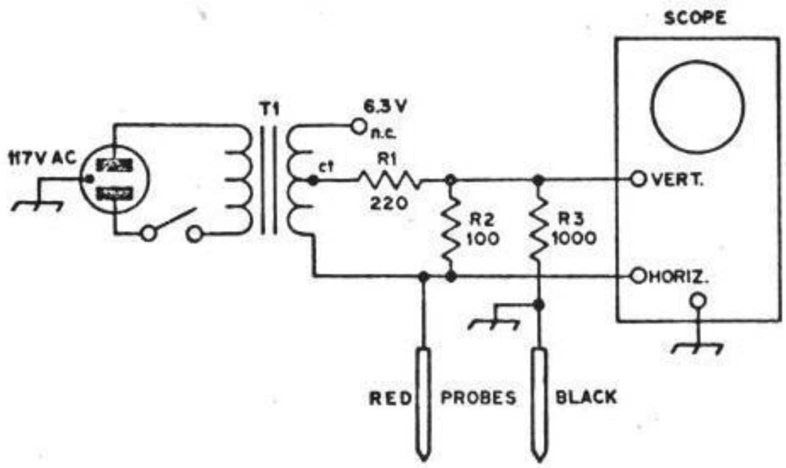

Fig. 1 — Circuit diagram of the Octopus in-circuit component testing device. T1 can be any small 6.3-volt unit. If one having no centertap is used, resistor R1 should be 560 ohms. Resistors can be 1/2-watt composition.

THE OCTOPUS

An Overall Component Tester for In-Circuit Troubleshooting

BY DAVID L. LUDLOW,* W7QHX

LOOKING FOR TROUBLE in equipment built on circuit boards usually involves removal of components, one at a time, for testing. This is a time-consuming procedure at best, and one runs the risk of damage, not only to the part being checked but to the board itself, and to adjacent components. The likelihood of making trouble for yourself increases as the size and spacing of parts decrease.

Moreover, ohmmeter testing cannot detect a shorted coil or an open capacitor, even after such parts are lifted from the board circuits. Also, some ohmmeters pass enough current at low resistances to damage solid-state components during the testing process. Obviously, some safe form of in-circuit testing is highly desirable.

The method described here is used with the equipment turned off, and uses voltages and currents low enough for safe testing of almost any transistorized circuit-board assembly. The needed tests can be made in most instances without removing the board from the equipment. The overall component tester, quickly dubbed "Octopus," is inexpensive to build and simple to use, involving only an oscilloscope as an auxiliary device.

Construction

The Octopus uses low-voltage ac, and limits currents to less than 1 mA. It energizes circuitboard components without removal of any connections, in much the same way as they are used in normal service in the equipment under test. It tests for shorts and opens, and shows forward-reverse ratios on junction components (diodes and transistors). By use of Lissajous figures and other combination displays on the oscilloscope, the Octopus facilitates analysis of circuits involving reactive components, transistors, and ICs that defy ohmmeter testing. It can show up high-resistance solder joints or test continuity of switches, fuses, lamps, or circuit-board patterns. The resistor network assures that the voltage and current will be limited to safe values.

If much work is to be done, the Octopus can be left permanently connected to a simple oscilloscope. The test prods should have small needle points, for easy access to cramped places and sure penetration of plastic and other moisture-proofing coatings. Permanent test-lead connection is also desirable, so that the setup will be ready for use at all times.

As can be seen in Fig. 1, the few parts that go into the construction of the Octopus are all commonly available items. Component values are not critical and any suitable substitute may be used. Since low voltages and currents are necessary in order to protect delicate components, the 1000-t2 resistor (R3) in series with the 1-V source voltage provided by the voltage-divider network (R1, R2) limits the current to 1 mA. A centertapped 6.3-V filament transformer can be used for T1 and the voltage from one half of the winding is dropped to 1 V by means of R I and R2. The leads should be color coded for easy identification with black for ground and red for the "hot" side. Be care that the equipment being tested is disconnected from the power source to avoid possible injury or damage. Also, unless all circuit points in the unit (which are not being tested) are isolated from the common ground of the Octopus and scope, erroneous readings will occur in some instances.

The unit was originally designed for in-circuit testing of Navy electronics equipment. Since the power cord, oscilloscope leads and probe cables protruding from various sides of the tester resembles an octopus, it is commonly called just that.

Operation

Each basic component projects a different scope display, making use of the Octopus a very simple matter. Connect the test leads across the component terminals or circuit points to be tested. A detachable clip for the black lead facilitates one-handed testing of many units. Because this is an ac device there is no need for lead reversal.

The six most common displays are shown in Fig. 2.

When observing transistors, check from the base to emitter and base to collector. A collector-emitter test would have to pass through two junctions in series, and therefore does not usually give a meaningful result, except to indicate a possible short.

A rough check on transistor condition is evident from the patterns of Fig. 3. An ideal single-junction pattern is the 90-degree step at the left (open in the reverse direction, short in the forward direction). A wider angle than 90 degrees indicates a less-than-perfect junction, with the quality degradation indicated by increasing angle.

Real trouble-shooting proficiency comes with the ability to sort out patterns resulting from combined components, as in the diode-capacitor circuit of Fig. 4. Here we have both a Lissajous figure and 90-degree junction step, informing us that the components are neither shorted nor open. A base emitter transistor test, where there is inductance in parallel with the junction, would look like Fig. 4, but with the loop at a wider angle because of the resistance of the inductor, the angle being characteristic of total base-emitter resistance, as in Fig. 3. Any shorted transistor junction would show up as a vertical line, as at the upper left of Fig. 2.

To distinguish between npn and pnp transistors, move the red probe to the transistor base and the black to either emitter or collector. If the step pattern opens downward the transistor is npn (emitter arrow pointing downward in the schematic diagram). If the pattern opens upward the transistor is pnp (outward-pointing arrow). The same technique is useful for checking diode polarity, of course.

The effect of a dirty or otherwise noisy control is seen in Fig. 5. Connect one probe to the control arm and the other to either end. Move the control through its range. A quiet, smooth-working control will show a clean line. Fuzziness indicates erratic or noisy operation. Low-value capacitors and inductors may appear as "open" or "shorted'

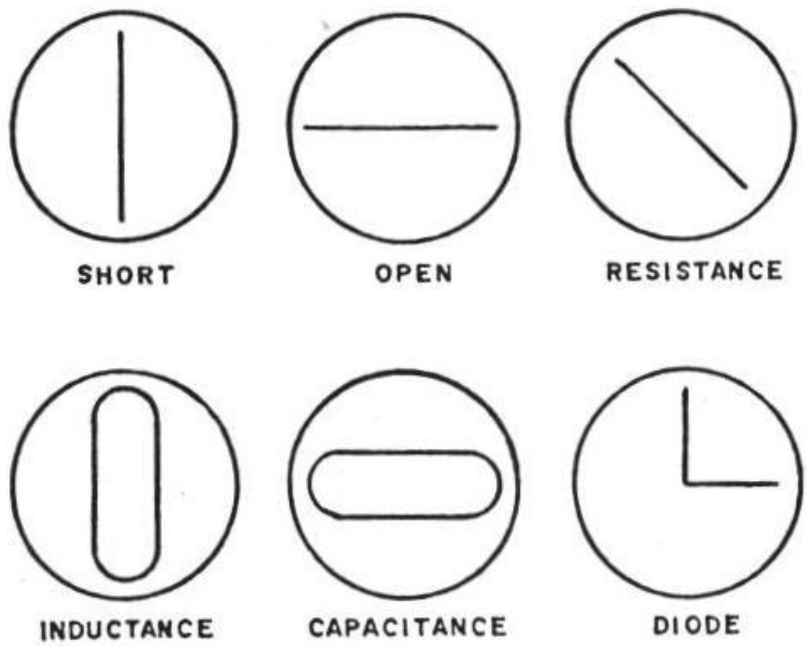

Fig. 2 — Typical oscilloscope displays for conditions most often encountered in equipment testing.

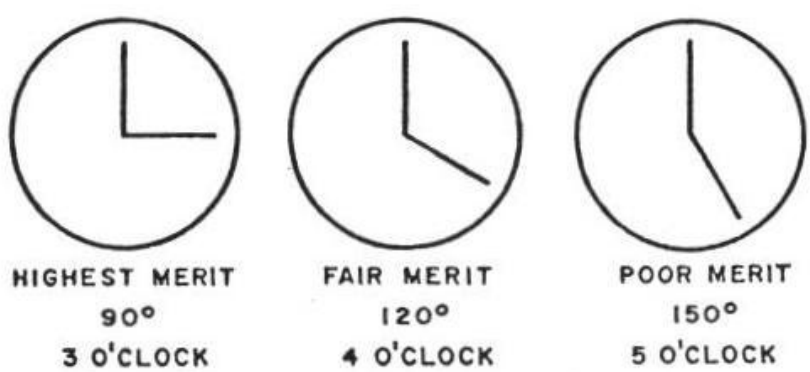

Fig. 3 — Transistor quality check, using the Octopus.

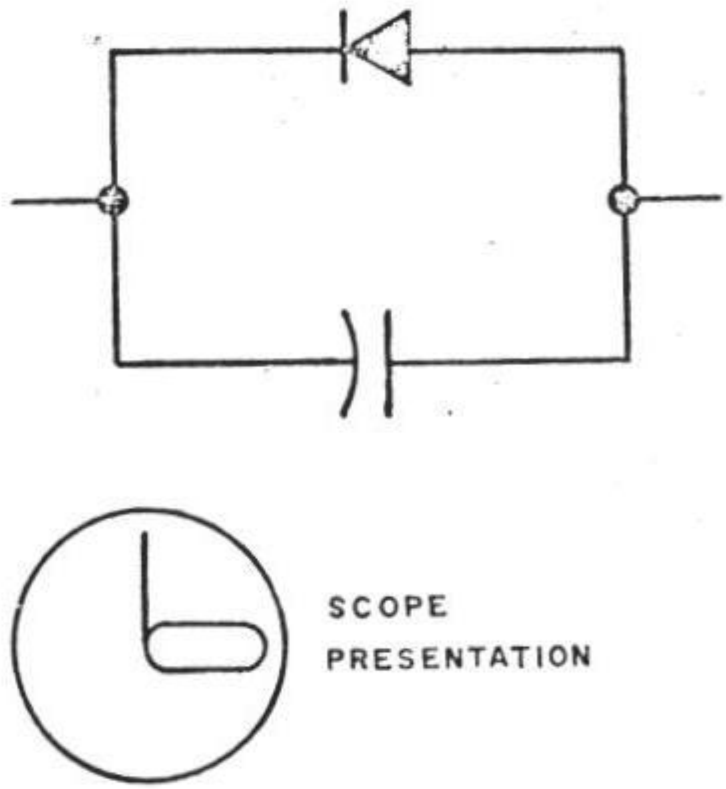

Fig. 4 — Combination pattern, showing that the diode-capacitor circuit is neither open nor shorted.

EDITOR'S NOTE: Our thanks go to David Ludlow. W7QHX, who wrote up his Octopus in a naval publication, and to David Walsh, W1FYX, who sent us the material for adaptation to *QST.*

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