16.3.7 Cell and Module *I–V* Systems

A wide variety of *I–V* measurement systems have been developed to measure the performance of PV devices, from 0.01-cm^2 area cells to multikilowatt arrays [2, 119]. A generic *I–V* system is shown in Figure 16.7. The voltage across the PV device (from a cell to an array) is biased with a variable load, with the current being sensed by a precision four-terminal shunt resistor or magnetic transducer. (Current through a solar cell should never be measured with a standard ammeter in series because the voltage bias developed across the meter will change the operating point of the cell.) Domestic and international standards have been developed for the minimum characteristics of typical *I–V* measurement systems [5–7, 9, 11, 13]. The critical parameters on the *I–V* curve are the open-circuit voltage (V_{OC}), the short-circuit current (I_{SC}), and the maximum-power point (P_{max}). Figure 16.8 shows a typical *I–V* curve for a 50-W module in the light at SRC and in the dark. The fill factor (*FF*) is a normalized parameter indicating how ideal the diode properties are, and it is calculated by the following expression:

$$FF = \frac{P_{max}}{V_{OC} I_{SC}} \tag{16.32}$$

The fill factor is often expressed as a percentage by multiplying equation (16.32) by 100.

The open-circuit voltage can be determined from a linear fit to the *I–V* curve around the zero current point or by measuring the voltage with the load disconnected. The value of V_{OC} is often obtained by linear interpolation of the two *I–V* points closest to zero current. Performing a linear regression using more than two points can reduce the uncertainty in V_{OC}; however, care must be taken not to include points resulting from blocking diodes in series with a module or fitting in nonlinear regions. One manufacturer

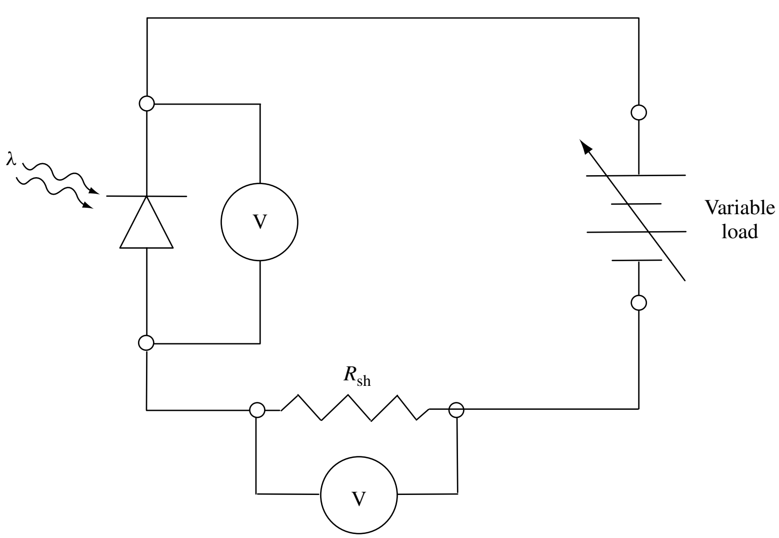

Figure 16.7 Typical current versus voltage measurement system