The fit value for L will reflect the minority-carrier diffusion length when L is greater than the depletion width, but less than the thickness of the layer. For small $\alpha(h\nu)^*L$, the QE is proportional to $\alpha(h\nu)$, allowing an easy fit to determine E_g from $\alpha(h\nu) = A^*(h\nu - E_g)^{0.5}$.

Photoluminescence (PL) intensity is commonly used to test the quality of a material, but the intensity strongly depends on carrier concentration and surface recombination. Time-resolved PL measurements on double heterostructures (passivated layers) of different thicknesses can quantify both the minority-carrier lifetime and the interface recombination velocity [117, 118].

9.7.2 Transmission Line Measurements

Once a device is made, in addition to the I-V and QE measurements, characterization of the device contacts using a transmission line measurement is useful toward diagnosing problems. Transmission lines [119] allow determination of the contact resistance (ρ_c) and the sheet resistance (R_s). The resistance, R, between any two pads as a function of x, the distance between the pads, is estimated by:

$$R = 2\rho_c/(w^2) + R_s/w^*x \tag{9.26}$$

where w is the width of the transmission line and the dimension of the square pads. ρ_c and R_s are calculated from the intercept and slope of the line [119]. If the sheet resistance is large compared with the contact resistance, then the current across the semiconductor/pad interface is not uniform, and the estimated ρ_c can be refined to a more accurate value of the contact resistance, ρ_c', using the equation:

$$\rho_c' = \rho_c^2/(w^2 R_s)^* \tanh^2\{w^2 R_s/[\rho_c^* \tanh(w^2 R_s/\rho_c)]\} \tag{9.27}$$

9.7.3 *I*-*V* Measurements of Multijunction Cells

The chapter on measurements (Chapter 16) describes how to measure the light I-V curve for a standard reference spectrum and for systematically varied spectra. Complete diagnosis of a multijunction cell requires characterization (an I-V curve) of each of the active junctions to quantify their photocurrents and shunting. It would also be useful to establish the photovoltages and series resistances of each junction, but these are difficult or impossible for a two-terminal, series-connected cell. We describe here some alternative approaches for characterizing the individual junctions.

In some situations, it is possible to apply a contact between the series-connected junctions. The three-terminal configuration allows measurement of each junction of a two-junction cell. For a three-junction cell, a three-terminal measurement allows independent measurement of the top or bottom cells, but measurement of the middle cell by itself may require four connections. A primary advantage of the three-terminal approach is that it allows measurement of the photovoltage of each junction. The measured photocurrents should be adjusted for the change in junction area that occurred when the third connection