4. Experimental Objectives

1) Master the method and the basic circuit of measuring V-I characteristics of nonlinear components.

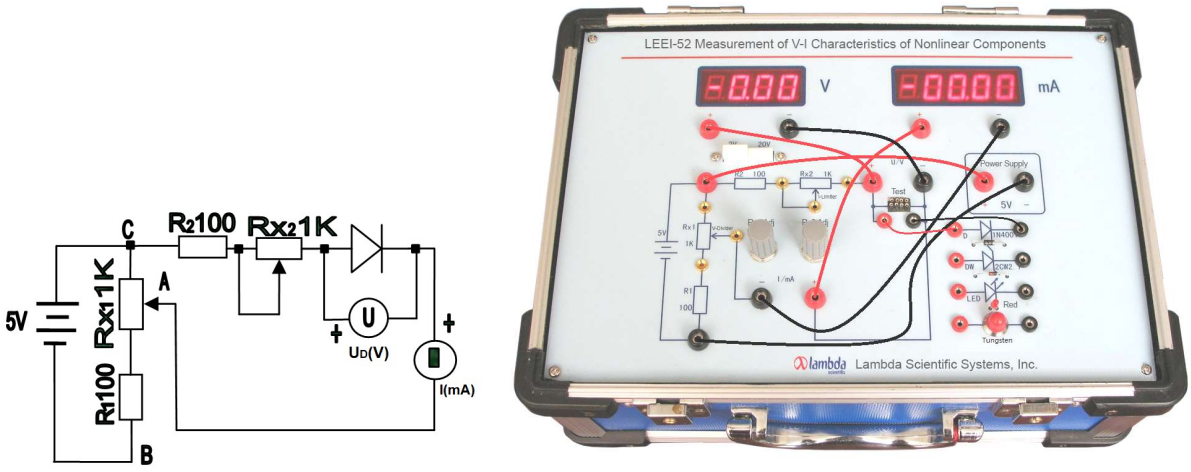
2) Master the basic characteristics of a diode, a Zener diode and a light-emitting diode. Accurately measure their forward threshold voltages.

3) Plot the graphs of V-I characteristic curves of the above three nonlinear components.

5. Experimental Procedures

1) Measure forward V-I characteristics of an ordinary diode

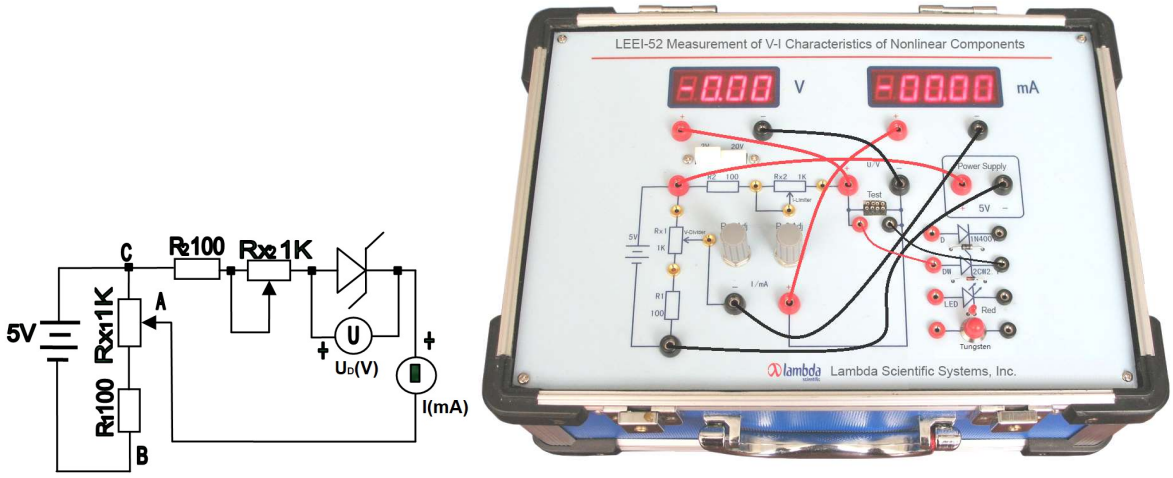
Wire the circuit per Figure 7. When measuring the forward V-I characteristics of the diode, the voltage is adjusted with the potentiometer V-Adj. (i.e. R_{x1}) starting from the minimum, observe the forward current. When there appears a forward current reading, adjust the voltage very slowly. When the forward current reaches 10 mA, stop the measurement. Record the I-U data, and plot the forward V-I characteristic curve.



(a) (b)

Figure 7 Measurement of forward V-I characteristics of an ordinary diode.

2) Measure forward and reverse V-I characteristics of a Zener diode



(a) (b)

Figure 8 Measurement of V-I characteristics of a Zener diode.

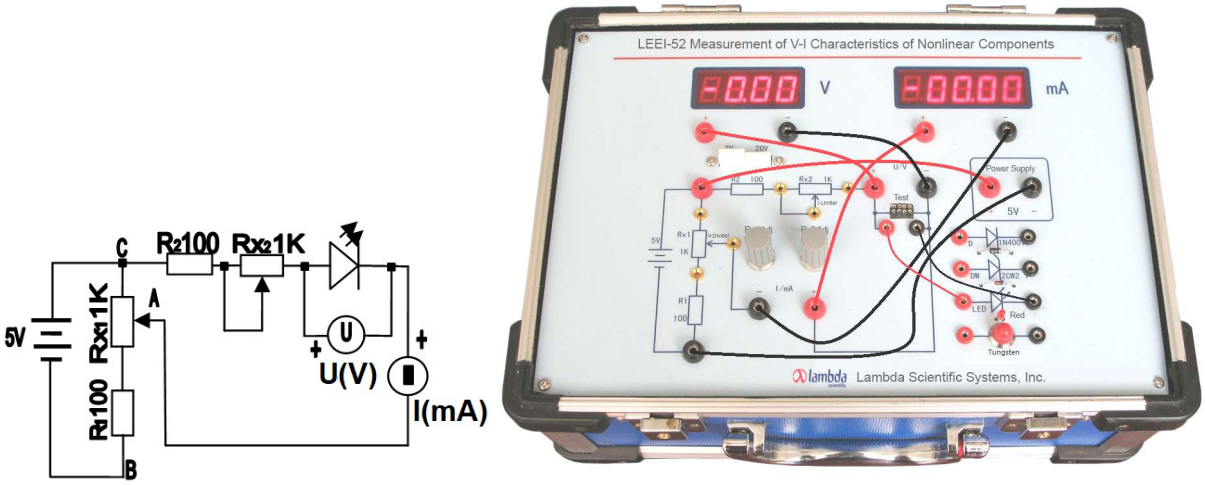
Wire the circuit per Figure 8. When measuring the forward V-I characteristics of the Zener diode, the voltage is adjusted with the potentiometer V-Adj. starting from the minimum, observe the forward current. When there appears a forward current reading, adjust the voltage very slowly. When the forward current reaches 10 mA, stop the measurement. Record the I-U data, and plot the forward V-I characteristic curve.

When measuring the reverse V-I characteristics of the Zener diode, just swap the two connection wires of the Zener diode to exchange polarity. The voltage is adjusted with the potentiometer V-Adj. Starting from the minimum, observe the reverse current. When there appears a reverse current reading, adjust the voltage very slowly. When the reverse current reaches 10 mA, stop the measurement. Record the I-U data, and plot the reverse V-I characteristic curve. Extrapolate the straight line to obtain the intercept, this is the reverse breakdown voltage of the Zener diode. The dynamic resistance of the Zener diode can be obtained by voltammetry.

3) Measure the forward V-I characteristics of a LED

The forward V-I characteristic of the LED is similar to the general diode, and its turn-on voltage is the lighting voltage. Because its peak wavelength is related to the forbidden band width Eg of the semiconductor material, LEDs made of different materials will emit light with different peak wavelengths, and the turn-on voltage will also be different. This experiment

provides a red LED. Measure its turn-on voltage and estimate its peak wavelength based on the turn-on voltage.

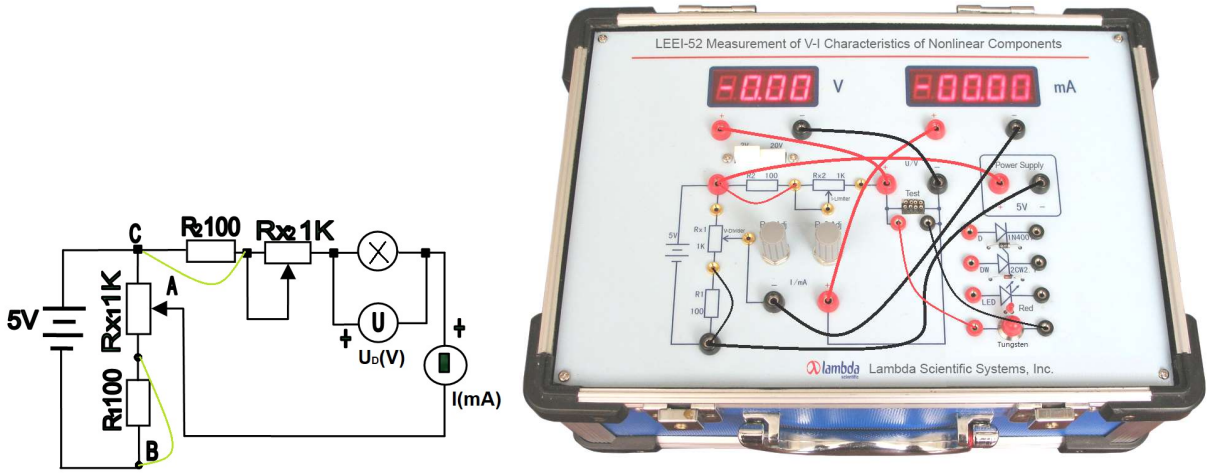


(a) (b)

Figure 9 Measurement of the forward V-I characteristics of a LED.

Wire the circuit per Figure 9. When measuring the forward V-I characteristics of the LED, the voltage is adjusted starting from the minimum, observe the forward current. When there appears a forward current reading, adjust the voltage very slowly with the potentiometer R_{x1}. When the forward current reaches 10 mA, stop the measurement. Record the I-U data, and plot the forward V-I characteristic curve. Note: the maximum forward current cannot exceed 20 mA, otherwise the LED may burn out.

4) Optional experiment: Study the non-linear characteristics and measure the V-I characteristics of a tungsten filament bulb



(a) (b)

Figure 10 Measurement of V-I characteristics of a tungsten filament bulb.

When measuring the V-I characteristics of a tungsten filament bulb (Labeled as “Tungsten” on the apparatus panel), the two 100 Ω protection resistors (R_1 and R_2) in the measurement circuit must be short-circuited with wires (i.e. use a wire to connect both ends of R_1 and use another wire to connect both ends of R_2), as shown in Figure 10.

The working principle of a tungsten filament bulb is as follows:

When a current flows through the tungsten filament, the resistance of the tungsten filament becomes hot and emits light. During operation, the filament is in a high temperature state, and the resistance value of the filament increases as the temperature increases. The greater the current through the filament, the higher its temperature and the greater the resistance will be. The V-I characteristic curve is not a straight line, so the tungsten filament bulb is a non-linear element.

Within a certain current range, the relationship between the voltage and current of the tungsten filament bulb is

$$U = K I^n, \tag{2}$$

where K and n are coefficients related to the tungsten filament bulb.

Experimental contents:

a. Measure the V-I characteristics of tungsten filament bulbs.

b. Verify formula (2) and find the coefficients K and n.

c. Find the resistance of the tungsten bulb at room temperature (Hint: make a graph of the relationship between the resistance R of the tungsten filament and the passing current I. Find the resistance R at I = 0 at room temperature.)

Note:

To measure the V-I characteristics of other user-selected components, there is a preset socket (labeled as “Test” on the panel) for mounting the component.