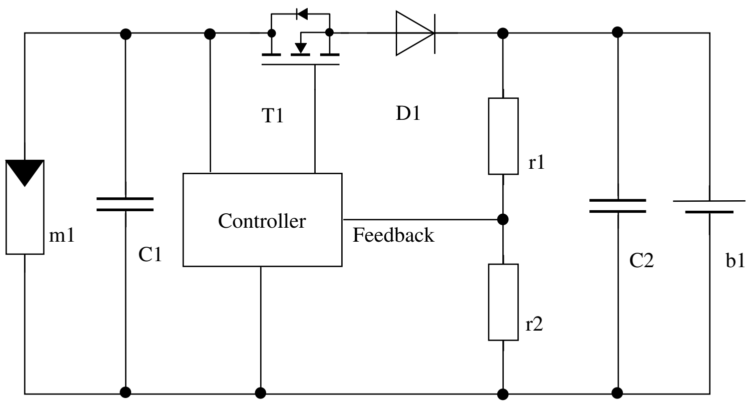

Figure 19.2 Linear charge controller based on the integrated voltage controller MIC 5158 (MICREL) labelled controller with an external power MOS-FET

the solar generator. By driving the controlling element appropriately, the battery voltage can be prevented from exceeding the end-of-charge limit.

Figure 19.2 shows the block circuit diagram of a linear series charge controller. In the constant-current (CC) phase, in which the battery voltage is below the end-of-charge voltage, the control element MOS-FET T1 is fully conducting. The solar generator and the battery are directly coupled via the blocking diode D1. The operating point of the solar generator is determined by the instantaneous insolation and the battery voltage. The power losses inside the control element are almost negligible in this phase. Additional power losses are caused by the voltage drop across the blocking diode D1, which in most cases will be a Shottky diode with a very low forward voltage drop. To minimise the power losses, the blocking diode can be replaced by a second MOS-FET connected back-to-back in series with T1. With such designs, care has to be taken that both MOS-FETs turn off during the night, and that no reverse current flows into the solar generator!

It is important to note that in most cases the energy gained by the reduction of power losses is not relevant for the function of the PV system. In fact, the goal is to reduce the voltage drop across the controller, which finally leads to a saving of one or two solar cells in the module.

As soon as the end-of-charge voltage has been reached, the gate voltage for the MOS-FET T1 will be reduced by the controller. Now, the output voltage is kept constant while the charging current will drop slowly according to the battery's increasing state of charge. In contrast to the first charging phase, now the difference between the solar generator voltage and the battery voltage will occur at the transistor terminals and cause some heat dissipation.

In Figure 19.3, the operating points for three different charging currents are shown as an example. The shaded areas are proportional to the power dissipated in the control element. As can be seen, this power is in the range between approximately one-fourth and one-tenth of the instantaneous maximum power point (MPP) power of the generator. The resulting heat must be dissipated by appropriate heat sinks. This is a clear disadvantage compared to the switching charge controllers described below. On the other hand, there are