B

BANDWIDTH

The term *bandwidth* is used in connection with the communication of information over a distance. The bandwidth of a *transmission system* (be it a twisted pair of wires, a telephone line, a laser beam, or a radio link) is the range of frequencies that can be transmitted without any appreciable loss in quality or signal strength. A telephone line, for example, can handle audio frequencies from 300 Hz to 3,400 Hz, giving a bandwidth of 3.1 KHz. This is adequate for speech, but not sufficient for hi-fi music reproduction.

The bandwidth determines the maximum rate at which data can be transmitted from one device to another. One of the reasons why the advent of cable television is relevant to home computing is that the cables need to be of an extremely high bandwidth, as one television channel occupies as much bandwidth as around 3,000 telephone conversations. Low-cost modems generally can't transmit data faster than about 1,200 baud using telephone lines. But linked to a cable television network, it would be possible to send an entire program to another user in a fraction of a second.

BANK SWITCHING

Every microprocessor or CPU has a fixed address range, determining the maximum number of memory locations that it can access individually. On an eight-bit CPU, such as the Z80 or 6502 found at the heart of most home computers, this address range corresponds to 64 Kbytes (i.e. locations 0 to 65,535), and this must accommodate all the RAM, ROM and input/output chips needed by the system. The newer, 16-bit business systems (including the Sinclair QL) can address much more memory — in some cases several Megabytes.

The only way in which you can add more than 64 Kbytes of memory to an eight-bit device is to use *bank switching*. This technique is used as standard on machines such as the Commodore 64 and the Lynx. On a bank switched computer there is never more than 64 Kbytes available to the CPU at any instant, but the operating system has the ability to select which 64 Kbytes it wants from a much larger amount. This is sometimes called *paging* and a common example is screen paging, where any one of, say, half a dozen areas of RAM can act as the current screen RAM. This makes near-instantaneous changes in screen display possible.

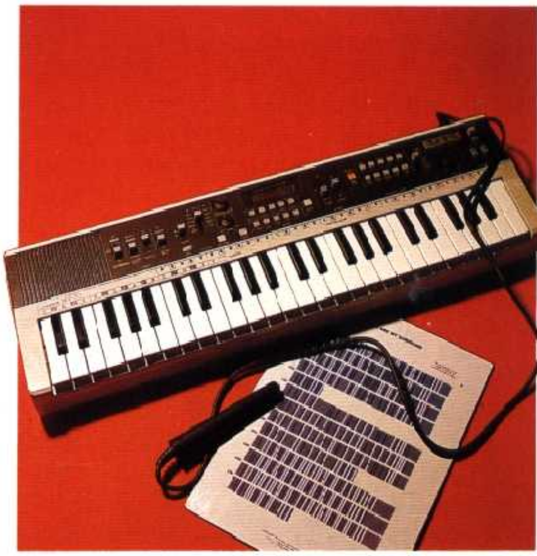
One way of visualising bank switching is to consider the memory map of a computer as a vertical strip divided up into sections. Horizontal strips of RAM can be moved left or right, so that the required section of extra memory appears in the memory map.

BAR CODES

Most people are now familiar with *bar codes* — if only because they are printed on so many food packages and magazines. They represent a means of printing digital data on paper that can be conveniently input to an electronic device. All the user has to do is pass a light pen across the printed strip of lines, which encode the data.

The use of bar codes is not restricted to the world of supermarkets, however. They have also been used as a means of entering music into a digital synthesiser (on the Casio organs) and Hewlett Packard pioneered the use of bar codes for entering programs from paper into a microcomputer.

The main difficulty in reading bar codes is in allowing for the fact that different people will move the light pen at different speeds. If you examine a bar code, you will notice that there are three pairs of synchronisation marks (long double lines): one pair at either end of the code, as well as a pair in the centre. The process of identifying the speed of movement and then retrieving the data is very similar to that of extracting the clock-pulse in synchronous transmission (see page 108) over the telephone.



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Storing Chords
Bar codes aren't just used for price tags on goods. This Casiotone organ stores music as bar codes to be read into its programmable memory

BASE

We are so used to counting in the decimal system that we sometimes forget it is a base system. In computing, it is more convenient to use a base other than 10 — in particular base two (binary) and base 16 (hexadecimal or hex). The base of a number system is more correctly called the *radix*, so that two is the radix of the binary system.

There is no limit to the size of the base or radix: the system of counting minutes and seconds is really base 60 (called *sexagesimal*). When we exceed 10, however, we run out of symbols that we would normally associate with numerical quantities. In hex, for example, the numbers 10 to 15 are represented using the letters A to F.

The choice of which base to operate in is purely arbitrary. The use of the decimal system probably results from our having 10 fingers; computers use binary because electronic devices have two stable states. The choice of hex is more involved: any eight-bit value (usually a data value) can be expressed using only two digits, whilst a 16-bit number (a memory address) needs only four.