well to the grid characteristics as to the solar generator performance. As all of the solar current flows through the inverter, its properties fundamentally affect the behaviour and operating results of the photovoltaic system.

Apart from the efficient conversion of direct to alternating current, the inverter electronics also include components that are responsible for the daily operation mode. They ensure that operation starts at the right time in the morning as soon as the solar cells deliver enough power. Unsuccessful start attempts require energy from the grid and should be avoided by good controls. During the day, the optimum working point on the I-V characteristic curve shifts according to the fluctuations in solar radiation and module temperature. Intelligent inverter control includes maximum power point (MPP) tracking and continuous readjustment to the most favourable working point. Protective devices are also integrated into the inverter, which automatically disconnect the system if irregularities in the grid or the solar generator occur.

Today most inverter models are additionally equipped with data loggers and measurement computers, which allow the power, voltage, current and other operating parameters to be recorded continuously. These data can be read out at intervals via a serial interface with a laptop computer and analysed.

17.3.3.2 Inverters for stand-alone systems

Because of the specific operating conditions of stand-alone inverters, different design aspects have to be considered.

In a typical domestic power supply, the ratio of the peak power to the average power is about 25:1, so the inverter must have a high efficiency of approximately 90%, particularly in the partial load range (5–10% of the rated power). Only a few inverters satisfy this condition together with a sinusoidal output voltage and the capacity to withstand short-term, double to triple overloading. Depending on the requirements, both sinusoidal and rectangular waveforms can be used.

The most important requirements on inverters for stand-alone photovoltaic systems are summarised in the following list.

- Large input voltage range (-10% to $+30\%$ of the rated voltage).
- Output voltage as close to sinusoidal as possible.
- Little fluctuation in the output voltage and frequency.
- $\pm 8\%$ voltage constancy, $\pm 2\%$ frequency constancy.
- High efficiency for partial loading; an efficiency value of at least 90% at 10% partial load.
- Ability to withstand short-term overloading for appliance starting conditions, for example, two to three times the rated current for 5 s for refrigerators and washing machines.
- Lowest possible overvoltages for inductive and capacitive loads.
- Half-wave operation possible, caused by power reduction with a diode, for example, in hair dryers.
- Able to withstand short circuits.