Solution Problem

Since a battery could be present, the first test should be intended to detect it. To do that, the voltage drops V_{ab}, V_{ac} and V_{bc} should be measured using a voltmeter. This test will show that no batteries are present.

Next, a testing circuit as shown in figure 4.1 should be used.

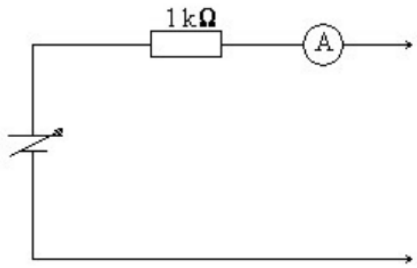


Figure 4.1

By means of this circuit, the electric conduction between a pair of terminals should be tested, marking all permutations and reversing the polarity. Resistor R_1 is included to prevent a large current across the diode. One conclusion is that between A and C there is a diode and a resistor in series, although its current position is still unknown. The other conclusion is that a capacitor is tighted to terminal B. To determine the actual circuit topology, further transient experiments have to be conducted.

In this way, it is concluded that the actual circuit inside the black box is that shown in figure 4.2.

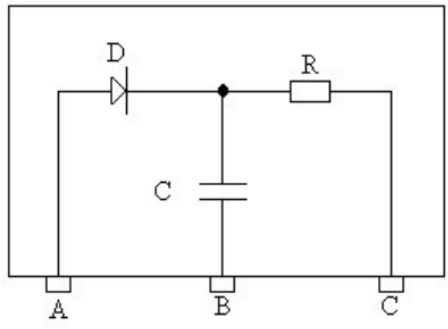


Figure 4.2

The best procedure for the resistor value determination is to plot a set of voltage and current values measured between A and C. Figure 4.3 shows the resulting plot. Extrapolating both linear regions, the values of V_o and V_z are obtained and the resistor value equals the reciprocal of the slope.

Similar, the best method to measure the capacitor value is to build a testing circuit as shown in figure 4.4. The current is adjusted to full scale and then, the switch is opened.

The time needed by the current to drop to its half value is measured. Applying the formulae $t = RCIn(2)$, the value of C is obtained.

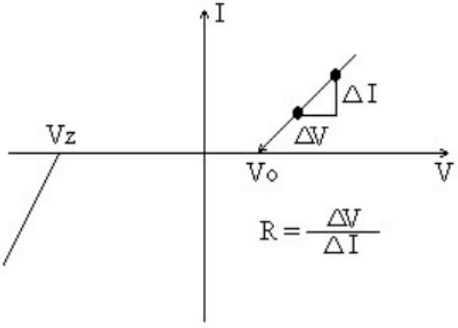


Figure 4.3

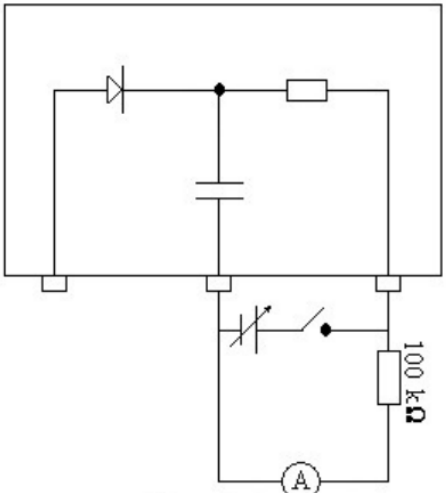


Figure 4.4

Marking Code

1. Determination of circuit topology: 8 points.
   1.1 For discarding the presence of a battery: 1 point.
   1.2 For drawing the exploring circuit which determine the circuit topology in a unique way: 7 points.
2. Resistor and diode parameters value measurement: 8 points.
   2.1 For drawing the measuring circuit: 2 points.
   2.2 Error limits calculation: 3 points.
   2.3 Result: 3 points.
   2.3.1 Coarse method: 2 points.
   2.3.2 Graphic method: 3 points.
3. Capacitor value measurement: 4 points.
   3.1 For drawing the measuring circuit: 2 points.
   3.2 Error limits calculations: 2 points.