Owner’s Manual for the BEBE5080-1718A

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Purpose

The purpose of this manual is to guide the user of the BE5080-1718A lamp replacement through its installation and theory of operation.

The BE5080-1718A lamp replacement module is designed to replace the lamp module E1 in the HP4800A Vector Impedance Meter. The BE5080-1718A should also work in the HP8640A/B option 1. Although it has not been tested in the HP8640A/B option1.   Referring to the application drawing below in Figure 1, the E1 module is in the negative feedback path of the Wein Bridge oscillator. The purpose of E1 is to regulate the negative feedback in order to keep the overall loop gain of the in the range of linear operation; This is the range of signal output in which the sine wave is pure and not clipped by running the output stage of the amplifier into saturation or cutoff. The lamps do this by changing resistance in response to the signal level coming from the output of the oscillator.

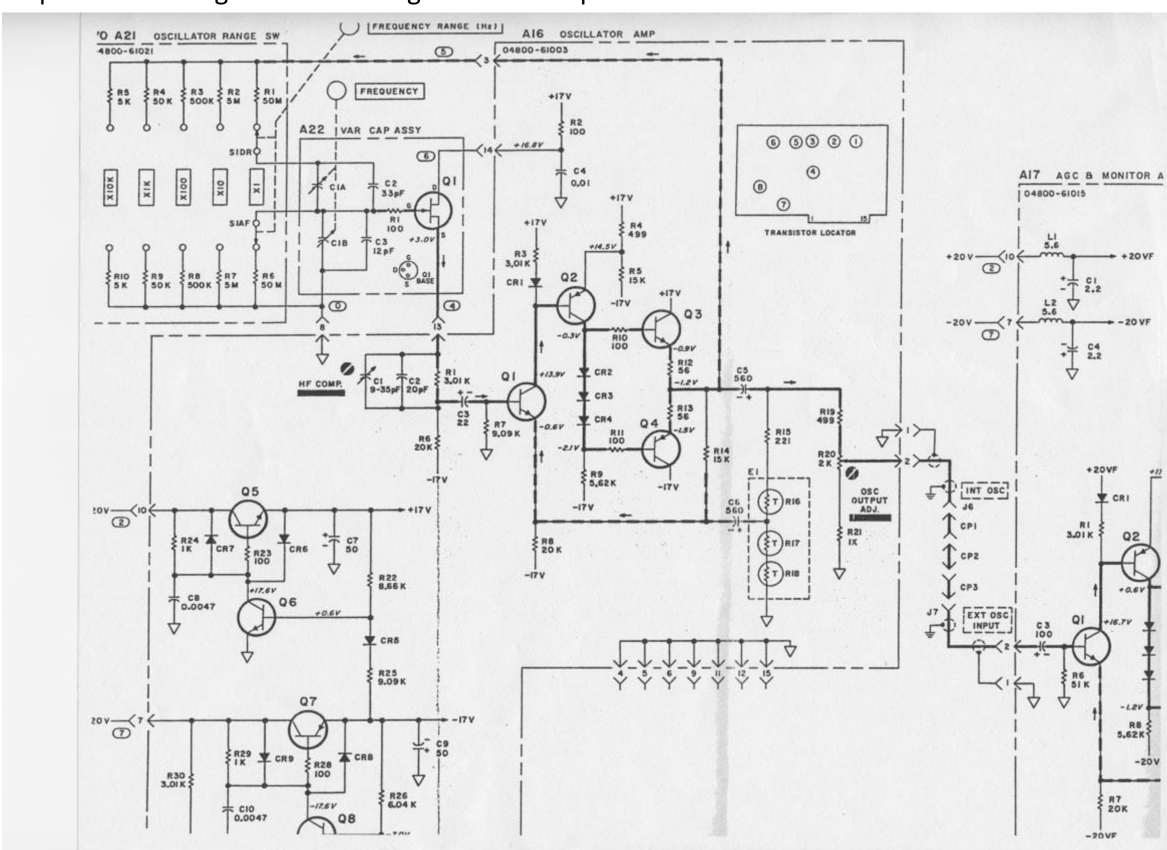

Figure 1. Wein Bridge Oscillator Section of the HP4800A Service Manual

This change in resistance is highly dependent on the temperature of the tungsten filament of the lamp. This temperature coefficient of resistance is nonlinear so this makes it a good control device. This lamp in the negative feedback path was used in the first HP product, the HP200A Wide Range Oscillator. This was the subject of William Hewlett's master's thesis.[1]

Since the lamps originally used are no longer available, a newer control device was sought. The Junction Field Effect Transistor (FET) has variable resistance characteristics that can be made to control the lower half of a voltage divider network inserted into the negative feedback path.

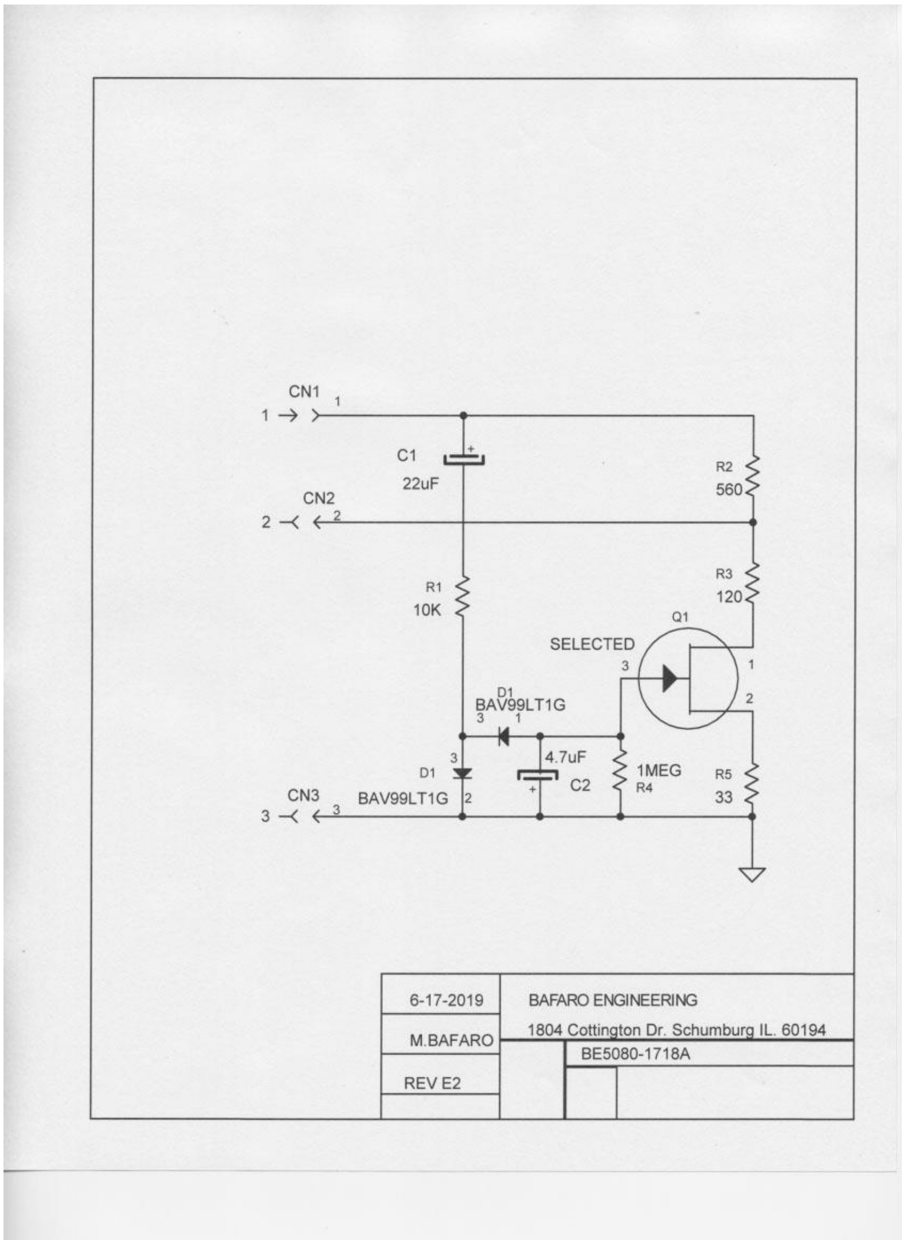

Figure 2. Schematic of the BE5080-1718A

Theory of Operation

As shown in Figure 2, CN 1 is the input to the device and it is connected to A16R15 in the 4800A. CN2 is the output of the device and it is connected to A16C6. CN3 is the ground of the module. The upper half of the divider network of the module is fixed by R2. The lower half of the divider network is an N channel J FET Q1. R5 in the source of the FET provides some source degeneration to improve the gain and bias stability of the FET.

The control (gate) voltage for the FET is derived by rectifying the oscillator output. This is done with coupling cap C1, R1, and the peak detector D1, and C2. This voltage is applied to the gate of the FET with a 1Meg input resistor R4. The time constant of C2 and R4 must be long in comparison to 5Hz, which is the lowest frequency at which the oscillator will run.

Under initial conditions, the FET is a low impedance from drain to source when the gate to source voltage (Vgs) is zero. Under these conditions, the divider network from CN1 to CN2 is a divider with a large attenuation; hence the negative feedback path around the oscillator is basically shut off and the positive feedback path is dominant. This allows the oscillator output signal to build up toward its steady state value. As the oscillator output signal increases, the voltage at the gate of the FET becomes more negative and the FET impedance increases. As the FET drain to source impedance increases, the negative feedback to oscillator also increases which reduces the overall loop gain. This reduction in oscillator loop gain keeps the oscillator output from going up into clipping. The oscillator will come to a steady state AC voltage as set by characteristics of the FET.

The startup of the 4800A that the module was developed on has a DC transient at start up that forces the amplifier output to the positive rail for a few milliseconds. This transient upset of the feedback control to the FET lasts a few milliseconds. But after the output transient is finished, the feedback control stabilizes and the oscillator comes to a steady state value.

The loop stability was evaluated by changing frequency ranges and noting speed with which the loop recovers from a change in frequency range switch setting. The best resistance values were selected by keeping the ringing of the oscillator output to a minimum when the range switch was moved. This also minimized the overshoot in oscillator output when the frequency range was changed.

Notice

Because of the large impedance in the gate of the FET, the circuit may be affected by high humidity and salt in the air as found in coastal areas. If the module is to be used under these conditions, please email the factory and a conformal coating will be added to keep the moisture and salt out of the sensitive circuits. If the module is operated without the conformal coating, the module must **not** be operated in condensing humidity conditions. If the module is operated in condensing humidity conditions, the control loop may not stabilize and the output level of the oscillator might vary with time or the output of the oscillator may go into clipping. The unstable output of the oscillator will cause the meters on the 4800A to operate erratically. This erratic meter operation is the first indication that original thermistor A16E1 is failing.

Installation

Figure 3. Original HP 5080-1718 Part

Since the 5080-1718 is a 3-pin device, it is suggested that the original part be removed by heating one pin at a time and slowly “rocking” the part out of the oscillator board a little at a time. It will take several rounds of applying heat at each of the 3 pins to remove the original part. Be careful not to overheat the traces on oscillator board. Applying too much heat may lift the trace from the board or open the plated through hole. Once the original part is removed from the oscillator board, it is suggested that the plated through holes be cleaned out with a vacuum de-soldering device before attempting to install the BEBE5080-1718A.

The BEBE5080-1718A is designed to be a drop-in replacement for the original HP part. As long as the pins from the replacement are straight and the plated through holes are clean, it should literally drop into place in the oscillator board. Solder in the new module and replace the oscillator board in the instrument. Check that the oscillator output is stable and adjust A16R20 to the original oscillator output specification. When the setup is complete, reassemble the rest of the instrument.

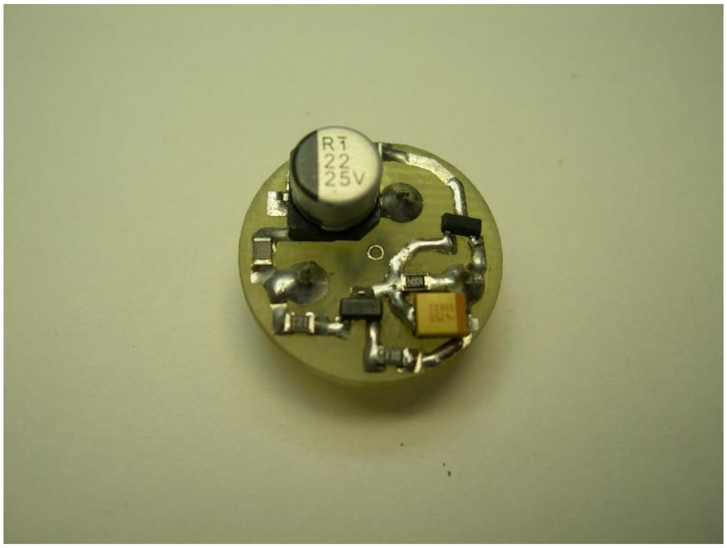

Figure 4. BEBE5080-1718A

The connecting pins are located so that they fit directly into the HP circuit board.

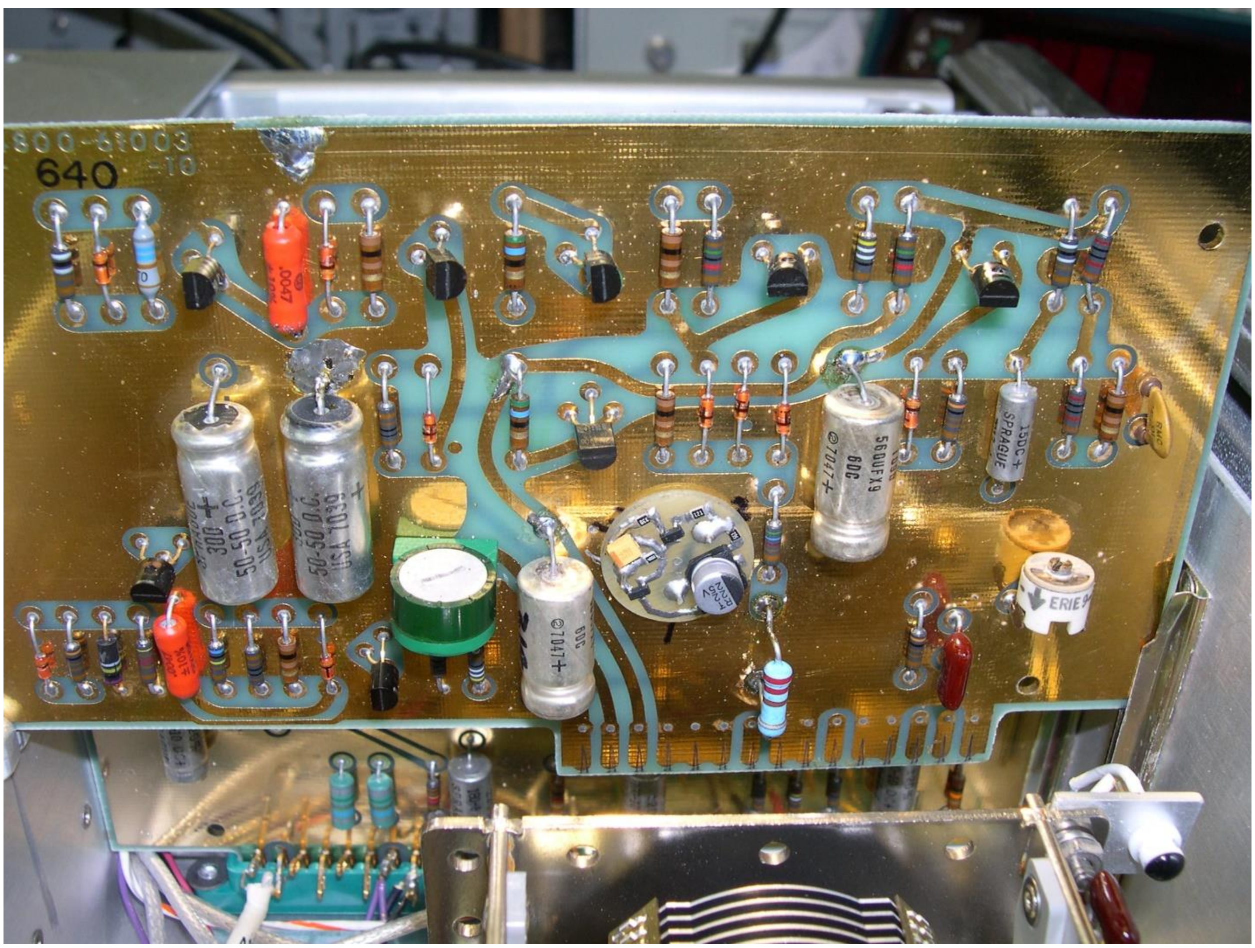

Figure 5. BEBE5080-1718A installed in the HP4800A circuit board.

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[1] Hewlett, William R, "A New Type Resistance-Capacity Oscillator," M.S. Thesis, Stanford University, Palo Alto, California, 1939.