



# **OPERATING AND SERVICE MANUAL**

-hp- Part No. 00654-90001

## **MODEL 654A TEST OSCILLATOR**

Serials Prefixed: 0951A-

Appendix C, Manual Backdating Changes,  
adapts manual to Serial No. 0951A00755  
and below.

Copyright Hewlett-Packard Company 1969  
P.O. Box 301, Loveland, Colorado, 80537 U.S.A.

Printed: MAY 1972

## SECTION I

### GENERAL INFORMATION

#### 1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 654A Test Oscillator is an ideal general purpose signal source whenever a flat balanced or unbalanced test signal is required. Balanced outputs of 135 ohms, 150 ohms and 600 ohms have many uses in the communications industry. Automatic leveling, together with the expanded meter, make the 654A ideally suited to voltmeter calibration or to test frequency response of components during manufacture. The instrument is shown in Figure 1-1 and the specifications are listed in Table 1-1.

General information relating to the instrument is listed in Table 1-2. The information in Table 1-2 should not be considered specifications.

1-3. The Model 654A is a stable, low distortion sine-wave signal source with a flat frequency response of  $\pm 0.5\%$  over the frequency range of 10 Hz to 10 MHz. The attenuators allow the signal to be adjusted in 1 dB and 10 dB steps from +10 dBm to -89 dBm, and the front panel AMPLITUDE control allows a continuous adjustment in level of  $\pm 1$  dB from the settings shown on the OUTPUT LEVEL attenuators. The flat frequency response is achieved by automatic leveling circuits within the 654A.

1-4. Five output impedances are available, selected by a front panel push-button control: these are 50 and 75 ohms unbalanced and 135, 150 and 600 ohms balanced. Balance is greater than 50 dB up to 1 MHz and greater than 40 dB up to 5 MHz.

1-5. The meter scale is expanded to indicate 0 dBm at center scale, with a total range of  $\pm 1$  dBm. The metering circuit monitors the signal level before the attenuators so that the meter indication is independent of the attenuator

settings; the meter indicates the signal level set by the front panel AMPLITUDE control. The output signal level into the load is the algebraic sum of the meter indication and the OUTPUT LEVEL attenuator settings.

1-6. An additional feature is the COUNTER OUTPUT rear panel BNC connector. This allows the Model 654A frequency to be continuously monitored by an electronic counter without interrupting measurements or affecting terminal balance.

#### 1-7. SUPPLIED ACCESSORIES.

Rack mount kit: -hp- Part No. 5060-0775.

#### 1-8. RECOMMENDED ACCESSORIES.

-hp- 11048C	50 ohm Feedthrough Termination
-hp- 11094A	75 ohm Feedthrough Termination
-hp- 11095A	600 ohm Feedthrough Termination
-hp- 11143A	Balanced BNC to Alligator clip cable

#### 1-9. INSTRUMENT AND MANUAL IDENTIFICATION.

1-10. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial prefix of your instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatible with newer instruments or the backdating information in Appendix C will adapt this manual to earlier instruments. All correspondence with Hewlett-Packard should include the complete serial number.

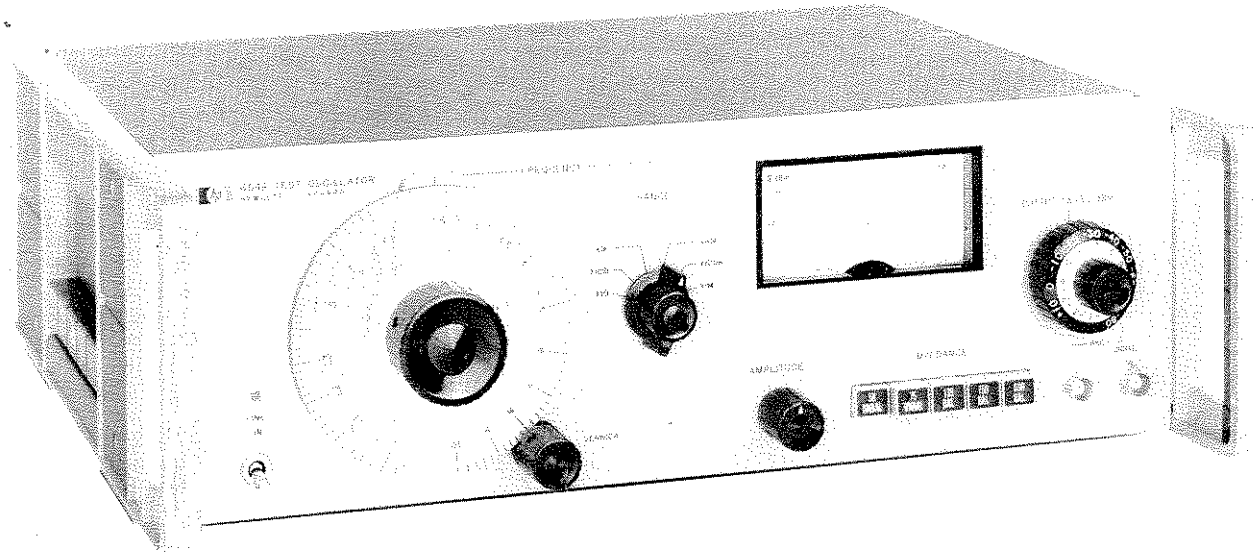


Figure I-1. Model 654A Test Oscillator

Table I-1. Specifications

<p><b>Frequency range:</b> 10 Hz to 10 MHz in 6 bands.</p> <p><b>Frequency accuracy:</b>  100 Hz (on X100 RANGE) to 5 MHz: <math>\pm 2\%</math>  10 Hz to 100 Hz: <math>\pm 3\%</math>  5 MHz to 10 MHz: <math>\pm 4\%</math></p> <p><b>Level flatness</b>(+10 dBm and 0 dBm): <math>\pm 0.5\%</math> referenced to level at 1 kHz from 10 Hz to 10 MHz for unbalanced outputs, 10 Hz to 5 MHz for 135 ohm and 150 ohm outputs, and 10 Hz to 1 MHz for 600 ohm output.</p> <p><b>Attenuator</b></p> <p><b>Range:</b> 99 dB in 10 dB and 1 dB steps.</p> <p><b>Accuracy:</b> <math>\pm 1.5\%</math> (0.15 dB) except <math>\pm 10\%</math> (1 dB) at output levels below 60 dBm at frequencies greater than 300 kHz.</p>	<p><b>Amplitude control:</b> greater than 2 dB.</p> <p><b>Amplitude accuracy:</b> <math>\pm 1\%</math> for 90 days (at 1 kHz, +10 dBm level with meter centered).</p> <p><b>Meter tracking:</b> <math>\pm 0.05</math> dB.</p> <p><b>Balance</b> (on balanced impedances) when measured by the procedure given in Paragraph 5-28: greater than 50 dB for frequencies from 10 Hz to 1 MHz, greater than 40 dB to 5 MHz.</p> <p><b>Distortion (THD)</b>  10 Hz to 1 MHz: greater than 40 dB below fundamental.  1 MHz to 10 MHz: greater than 34 dB below fundamental.</p> <p><b>Hum and noise:</b> greater than 70 dB down at full output.</p>
---	--

Table I-2. General Information

<p><b>Output impedance:</b> 50 ohm unbalanced, 75 ohm unbalanced, 135 ohm balanced, 150 ohm balanced and 600 ohm balanced.</p> <p><b>Output level:</b> +11 dBm to -90 dBm, 10 dB and 1 dB steps with adjustable <math>\pm 1</math> dB meter range; calibrated for each impedance.</p> <p><b>Meter resolution:</b> 0.02 dB.</p>	<p><b>Output connectors:</b> BNC. Maximum voltage which can be applied to the output: less than <math>\pm 3</math> V peak.</p> <p><b>Counter output:</b> greater than 0.1 V rms into 50 ohm, BNC connector.</p> <p><b>Operating temperature:</b> <math>0^{\circ}\text{C}</math> to <math>+55^{\circ}\text{C}</math> (<math>32^{\circ}\text{F}</math> to <math>130^{\circ}\text{F}</math>).</p> <p><b>Power:</b> 115 V or 230 V <math>\pm 10\%</math>, 48 Hz to 440 Hz, 30 W nominal, 35 W max.</p>
--	--

## SECTION II

### INSTALLATION

#### 2-1. INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also, check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Section V of this manual. If there is damage or deficiency, see the warranty on Page ii of this manual.

#### 2-3. POWER REQUIREMENTS.

2-4. This instrument will operate from either 115 or 230 Vac, 48 Hz to 440 Hz. The instrument can easily be converted from 115 volt to 230 volt operation by changing the position of the slide switch located on the rear panel, so that the designation appearing on the switch matches the nominal voltage of the power source.

#### 2-5. GROUNDING REQUIREMENTS.

2-6. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cord which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cord three-prong connector is the ground wire.

2-7. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

#### 2-8. INSTALLATION.

2-9. This instrument is fully transistorized; therefore no special cooling is required. However, the instrument should not be operated where the ambient temperature is outside the limits specified in Table 1-1.

#### 2-10. RACK/BENCH INSTALLATION.

2-11. This instrument is initially shipped as a bench-type instrument (unless ordered specifically as a rack-type) with plastic feet and tilt stand in place. Conversion to a rack-mounted instrument can be accomplished by using the rack-mounting kit and instructions furnished with your instrument.

#### 2-12. REPACKAGING FOR SHIPMENT.

2-13. The following is a general guide for repackaging for shipment. If you have any question, contact your local -hp- Sales and Service Office. (See Appendix at the back of this manual for office location.)

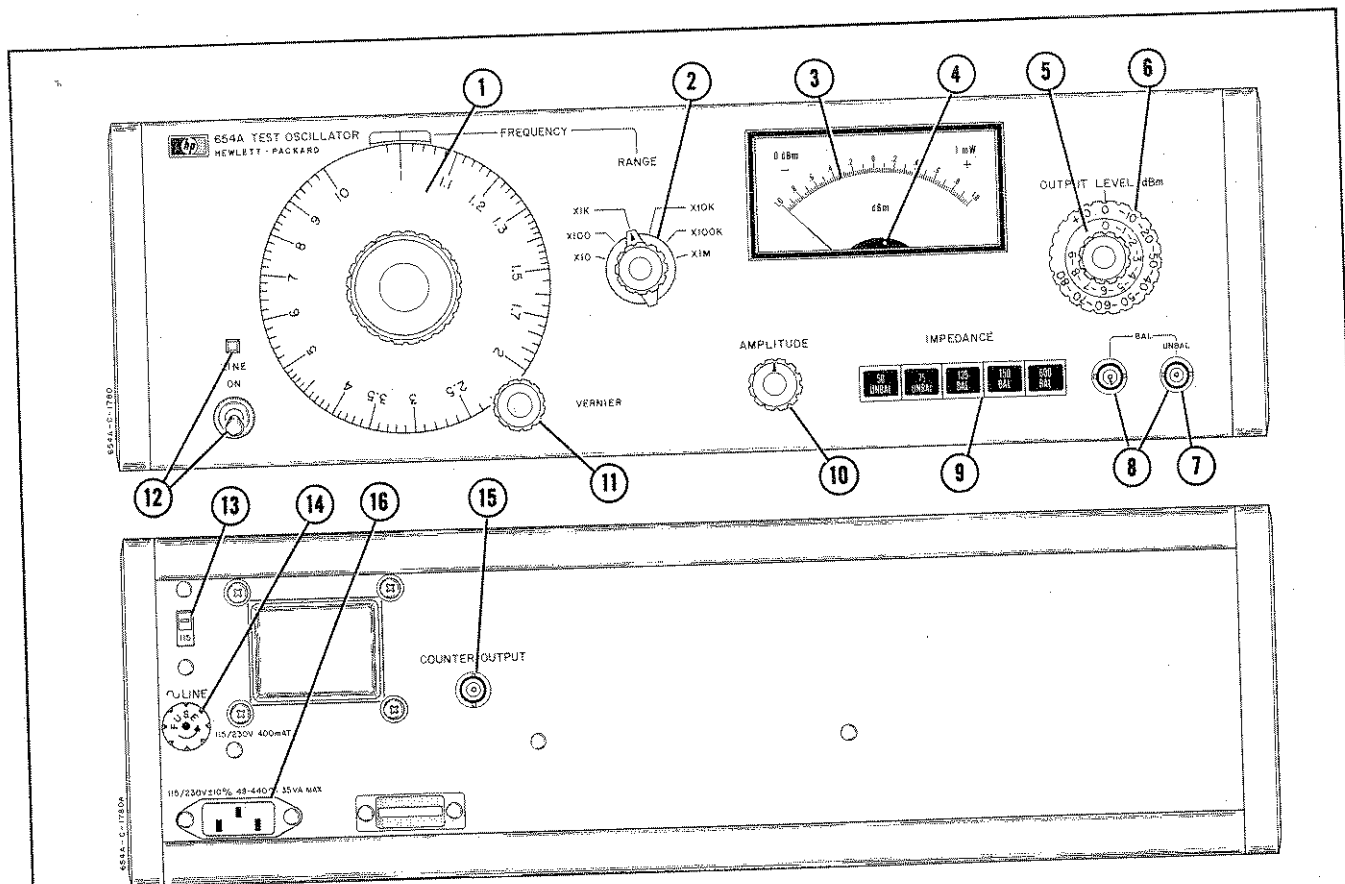
#### NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and serial number.

- a. Place instrument in original container if available. If original container is not available, a suitable one can be purchased from your nearest -hp- Sales and Service Office.

If original container is not used,

- b. Wrap instrument in heavy paper or plastic before placing in an inner container.
- c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.
- d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.
- e. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.



- ① **FREQUENCY dial (C1A/B/C):** Varies test frequency continuously within each frequency range. Dial reading multiplied by range setting gives the output frequency in Hz of the 654A.
- ② **FREQUENCY RANGE switch (S2):** Selects one of six frequency multipliers from X10 to X1M.
- ③ **Output Meter (M1):** Monitors amplitude of 654A output prior to **OUTPUT LEVEL** attenuators. Algebraic sum of meter indication and **OUTPUT LEVEL** attenuator setting gives output power into rated load.
- ④ **Mechanical Zero Adjust:** Allows meter to be mechanically zeroed, when instrument is off.
- ⑤ **OUTPUT LEVEL (S4):** Attenuates 654A output signal in nine steps of 1 dBm each.
- ⑥ **OUTPUT LEVEL (S4):** Attenuates 654A output signal in nine steps of 10 dBm each.
- ⑦ **UNBAL output (J4):** BNC connector provides an unbalanced output signal, at impedances of 50 ohms and 75 ohms.
- ⑧ **BAL output (J3 and J4):** BNC connectors provide a balanced output signal at impedances of 135 ohms, 150 ohms and 600 ohms.
- ⑨ **IMPEDANCE switch (A4S1):** Selects required output impedance of instrument; pushbuttons are interlocked so that when one is pressed the others spring out.
- ⑩ **AMPLITUDE control (R3):** Allows adjustment of +/- dBm of output signal amplitude.
- ⑪ **FREQUENCY VERNIER:** Provides a fine frequency adjustment for **FREQUENCY** dial.
- ⑫ **LINE ON switch (S1) and Pilot Lamp (DS1):** Switch applies primary power to instrument; pilot lamp glows to indicate application of primary power.
- ⑬ **115 V or 230 V Slide Switch (S3):** Sets instrument to operate from a primary power source of either 115 Vac or 230 Vac, 48 Hz to 440 Hz.
- ⑭ **FUSE (F1):** 0.4 amp slow blow fuse protects instrument from overloads.
- ⑮ **COUNTER OUTPUT (J2):** BNC connector provides signal output of greater than 0.1 V rms into a 50 ohm load, at same frequency as front panel outputs.
- ⑯ **Primary Power Connector (J1):** Connects primary power to instrument.

Figure 3-1. Location of Controls, Indicators and Connectors

## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. INTRODUCTION.

3-2. This section contains instructions and information necessary for the operation of the 654A Test Oscillator. Included in this section are identification of controls, indicators and connectors, turn-on procedure, meter mechanical zero adjustment and operating instructions.

#### 3-3. CONTROLS, INDICATORS, AND CONNECTORS.

3-4. All operating controls, indicators and connectors of the 654A are identified and described in Figure 3-1.

#### 3-5. TURN-ON PROCEDURE.

#### 3-6. OUTPUT METER MECHANICAL ZERO ADJUSTMENT.

3-7. The Model 654A output meter is properly mechanically zero-set when the meter pointer rests over the -1 dBm mark. Zero-set the output meter to obtain maximum accuracy and mechanical stability in the following manner. With LINE switch turned off, insert pointed object (such as tip of ball point pen) into recess on adjustment wheel, and rotate wheel until meter pointer rests exactly over -1 dBm mark.

#### 3-8. PRIMARY POWER APPLICATION.

- a. Before applying primary power to instrument, set 115 or 230 volt slide switch (S3) to position which indicates primary voltage to be used.
- b. Connect primary power to connector J1. Switch LINE switch (S1) to ON position; pilot lamp (DS1) will glow.

#### 3-9. OPERATING INSTRUCTIONS.

- a. Zero-set meter (Paragraph 3-7) and turn instrument on (Paragraph 3-8).
- b. Set the FREQUENCY RANGE switch and FREQUENCY dial (with VERNIER) to the desired frequency. (Dial reading multiplied by range setting gives the frequency in Hz.)
- c. Connect a frequency counter to the rear panel COUNTER OUTPUT, if desired.
- d. Select the required output impedance by pressing the appropriate IMPEDANCE pushbutton.

- e. Adjust the OUTPUT LEVEL attenuators and the AMPLITUDE control for the desired signal output level. The algebraic sum of the meter indication and the attenuator setting gives the power level, in dBm, into a load equal to the impedance selected by the IMPEDANCE pushbutton. In Table 3-1, the 0 dBm and +10 dBm levels are converted to voltage for each impedance.



SWITCH THE 10 DBM STEP ATTENUATOR DOWN BEFORE CONNECTING TO SENSITIVE EQUIPMENT, SUCH AS THERMAL CONVERTERS, SO AS TO PREVENT DAMAGE FROM OVERLOADING.

Table 3-1. dBm/Voltage Conversion Chart

0 dBm = 1 m watt into rated load.		
Impedance	0 dBm	+10 dBm
50 ohm	0.224 V rms	0.707 V rms
75 ohm	0.274 V rms	0.866 V rms
135 ohm	0.367 V rms	1.162 V rms
150 ohm	0.387 V rms	1.225 V rms
600 ohm	0.775 V rms	2.449 V rms

- f. Connect the load to the output connectors. Use the UNBAL connector for 50 ohm and 75 ohm loads and both connectors (BAL) for 135 ohm, 150 ohm and 600 ohm loads.

#### 3-10. OPERATING CHECK.

3-11. Before making measurements using the 654A, perform the following front panel checks to ensure that your instrument is operating correctly.

- a. Turn AMPLITUDE control until white arrow on knob is pointing up; meter should indicate approximately 0 dBm.
- b. Turn AMPLITUDE control extreme counterclockwise; meter should indicate -1 dBm or less.
- c. Turn AMPLITUDE control extreme clockwise; meter should indicate +1 dBm or greater.