Purpose Designed

Uncommitted Logic Arrays (ULAs) can handle all the functions of a home computer, apart from the CPU, ROM and RAM

Of the many advances in electronic design that have resulted from the microcomputer boom, one of the most significant has been the development of a type of chip called an Uncommitted Logic Array (ULA). Though largely unrecognised by the general public, this quiet revolution has been going on for some years now, to the point where it recently became possible to build very sophisticated computers and other devices with no more than four major components: a CPU, some RAM, some ROM and — to tie these all together — a ULA.

So what is a ULA? As the name suggests, it is a large number (an array) of logic gates, which are initially uncommitted but can be modified to carry out almost any operation that the designer needs. The ULA can be considered as a development of the ROM, since the contents of both of these components can only be specified by the chip manufacturer, not by the user.

Before a ROM or ULA is 'programmed' it consists of no more than a large number of simple electronic circuits or cells, which are not connected and therefore cannot perform any action. All chips are constructed by building up layers of semi-conductor materials (see page 122). The final layer is usually made of conducting material, and forms the connections between the various cells. It is the wide variety of possible interconnections that gives the ULA its flexibility; and though each cell is quite simple, consisting perhaps of a couple of transistors or a single resistor, they can be connected to each other by the final layer to build fairly complex circuits such as flip/flops (see page 305).

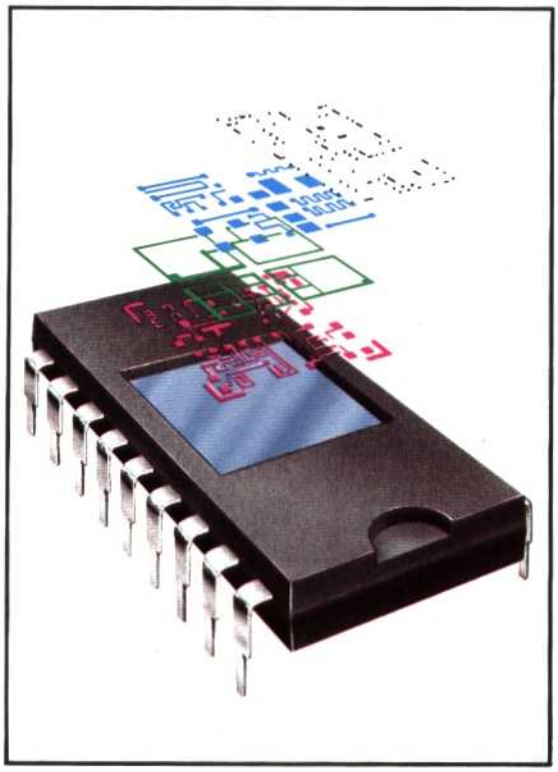
Such circuits, called 'modules', can usually be built from less than half a dozen cells, and since a large ULA may have several thousand cells, the modules themselves can be interconnected to build complex circuits, such as registers, counters, and timing circuits. The functions performed by these circuits are normally carried out in a home computer by a collection of general purpose logic chips.

A ULA can be programmed to perform an extremely diverse range of activities. Any given ULA could be made to synthesise sound, or control the exposure, focus and motor in a camera, or do most of the work in a digital thermometer. And besides the ULA, almost no external circuitry is needed — except for a battery, a switch and some sensors or control buttons.

As might be expected, computers are extensively used in the process of designing the layer that interconnects the cells of a ULA. A mini-computer, such as a DEC PCP11/23, running a Computer Aided Design system, first builds up an encoded diagram of the desired logic. The system then draws, and similarly encodes, a map of the planned layout. This is done on a graphics terminal, and a hard copy of the design can be produced on a plotter.

Once the design is complete it is transmitted to a larger computer, which checks that the plan is acceptable, compares it with the original logic design, and ensures that it doesn't contain any serious errors. It is then submitted to another program that simulates the circuit which would result, using a test program provided by the customer. When the design is finalised, the computer can produce the artwork for the optical mask used in making the final layer.

How far can ULAs go? The idea of putting a lot of simple circuits in silicon and allowing the user to decide how they should interact is so appealing that it might become the recognised method of implementing most circuitry. However, at the present level of technology, ULAs are economic only when at least a couple of thousand identical circuits are needed. The PROM (Programmable Read Only Memory), EPROM (Erasable PROM), EEPROM (Electrically Erasable PROM), and EAROM (Electrically Alterable ROM) are all alternatives to the ROM that can be programmed by a user with suitable equipment. It may not be too long before user-programmable equivalents to the ULA appear, too.



STEVE CROSS

Higher Plane
All semiconductor chips are built up from layers of semiconductor deposits, which are individually etched to create the circuit elements. The final layer determines the connection between elements. A ULA consists of an array of logic elements that can be combined to form a complex logic circuit