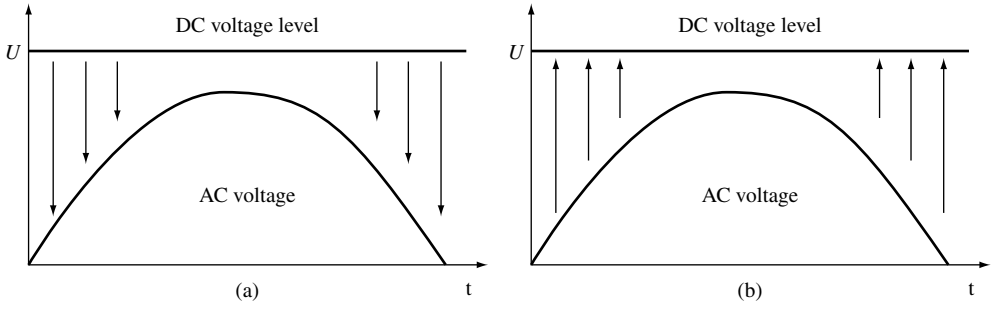

Figure 19.37 (a) Step-down conversion in the forward power-flow mode. (b) Step-up conversion in the reverse power-flow mode

19.2.4.3.7 Bi-directional step-up/step-down conversion

The concept described above allows reversed power flow only in cases in which the DC voltage level is always higher than the peak voltage of the AC side, which means that $U_{DC} \geq 358$ V for 230 V AC. However, there are two possibilities to lower the DC voltage level, that is, to install a transformer at the AC side or to install a bi-directional DC-DC converter at the DC side. Since a conventional step-down converter, as was described earlier, is not able to act as a step-up converter in the reversed power-flow mode, either two converters in anti-parallel mode or a different conversion concept would be necessary. One topology developed by Cuk [8] in 1977, which is able to fulfil these requirements, is given in Figure 19.38.

This conversion principle is in fact able to perform step-up as well as step-down conversion in both directions. The relation between the input voltage U_1 and the output voltage U_2 becomes:

$$U_2 = U_1 \cdot \frac{t_{on}}{(t_{off} + t_{on}) \cdot \left(1 - \dfrac{t_{on}}{(t_{off} - t_{on})}\right)}$$

Switches S1 and S2 operate complementarily, for example, if S1 is on, S2 is off and vice versa.

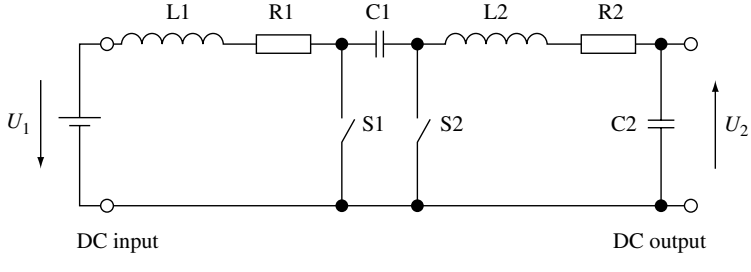

Figure 19.38 Bi-directional Cuk converter