IAN McKINNELL

electric signals used inside a computer are far too small to be of direct use. Even a device as small as a torch bulb uses considerably more power than any of the parts inside a computer; so some means is needed of translating the tiny voltages inside a computer into more powerful ones (and sometimes these can be as great as mains voltages). This is usually done in a number of stages.

The first stage is inside the computer itself. The computer needs some way of sending signals to the outside world. This is done by choosing a section of the computer's memory and setting it aside for just this purpose. The microprocessor will send messages to this part of memory just like any other, but when they get there they are treated differently. This is because this part of memory is known as a *user port* and the information stored in it can be read electronically from outside the micro without affecting its working in any way.

Some micros have a user port as standard, others can have them fitted as an option. By itself the user port can be used to turn LEDS (light-emitting diodes) on and off, but most practical systems need other components as well. Perhaps the most useful is to add a few electronic components, plus a small extra source of electric power, to allow relays to be controlled. *Relays* are essentially switches that can turn on and off relatively large electric currents and yet can be controlled by small electric currents. They provide one of the best ways of converting the small electric pulses used by a computer into useful currents. One of the first aims of anybody experimenting with computer control should be to get a system that allows relays to be used. This is

because so many different things can be controlled by relays. Everything from electric motors, water pumps, lights, bells and buzzers to model railways and radio-controlled model cars.

Most relays used by home enthusiasts can cope only with the sort of equipment that will run off batteries. This gives plenty of scope for most projects. A few people will find they need larger relays that can switch mains current. Because mains electricity is extremely dangerous, only properly tested commercial products should be used, and not many are available. People working with small voltages can choose either to buy or make ready-made relay switching units that plug straight into a computer.

Mains switching allows the computer to control heaters, powerful lights and dozens of other household items. It also enables the computer to act as a timer to turn the television on to catch a favourite programme, or to turn the house lights on and off to deter burglars.

At the present time, a computer has to be directly connected to the units it is controlling, and this is rather a limitation. Several companies are developing products to overcome this. These work by enabling the wires that carry the mains electricity around the house to carry data as well. The system will have a computer in one room sending signals to *slave* units around the house, which are plugged into ordinary sockets. The computer can send individual messages to each slave telling it to turn the power on or off. Any ordinary household item, such as a table lamp, television or heater, can be plugged into the slave and thus controlled by the computer.

FEEDBACK SIGNALS

It has already been said that almost all computer-controlled systems need some kind of feedback to measure how the system is working. It might seem that there's no need for feedback when a computer is just turning lights on and off. Yet it would be much better if the computer could tell when it was dark outside and turn the lights on in response to that information. It would also be useful if the computer could tell when people enter a room so that it could turn the light on for them. If a computer is controlling a heater it needs feedback to tell it how warm the room is so that it can keep a constant temperature.

There are two types of feedback signals. Some signals can only be on or off, with no intermediary states. Such a signal might be a switch that can tell if a window is open or shut, or that the door bell is being pressed. User ports are able to read in this