December 1970

Brief 70-10498

NASA TECH BRIEF

A Power Semiconductor Test Circuit with Reduced Power Requirements

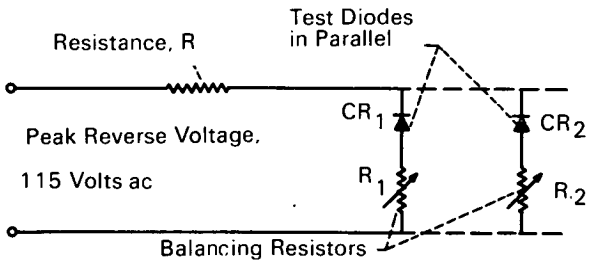

Figure 1. Conventional Test Circuit for Operation of Diodes as ac Rectifiers.

A simple switching circuit utilizing a silicon controlled rectifier was developed and used to reduce the input power requirements normally associated with testing power semiconductors in an operational type mode. It is desirable in many instances to test semiconductors in operational modes such as ac rectification in the case of diodes. Examples of this type application would be power burn-in requirements in quality assurance programs or running tests under operational conditions during nuclear radiation testing. In either case, large numbers of devices are generally involved, large forward currents are required for one-half cycle of the ac applied voltage, and large reverse voltage biases are required on alternate half cycles of the applied voltages. The conventional circuit for this type of testing causes problems where the test may be located in a rather inaccessible area; the problems include the inability to furnish the large amounts of power required, the actual physical size of the power resistors, wiring, and the heat generation itself.

The circuit devised alleviates these problems as illustrated by the following examples. Assume that it is required to test 30 power diodes in an ac rectification mode with a forward current of 10 amp full cycle average and a reverse voltage of 115 V rms on alternate half cycles. Using a conventional circuit, Figure 1 with 115 V ac input voltage, the desired reverse voltage across the diode is obtained on that half cycle where the polarity on the diode is reversed. The circuit condition presents no problem since the reverse current is small with the diode acting essentially as an open circuit. The power dissipation is negligible. However, when the diode is forward biased on the alternate half cycle with the average forward current of 10 amp, the diode looks essentially like a short circuit (0.8 V drop). In this case, 114.2 V at 10 amp must be dropped across a series resistor. Thus, the value of the resistance for one test diode would have to be 11.42 ohms, and the power that must be dissipated in the resistance for one diode is 1142 W. For 30 diodes a current of 300 amp is required and 34.26 kW must be dissipated in a series resistance.

These circuit requirements of a large voltage, small current, on one half cycle, and a small voltage, large current, on the alternate half cycle suggest that some type of switching would be practical. The basic circuit illustrated in Figure 2 meets these circuit requirements. In this circuit, the secondary of transformer T_1 is tapped at approximately 2.0 V ac, and the total secondary voltage is 117 V ac, or a slightly greater than 1:1 ratio. The silicon-controlled rectifiers and the diode CR_1 act as switches on alternate half cycles. The test diodes in parallel are CR_2 . . . . . CR_n. The operation of the circuit is illustrated in Figures 3 and 4.

In Figure 3, with the polarity of the secondary of T_1 as shown, the silicon-controlled rectifier (SCR) is turned off and CR_1 is forward biased, which then places 117 V ac across R_1, CR_1, CR_2, and R_3 in series.

(continued overleaf)

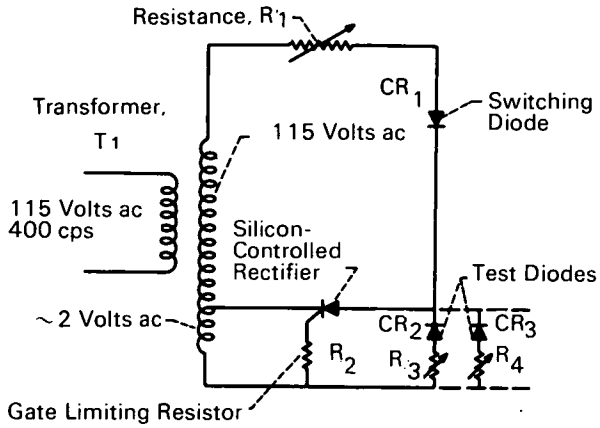

Figure 2. Test Circuit for Testing Diodes Operating as ac Rectifiers to Reduce Input Power Requirements

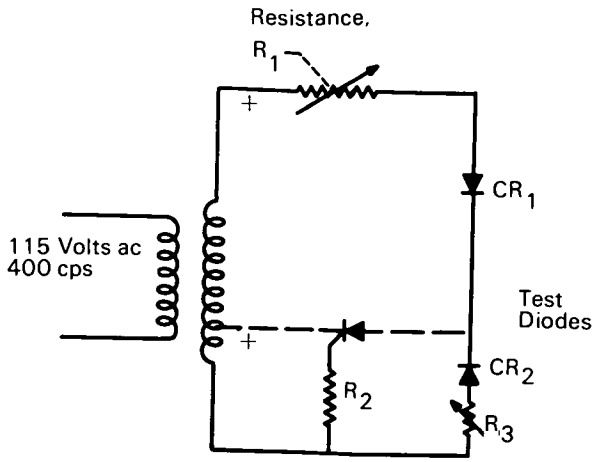

Figure 3. Circuit Condition when Test Diodes are Reverse Biased.

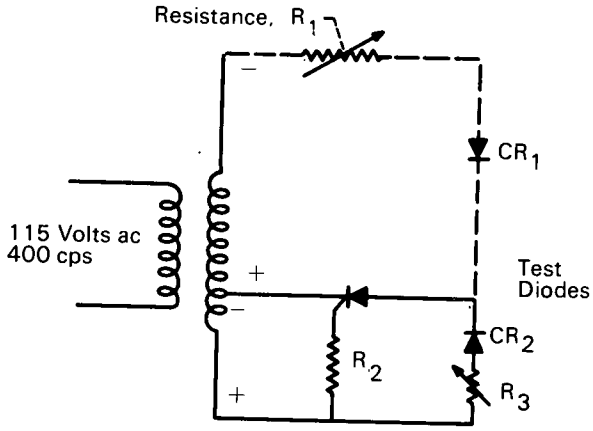

Figure 4. Circuit Condition when Test Diodes are Forward Biased.

R_1 is adjusted until the desired reverse voltage is dropped across the diode; little power is dissipated in R_1 because only the reverse leakage current of the test diodes flows through it. On the alternate half cycle, the SCR is turned on and the diode CR_1 is reverse biased (turned off), as shown in Figure 4. The 2.0-V tap now furnishes 2 V to the SCR, R_3, and the test diodes in series. R_3 is adjusted until 10 amp flow in the diode CR_2. Since R_3 is negligible as compared with R_1, the drop across R_3 in the reversed bias condition will be negligible.

The advantages of this circuit are apparent in the power requirement for a test diode, which is 20 W, and the requirement for 30 test diodes is 0.6 kW. Therefore, the current requirement from the 115-V ac source is 5.2 amp.

Notes:

1. This circuit could also be used for testing switching transistors or silicon controlled rectifiers by simply adding a properly phased base or gate current for switching the test device.
2. No additional documentation is available. Specific questions, however, may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10498

Patent status:

No patent action is contemplated by NASA.

Source: J. F. Been
Lewis Research Center
(LEW-11175)