INSTRUCTION AND OPERATING MANUAL

FOR

MODEL 100B

LOW FREQUENCY
STANDARD

Type No. 6548

HEWLETT-PACKARD COMPANY
275 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

LOW FREQUENCY STANDARD

MODEL 100B

CAUTION

READ BEFORE TURNING ON THE INSTRUMENT

The heating of the crystal oven in this instrument is regulated by a mercury-column switch. Occasionally, the mercury column is separated by jarring and vibration of the unit in shipment.

After turning the instrument on for the first time, keep a close check on the temperature of the crystal oven as indicated by the thermometer in the front panel. When the instrument has been on about 30 minutes, the crystal oven should remain automatically at a rather constant temperature. This condition will be indicated by a shutting off of the crystal pilot lamp from time to time, and by the fact that the thermometer will reach a fairly steady reading of about 65 degrees Centigrade.

However, if the crystal pilot light stays on continuously, and if the thermometer goes up beyond 70 degrees, the mercury column in the switch or thermometer has probably been separated in shipment. Turn the instrument off immediately and proceed as follows.

Remove instrument from cabinet and remove crystal oven unit which plugs in tube socket adjacent to thermometer window. Remove thermometer bracket and pull thermometer carefully from oven.

Inspect thermometer for mercury column separation and any minute air bubbles in mercury bulb.

If either air bubbles or separation are present, place the thermometer bulb in ice water until mercury occupies only the bulb compartment. Tap lightly to remove any bubbles or globules left in column.

Then place the bulb in a vessel of water and heat until mercury completely fills column and a small portion of the enlargement at top of column. Then remove thermometer and watch mercury descend to room temperature. If there is no separation or bubbles present, the thermometer may now be put back in service. It may be necessary to repeat the above procedure more than once to unite all the mercury and remove all bubbles.

-CAUTION-

If after replacing the "crystal and heater" unit the crystal heater pilot stays on after thermometer reaches 70°, the mercury switch column has probably separated. Proceed as follows: Remove crystal oven unit and thermometer as described above. Remove mercury switch bracket and the three screws on the outside bottom of casting and one screw at top end of unit.

Remove cover and lift inner unit out of casting. Then remove the mercury thermostat switch from its recess in inner casting.

To unite the mercury column and remove bubbles, use same procedure as used for the thermometer.

> CAUTION: Immerge only bulb portion of mercury switch. If mercury switch leads get wet or any moisture collects beneath the plastic insulator covering the contact rings, remove the plastic insulator and dry tube and insulator and leads thoroughly before placing back in service. Otherwise leakage between leads may cause heater relay to remain open.
>
> Also, when replacing mercury switch do not seat it any deeper in casting than necessary; otherwise the thermometer will not seat to necessary depth.

Reassemble the crystal oven unit and place in instrument. Turn the instrument on and keep a check on the thermometer to ascertain that the switch and thermometer are working properly.

INSTRUCTIONS

Low Frequency Standard

Model 100B

GENERAL DESCRIPTION

The Model 100B Low Frequency Standard consists of a 100 kc crystal-controlled oscillator, and a series of three 10 to 1 regenerative modulator type frequency dividers providing frequencies of 10 kc, 1 kc, and 100 cps. Output from each frequency is brought to separate terminals at the rear of the chassis through buffer stages having a low output impedance. Two output terminals are also provided on the front panel, together with a switch to select any one of the output frequencies desired. Output on all frequencies is essentially sinusoidal.

100 kc Oscillator: The 100 kc oscillator consists of a 100 kc crystal having a temperature coefficient of 2 cycles per megacycle per degree Centigrade, in a modified Colpitts circuit using a 6SJ7 oscillator tube. A thermostatically-controlled oven is employed to regulate the crystal temperature. The crystal is in series with the tank inductance, the circuit oscillating under control of the crystal when the tank circuit is tuned approximately to the crystal frequency. Oscillations will be maintained over a fair range of the tuning capacitor, which is used to adjust the crystal to exactly 100 kc.

Frequency Dividers: The frequency of the 100 kc oscillator is divided in steps of 10 to 1, by means of three regenerative modulator type frequency dividers. The first divider steps the 100 kc down to 10 kc, the second divider steps the 10 kc down to 1 kc, and the third steps the 1 kc down to 100 cps. The action of all three dividers is alike, although the exact method of obtaining the result differs slightly in each. The fundamental action is as follows:

A frequency f is introduced into the first grid of a 6L7 modulator tube, which has its plate circuit tuned to a frequency f/10. The plate circuit is also coupled to one of the grids of another 6L7 acting as a frequency multiplier, and having its plate circuit tuned to a frequency 9f/10. The plate circuit of the multiplier is in turn coupled back to the third grid of the modulator tube.

Assume a transient of some sort has started a small voltage of a frequency f/10 in the plate circuit of the modulator. This is multiplied by the multiplier tube to a frequency 9f/10, and fed to the third grid of the modulator where it mixes with the frequency f coming in on the first grid to give a frequency f - 9f/10, or f/10, in the modulator plate circuit, increasing the f/10 voltage started out by the initial transient.

The action goes around the circuit again, the f/10 voltage soon building up to a stable maximum value. If the incoming frequency f is removed, the f/10 will immediately stop, for there is nothing to mix with to maintain itself in operation.

In order to facilitate the multiplying action in certain cases, some of the frequency f is introduced in one of the other grids of the multiplier tube where a modulating action then takes place, similarto that in the modulator tube, the frequency f combining with the frequency f/10 to give a frequency f - f/10, or 9f/10, in its plate circuit.

Buffer Stages: Output from the 100 kc oscillator, and each of the dividers is taken from separate buffer stages consisting of 6AC7's, triode connected, in a cathode load circuit. This provides a low output impedance, so that loads as low as 1000 ohms may be placed across the output without appreciably lowering the output voltage. The cathode load circuit also provides complete isolation of the different output frequencies.

Power Supply: The power source should be a 115 volt, 60 cycle supply line. The high voltage is obtained from an electronically-regulated rectifier supply so that the line voltage may vary from 105 to 125 volts without affecting the operation. Regulating the high voltage supply also provides a low audio impedance in the plate supply circuit, and aids in preventing interaction between the various output frequencies.

OPERATION

Initial Installation: When the instrument is first put into operation, the following procedure should be observed:

1. Make sure all tubes are firmly in their sockets, and that the grid clips are on all the 6L7 tubes.

2. Follow the cautions on the first page of this manual.

3. Plug power cord into a 115 volt, 60 cycle power supply. It will take about 24 hours of heating for the crystal itself to come up to the proper operation temperature.

At the end of that time, check the ratios between the various frequency dividers with an oscilloscope, as follows:

a. Connect the horizontal defecting plates to the 10 kc binding posts, and the vertical deflecting plates to the 100 kc binding posts. A stationary pattern with 10 peaks across the top should be obtained. If this pattern is not stationary, or is blurred, adjust the tuning capacitor in the 10 kc divider until a clear, stationary 10 to 1 pattern is obtained. The capacitor should be left in the central position between the two points where the pattern ceases to be stationary. Each divider circuit is directly in line, front to rear, with its corresponding output terminals at the rear of the chassis.

b. Repeat above procedure, using the 10 kc and the 1 kc output, and the tuning capacitor on the 1 kc divider.

c. Repeat, using the 1 kc and 100 cps output, and the tap-switch capacitor adjustment for the 100 cps divider.

Output voltages from all frequencies should be 5 volts or better on open circuit after above adjustment. The instrument is now ready for operation.

Output from any of the output frequencies may be obtained separately from the marked binding posts at the rear of the chassis, or if desired, any of the frequencies may be obtained from the binding posts on the front panel by setting the selector switch to the desired frequency. Output at all frequencies is practically sinusoidal, so that frequencies may be used for frequency determination by means of Lissajou's figures up to high and complex ratios.

Loading the output with less than 1000 ohms load will lower the output voltage considerably, and will also cause some distortion which might be objectionable for use with high multiple or complex patterns. <u>If harmonics of the output are desired</u>, see page 5 for complete instructions.

<u>Adjustment of 100 kc Oscillator Frequency:</u> The frequency of the 100 kc oscillator has been set at the factory to within a cycle or two of 100 kc at the existing room temperature,

Such accuracy is sufficient for most purposes, but if a closer adjustment is desired, it may be obtained by tuning the small self-locking variable air capacitor, labeled FREQ. ADJ. on the front panel, and setting the crystal exactly to 100 kc by beating it with the standard 5 mc signal from WWV in Washington, D.C., picked up on a short wave receiver.

MAINTENANCE

After the initial adjustments have been made, no further adjustment should be required, except for occasional blowing out of the unit, and a check on the condition of the tubes. The fan should be cleaned and oiled every 30 days.

One check it is well to make periodically, is that of the frequency ratio of the dividers, as explained in the operating section, under initial adjustments. These dividers should remain in operation indefinitely without change, but extreme temperature changes or ageing of the tubes, etc., may cause them to become de-tuned, and be off frequency, so that an occasional check is a safety precaution.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes as well as other electron tubes, fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Truck or Railway Express. The instruments should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material.

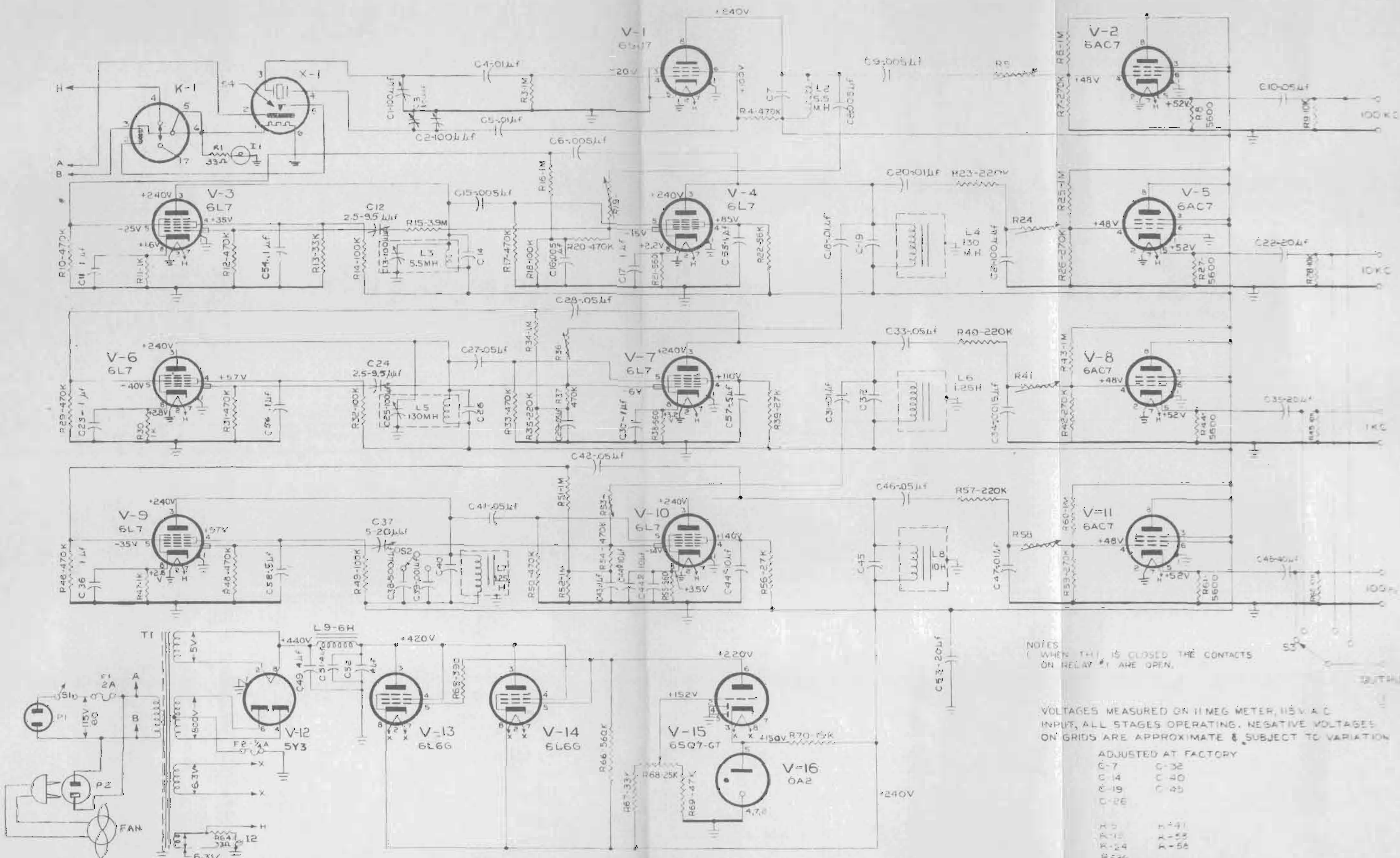
DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

275 PAGE MILL ROAD PALO ALTO, CALIF. U.S.A.

CABLE "HEWPACK"



SCHEMATIC DIAGRAM OF -hp- MODEL 100B LOW FREQUENCY STANDARD