8.4 CONTROL OF ELECTRIC DRIVES USING MICROPROCESSORS

Before discussing the aspects of design of control systems for variable drives using a microprocessor a few of the application examples are discussed in the following. These are:

i. speed control of dc motors using dual converters.
ii. field oriented control of three-phase induction motor.
iii. speed control of synchronous motors.

The specific functions of the microprocessor in the above applications can be recognised after knowing the specifications of the performance. These serve in formulating the stages involved in the design.

8.4.1 Control of dc Drives Using Microprocessors

The dc motors fed from thyristor converters for variable speeds are being extensively used in general industrial applications. A dual converter, which is a combination of two antiparallel connected three phase/single phase bridge converters, provides a reversible dc drive with regenerative facilities. The response of the drive is fast. The speed control systems of the drive using the dedicated hardware with discrete components as well as a microprocessor, are shown in Fig. 8.6. Figure 8.6 clearly specifies the functions of a microprocessor in such a system. The scheme requires a number of parts or components and careful adjustment when based on analog techniques. However, by proper selection of counters to perform several jobs, the number of components can be reduced. The microprocessors

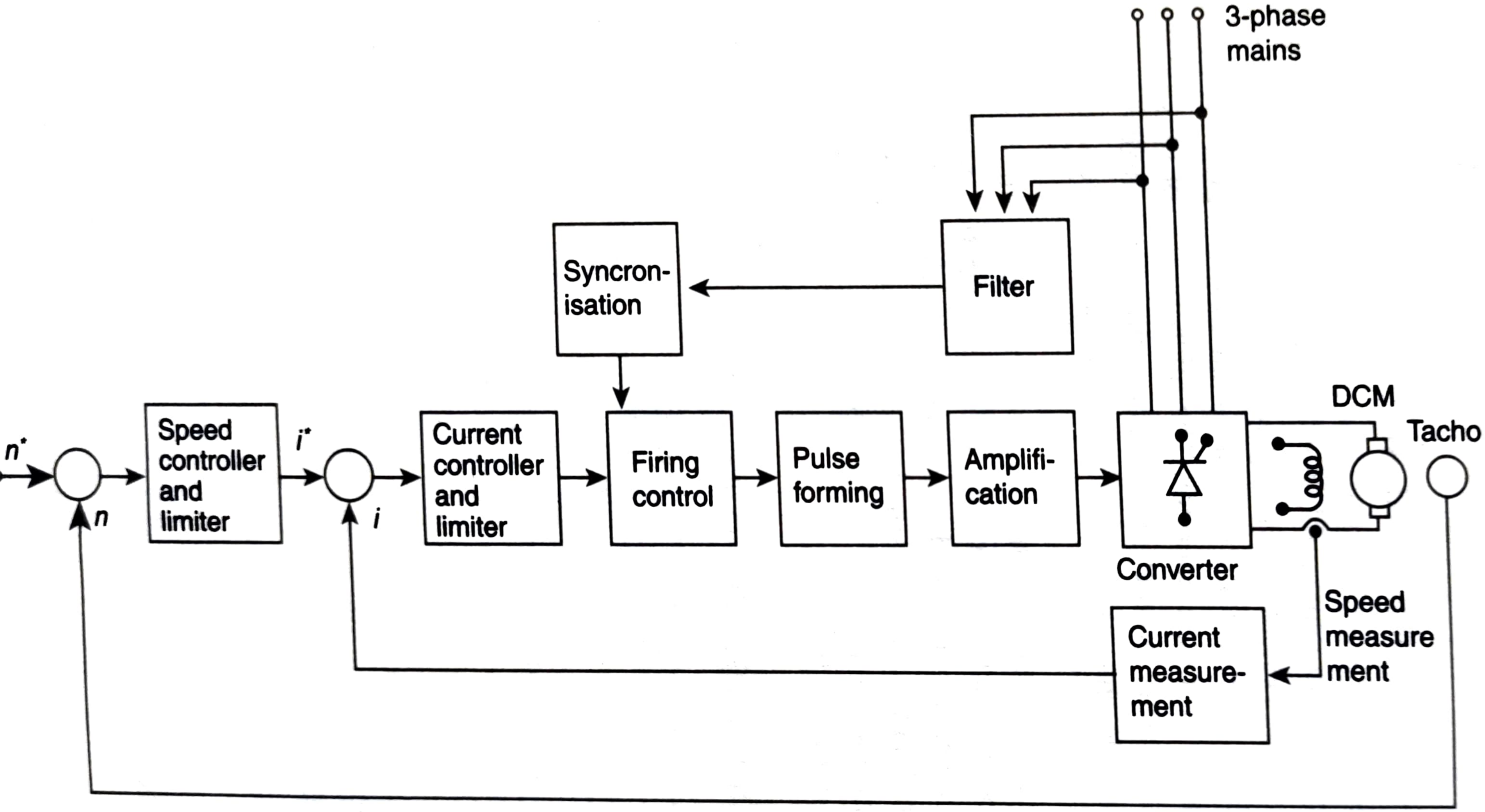

Fig. 8.6(a) Block diagram of a thyristor converter fed separately excited dc motor using hardware

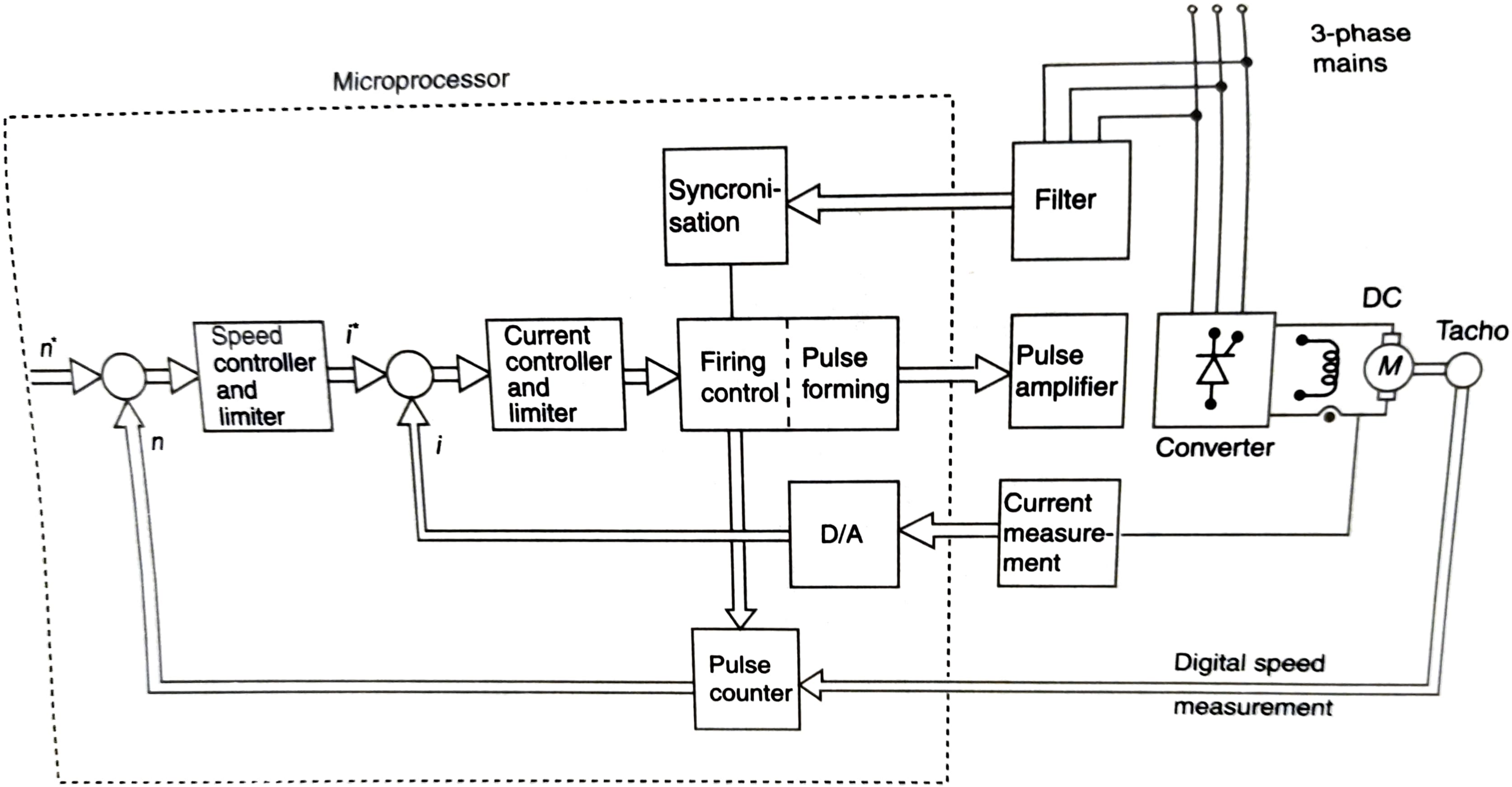

Fig. 8.6(b) *Block diagram of a separately excited dc motor drive using a microprocessor*

effectively replace these schemes for dc motors of high performance because of their varied functional capabilities. At the outset it may seem that the interface circuits between the microprocessor and the system tend to increase the overall cost and decrease the advantage of microprocessors. However the improvement in the functions, reliability, size of the control equipment, and rapid reduction in manufacturing costs are possible with the fast growth and developments of digital systems and A/D and D/A converters, to make the system economical and cost effective. Among the functional capabilities of a microprocessor are higher level reliability, availability, and serviceability, which are instrumental in the increase of productivity of a drive.

The following are the functions of a microprocessor in the control of a dc motor fed from a dual converter:

Speed Sensing As has already been explained, a digital speed encoder provides the information concerning the speed to a microprocessor. The train of pulses from the shaft encoder are processed in the microprocessor to estimate the speed.

Feedback Control The closed loop control here has an inner current loop and an outer speed loop. The necessary reference values are stored in the memory of the microprocessor. The current is measured and converted to a digital quantity using an A/D converter. After conversion the signal is fed to the microprocessor based control system. The speed signal is available in digital form. The necessary controllers and limiters can be implemented on the microprocessor, as has already been explained. The controllers implemented on a microprocessor are adaptive. These improve the performance and flexibility of the microprocessor. The system must be capable of taking care of variable gain during field weakening mode as decided by the operating condition to obtain the desired speed-torque characteristic.

A converter feeding a back emf load (as in the control of dc motor) operates in the discontinuous mode of operation under certain conditions of loading. The converter possesses a non-linear transfer characteristic with variable gain. The performance of the drive is sluggish. The non-linearity must be compensated by a proper feedback loop or linearising the operation using an inverse non-linear function. This function of the microprocessor must be supported by a suitable software. When the conduction is continuous the converter voltage is a constant, independent of load. In the discontinuous conduction, the angle of conduction and hence the converter voltage depend on the load. When once the discontinuous current limit is reached at a firing angle (Fig. 8.7), the converter voltage increases. To bring the value of V_d to the value corresponding to continuous conduction the firing angle must be increased by $\Delta\alpha$. From the external characteristic of the converter the change in $\Delta\alpha$ as a function of I_d at a given firing angle α can be stored in a look-up table. The firing of the converter is controlled so that the gain of the converter is invariant. The non-linear characteristic of $\Delta\alpha$ vs I_d at a given firing angle is shown in Fig. 8.7, and the block diagram implementing the correction is shown in Fig. 8.7(b).