Microcomputer design

1 —Introduction to digital hardware based on a microprocessor

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The low cost computing power of the microprocessor is now being used to replace not only other forms of digital electronics but also analogue electronics and electromechanical and pure mechanical control systems. It is not unreasonable to assume that within the next five years or so there will be hardly any companies engaged in electronics which are not using microprocessors in one area or another. One implication of this technology is that engineers skilled in the design of more conventional electronic circuits and systems now have to acquire new disciplines — those of digital computer system design and programming. This series of articles will present the theory and application of microcomputers by reference to a particular commercially available microprocessor, and to its use in a particular microcomputer system available to amateur experimenters as a kit (see panel). This low-cost kit includes memory, input/output circuits and a keyboard, and can be used in the home with a domestic television set as a display unit and an audio cassette recorder for permanent storage of programmes. The first article examines the hardware components and principles of operation of such a general purpose computer system. Future articles will explore programming languages, the organization of the central processing unit, and practical design techniques for both the hardware and software of microprocessor-based systems.

In its most general form a digital computer system has the structure shown in Fig. 1. The central processing unit (c.p.u.), memory and input and output units are the essential hardware blocks which any computer must have. The c.p.u. does the work, manipulating data as directed by a programme stored in the memory. The memory may also be used for storing data. Information is transferred to and from the outside world by the c.p.u. via the input and output units.

The c.p.u. being the most complex part and the heart of all operations in the system, will be examined first. It may be viewed as two parts. One part, called the arithmetic and logic unit, actually does the work, while another part controls the sequence in which the various functions are performed. For the moment our main attention will be given to the arithmetic and logic unit (a.l.u.).

Any digital computer, including a microprocessor-based system, performs its data manipulation operations by utilising various combinations of the basic Boolean logic functions AND, OR, NAND, NOR etc. Of course, in a processor system many of the operations are often compounded from these basic functions to provide more complex operations. Programme instructions are used to selectively activate the various logic and arithmetic functions of the processing unit in order to achieve the required result. Consequently, a processor may be viewed as a programmable, general purpose logic block.

In this concept lies one of the reasons

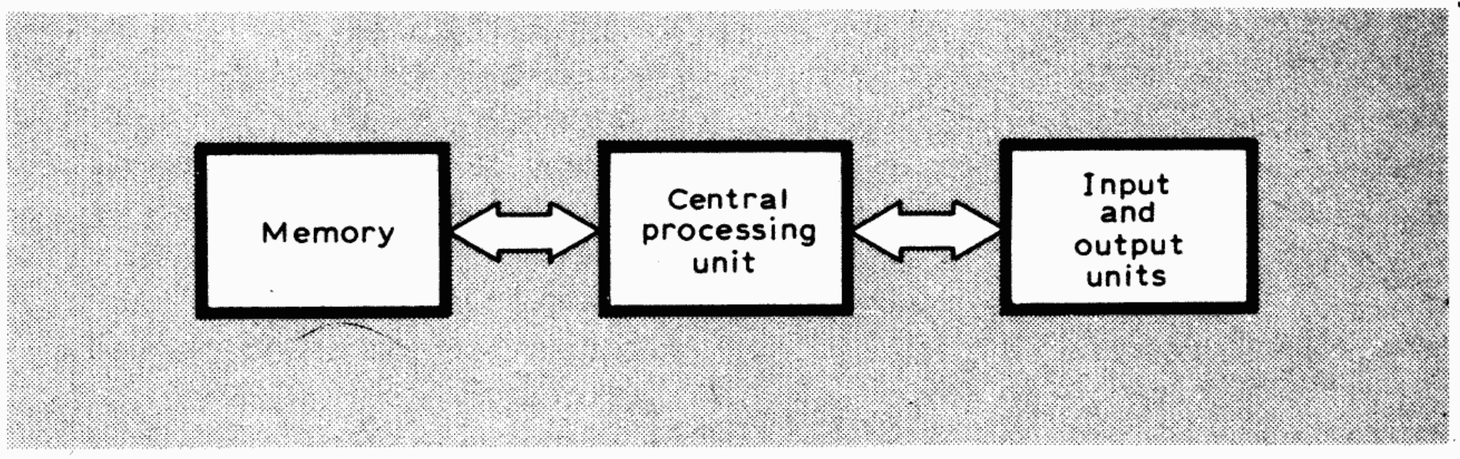

Fig 1

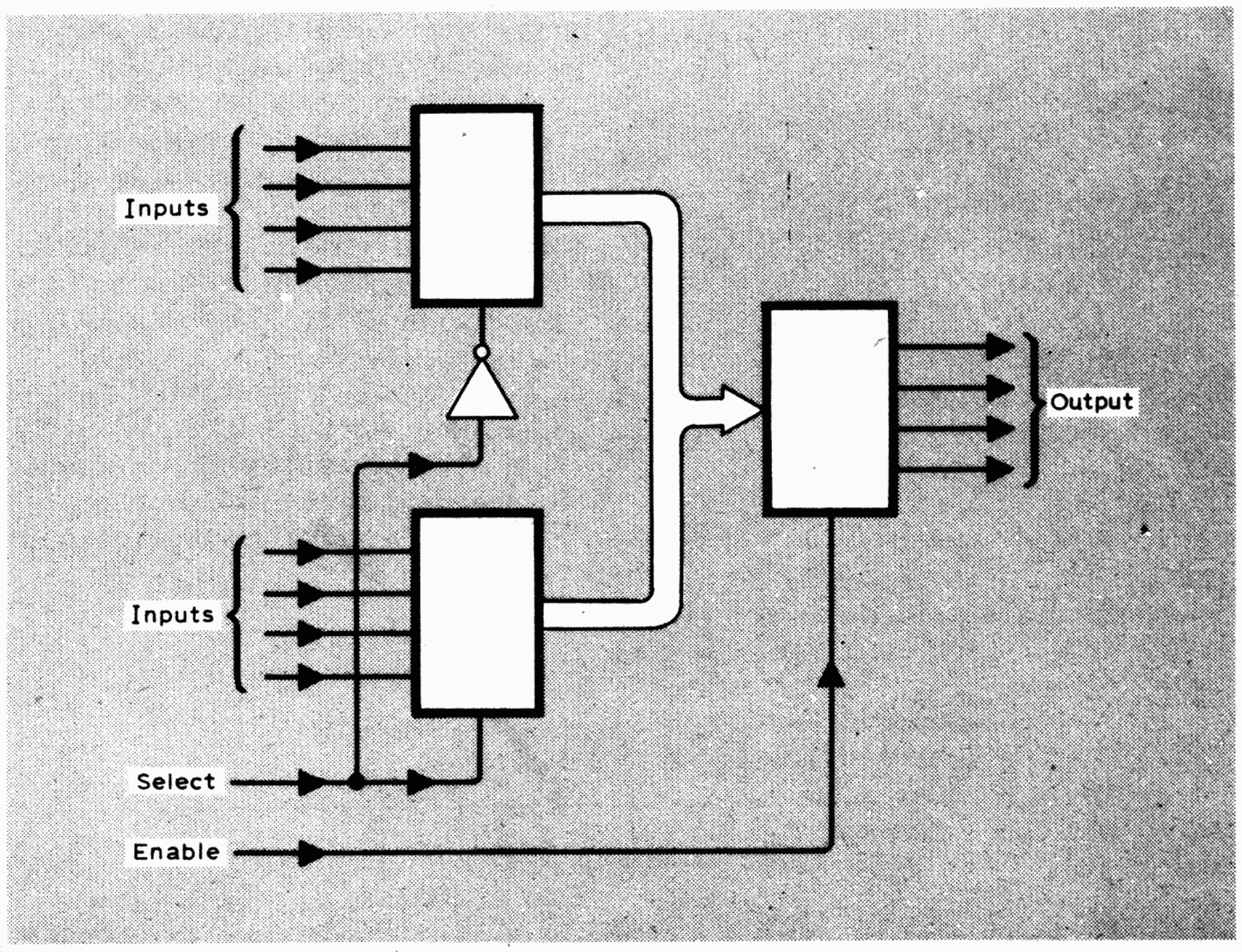

Fig 2

Fig. 1. Basic structure of a digital computer.
Fig. 2. A typical standard logic block, considered in the article as a step on the way to programmable logic.