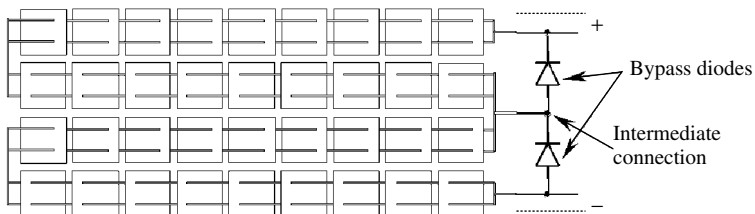


**Figure 7.21** Computer simulation of the  $I-V$  curves of a 36-cell series string without and with two bypass diodes, connected as shown in the bottom of the figure, when one cell is 50% shaded. The currents through the shaded substring and its bypass diode are also shown

The practice is to take electrical terminals outside the encapsulation not only for the extremes of the series string, but also for intermediate points as well, so that bypass diodes are connected in the junction box 12 or 18 cells each (Figure 7.22). Endurance to shading is a standard test for module qualification.

The influence of local shading on the module output depends on the details of the  $I-V$  curve of the cells as well. Under certain circumstances of partial shading, it is beneficial that the cells show some shunt resistance. However, tight control of leakage currents by processing is not easy.



**Figure 7.22** Two bypass diodes in a 36-cell module. The connections are done in the junction box