

Equivalent Resistance

Consider a circuit connected to a current source and a voltmeter as shown in Figure 1. The input to this circuit is the current of the current source and the output is the voltage measured by the voltmeter.

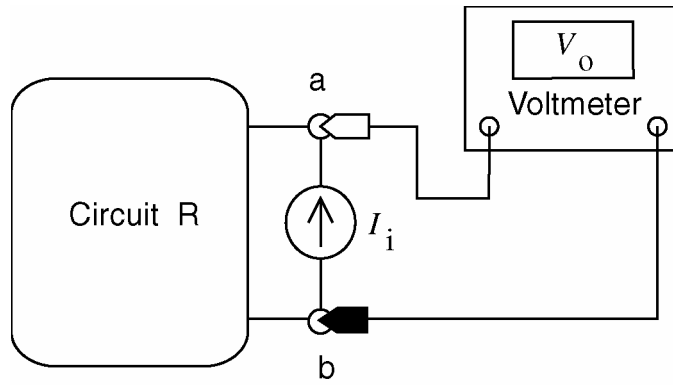


Figure 1 Measuring the equivalent resistance of Circuit R.

When “Circuit R” consists entirely of resistors, the output of this circuit is proportional to the input. Let’s denote the constant of proportionality as R_{eq} . Then

$$V_o = R_{eq} I_i \quad (1)$$

This is the same equation that we would get by applying Ohm’s law in Figure 2.

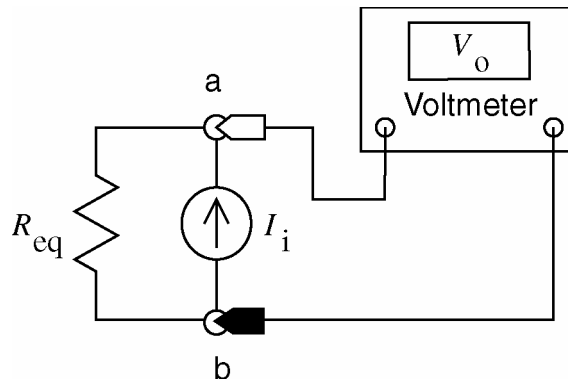


Figure 2 Interpreting the equivalent circuit.

Apparently Circuit R in Figure 1 acts like the single resistor R_{eq} in Figure 2. (This observation explains our choice of R_{eq} as the name of the constant of proportionality in Equation 1.) The constant R_{eq} is called “the equivalent resistance of circuit R as seen looking into the terminals a-b”. This is frequently shortened to “the equivalent resistance of Circuit R” or “the resistance seen looking into a-b”. In some contexts, R_{eq} is called the input resistance, the output resistance or the Thevenin resistance (more on this later).

Figure 3a illustrates a notation that is sometimes used to indicate R_{eq} . This notion indicates that Circuit R is equivalent to a single resistor as shown in Figure 3b.

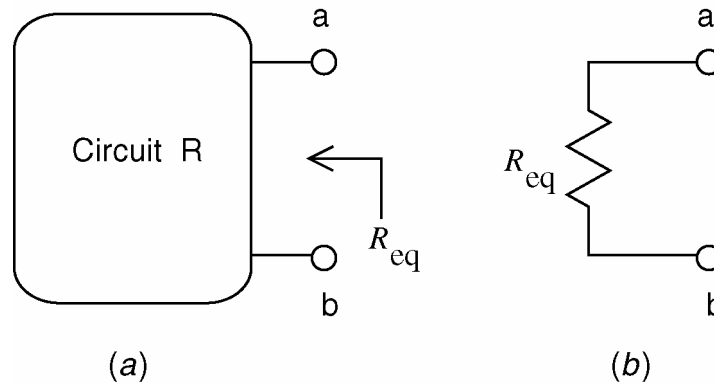


Figure 3 (a) A notion indicating the equivalent resistance and (b) the interpretation of that notation.

Figure 1 shows how to calculate or measure the equivalent resistance. We apply a current input, I_i , measure the resulting voltage V_o , and calculate

$$R_{eq} = \frac{V_o}{I_i} \quad (1)$$

The equivalent resistance can also be measured using an ohmmeter as shown in Figure 4. The color-coding of the ohmmeter probes can be ignored. (A multimeter is a meter that can be used to measure voltages, currents or resistances. A dial on the front of the multimeter is used to select which quantity will be measured. A voltmeter may well be a multimeter set to measure voltage. The color-coded probes of the multimeter will then indicate the reference polarity of the measured voltage. A multimeter that is set to measure resistance is an ohmmeter. The probes will still be color-coded, but now the color-coding has no significance.)

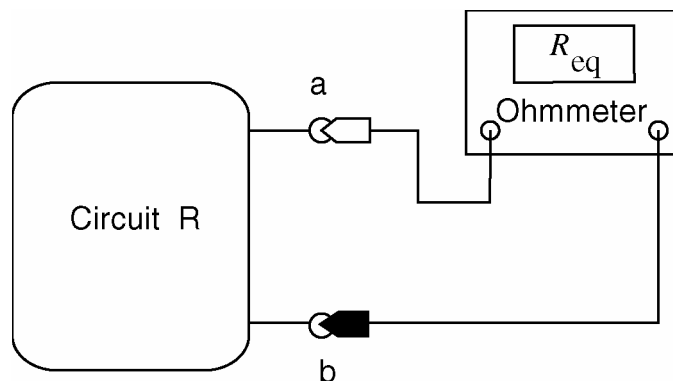


Figure 4 Measuring equivalent resistance using an ohmmeter.