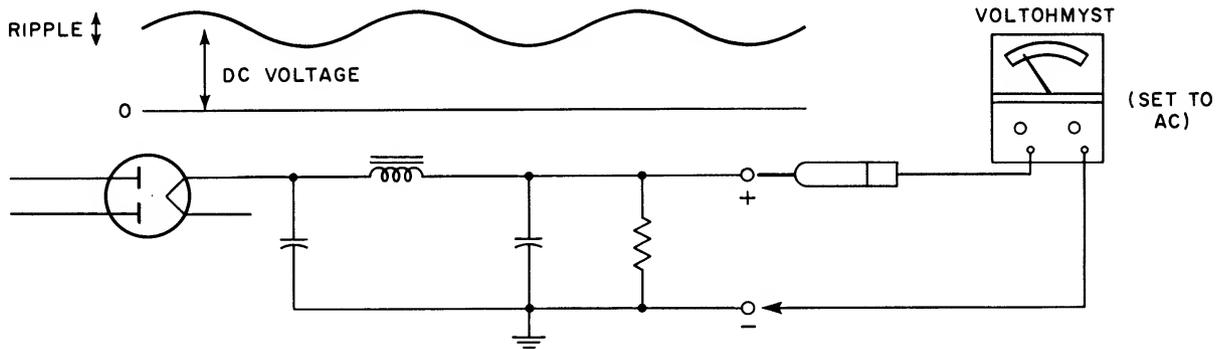


Figure 4. Measuring ripple voltage in PS output.

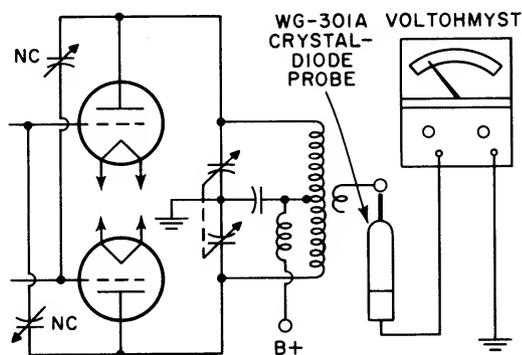


Figure 5. Neutralization of final amplifiers.

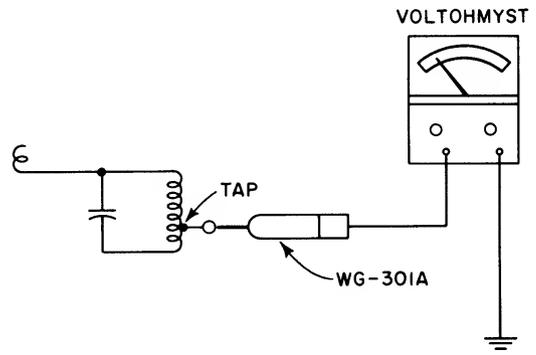


Figure 6. The VoltOhmyst used as a wavemeter.



From your local RCA distributor, headquarters for RCA receiving and power tubes.

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RCA Tubes for Linear RF Power Amplifier Service (Single-Sideband, Suppressed Carrier)

(Arranged according to Power Output)

Typical Operating Conditions (Per Tube)

RCA Type	Class	Max. Freq. (MHz)	Heater (V)	DC Plate Voltages				DC Bias No. 1 Volts	DC Bias No. 2 Volts	DC Bias No. 3 Volts	Zero-Beam-Current Biasing	Approx. Max. Output	
				Plate	Screen	Control	Beam					Watts	dBm
6CL6	AB ₁	60	6.3(H)	300*	150	0	6	4.6	16	0	9100	3	
6R73	AB ₁	60	6.3(H)	400	250	0	24	8.4	33	0	5600	9	
2E24	AB ₁	125	6.3(H)	500	210	0	21	10	35	0	8300	11	
1614	AB ₁	80	6.3(H)	450	300	0	35	14	50	0	5000	16	
2E26	AB ₁	125	6.3(H)	500	210	0	30	9	53	0	5370	17	
6883	AB ₁	125	12.6(H)	500	210	0	30	9	53	0	5370	17	
837	B	20	12.6(H)	500	0	0	0	2.6	61	3.5	4630	21	
807	AB ₁	60	6.3(H)	750	300	0	35	15	71	0	6250	35	
1625	AB ₁	60	12.6(H)	750	300	0	35	15	71	0	6250	35	
6816	AB ₁	60	6.3(H)	850	300	0	15	40	100	0	3500	40	
6524	AB ₁	100	6.3(H)	600	300	0	33.5	67†	30A	122	0	12100‡	50
6850	AB ₁	100	12.6(H)	600	300	0	33.5	67†	30A	122	0	12100‡	50
6146	AB ₁	60	6.3(H)	750	180	0	46	12	98	0	4640	52	
6883	AB ₁	60	12.6(H)	750	180	0	46	12	98	0	4640	52	
809	B	60	6.3	700	—	0	72	35	118	8	3900	59	
823-B*	AB ₁	200	6.3(H)	750	225	0	25	50†	20A	132A	0	13640‡	68A
805	B	30	10.0	1250	—	0	110	78	204	3.5	3560	155	
828	AB ₁	30	10.0	2000*	750	0	115	95	25	116	0	10300	157
4X150A	AB ₁	500	6.0(H)	1250	300	0	50	57	202	0	3500	157	
811-A	B	30	6.3	1500	—	0	85	13	150	13	6260	160	
813	B	30	10.0	2500	—	0	91	30	133	12	11000	219	
6161	B	900	6.3(H)	1600	—	0	82	80	239	18	3720	225	
813	AB ₁	30	10.0	2500*	750	0	95	90	25	148	0	9660	245
7094	AB ₁	60	6.3(H)	2000	400	0	44	30	200	0	6000	280	
7034	AB ₁	150	6.0(H)	2000	300	0	48	60	250	0	4270	290	
833-A	B	30	10.0	3000	—	0	165	50	328	5	5600	700	

* Twin Type
† Total Value per tube in Push-Pull application
‡ Grid No. 1 to Grid No. 3 Signal
§ With Grids Nos. 1, 2 & 3 tied together at socket

How to put your finger on the right tube for SSB!

The right RCA Tube for your single-sideband amplifier is listed in this chart. For the power you want, simply read down the column on the right. For the corresponding RCA Tube type, read the column on the left. When you make your choice—let the Typical Operating Conditions be your guide.

Known for their big reserve of cathode emission,

RCA Tubes meet the requirements for single-sideband transmission—to the letter. And they have the power sensitivity it takes to build a signal up to full power in one stage—from low input signals. When you go SSB...any power from a few watts to the limit...remember, you can do it better with RCA Tubes. They are available at your RCA Tube distributor.



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