Two different control strategies are used. The multiple switches can be driven in parallel, turning the full array current on and off in one step. A preferred strategy is to drive the switches in a certain sequence that allows stepwise adjustment of the charging current.

With all of the switching controllers described above, the designer or end user has to be aware that the solar generator is directly coupled with the battery and the load. If the battery connection is interrupted (maintenance work, lead breakage, blowing of the battery fuse etc.), the full open-circuit voltage of the PV generator can be applied to the load and may destroy it! To prevent damage, either the loads must be able to withstand the high voltage or the controller must be designed to avoid voltages higher than the rated output. This can be achieved, for example, by rapid over-voltage detection and load cut-off.

19.1.1.4 Control strategies

When the end-of-charge voltage is reached for the first time, the battery is not yet fully charged. The missing 5 to 10% of charge can be added to the battery by keeping it at the end-of-charge voltage level for a prolonged period. In this constant-voltage (CV) phase, the charging current will slowly decrease. How can such a charging regime be implemented by a series or shunt controller as described above, which can only switch all of the PV generator current on and off? Two techniques are used in practice to approximate the ideal CC/CV charging mode.

In a two-position controller, the charging current is dropped to zero by either opening the series switch or closing the shunt switch as soon as the end-of-charge voltage has been reached. As a result, the battery-terminal voltage decreases. The charging current is enabled again when the battery voltage drops below a threshold that is between 5 and 50 mV/cell lower than the end-of-charge voltage.

This sequence gets repeated periodically and the charging pulses become shorter and shorter, while the intervals in between become longer, as the battery's state of charge increases as shown in Figure 19.7. The average charging current decreases, while the terminal voltage is more or less constant. The period of the cycle described above is

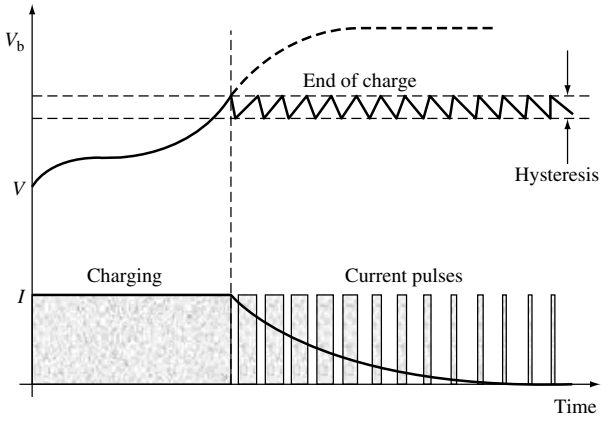

Figure 19.7 Battery voltage and current during charging