Constructional Project

MICRO ALARM

JOHN LEWIS

Protect your valuable microcomputer with this inexpensive, easy to build alarm.

MICROS are now very popular in schools, offices and homes. When used in a classroom or office there are obviously occasions when the micro will be left unattended and extremely vulnerable to sneak thieves. At home, when the owner is out, some kind of alarm system specifically for the micro will provide peace of mind. After video recorders, home micros are an obvious target for thieves.

According to psychologists, the average thief entering a house is in a tense and anxious state. The main purpose of an alarm system is to increase the level of panic in the opportunist thief to such an extent that he abandons his loot and beats a hasty retreat.

This alarm system is placed inside the micro where it is inaccessible unless the lid is removed. Obviously this will take time which the average thief will feel he does not have. The alarm is triggered by disconnecting a jack plug from a firmly attached socket on the computer trolley. Replacement of the plug is necessary before the alarm can be reset by also reconnecting the micro to the mains supply and switching on. The micro, therefore, cannot be removed from its normal position without triggering the alarm.

CIRCUIT DESCRIPTION

When SK1 and SK2 are linked (Fig. 1), the input pins of gate 2 (IC1) are held at logic 0. Gates 3 and 4 form a SET-RESET bistable, the output of which (pin 11) is normally at logic 0. Transistor TR1 is off and, therefore, alarm WD1 is also off, this is true whether the power supply of the micro is on or off.

If the wire joining SK1 and SK2 is broken or pulled out, the input pins of gate 2 rise to logic 1. The input to the SET-RESET bistable on pin 13 goes to logic 0 making its output switch to logic 1. Current flows through R3 into the base of TR1 turning it on and producing a loud noise from WD1. The alarm will remain on even when SK1 and SK2 are once again joined.

Provided SK1 and SK2 are joined, a pulse on pin 8 of gate 4 may be used to reset the SET-RESET bistable which will turn off the alarm. The reset pulse is generated by turning off the power to the micro at its main switch and then turning it back on again.

The +5 volt micro power supply is connected to the inputs of gate 7 through C2 and R6 which form a differentiating circuit. The rising voltage of the power supply as it is turned on produces a positive going pulse on

COMPONENTS

Shop Talk
See page 660

Resistors

R1, R2, R4, R5, R6	1M (5 off)
R3	10k

All 0.25W carbon± 10%

Capacitors

C1	10µ elect. 16V
C2, C3	0µ1 disc ceramic (2 off)

Semiconductors

D1	1N4001 silicon diode
TR1	BC109 *n.p.n.* silicon transistor
IC1, IC2	4011 quad 2 input CMOS NAND gate (2 off)

Miscellaneous

WD1 p.c.b. mounting audible warning device (RS 249 794); 14 pin d.i.l. sockets (2 off); printed circuit board, available from the *EE PCB Service code EE621;* 2.5mm jack plugs (2 off); 2.5mm jack sockets (2 off); 1 metre screened lead; plastic box approx. 90×60×25mm; micro disc drive power connector (see text); PP3 battery clips; PP3 alkaline battery.

Approx. cost Guidance only £8.50

Fig. 1. Circuit diagram of the Micro Alarm.

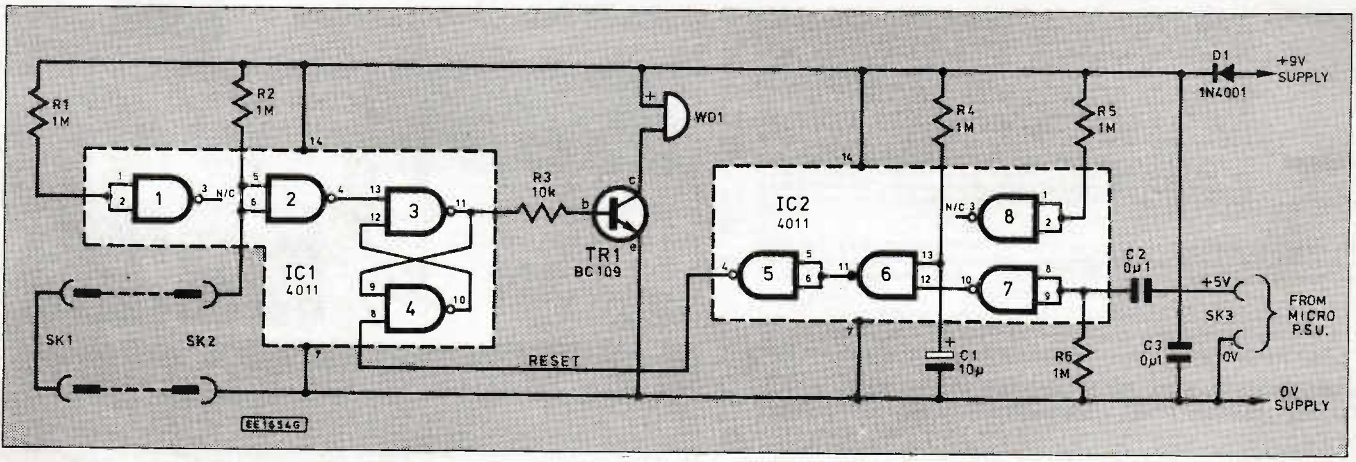


Table 2.2.
Resistor Letter Codes

Letter	Represents
R	Units
k	Thousands
M	Millions
G	Thousands of millions
T	Millions of millions

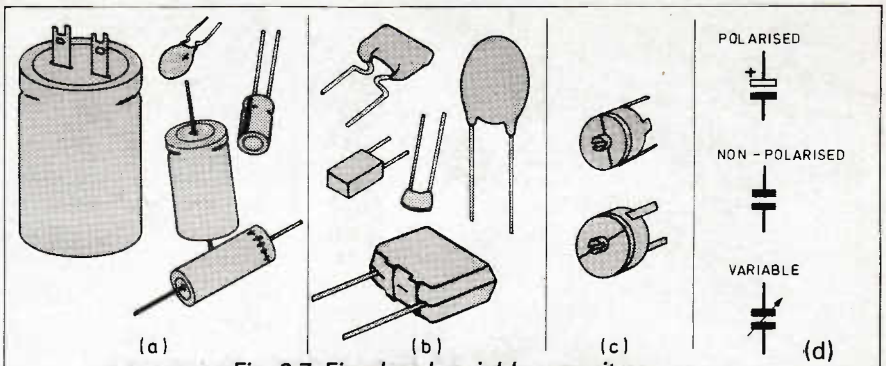


Fig. 2.7. Fixed and variable capacitors.

passing through the resistor in a given time.

The physical size of the resistor is usually an indication of the power rating (the bigger the resistor the higher the wattage) but, to be certain about it, consult the supplier's catalogue or the packet in which it was despatched. If the wattage rating of a particular resistor is not specified on the circuit diagram it usually means that it expends less energy than the smallest resistor one can buy; in which case any convenient one *of the correct resistance* may be used.

Capacitors

The physical appearance of a particular capacitor depends on its method of construction and the type of material used in its manufacture. Some capacitors are polarised (you will recall that polarised components must be correctly orientated when placed in a circuit) and some are not. Also, like resistors, capacitors may be fixed or variable. Fig. 2.7 illustrates some polarised (a), non-polarised (b), and variable (c) capacitors. Capacitor circuit symbols are given in Fig. 2.7d.

Capacitor Colour Coding

Although capacitor coding conventions vary from manufacturer to manufacturer, they usually follow a similar coding arrangement to that of resistors for the capacitance value. Table 2.1 shows the coding for Mullard C280 Series capacitors.

The basic unit of capacitance is the Farad (symbol F), but this is a very large value–a one Farad capacitor is far too large for most practical applications, so capacitor values are expressed in microFarad (symbol μ), nanoFarad (symbol nF), and picoFarad (symbol pF):

$1\mu F = 0.000001F = 10^{-6}$
$1nF = 0.000000001F = 10^{-9}$
$1pF = 0.000000000001F = 10^{-12}$

These are the most common symbols used for representing very small values of capacitance. The whole range of symbols for large and small values of any kind is given in Table 2.4.

Voltage Rating

Capacitors have a working voltage rating. This rating is the greatest voltage that the capacitor can withstand without physically breaking down and failing to operate. There are only two working voltage variations in the C280 series, these are 250V (this means any voltage up to 250 volts) and (up to) 400V, as shown in the table.

Capacitor tolerance values are expressed as a percentage of the component value in exactly the same way as resistor tolerances, although they do seem to be coded somewhat arbitrarily which doesn't make it easy to memorise. It helps, though, that 1%, 2% and 5% are according to the standard colour code.

Fig. 2.8 gives an example of the use of Table 2.1 in evaluating a 0.47μF capacitor. The top two bands (tens and units), yellow (4) and violet (7), mean that the capacitance value is 47 multiplied by the value represented by the yellow third band (10,000pF) in the "multiplier" column of the table. 47×10,000 evaluates to 470,000pF which is 0.47μF (by shifting the decimal point six places to the left). This capacitor has a 20 per cent (black fourth band) tolerance and a maximum working voltage of 250V represented by the red fifth band.

If you have had any difficulty in understanding the number representations above (e.g. 10^{-6}), the following passage and the one on scientific notation should help.

Powers of Ten

Very large numbers (say, greater than 1000) and very small numbers (say, less than 0.001) are very common in electronics and become an annoyance to write and use because of all the zeros. There is a particularly tidy way of abbreviating such large and small quantities; for example, 1000000 may be abbreviated to 10^6 (pronounced ten to the power of six or just ten to the sixth) and 0.000001 may be abbreviated to 10^{-6} (pronounced ten to the power of minus six or just ten to the minus six).

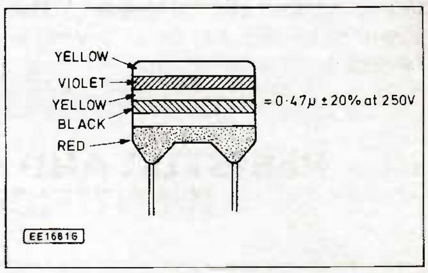


Fig. 2.8. Example of capacitor colour coding.

There is nothing special about this shorthand notation, it simply expresses the quantity as a power of ten, meaning a representation which states how many times ten is multiplied by itself:

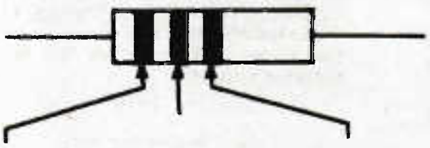
$$1000000 = 10\times10\times10\times10\times10\times10 = 10^6.$$

Here is a range of numbers showing equivalent power of ten representations:

$1 = 1\times10^0$
$10 = 10^1$ $\quad 0.1 = 10^{-1}$
$100 = 10^2$ $\quad 0.01 = 10^{-2}$
$1000 = 10^3$ $\quad 0.001 = 10^{-3}$
$10000 = 10^4$ $\quad 0.0001 = 10^{-4}$
$100000 = 10^5$ $\quad 0.00001 = 10^{-5}$
$1000000 = 10^6$ $\quad 0.000001 = 10^{-6}$

Multiplication and division of large and small numbers can be done much more quickly using power

Table 2.3. Examples

Colour Code 			Resistance in ohms	Letter Code
Yellow	Violet	Silver	0.47	R47
Yellow	Violet	Gold	4.7	4R7
Yellow	Violet	Black	470	470R
Red	Red	Red	2.2k	2k2
Yellow	Violet	Yellow	470k	470k
Brown	Grey	Green	1.8M	1M8
Brown	Black	Blue	10M	10M

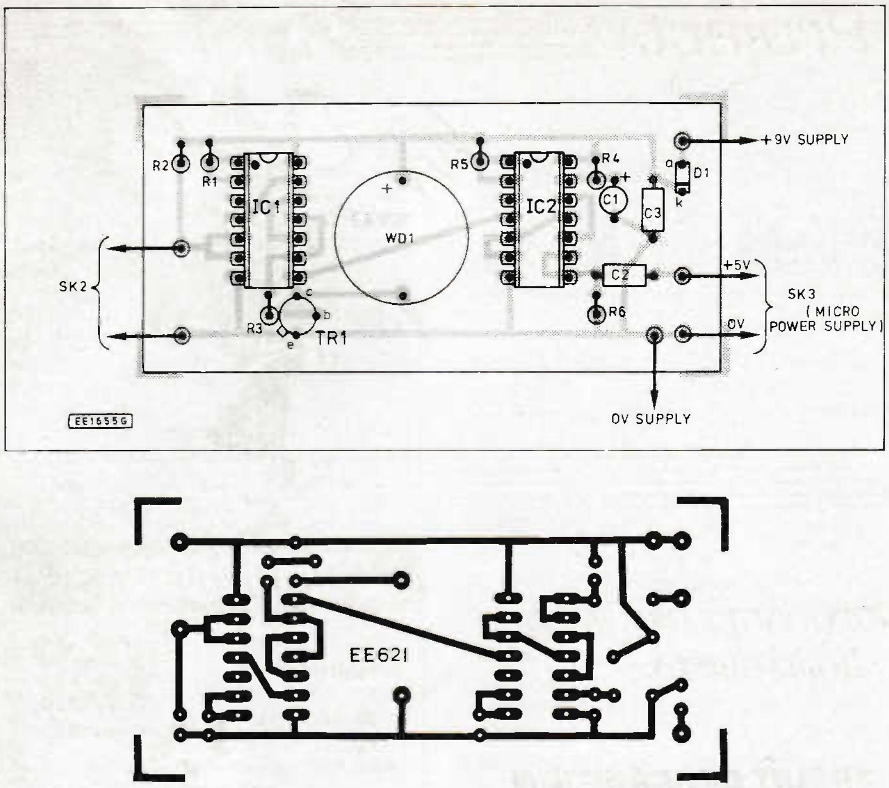


Fig. 2. P.C.B. layout and wiring diagram.

the inputs to gate 7. A brief logic 0 pulse appears on the output of gate 7 and, after passing through gates 6 and 5, resets the SET-RESET bistable. To ensure that the alarm is not set off when the 9 volt supply is connected, pin 13 of gate 6 has R4 and C1 connected to it to generate an automatic reset pulse. The circuit takes virtually no current from the micro's power supply.

Gates 1 and 8 are spare and so have their inputs connected through resistors R1 and R5 to the positive power supply rail. This ensures that the power consumption of the circuit is virtually zero provided that the alarm has not been triggered, thus giving long battery life in normal use. Diode D1 protects the circuit in the event of the battery being wrongly connected. Capacitor C3 decouples the power rail and removes any spikes.

CONSTRUCTION

The circuit may be constructed most easily on a printed circuit board, the layout of which is shown in Fig. 2. The resistors may be mounted first on the board followed by the capacitors, diode and transistor. Notice that C1 is an electrolytic type and must be inserted with the correct polarity. The audible warning device specified must also be connected the correct way around. Sockets are recommended for IC1 and IC2 which are CMOS types. As a result, it is essential that suitable precautions are taken to prevent damage from static electricity.

Socket SK1 (Fig. 3) is a short circuited 2.5mm jack socket which must be securely fitted at a suitable location on the computer desk. SK2 should be mounted on the rear of the micro in a convenient position. If you do not fancy the idea of boring a small hole in the rear of your micro then it would be possible to use a floating jack socket on a short length of lead through a ventilation slot. The two jack sockets are joined by a suitable length of screened lead fitted with 2.5mm jack plugs at each end. When moving the micro legitimately from one place to another, it is necessary to insert a short circuited 2.5m jack plug into SK2.

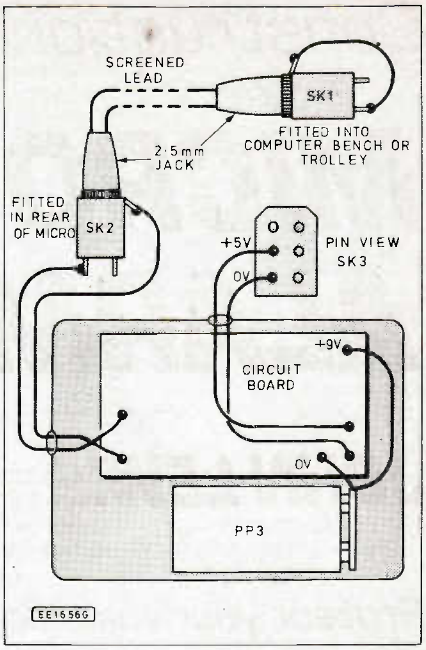
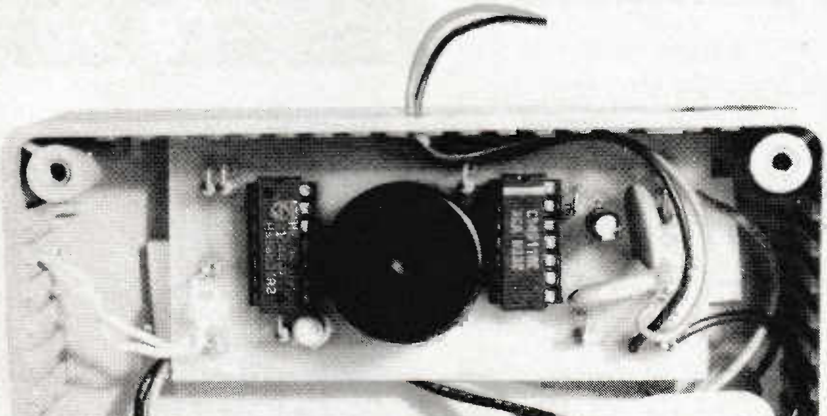


Fig. 3. Interconnections for the Micro Alarm.

CONNECTIONS

Socket SK3 is used to connect the alarm circuit to the +5 volt and 0 volt lines of the micro. On the BBC Micro this can be the standard disc drive power connector (as shown in Fig. 3). On most micros 5V power lines can also be found on the user port etc. and some constructors may find these other outlets more convenient. Great care must be taken, however, to prevent any damage to the micro and also not to invalidate the manufacturer's warranty.

The circuit must be mounted in a plastic box with small holes to allow the maximum amount of sound to be emitted. There is room in most micros for the specified size of box. In the BBC Micro it can sit on top of the circuit board or it could be stuck on the underside of the lid with double sided sticky tape. Obviously there must be no metal parts of the box which could come into contact with the micro circuit board. ☐



ACTUALLY DOING IT!

by Robert Penfold

Fixing controls, sockets, etc. on to the case of a project seems like a very straightforward task, and I suppose that in most respects there is little that can go wrong when carrying out this part of project construction. On the other hand, there are a few points which should be borne in mind when dealing with this aspect of construction.

GENTLY DOES IT

Perhaps the most important point to remember is that electronic components are not, in the main, particularly tough. People who are experienced in something like car servicing tend to tighten everything just as tight as they can. When this approach is applied to electronics it is usually disastrous!

It seems to be increasingly common for switches, potentiometers, etc. to have plastic mounting bushes. While the plastic used in the construction of these components is very tough, it does not seem to equal steel in this respect. The mounting nuts can be screwed down quite tightly, and can certainly be tightened sufficiently to hold the components firmly in place. If you really give it everything you have got, the chances are that the screw-thread will be sheared rather than the component being fixed more firmly in position.

It is not only components with plastic mounting bushes where you need to exercise a certain amount of care. I have found that some sub-miniature switches (especially the smallest size of toggle switch) are easily damaged. The problem here is presumably one of making something as small as that, really tough at an affordable price. Anyway, with these it is best to tighten the mounting nut no more than is absolutely necessary in order to keep the component securely in place. Overtightening can in some cases result in the front part of the switch snapping away from the main body of the component.

If this should happen, then the component is a complete write-off. If a screw-thread shears you may find that the component can still be fixed in place with the help of some adhesive on its mounting nut and bush. An epoxy resin type or some other high quality gap-filling adhesive is required. This should hold the component in place, but if you ever need to remove it again this could prove to be very difficult.

LOCATING LUG

On virtually all potentiometers, plus a few other front panel mounting components, you will find a locating lug (Fig. 1). The idea here is to have a hole for this lug in the panel on which the potentiometer is mounted. This helps to resist any tendency for the component to rotate when its control knob is adjusted, and helps to make construction just that bit tougher and more reliable.

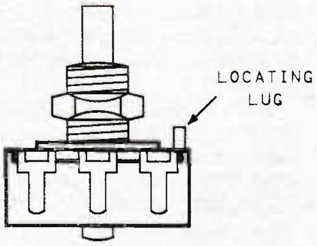


Fig. 1. Locating lug on a potentiometer.

This lug is something that works better in ready-made equipment than it does in most home constructor designs. With the former it is normal to have a main panel on which the controls are mounted, and then a dummy panel fitted over this, as in Fig. 2. This dummy panel hides the mounting nuts for the controls, as well as the holes in the front panel for the locating lugs.

While it is quite possible to emulate this method of construciton when building electronic projects, and I have done so on a number of occasions, it is not greatly used in practice. It might be worthwile for some larger projects, but it is not generally very practical for the smaller types.

This method of construction works best with cases that are designed to have a dummy panel, but few ready-made cases fall into this category. There is a useful variation on this technique where the controls are fitted on some form of mounting bracket which fits just behind the front panel. In effect, the real front panel becomes the dummy panel, and is devoid of mounting nuts.

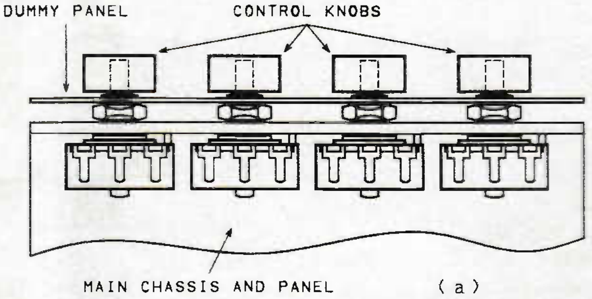


Fig. 2 (left). Dummy front panel to hide the nuts.

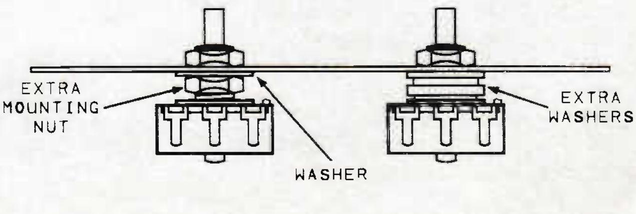


Fig. 3 (right). Using two nuts or extra washers to mount the controls.

With a large case that gives easy access to its interior it is usually quite easy to provide a suitable mounting bracket. Something as basic as a large "L" shaped aluminium bracket fixed on the base panel of the case will usually suffice. With small cases this system is usually impractical.

DIRECT MOUNTING

It is more usual to mount components direct on the front panel of a project, and to use "recessed" control knobs that cover the mounting nuts. These knobs are not normally very deeply recessed though, and will only cover the mounting nut if there is very little of the mounting bush protruding beyond the nut.

This normally necessitates the use of some form of spacer to reduce the penetration of the mounting bush through the front panel. In other words, an extra mounting nut or some washers must be used over the mounting bush, as in Fig. 3. The use of an extra mounting nut is the better method, as it avoids having any stress on the body of the component.

When using extra washers, the mounting bush and body of the component are pushed apart with considerable force when the mounting nut is tightened, and as explained previously, this can be disastrous with some miniature controls.

Unfortunately, potentiometers and many switches are only supplied with a single mounting nut, and extra mounting nuts for components seem to be very difficult to obtain. In fact I do not know of any current source of supply. Perhaps we should all write and complain to the main component manufacturers in an attempt to rectify this situation? In the meantime, there may be no alternative to using extra washers.

BUSH SIZES

It is worth pointing out that there are currently two common bush sizes for rotary potentiometers and similar components. Most types now have the metric 10 millimetre diameter threads, but there are still plenty of components which have the old ⅜ inch threads. Mounting nuts for one type **will not** fit the other (⅜ inch is only about 9.5 millimetres).

With either method of spacing, it is quite possible that the locating lug will be left just short of the front panel, so that it can just be ignored. If it should still reach the panel, I would not advise making a hole for it in the panel. Unless you are going to use large control knobs, the knobs will fail to cover over the protruding locating lugs, giving a rather unsightly appearance to the finished project.

There is usually no difficulty in using a pair of pliers to either bend the lugs sideways and out of the way, or to simply snap them off. If neither of these methods are successful, then it should be possible to file down the lugs slightly.

SPINDLE TRIMMING

The spindles of most controls are very generous in length, and are often around 50 to 100 millimetres long. With the controls mounted direct on the front panel of a case it is not normally necessary to have the spindles more than about 10 millimetres in length.

Even slightly over-length spindles are undesirable as they prevent the control knobs from fitting reasonably flush against the front panel. This could result in the mounting nuts being left uncovered, giving the front panel a rather scrappy appearance. On the other hand, you must be careful not to trim spindles fractionally too short, or you might find that the control knobs cannot be fixed in place properly.

The standard advice is to grip the spindle in a vice when cutting it to length, do not fit the body of the component in the vice. The main reason for doing things this way is that it avoids the risk of damaging the component. Merely gripping the body of a component in a vice could potentially cause it serious damage. Then going on to saw the spindle would put a further strain on the component. Being realistic about it, gripping the body of the component leaves the spindle free to rotate, making it extremely difficult to saw through it anyway.

At one time it was not easy to grip the spindles in a vice, as the spindles were virtually all of the round variety. These seem to be pretty rare these days, and most have a "flat" on the spindle. These can be held securely in the vice without any difficulty.

If you do encounter a component with an "all-rounder" spindle, it requires a vice with "V" cuts in the jaws in order to hold it really firmly. Without such a vice, grip the shaft as tightly as you can in an ordinary vice and proceed very carefully.

CUTTING

Whether the spindle is made from metal or plastic, it should be easy to cut through it using a hacksaw or a junior hacksaw. In the case of the plastic type, these seem to be made from quite a soft plastic that is very easily cut. In fact it is possible to cut through them using large wire clippers, or any large, heavy duty "scissor type" cutting tool.

The ideal length for the spindle depends on the particular control knobs used. About 8 or 9 millimetres is suitable for most control knobs. However, if you want to get the length absolutely perfect for the knobs you are using, push a spindle as far into one of the knobs as it will go, and then mark the spindle at the point where it enters the knob. The distance from this mark to the end of the spindle then gives you the optimum spindle length.

It is worth noting that not all control knobs have the mounting nut recess. Unless you are going to use the dummy panel method of construction it is advisable to avoid knobs that do not have this recess, as they provide far less neat looking results.

FLAT FILING

Most component retailers only supply knobs that are for standard 0.25 inch or 6 millimetre spindles, and have grubscrew fixing. Be careful if you buy any "bargain" control knobs, as these might be for some non-standard shaft diameter. Cheap control knobs are often of the push-on type, and I am not too keen on this type of knob for home constructor use. Their advantage is that the lack of any fixing screw helps to give the project a neater appearance. Their drawback is that if the flat on the spindle is a bit too deep the knobs may be inclined to keep falling off. If the flat is absent, the knobs will not fit at all.

Where the flat is absent it is not usually too difficult to add one using a small flat file, but getting it just right might be more difficult. It should ideally be done before the shaft is cut to length. You can then hold the component by trapping the end of the spindle in a vice, and file the flat on the section of the shaft next to the mounting bush. Comparison with a component that has a standard flat will help you to gauge how much to file away. When the filing has been completed, trim the shaft to length in the normal way.

This is one of those tasks that seems perfectly simple and straightforward, but which can easily go wrong. File away too little and the knob will probably not fit—file away too much and it will not stay in place. It is best to deliberately file away too little, and to then do some "fine tuning" until the knob fits. However, this "fine tuning" must be done after the spindle has been trimmed to length, and it is then not very easy to grip the spindle in the vice and work on it.

You will often have to hold the component as best you can in one hand, and gently file away at the shaft using the file in the other hand. The softness of plastic shafts means that this is not too difficult or time consuming. With metal shafts you must take things slowly and have patience. Do not try to force push-on knobs onto a spindle. Many of these knobs are not made from particularly tough plastics, and could simply split open.

EE CROSSWORD 7

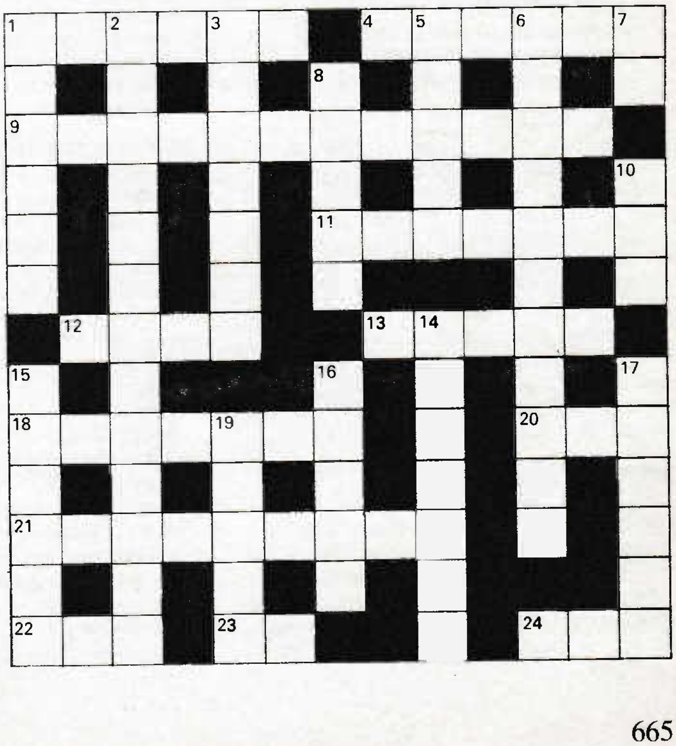
CLUES ACROSS

1 and 17 This device keeps colours untainted. (6,6)
4 Type of circuit that recovers the G-Y signal. (6)
9 Adjustment required for a "wobbly" head. (12)
11 Part of the chroma that carries the R-Y information. (7)
12 Viennese oscillator? (4)
13 The d.c. resistance. (5)
18 Method of tuning to increase bandwidth. (7)
20 Transmitting authority. (1,1,1)
21 Type of transistor construction. (9)
22 A conductor, atomic number 50. (3)
23 Current that does not change direction. (1,1)
24 Test generator used to adjust convergence. (3)

DOWN

1 Engineers adjustment. (6)
2 Conversion of a.c. to d.c. (13)
3 Get this correct or skew error will occur in a vtr. (7)
5 Code used for digial information. (1.1.1.1.1.)
6 Ability to remain magnetised. (11)
7 Two dimensional plotter. (1,1)
8 Type of delay causing phase distortion in LC tuned circuits. (5)
10 Myriametric waves. (1,1,1)
14 An oscillator using a tapped coil. (7)
15 This ratio is 4:3. (6)
16 These bands are no longer used in video recorders. (5)
17 See 1
19 The visual result of poor reception. (5)

For fun only—answers on page 673



◎◎◎REPORTING AMATEUR RADIO◎◎◎

TONY SMITH G4FAI

NEW UK AMATEUR LICENCE

THE DTI has completed a major review of the amateur radio licence and a new licence will be introduced on 1st January,1989. There are a number of important changes, the significance of which will be examined in later columns. In a new Information Sheet, No. 7 *New Amateur Radio Licences*, the DTI highlights some of these, namely:

- conformity with the requirements of the The European Conference of Postal and Telecommunications Administrations (CEPT) Recommendation T/R 61-01, which will enable UK amateurs, and those from other CEPT countries also observing the recommendation, to operate amateur stations in each other's countries under the authority of their existing licence. (See "European Common Licence" this column, June 1988).
- relaxation of restrictions on operations by the Radio Amateur Emergency Network (RAYNET);
- amateur maritime mobile operation without the need for a separate licence;
- operation using digital communications (including packet radio, although mailbox operation will need a separate authority);
- relaxation of restrictions on message handling;
- unattended operation of beacons and low power devices;
- simplification of identification requirements when operating;
- log keeping permitted on magnetic disc or tape;
- operation of radioteletype (RTTY) equipment on 1850-2000kHz.

NOVICE LICENCE

The two main types of licence will remain, Class A (all bands) and Class B (all bands including and above 50MHz). These will be equivalent to CEPT licence classes 1 and 2 respectively.

Regarding a possible Student or Novice Licence, the Information Sheet comments that now the review of the main licence is completed consideration can be given to the RSGB's proposals for a licence category that might encourage more people into amateur radio, "without, of course, allowing any diminution of standards".

NEW SYLLABUS

A new City and Guilds of London Radio Amateur's Examination syllabus will be examined for the first time in May 1989. For those studying to sit the examination under the new syllabus, a new edition of the free DTI booklet, *How to become a radio amateur*, can be obtained from: Radio Amateur Licensing Unit, Post Office Counters Ltd., Chetwynd House, Chesterfield, S49 1PF. This contains the full text of the new licence and a summary of the examination syllabus.

Students sitting the December 1988 examination will be examined on the old licence conditions, but are strongly recommended to carefully review the new licence once they have taken the examination. From December, such candidates can obtain booklet BR 68 from the Licensing Unit, which contains the full text of the new licence.

THE VOICE OF THE ANDES

International broadcasting station HCJB, located in Quito, Ecuador, has some interesting links with amateur radio. It originally started with a 200 watt transmitter in 1931 as a missionary station broadcasting to Ecuador, at a time when there were only a handful of radio receivers in the whole of that country! The day before it was due to go on the air a valve in the transmitter failed and a 120 mile dash across country was made to Ecuador's only radio amateur, who loaned the new station a valve from his own equipment to enable the first broadcast to take place.

As time went on the station obtained larger transmitters which covered the whole of South America. Using an amateur station, however, Clarence Jones, who was running HCJB, discovered that with short-waves he could communicate with the world and thus the idea of broadcasting HCJB around the clock to all parts of the globe, was born.

In 1940, a new 10kW short-wave transmitter came into use on the 25 metre band. Although reception was better everywhere, it was noted at night that a round, ball-like, glow was visible on the ends of the new rotary beam antenna elements, which were literally burning away in the rarefied mountain atmosphere.

NEW ANTENNA DESIGN

Clarence Moore, the engineer who constructed the new transmitter, and who also happened to be a radio amateur, studied the problem and eventually concluded that in this particular location an antenna element should have no ends to burn away, but should bend round to meet each other to form a square-shaped radiator. An experimental version was constructed and the corona effect disappeared.

Because of its shape it became known as the "quad" antenna and later a parasitic relector was added to improve its beaming qualities. This version, known as the "cubical quad", used at HCJB until 1953, became, and remains to this day a popular amateur antenna. For his radio work in Ecuador, the government honoured Moore with a special amateur radio call-sign for life—HC1JB.

The low radiation angle of the quad gives good long-distance (DX) performance with high gain and a good front-to-back ratio. With its compact dimensions compared to other antennas (half the width of a conventional dipole for the same frequency) it is relatively easy and inexpensive to make up as a "homebrew" project. I have one, for instance, for the two metre band which measures approximately 500mm (20 inches) square with the elements 200mm (9 inches) apart. This is located in a room at the top of the house and with just 2 watts of power (in "lift" conditions). I have worked with this into parts of Europe over 600 miles away—an extremely good achievement for such a small indoor antenna.

HAM RADIO TODAY

On Wednesdays, at 0800 GMT (on 9610 and 11835kHz) and 2130 GMT (on 15270 and 17790kHz) HCJB's *Ham Radio Today* programme, presented by John Beck, HC1QH, covers the world of amateur radio for both amateurs and interested non-amateurs.

A recent programme I listened to included an amateur radio news bulletin; a discussion on how Morse code signals should be reported over the air; an on-going series about the propagation of radio waves; an explanation of the NCDXF beacon system on the 20m band; details of amateur radio books available in the UK; an interview with a member of the Federal Communications Commission, discussing amateur radio regulations in the USA; the pros and cons of buying new or used equipment; and letters from listeners. It is a programme well worth listening to.

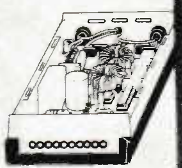
ANTENNA LEAFLET

For shortwave listeners, an English programme schedule can be obtained from HCJB, PO Box 691, Quito, Ecuador. They also have a useful Short Wave Antenna leaflet which gives information on making four different types of receiving antenna, including a multi-band cubical quad, and an antenna tuning unit.

As mentioned earlier, HCJB is a missionary station. It was set up in the mountains close to the Equator at a time when conventional radio experts pronounced such a site to be the last place on earth to establish an effective radio station. Years later opinion changed and now HCJB is considered to be sited most favourably to achieve world-wide coverage of its broadcasts. With its background and purpose, it is not surprising that HCJB feels there was some special inspiration when the original decision to locate a station at Quito was made. the story of Clarence Jones and HCJB is told in a fascinating book, *Come Up To This Mountain*, by Lois Neely, and published by Tyndale House Publishers, Wheaton, Illinois.

POWER CONDITIONER

FEATURED IN ETI
JANUARY 1988



The ultimate mains purifier Intended mainly for lowering the noise floor and improving the analytical qualities of top-flight audio equipment

The massive filter section contains thirteen capacitors and two current balanced inductors, together with a bank of six VDRs, to remove every last trace of impulsive and RF interference. A ten LED logarithmic display gives a second by second indication of the amount of interference removed

Our approved parts set consists of case, PCB, all components (including high permeability toroidal cores. ICs. transistors, class X and Y suppression capacitors, VDRs etc.) and full instructions

PARTS SET **£28.50** + VAT

Some parts are available separately Please send SAE for lists. or SAE + £1 for lists circuit, construction details and further information (free with parts set)

KNIGHT RAIDER

FEATURED IN ETI JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bouncing backwards and forwards along the row. Press again and try one of the other six patterns. An LED display on the control box let's you see what the main lights are doing.

The Knight Raider can be fitted to any car (it makes an excellent fog light) or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

The parts set consists of box, PCB and components for control, PCB and components for sequence board, and full instructions.

Lamps not included.

PARTS SET **£19.90** + VAT

RAINY DAY PROJECTS

All can be built in an afternoon!

JUMPIN' JACK FLASH (ETI March 1988)	
Spectacular rock stage and disco lighting effect!	£6.90 + VAT
CREDIT CARD CASINO (ETI March 1987)	
The wicked pocket gambling machine	£5.90 + VAT
MAINS CONTROLLER (ETI January 1987)	
Isolated logic to mains interface	£6.20 + VAT
MATCHBOX AMPLIFIERS (ETI April 1986)	
Listen. 50W of Hi-Fi power from an amp small enough to fit in a matchbox!	
Matchbox Amplifier (20W)	£6.50 + VAT
Matchbox Bridge Amplifier	£8.90 + VAT
L165V Power Amplifier IC with data and circuits	£3.90 + VAT
TACHO/DWELL METER (ETI January 1987)	
Turn your Metro into a Porsche!	£16.40 + VAT
HI-FI POWER METER (ETI May 1987)	
Measures Hi-Fi output power up to 100W – includes PCB, components, meters	
Mono power meter	£3.90 + VAT
Stereo power meter	£7.20 + VAT

FEATURED IN ETI
AUGUST 1988

There's nothing quite so encouraging as having a quantifiable result to show for your training efforts. If you are not particularly fit, your resting heart rate will be around 80 beats per minute. As your jogging, aerobics or sport strengthens your heart the rate will drop dramatically – possibly to 60bpm or less. With the S101, you can watch your progress day by day.

Breathing is important too. How efficiently do you take up oxygen? How quickly do you recover from 'oxygen debt' after strenuous activity? The S101 will let you know.

The approved parts set consists of case, 3 printed circuit boards, all components (including 17 ICs, quartz crystal, 75 transistors, resistors, diodes and capacitors), LCD switches, plugs, sockets, electrodes, and full instructions for construction and use.

PARTS SET **£33.80** + VAT

Some parts are available separately. Please send SAE for lists, or SAE + £2 for lists, circuits, construction details and training plan (free with parts set)

THE DREAM MACHINE

FEATURED IN ETI
DECEMBER 1987

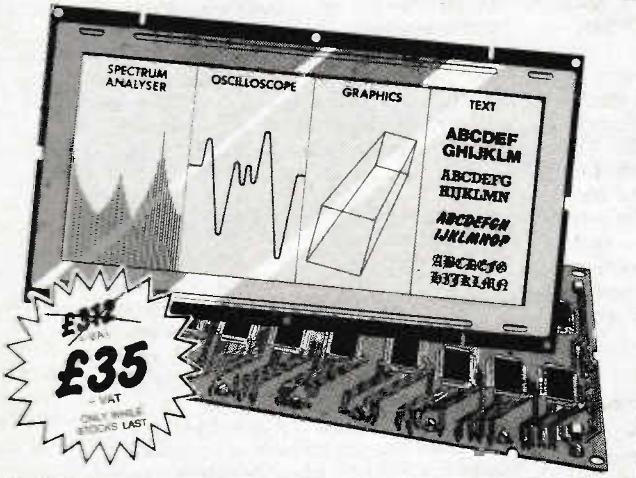
Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a peaceful, refreshing sleep.

For many, the thought of waking refreshed and alert from perhaps the first truly restful sleep in years is exciting enough in itself. For more adventurous souls there are strange and mysterious dream experiences waiting. Take lucid dreams, for instance. Imagine being in control of your dreams and able to change them at will to act out your wishes and fantasies. With the Dream Machine it's easy!

The approved parts set consists of PCB, all components, controls, loudspeaker, knobs, lamp, fuseholders, fuse, mains power supply, prestige case and full instructions.

PARTS SET **£16.50** + VAT

AVAILABLE WITHOUT CASE FOR ONLY **£11.90** + VAT



GRAPHICS DISPLAY OFFER

These beautiful dot matrix LCDs were originally ordered from Hitachi by a top flight instrumentation manufacturer. Unfortunately their new product – a portable 'scope – was ditched before they even had a chance to open the cartons!

But it's an ill wind that blows nobody any good. Because of their bad management, you now have the chance to own a high grade graphics display module at a tiny fraction of the normal price. Hitachi distributors will charge £312 each for these displays. From us, while stocks last, the price is £35!

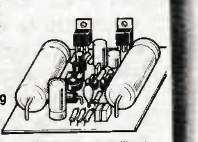
The LM236 display module has a 9½" x 4" display area made up of 640 x 200 pixels. Since each pixel can be accessed individually, the display is equally at home as a 'scope screen, a spectrum analyser display, a graphics monitor or a text screen.

To help organise the display, mounted on the back is a control board with 20 LSI ICs. This keeps track of all the individual dots and allows the screen to be filled via a simple eight-bit-at-a-time interface.

To use the display, you will need to be fairly self-sufficient in logic design – you must know how to organise a frequency divider and serial data transfer. Apart from these basics, the data supplied with the module will tell all you need to know to get it up and running.

ARMSTRONG 75W AMPLIFIER

FEATURED IN PE
JULY 1988



A.J. Armstrong's exciting new audio amplifier module is here at last!

Delivering a cool 75W (conservatively rated – you'll get nearer 100W), this MOSFET design embodies the finest minimalist design techniques, resulting in a clean, uncluttered circuit in which every component makes a precisely defined contribution to the overall sound.

You can read all about it in the July issue of PE, but why bother with words when your ears will tell you so much more?

Parts set includes top grade PCB and all components.

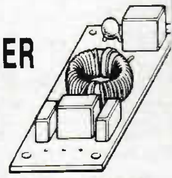
SPECIAL INTRODUCTORY PRICE FOR FULLY UPGRADED MODULES.

SINGLE PARTS SET **£14.90** + VAT
STEREO PAIR **£25.90** + VAT

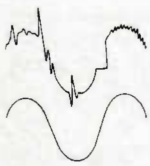
Please send SAE + £1 for data and circuits (free with parts set), including diagrams for matching pre-amp and power supply. This amplifier will not be available from your usual audio supplier – we produce the only designer approved parts set.

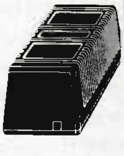
MAINS CONDITIONER

FEATURED IN ETI
SEPTEMBER 1986



Cleans up mains pollution easily and effectively. You'll hardly believe the difference in your Hi-Fi, TV, Video, and all other sensitive equipment.





PARTS SET **£4.90** + VAT
RUGGED PLASTIC CASE **£1.65** + VAT

BIO-FEEDBACK

FEATURED IN ETI
DECEMBER 1986

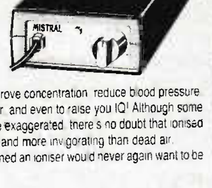
Bio-feedback comes of age with this highly responsive, self-balancing skin response monitor! The powerful circuit has found application in clinical situations as well as on the bio-feedback scene. It will open your eyes to what GSR techniques are really all about.

The complete parts set includes case, PCB, all components, leads, electrodes, conductive gel, and full instructions.

PARTS SET **£13.95** + VAT
BIO-FEEDBACK BOOK **£3.95** (no VAT)

Please note: the book, by Stern and Ray, is an authorised guide to the potential of bio-feedback techniques. It is not a hobby book, and will only be of interest to intelligent adults.

POWERFUL AIR IONISERS



Ions, the miraculous *vitamins of the air*, have been credited with almost magical powers.

They are said to improve concentration, reduce blood pressure, help you sleep better, and even to raise you IQ! Although some of the claims may be exaggerated, there's no doubt that ionised air is cleaner, purer and more invigorating than dead air. Anyone who has owned an ioniser would never again want to be without one!

The Direct-Ion caused a sensation when it appeared as a project in ETI. Two years later, in October 1988, the Mistral was unveiled. Which will you go for – the compact, powerful, value for money Direct Ion or the sophisticated, no compromise Mistral? The choice is yours!

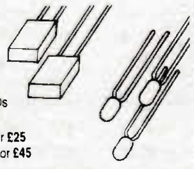
MISTRAL IONISER PARTS SET **£24.80** + VAT
DIRECT-ION PARTS SET (BLACK CASE) **£11.50** + VAT
DIRECT-ION PARTS SET (WHITE CASE) **£11.80** + VAT

LM2917 EXPERIMENTER SET

Consists of LM2917 IC, special printed circuit board and detailed instructions with data and circuits for eight different projects to build. Can be used to experiment with the circuits in the Third Great Little IC feature (ETI December 1986).

LM2917 EXPERIMENTER SET **£5.80** + VAT

LEDs



Green rectangular LEDs for bar-graph displays.

50 for **£3.50**	500 for **£25**
100 for **£6**	1000 for **£45**

DIGITAL AND AUDIO EQUIPMENT LEDs
Assorted 3mm LEDs: red, green, yellow and orange.
25 of each (100 LEDs) for **£6.80**

BRAINWAVE MONITOR

FEATURED IN ETI
AUGUST 1987

The most antonishing project ever to have appeared in an electronics magazine. Similar in principle to a medical EEG machine, this project allows you to **hear** the characteristic rhythms of your own mind! The alpha, beta and theta forms can be selected for study and the three articles give masses of information on their interpretation and powers.

In conjunction with Dr. Lewis's Alpha Plan, the monitor can be used to overcome shyness, to help you feel confident in stressful situations, and to train yourself to excel at things you're no good at.

Our approved parts set contains case, two PCBs, screening can for bio-amplifier, all components (including three PMI precision amplifiers), leads, brass electrodes and full instructions.

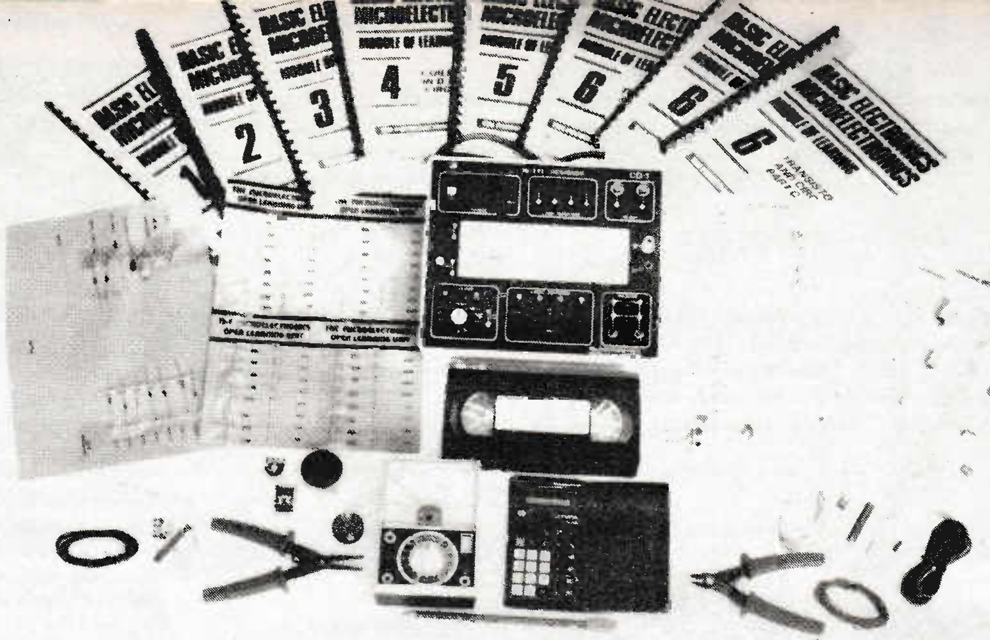
PARTS SET **£36.90** + VAT ALPHA PLAN BOOK **£2.50**
SILVER SOLUTION (for plating electrodes) **£3.60** + VAT

Parts set available separately. We also have a range of accessories, professional electrodes, books, etc. Please send SAE for lists, or SAE + £2 for lists, construction details and further information (free with parts set)

Prices shown are exclusive of VAT, so please add 15% to the order total. UK postage is 70p on any order. Carriage and insurance for overseas orders £4.50. Please allow up to 14 days for delivery.

Specialist SEMICONDUCTORS LIMITED

SALES DEPT., ROOM 111, FOUNDERS HOUSE, REDBROOK, MONMOUTH, GWENT.



BASIC ELECTRONICS REVIEW

Education and Training for Change is the distinctive motto adopted by the East Devon College of Further Education. This neatly and succinctly exemplifies the role of "further education" in today's changing technological climate and is particularly appropriate as we progress into a new era in which Open Learning is expected to play an increasingly important role in providing a flexible means to retraining and industrial up-dating.

Open Learning is a solution to the ever-pressing need to keep abreast of modern technology. Indeed, the readers of *Everyday Electronics* would almost certainly make ideal candidates for an Open Learning course, as witnessed by the popularity of several recent series including *Teach-In* and *Introducing Microprocessors*.

Basic Electronics and Microelectronics is the title of an Open Learning package produced by the Microelectronics Open Learning Unit based at East Devon College of Further Education. The course was produced under the Manpower Services Commission *Open Tech Project*. This initiative has been instrumental in vastly increasing the range and variety of Open Learning packages currently available. The producer of a package (in this case the Microelectronics Open Learning Unit of East Devon College) enters into a contract with the Manpower Services Commission and the result is a learning package which is made available for purchase by educational establishments, industry, and individuals.

PRACTICAL KIT

The heart of the *Basic Electronics and Microelectronics* package is a practical kit which provides "hands-on" learning, using real components and working circuits. The philosophy is simple; familiarity with components is developed through frequent handling. This, in turn, aids the learning process by relating electronic theory to the practice of assembling components and devices into a variety of working circuits

The practical kit is extremely comprehensive and is based on a circuit breadboard having its own power supply on which a wide range of circuits are built and tested. Newcomers will doubtless be pleased to note that no soldering is required since the breadboard accepts standard component leads which are simply pushed into contact strips.

Approximately 120 components are supplied (these are all neatly labelled) together with a basic analogue multimeter, tools, calculator, notepad and pencil. The kit is packed in a large box and contains everything that a student would require in order to complete the study programme. Indeed, the kit is so complete that it also includes a calculator, notepad and pencil!

MODULES

The written component of the *Basic Electronics and Microelectronics* package consists of a series of texts (the Microelectronics Open Learning Unit calls these *Modules of Learning*). Modules have been designed and written by qualified electronic engineers who have wide industrial and teaching experience. The *Phase 1* kit offers a choice of five packages, four of which consist of a *Foundation Pack* containing the main hardware plus a *Course Pack* of associated written learning materials and electronic components.

A total of 20 to 25 hours is required to complete each module. The rate at which students progress is, however, completely flexible though, as with all Open Learning schemes, students are well advised to develop a study plan in which periods of time are reserved for study on a regular basis. Without such a structure, study is likely to be haphazard and students can all too easily "get behind". As a guide, a routine of two evenings' study (each of no more than two hours) per week should allow students to progress at a sensible rate without greatly disrupting the normal domestic routine.

Few people can effectively cope with protracted periods of intensive study and the initial temptation to "cram" the course into a very short period should be avoided at all costs. In any event, progression through an Open Learning package should be steady, with a series of defined goals and plenty of time allowed for review and consolidation. It is heartening to note that the *Microelectronics Open Learning Unit* can supply students with tutorial support via a Technical Counsellor who is able to give help and guidance by telephone.

This review is confined to the first six modules of *Basic Electronics and Microelectronics* (from *Use of Equipment and Electric circuits to Transistors and Circuits*). Each module is presented in spiral bound A4-format and the largest (Module 6B) contains 176 pages. The text is liberally interspersed with examples and practical exercises. The quality of presentation is consistently good, the text is succinct, and the diagrams are excellent.

I particularly liked the way in which circuits are presented together with matching wiring layouts (necessitating large fold-out pages in the later modules). This technique will undoubtedly simplify the process of converting circuit diagrams into working breadboard circuits and greatly minimise the frustration which newcomers often experience when laying out circuits for the first time.

MODULE 1

Module 1 deals with using the multimeter and the breadboard "Circuit Designer". The breadboard connecting arrangement is particularly well explained. This module should be completed in a single evening session and should be tackled after watching the accompanying video (more of this later).

MODULE 2

Module 2 introduces students to some essential basic electronic theory. Series and parallel circuits are discussed and open and short-circuit faults are considered. Sections are included on power and power ratings and the effect of temperature on resistance is explained. Measurement errors are introduced and the module ends with a discussion of voltage and current division and a "Simple Resistance Bridge Circuit".

The module contains several very useful appendices including a list of specific learning objectives presented in standard BTEC format. It was, perhaps, a pity that other modules do not contain similar listings which can be extremely useful for lecturers and teachers planning college-devised BTEC units! *(Note these listings are now available for all modules on request—Ed.)*

MODULES 3 to 6

Modules 3 and 4 deal respectively with "Capacitors in D.C. Circuits" and "Coils in D.C. Circuits". All of the usual theory is covered and some well thought out practical exercises have been included. Semiconductor diodes are introduced in Module 5. This module covers diode characteristics and rectification and also contains sections on l.e.d. and Zener diodes.

The real "meat" of the course is contained in Module 6 which, by virtue of its considerable breadth, is presented in three separate parts. The first part deals with an introduction to transistors (including symbols, identification and the concept of current and voltage gain). The second part deals with input and output resistance, the emitter follower, and transistor applications (including a wide variety of oscillator circuits).

The last instalment, Module 6(c), deals with astable and monostable multivibrators, field effect transistors and an f.e.t. liquid level control circuit. Power ratings of transistors are also discussed and simple resistive tests for transistors are introduced.

My only reservation concerning Module 6 is that the practical content would have been even better if an oscilloscope was provided as part of the *Phase 1 Kit!* The use of an oscilloscope is almost essential when investigating the large majority of circuits introduced in this module but this has almost certainly been ruled out on the grounds of expense.

VIDEO

The VHS-format video supplied with the *Basic Electronics and Microelectronics* package provides a brief introduction to the practical kit. The major part of the video is concerned with using the tools and mutimeter supplied with the package and preparing components for use with the circuit breadboard. It was, therefore, a pity that the quality of the video was not good enough to show some of the finer detail and a printed sheet of straightforward line drawings would have been a good deal better. The video also deals with the *Phase 2 Microcomputer Kit* and this, of course, is not relevant to *Basic Electronics and Microelectronics* course.

COST

Unfortunately, Open Learning is a rather costly business. The "value added" content of an Open Learning course is considerable and, in order to assess the extent to which a course is "value for money" one should not fall into the trap of merely counting the cost of the hardware items provided in the practical kit. Furthermore, the cost of a conventional course of part-time day or evening study cannot be meaningfully equated with the cost of an "equivalent" Open Learning package.

The flexibility of Open Learning is undoutedly its major selling point. The course can be made available "off-the-shelf" and the practical kit replenished for use by a succession of students. Since the selling price of an Open Learning package will be very much dependent on the size of the print run and the quantity of practical kits produced, costs will inevitably be rather high unless a very high production run can be envisaged.

The cost of purchasing a comprehensive Open Learning package outright will thus usually be prohibitive as far as individuals are concerned. Educational establishments and employers, on the other hand, are much more likely to invest in such packages, making them available to students or staff at a modest charge.

The *Basic Electronics and Microelectronics Foundation Pack* costs £245 whilst the *Basic Electronic pack* (comprising modules 1 to 6 and including a video cassette) is priced at £255. A basic electronics course would thus cost £500 (i.e. £245 plus £255). The remaining course packs *(AC Current and Power Control, Microelectronics and Linear Integrated Circuits,* and *Digital Electronics)* are priced at £112, £70 and £167 respectively. An additional package, *Transducers and Sensors,* does not have a complementary practical package and thus costs a more modest £40.

The Microelectronics Open Learning Unit offers a discount of £20 on the purchase of the *AC Current and Power Control, Microelectronics and Linear Integrated Circuits, and Digital Electronics* packages for those already in possession of the *Basic Electronics Pack.* A complete package is also available which comprises all five course packages, plus the *Foundation Package* and this is priced at £835.

Prices of Open Learning packages do vary quite widely and it is not always easy to compare "like with like". Bearing in mind the comprehensive nature and quality of the package, the cost of the Microelectronics Open Learning Unit package is not at all excessive.

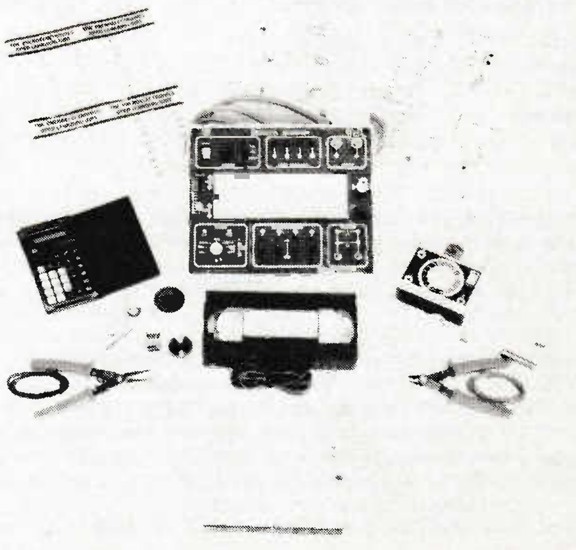
OVERALL REACTIONS

The *Basic Electronics and Microelectronics* course is both beautifully presented and extremely comprehensive. The *Basic Electronics Pack* can be very highly recommended as a well thought out introduction to electronics which will provide the student with a thorough grounding in the principles and practice of basic electronic circuits.

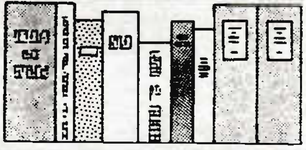
It is a shame that individuals will almost certainly not be able to afford to invest in such a package. This need not, however, deter them approaching their employer, local Further Education College, or ITEC to see if the package is available within an existing Open Learning provision. If it is, readers can rest assured that they have access to one of the best of today's Open Learning packages!.

The Microelectronics Open Learning Unit may be contacted at **Twyford House, Kennedy Way, Tiverton, Devon EX16 6RZ. ☎ Tiverton (0884) 255625.** □

By Mike Tooley



BOOK REVIEWS



OSCILLOSCOPES, HOW TO USE THEM (2nd Edition)

Author	Ian Hickman
Price	£5.50 Hard Cover
Size	124 pages
Publisher	Newnes
ISBN	0-600-33373-6

SINCE this book was first published in 1986 many changes have taken place and few would disagree with the statement that nothing changes as fast as electronic technology. This makes an up dated version of Oscilloscopes and how to use them, all the more welcome.

The oscilloscope is used when ever a visual representation of what is occurring in an electrical circuit is essential. It's users are many and varied, a valued piece of equipment that has been used for many years, by design engineers, research students, trouble shooters and more and more as a diagnostic tool by the medical profession. All those mentioned in the above categories, as well as hobbyists will greatly benefit from acquiring this book. There are chapters on basic oscilloscopes and advanced real time oscilloscopes as well as a generous amount of text devoted to accessories such as calibrators, cameras, hoods, probes and special graticules. Chapter six is particularly useful, as the author explains why it is important to choose the right model for certain applications and what is most helpful, quotes makes and model numbers. I am not certain why the author has saved "How oscilloscopes work" for the last two chapters but Ian Hickman is a master of his subject, and I am sure his reasons are good ones. Their position in the book is quite apparent from the list of contents, and many readers may not need to read them but to all those who use oscilloscopes or would like to learn how to use them, I strongly advise you to buy a copy of this excellent book.

See

DIRECT BOOK SERVICE

Page 674

A TV-DXERS HANDBOOK

Author	R. Bunney
Price	£5.95
Size	96 pages (large format)
Publisher	Bernard Babani (Publishing) Ltd
ISBN	0 85934 150X

THIS book is an enlarged and updated version of an earlier work, *Long Distance Television Reception*. It claims to be a "practical guide for the beginner and a source of reference for the established enthusiast", so I decided to review it mainly from the beginners point of view. Reception of signals from distant TV broadcast stations, especially in other countries, is not normally possible with domestic aerials and receivers. This book explains why this is so, how they *can* be received, and how such signals can be identified.

Reception of DX (long distance) signals is greatly affected by the state of the Troposphere and/or the Ionosphere, as well as by such factors as meteor showers, auroral conditions, lightning, and even flying aircraft. A chapter on propagation covers all these in an interesting and not too complicated way for beginners.

This is not really the case, however, with subsequent sections on receiver requirements, tuners i.f. strips, and the various video stages of a TV receiver. For someone already familiar with TV circuitry, these chapters identify the more demanding requirements of long distance, as opposed to domestic reception. They go on to discuss how best to meet these requirements, by selection of a receiver with particular features, by modifying existing sets, or adding external units.

Opinions apparently differ as to whether reception of satellite TV signals is *real* TV-DXing. By exploring propagation phenomena, receiver and aerial techniques, and experience, long distance signals can be received direct from a distant transmitter. By contrast, long distance signals relayed from a satellite in line of sight above the horizon can usually be received without the need for skill on the part of the operator. All that is needed is a dish antenna, appropriate hardware, and a specialised receiver, to have the signals come romping in.

The coming decade will see dramatic changes in the broadcasting field, with such installations becoming commonplace in the domestic situation. But the acquired skills and consequent satisfaction achieved from direct reception seem to suggest there will always be enthusiasts wanting to do things the hard way!

There is a good treatment of aerials, ranging from a simple wideband dipole to multi-element specialised types with very high gain. There is information on a number which can be home constructed, together with a wide range of low-noise aerial amplifiers capable of boosting weak signals to a usable level.

Overall, the book performs better as a "source of reference for the established enthusiast" than as a "practical guide for the beginner", indeed it is difficult to see how it could satisfactorily meet both claims. For the existing practitioner, it has useful tables, international transmission standards, channel and cable allocations, a variety of circuits, satellite frequency lists, glossaries of terms, advice on coping with interference from strong adjacent stations, and so on.

There *is* advice for the absolute beginner if you search for it in the book's information packed pages. This tells us that signals of high strength can be received "over quite considerable distances and with the very basic of aerial systems—a wideband dipole feeding into a v.h.f. Band 1 receiver . . . " This will give "hopefully spectacular" results, encouraging the viewer to go on to acquire greater skills, improved hardware, and a "greater dedication to the hobby".

Details of how to make the aerial are given, but it is not too clear how one obtains a suitable receiver. I am almost converted to the idea of trying TV-DXing myself, but what I would really like to see is another book, written *specially* for beginners, explaining how to get started, what results to expect, and how to achieve them.

This present book may not be for raw beginners, but once you get started on TV-DXing it must surely be a useful addition to your bookshelf, becoming increasingly helpful the deeper you get into this intriguing hobby.

T.S.

KEY TECHNIQUES FOR CIRCUIT DESIGN

Author	G. C. Loveday
Price	£6.75
Size	128 pages, paperback
Publisher	The Benchmark Book Company.
ISBN	1871047005

DESIGNING an electronic circuit from first principles may seem a daunting prospect to many amateur constructors or even professionals working in electronics. I imagine that in the event of needing such a circuit, most people will search around to find one that comes as near as possible to modify it if necessary—and if they are able.

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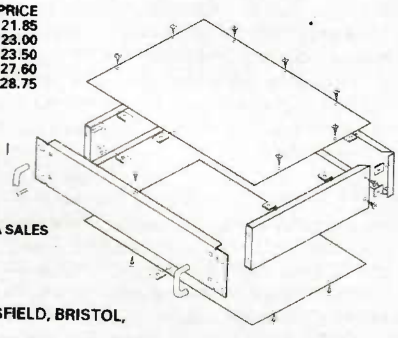

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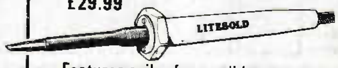

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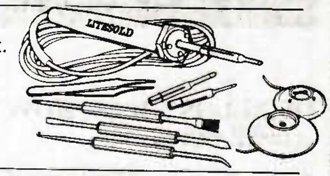

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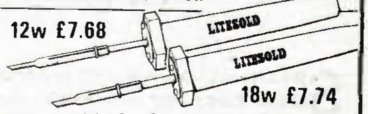

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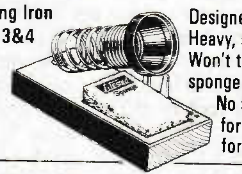

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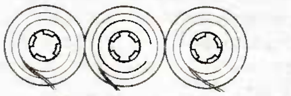

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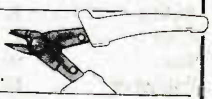

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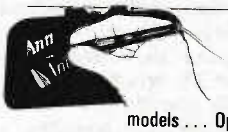

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DOWN TO EARTH

BY GEORGE HYLTON

ACTIVE FILTERS

Active filters are all the rage nowadays. For the experimenter, however, there's a bit of a problem. The texts about them seem to come in two varieties, neither of which is very helpful.

One is full of highbrow maths and short on component values. The other gives component values, but for filters which never seem to be quite what one needs.

PRACTICAL CASE

It so happened that I needed a decent low-pass audio filter recently. I'd been working on a simple short-wave reciever. The r.f. front end part of the design was finished and I now needed an audio section.

Short-wave broadcast stations are packed like sardines, often only 5kHz apart. Reception is often noisy. Simple receivers of the direct conversion or synchrodyne kinds (mine is both) convert adjacent-channel signals into noise, mostly high pitched.

A good low-pass audio filter is needed to reduce this "sideband splash". Ideally, the filter should have a variable cutoff frequency so that it can be adjusted to suit the reception conditions of the moment. None of my books and magazines had a ready-made answer. I was stuck.

AN UNUSUAL COMPONENT

At this point, chance came to my aid. One day I called at **J & N Bulls'** shop in Hove, to buy an isolation transformer which had appeared in one of their familiar advertisements on the inside front cover of *EE*.

While I was there they gave me their current bargain list. Browsing through this I later found an unusual component: a quad (four-gang) 50 kilohm potentiometer. Dual (two-gang) pots for stereo are common enough. Quad pots, presumably for quadraphonics, are rare.

I figured that with a quad pot I could make a four-section variable cut-off low-pass *RC* filter (Fig. 1). With *R* variable I should get at least a ten-to-one range of cut-off frequency, more than enough for speech and music and maybe of some use for CW.

So next time I visited Bulls' I bought some "quad pots". They turned out to be neat little Japanese jobs. Ohmmeter tests showed that they were log law, and actually about 45k max.

Would they do the job? I assembled the filter on a plug-in breadboard, using 4n7 capacitors for *C*. Why 4n7? Well, I happened to have plenty of that value, but I did make a quick check with a nomogram which showed me that 4n7 has a reactance of 45k at about 760Hz.

The −3dB cutoff frequency of a single *RC* section falls at the point where the reactance of *C* equals *R*. With four sections it would be lower in frequency, but at least I was in the right area. With the pot set near minimum resistance the cut-off would be at least ten times higher, at 7.6kHz, which was about as much as I needed.

The next job was to hitch my audio generator to the filter input and set *R* to give a practical cutoff frequency. I chose 3kHz, which is the sort of cutoff you need when interference is bad.

The response turned out to be as shown in curve *A*. Not bad, but a bit droopy. Could it be made flatter in the pass-band and steeper beyond it?

PHASE SHIFT OSCILLATOR

I've always found oscillator circuits interesting, and I knew of one which can use exactly this sort of *RC* lowpass network for tuning. The circuit block diagram is shown in Fig. 2. Note that the amplifier is inverting, as indicated by the minus sign in front of the gain symbol, *A*.

At frequencies well below cutoff the feedback through the *RC* network is negative. At d.c., all the amplifier output is fed back negatively to the input and the gain is effectively one.

As the frequency is raised, the effect of *C* becomes significant. From Fig. 1, curve *A*, it's clear that *C* produces attenuation. But it also produces phase shift. This means that the feedback isn't quite so negative, so the gain isn't reduced as much as might be expected.

At one frequency, the phase shift is −180°. That is, the phase is inverted by the network. So there are now two phase inversions (one in the amplifier, one in the network), which means that the overall feedback becomes positive. If the gain (−*A*) is high enough, the circuit oscillates.

Using a double-beam oscilloscope to compare input and output signals it was easy to adjust the frequency of my audio generator to get a shift of 180° from my *RC* lowpass. I found that the output signal was then about one sixteenth of the input.

This meant that in Fig. 2 if the amplifier gain exceeds 16, the circuit will oscillate. For gains a bit short of 16 it won't, but a peak will appear in the response. Clearly, the peak will get sharper as the gain is raised towards the oscillation point and less sharp as it's reduced.

There seemed to be a fair chance of finding a gain at which the response is reasonably level, up to a frequency somewhere near the 180° one. Beyond it the gain must drop sharply, for two reasons. First, the attenuation of the network increases faster than the amplifier can compensate. Secondly, beyond the 180° frequency the feedback becomes less positive.

At very high frequencies each section must have a phase shift of nearly 90°, giving a total network phase shift of 360°. The feedback is then negative.

BENCH TEST

Theorising is all very well, but does it work? Next step: try it and see.

The "circuit" in Fig. 2 is just an aid to understanding. It has no provision for applying input signals.

After a good deal of doodling I arrived at the practical test circuit of Fig. 3. Here, transistor TR1 is just an emitter-follower input buffer. The voltage gain comes from transistor TR2 and is about 8. TR3 is an output buffer.

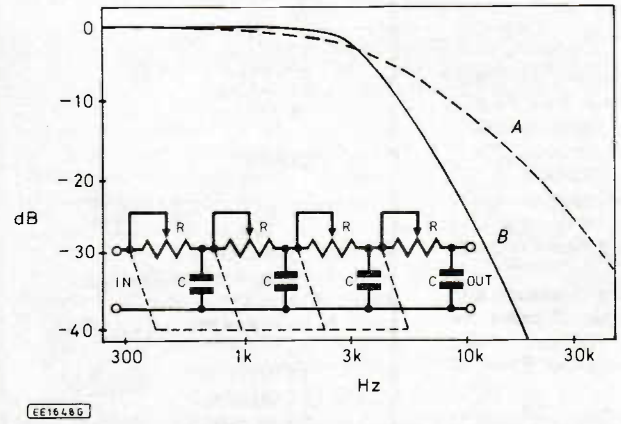

Fig. 1. Four-section RC *low-pass network. Curve A shows the response of the network alone for values of R and C which produce a −3dB point at 3kHz. Curve B is for an active filter with a similar network.*

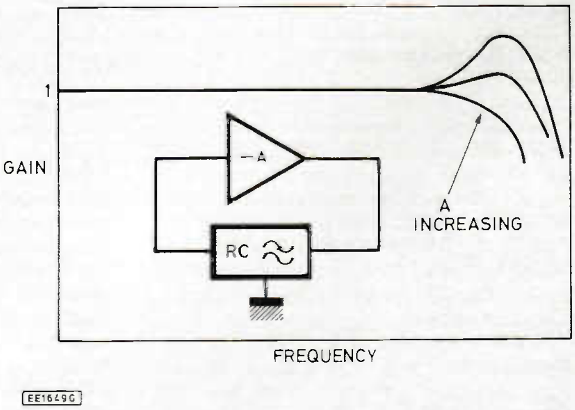

Fig. 2. When an RC *lowpass with three or more sections is connected as a feedback path in an inverting amplifier the frequency response becomes very dependent on the gain when the phase shift of the network is close to 180°.*

Adding the input signal to the feedback is arranged for by resistors R1 and R2. At very low frequencies the gain is mainly defined by these resistances, which form a negative feedback network.

If transistor TR2 had infinite gain then the effective very-low frequency gain would be $R2/R1 = 1.5$. But since the actual gain of TR2 is low the real l.f. gain is less than 1.5. In fact, resistor R2 was selected by trial and error to set the gain as close to one as possible using E12 resistances. (It's a little over one in fact.)

At higher frequencies, where the *RC* phase shift makes the feedback more positive the gain of TR2 has much more influence. To adjust it I used various values for resistor R4 until I found one (82k) that gave the flattest response, plotted in Fig. 1 as curve *B*. To make this comparable with *A*, the network resistances R were adjusted to give the same −3dB point, 3kHz. The improvement is obvious.

Having produced a useful-looking 3kHz lowpass filter, the next step was to vary R and confirm that the response keeps the same general shape but with different cutoff frequencies. The lowest obtainable cutoff (−3dB) proved to be 560Hz. The highest I checked was 10kHz: beyond that was of no interest to me.

In all cases the response was like curve *B*: fairly level in the pass band and fairly steep in the stop band. Very satisfactory, considering that I'd done no maths and, used no unusual or close tolerance component values (the 4n7 capacitors were 10 per cent).

Also, the filter has equal values of C and equal values of R. My search through the literature turned up designs where if the Rs were equal the Cs were not, and vice versa.

I was beginning to get quite smug about it when I ran a test which showed that one of my tacit assumptions was quite wrong: the response at the 180° frequency was well down. I'd assumed that the 180° frequency would lie in the passband, not outside it.

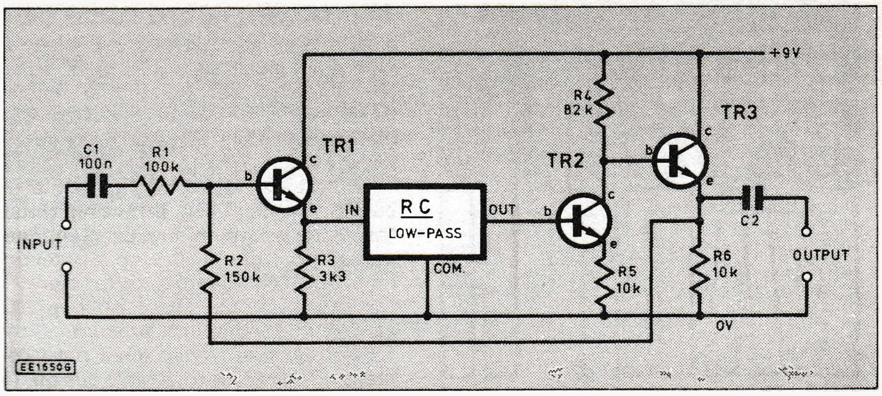

Fig. 3. Circuit diagram for a practical lowpass active filter embodying a four-section RC *network with equal* C *and equal* R.

FIXED FILTERS

If you want to use fixed values of R and C and don't want to resort to cut-and-try you need more information. How much? The essentials seem to be C, R and −3dB frequency for one filter. From these it should be possible to estimate the values for other filters.

I set up my circuit using fixed close tolerance components: $R=10k$, $C=10n$. These gave a −3dB response at exactly 1kHz.

Very convenient. If either C or R is increased the cutoff frequency is decreased. The response, then, is inversely proportional to C times R.

My 1kHz filter has $CR=100$, if C is in nF and R in kΩ. This suggests a simple design formula: $CR=100/f_c$, where f_c is the −3dB frequency in kHz, C is in nF and R is in kΩ.

Thus for a 4kHz filter CR would be 25. If you happen to have plenty of one nano-Farad capacitors then R needs to be 25 kilohms. If you use 22k the bandwidth will be a bit more than 4kHz; with 27k it will be a bit less.

This is all you need to design your own "active" lowpass filter. Well, not quite. You have to make sure that the filter impedence is compatible with the circuit in which you connect it.

The network should be driven from a source whose impedance is much less than R. It should be terminated by an impedance much greater than R.

My circuit should work for most practical values, provided that it is driven from a source impedance small compared with resistor R1 (if not, reduce R1 to keep it, plus the actual source impedance equal to 100k approx.). Also, the load connected to the output (capacitor C2 and ground) should be at least 10k.

Any high gain audio transistors will do.

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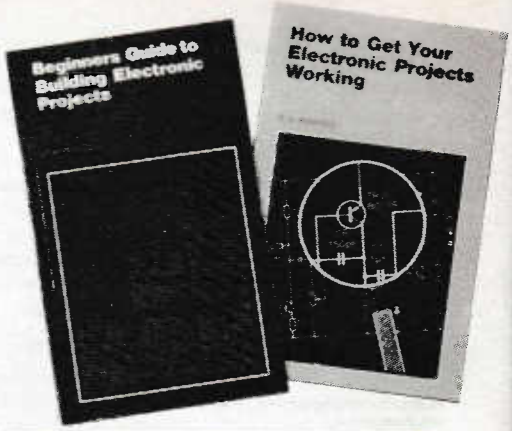

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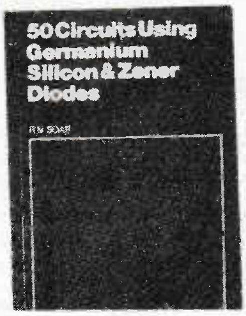

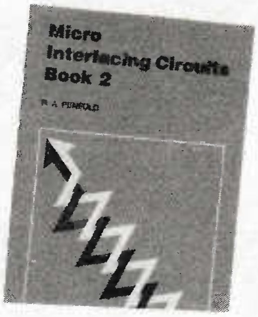

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64 pages **Order Code BP42** **£1.95**
BOOK 2 50 more l.e.d. circuits **Order code BP87** **£1.35**

MICRO INTERFACING CIRCUITS—BOOK 1
MICRO INTERFACING CIRCUITS—BOOK 2
R. A. Penfold
Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.

Book 1 is mainly concerned with getting signals in and out of the computer;. Book 2 deals primarily with circuits for practical applications.
Book 1 *112 pages* Order code BP130 £2.25
Book 2 *112 pages* Order code BP131 £2.75

A MICROPROCESSOR PRIMER
E. A. Parr, B.SC., C.Eng., M.I.E.E.
Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such ideas as relative addressing, index registers, etc., are developed.
96 pages **Order code BP72** **£1.75**

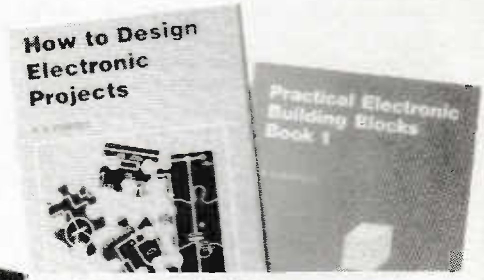
A PRACTICAL INTRODUCTION TO MICROPROCESSORS
R. A. Penfold
Provides an introduction which includes a very simple microprocessor circuit which can be constructed so that the reader can experiment and gain practical experience.
96 pages **Temporarily out of print**

ELECTRONIC CIRCUITS HANDBOOK
Michael Tooley BA
This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.

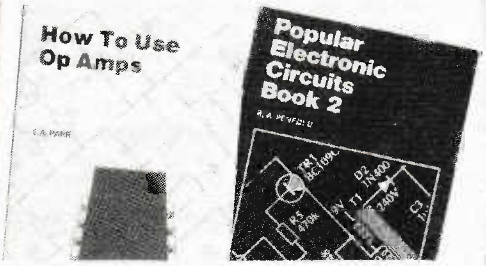
Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.

Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.

As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right.
277 pages Order code **NE05** **£14.95**



COIL DESIGN AND CONSTRUCTION MANUAL
B. B. Babani
A complete book for the home constructor on "how to make" RF, IF, audio and power coils, chokes and transformers. Practically every possible type is discussed and calculations necessary are given and explained in detail. Although this book is now rather old, with the exception of torroids and pulse transformers little has changed in coil design since it was written.
96 pages **Order Code 160** **£2.50**



HOW TO USE OP-AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.
160 pages **Order code BP88** **£2.95**

HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold
The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided.
128 pages **Order code BP127** **£2.25**

POPULAR ELECTRONIC CIRCUITS —BOOK 1
POPULAR ELECTRONIC CIRCUITS —BOOK 2
R. A. Penfold
Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.
BOOK 1 *160 pages* **Order code BP80** **£1.95**
BOOK 2 *160 pages* **Order code BP98** **£2.25**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS

R.A. Penfold

Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.

The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.

88 pages **Order code BP180** **£2.95**

MODERN OPTO DEVICE PROJECTS

R.A. Penfold

In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these devices have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.

While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.

104 pages **Order code BP194** **£2.95**

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS

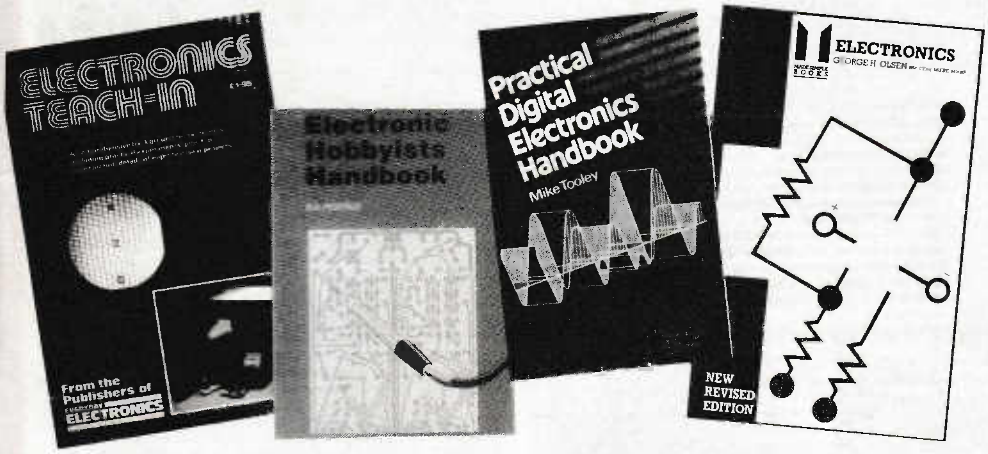
Robert Penfold

Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.

The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.

92 pages **Order code BP179** **£2.95**

DATA AND REFERENCE



ELECTRONICS TEACH-IN

Michael Tooley BA and David Whitfield MA MSc CEng MIEE (published by *Everyday Electronics*)

This value for money *EE* book provides a comprehensive background to modern electronics including test gear projects. A complete course in basic electronics; designed for the complete newcomer it will however also be of value to those with some previous experience of electronics. Wherever possible the course is related to "real life" working circuits and each part includes a set of detailed practical assignments. Includes details of eight items of related test gear giving full constructional information and diagrams for each one. They are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator. An excellent companion for anyone interested in electronics and invaluable for those taking G.C.S.E. and BTEC electronics courses.

104 pages (A4 size) **Order code EE/T-I** **£1.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.

The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.

256 pages **Order Code BP53** **£2.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST

G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.

The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics.

128 pages **Order Code 228** **£2.50**

MICROPROCESSING SYSTEMS AND CIRCUITS

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

A truly comprehensive guide to the elements of microprocessing systems which really starts at the beginning. Teaches the reader the essential fundamentals that are so important for a sound understanding of the subject.

256 pages **Order Code BP77** **£2.95**

ELECTRONIC HOBBYISTS HANDBOOK

R.A. Penfold

Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.

88 pages **Order code BP233** **£4.95**

AUDIO

F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.

320 pages **Order Code BP111** **£3.50**

HOW TO IDENTIFY UNMARKED ICs

K. H. Recorr

Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.

Chart **Order code BP101** **£0.95**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART

B. B. Babani

Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.

Chart **Order code BP7** **£0.95**

CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS

M. H. Banani, B.Sc.(Eng.)

Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.

Chart **Order Code BP27** **£0.95**

RECOMMENDED READING

FOR INTRODUCING DIGITAL ELECTRONICS

ELECTRONICS–A "MADE SIMPLE" BOOK

G. H. Olsen

This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.

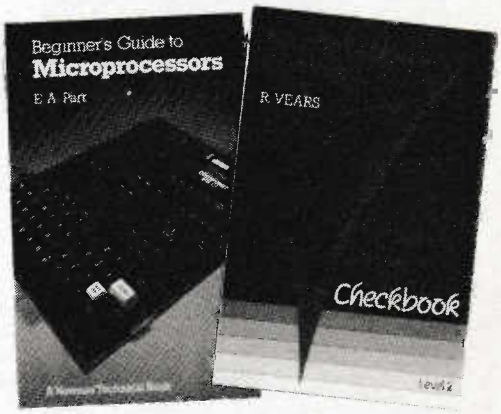
330 pages **Order code NE10** **£4.95**

PRACTICAL DIGITAL ELECTRONICS HANDBOOK

Mike Tooley (Published in association with *Everyday Electronics*)

The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.

208 pages **Order code PC100** **£6.95**



BEGINNERS GUIDE TO MICROPROCESSORS

E.A. Parr

An excellent grounding in microprocessors, this book is broadly relevent to the whole of our Introducing Microprocessors course. It is easy to read and well illustrated.

224 pages **Order code NE03** **£4.95**

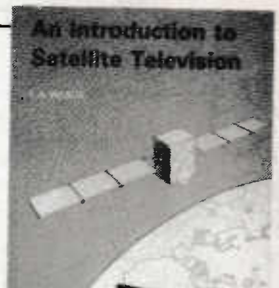
MICROELECTRONIC SYSTEMS 2 CHECKBOOK

R. Vears

The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.

194 pages **Order code NE04** **£4.95**

DATA AND REFERENCE

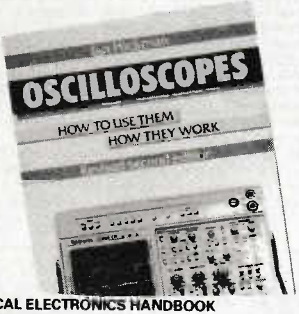


OSCILLOSCOPES: HOW TO USE THEM–HOW THEY WORK
Ian Hickman

Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models is available. But which is the right 'scope for a particular application? Which features are essential, which not so important? What techniques will get the best out of the instrument?

Ian Hickman, experienced in both professional and hobbyist electronics, has revised this well-established book to help all oscilloscope users–and potential users.

133 pages **Order code NE09** **£5.95**



PRACTICAL ELECTRONICS HANDBOOK
Ian Sinclair

Ian Sinclair has now revised this useful and carefully selected collection of standard circuits, rules-of-thumb, and design data for professional engineers, students and enthusiasts involved in radio and electronics. Covering passive and active components, discrete component circuits (such as amplifiers, filters and oscillators) and linear and digital i.c.s, the book includes many items which are not elsewhere available in a single handy volume. The operation and functions of typical circuits are described, while mathematics is limited to that necessary for deciding component values for any application.

This revised edition contains more details on computers and microprocessors and has been brought up to date throughout.

199 pages **Order Code NE06** **£7.95**

BEGINNER'S GUIDE TO HI-FI
Ian Sinclair

The *Beginner's Guide to Hi-Fi* will appeal to the audio enthusiast, whether newly won over by advances in technology or well established and wondering whether to update equipment. The book deals with the sound from its sources in the studio to its ultimate end in your ears, and shows what sound is, how it is recorded and how it is reproduced.

Every aspect of Hi-Fi, from pickup cartridges to loudspeakers, has been covered, and the emphasis has been on explaining design aims. Cassette systems have been given considerable prominence, including the more modern Dolby C and dbx noise reduction systems. The CD record has been covered in detail so that you can find out just why this system of sound reproduction is so superior.

194 pages **Order Code NE07** **£4.95**

ELECTRONICS-BUILD AND LEARN
R. A. Penfold

The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components–resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.

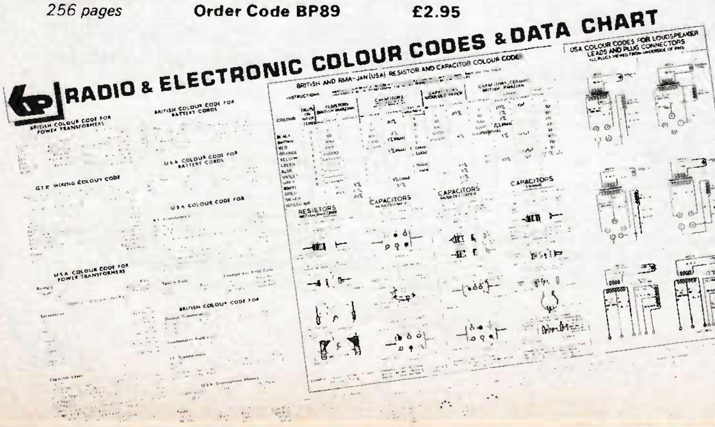
At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.

120 pages **Order Code PC103** **£5.95**

COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.

A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible. While not getting involved in the more complicated theory and mathematics, most of the modern transmission system techniques are examined including line, microwave, submarine, satellite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmission assessment are included, finally a short chapter on optical transmission.

256 pages **Order Code BP89** **£2.95**

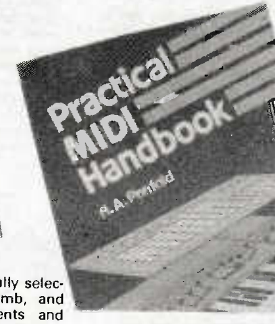


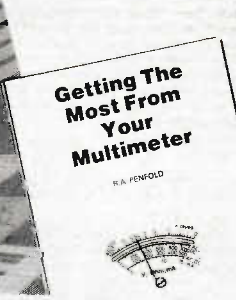
GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold

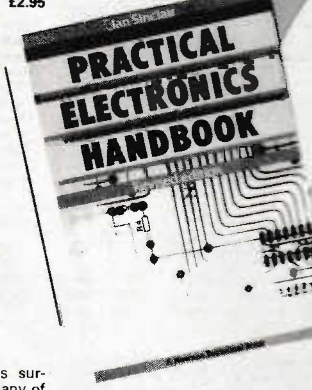
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

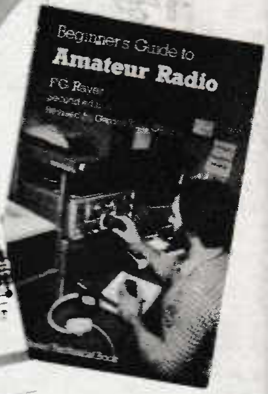
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages **Order code BP239** **£2.95**









PRACTICAL MIDI HANDBOOK
R.A. Penfold

The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.

The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.

128 pages **Order code PC101** **£5.95**

INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair

Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.

All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.

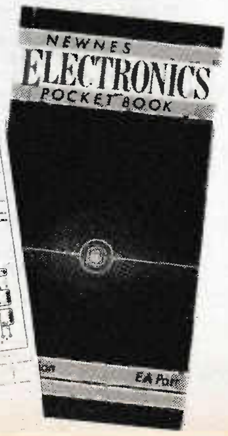
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product

128 pages **Order code PC102** **£5.95**

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels

Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.

320 pages **Order code BP85** **£2.95**



TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller

Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief description of these faults, *vis*—sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.

Chart **Order code BP70** **£0.95**

DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels

Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.

256 pages **Order code BP140** **£4.95**

LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels

Shows equivalents and pin connections of a popular selection of European, American and Japanese linear i.c.s. Also includes details of functions, manufacturer and country of origin.

320 pages **Order code BP141** **£4.95**

INTERNATIONAL DIODE EQUIVALENTS GUIDE
A. Michaels

Designed to help the user in finding possible substitutes for a large selection of the many different types of diodes that are available. Besides simple rectifier diodes, also included are Zener diodes, l.e.d.s, diacs, triacs, thyristors, OCIs, photo and display diodes.

144 pages **Order code BP108** **£2.25**

NEWNES ELECTRONICS POCKET BOOK
E. A. Parr

Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op amp applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.

315 pages (hard cover) **Order Code NE02** **£8.95**

TRANSISTOR SELECTOR GUIDE

This unique guide offers a range of selection tables compiled so as to be of maximum use to all electronics engineers, designers and hobbyists.

Section 1: Covers component markings, codings and standards, as well as explaining the symbols used.

Section 2: Tabulates in alpha-numeric sequence the comprehensive specifications of over 1400 devices.

Section 3: Tabulates the devices by case type.

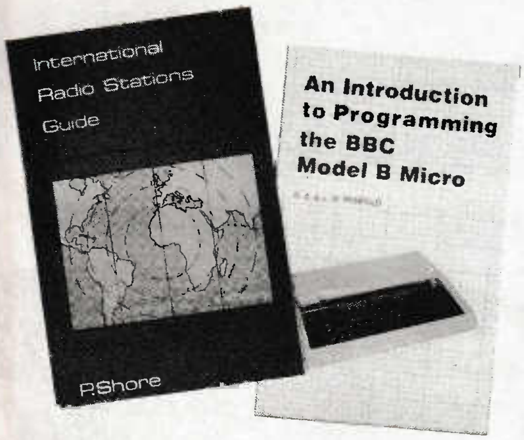
Section 4: Considers particular limits to the electrical parameters when compiling the tables.

Section 5: Illustrates package outlines and leadouts.

Section 6: Consists of a surface mounting device markings conversion list.

192 pages **Order code BP234** **£4.95**

RADIO/TELEVISION



AN INTRODUCTION TO RADIO DXING
R. A. Penfold

Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.

112 pages **Order code BP91** **£1.95**

INTERNATIONAL RADIO STATIONS GUIDE
P. Shore

Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:
Listening to Short Wave Radio; ITU Country Codes; Worldwide Short Wave Radio Stations; European, Middle East and North African Long Wave Radio Stations; European, Near East and North African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time differences from GMT; Abbreviations; Wavelength/Frequency Conversion.

320 pages **Order code BP255** **£4.95**

BEGINNER'S GUIDE TO AMATEUR RADIO
F.G. Rayer Second edition revised by Gordon King G4VFV.

Whether you are new to radio, or have become interested by way of CB, it is hoped that this book, will further whet your appetite and put you in good stead for passing the Radio Amateur's Examination and becoming a licensed radio amateur.

188 pages **Temporarily out of print**

AN INTRODUCTION TO SATELLITE TELEVISION
F.A. Wilson

As a definitive introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc.
There is also plenty for the DIY enthusiast with practical advice on choosing and installing the most problematic part of the system—the dish antenna.

104 pages **Order code BP 195** **£5.95**

COMPUTING

GETTING THE MOST FROM YOUR PRINTER
J. W. Penfold

Details how to use all the features provided on most dot-matrix printers from programs and popular word processor packages like Wordwise, Visawrite and Quill, etc. Shows exactly what must be typed in to achieve a given effect.

96 pages **Order Code BP181** **£2.95**

A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., C.Eng., M.I.E.E.

This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.

192 pages **Order Code BP112** **£3.50**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold

Obtain a vast increase in running speed by writing programs for 68000 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.

112 pages **Order code BP184** **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.

It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.

144 pages **Order code BP119** **£2.50**

AN INTRODUCTION TO PROGRAMMING THE COMMODORE 16 & PLUS 4
R. A. Penfold

Helps you to learn to use and program these two Commodore machines with the minimum of difficulty by expanding and complementing the information supplied in the manufacturer's own manuals.

128 pages **Order code BP158** **£2.50**

AN INTRODUCTION TO PROGRAMMING THE BBC MODEL B MICRO
R. A. & J. W. Penfold

Written for readers wanting to learn more about programming and how to make best use of the incredibly powerful model B's versatile features. Most aspects of the BBC micro are covered, the omissions being where little could usefully be added to the information provided by the manufacturer's own manual.

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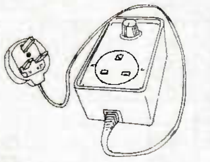

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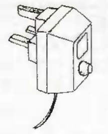

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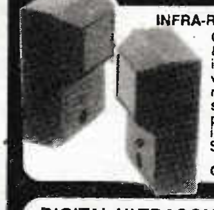

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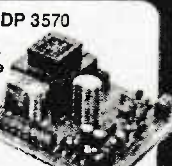

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ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

A silk purse from a sow's ear?

MR. A. J. HARPER has sent me a long and very entertaining account of his attempts to customise his Spectrum. Mr. Harper writes:

After the rush of enthusiasm which followed the construction of the Z80-PIO, Speech Synthesiser, and Joystick Interface in early 1987, the configuration of my Spectrum rapidly became a mass of tangled wires and badly connected p.c.b.s which was a nightmare to modify and very vulnerable to damage by children who for some reason (perhaps because THEY own most of the software) felt that they had at least equal claim on the machine.

The general mess was also falling foul of the domestic authority who offered some rather radical solutions inconsistent with the normal treatment of computer equipment.

Following the formation of a "Computer Users' Sub-committee", the following major shortcomings were identified:

- *(a) Poor keyboard (the old rubber one with "sticky" down key action)*
- *(b) Insufficient sound output*
- *(c) Poor display (based on an outdated black and white TV)*
- *(d) Configuration of add-ons unacceptable (multiple p.c.b.s attached, some requiring hard-wiring)*

Solution

The solution to points (a), (b), and (c) are simply "buy a keyboard kit, make an amplifier, and purchase a good colour TV" (take a deep breath and forget the overdraft!). Unfortunately, these solutions only serve to exacerbate the "spaghetti junction" problem.

Mr. Harper's solution to this problem (which must surely be shared by a great number of Spectrum enthusiasts) is that of rebuilding the Spectrum into a larger enclosure (containing the tape recorder, power supply, audio "beep" amplifier, and Spectrum p.c.b. together with expansion "motherboard"). Mr. Harper continues:

The configuration, both external and internal, of a typical industrial PC (e.g. an IBM-XT) has much to commend it. The two main features are a solid "box" on which a display is placed, and an internal hardware configuration which permits easy expansion by the addition of extra p.c.b.s to a motherboard.

The nub of the problem is the ***motherboard.*** *Here is an area in which* Everyday Electronics *could help. I could find no product designed specifically for the Spectrum. In fact this single obstacle nearly foundered the whole project. The most obvious connectors to use are the 2×32-way DIN 41612 indirect edge connectors (available from component suppliers). These will accomodate the 2×28-way expansion bus of the Spectrum edge connector with a small spare capacity. However, standard Veroboard will not be suitable for use as a motherboard without an unwieldy amount of cuts and wiring. The task of a home-made p.c.b. was somewhat daunting; I can do the odd "through pin track" but with 32 per connector times 6 connectors on the board—I know my limits!*

Amstrad Board!

My solution involved using an Amstrad Motherboard (purchased from Maplin) which can accommodate six of the previously mentioned DIN connectors. However, there are still some problems. The board terminates in a 2×25-way p.c.b. edge and a matching 2×25-way IDC socket at the other end to allow the board to be extended. Two of the 2×25-way tracks are power rails and are connected to pairs of pins. This is also true of one pair of the 2×32-way tracks which are not connected to the 2×25-way terminal connections.

By suitably placing the standard 2×28-way connector at the "tongue" edge of the board, the majority of the Spectrum connections may be made directly to the fingers of the tongue. By sacrificing the redundant negative power lines and transferring the 0V and 5V connections to the 2×25-way power positions, the five missing positions to the left of the slot can be relocated.

Fun though this was, a ready made board with a standard 2×28-way connector attached would, I am sure, appeal to readers. So, come on E.E., such a board could unscramble the backplane into a data bus, address bus, and control bus to aid the wiring of subsequent plug-in p.c.b.s.

Colour Monitor

Much to my surprise, the cheapest way to acquire a colour monitor is to buy a colour television with a composite video input. After some research, I bought the Philips 15CE1210 14 inch colour TV with flatishscreen and sharp corners. This set has both composite video and RGB inputs. The composite video can either enter through the video input on the front or via the SCART socket at the rear.

Initially, I connected a video cable to pins 15B and 14B of the edge connector. The picture was of worse quality than through the Spectrum's modulator! A hard look at the Spectrum's p.c.b. indicates that the video signal runs a considerable distance round the p.c.b. totally unshielded accompanied by n-MHz signals in profusion. This surely cannot be a good interference free environment for the video path?

Fortunately, the video chip (the LM1889N) at the left of the Spectrum p.c.b., provides its composite video output in the form of a single wire which enters the modulator. It is not too difficult to attach the inner conductor of the co-ax to this point. The outer (earth) shielding can be connected close by (I used the earth on the modulator, though other positions are possible). The result, much to my relief, was a much improved picture. I subsequently compared the composite video and modulator pictures for several games. Incidentally, the Psion Chess programme provides a good test card as the pieces and board colour can be "user selected".

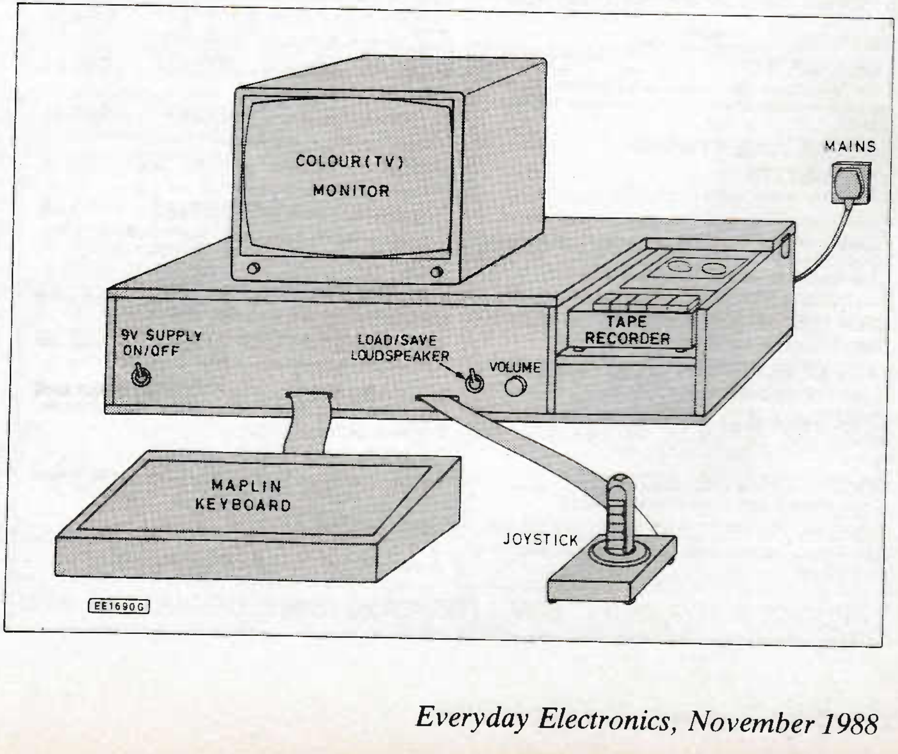
Finally, I completely disconnected the modulator from the video input and its power supply. This further improved the picture quality. (The capacity of the modulator for mischief can perhaps best be illustrated by the fact that I can receive a fuzzy picture of the Sinclair copyright message even when there is no connection to the TV!).

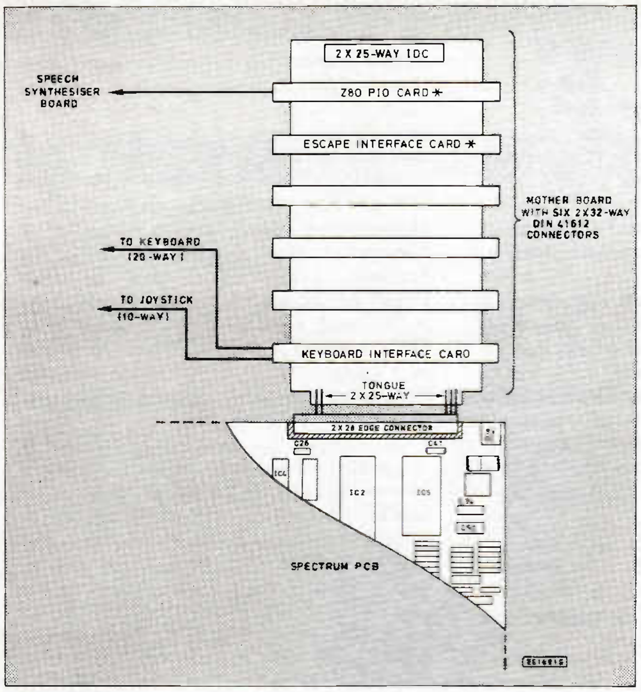
Audio

The audio "beep" amplifier is based on the LM380N. Some care is needed with the layout and shielding of wires. At one point I had quite good reception of a French radio station. . . .The power is taken from the Spectrum's raw 9V supply. A three way switch provides for LOAD/SAVE/LOUDSPEAKER. Provision is also made to switch off the loudspeaker since there are occasions when the whole house does not want to be deafened by crashing space invaders.

"A silk purse from a sow's ear?" *was the question posed in the title of this report. To a*

Fig. 1. General arrangement of the improved Spectrum "workstation".





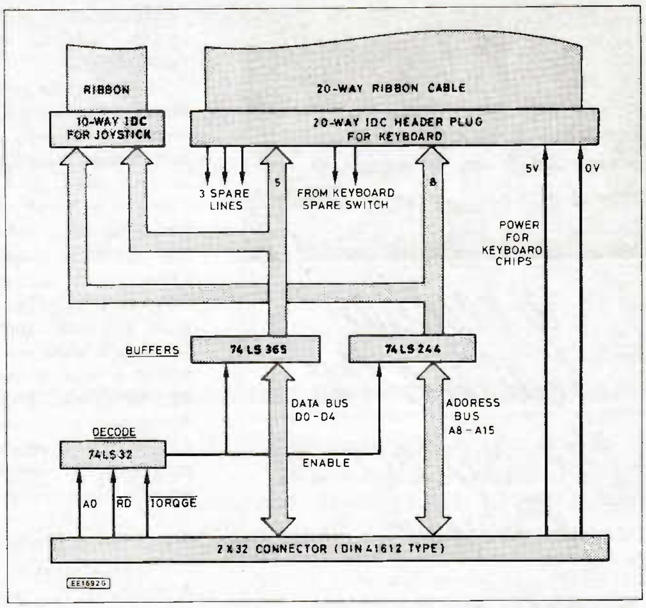


Fig. 3 (above). Details of suggested keyboard interface.

Fig. 2 (left). Outline arrangement of motherboard (*=features to be added).

considerable degree I believe that the project has succeeded though I might suggest that a Spectrum is really "a silk purse disguised as a sow's ear"*; it is up to the owner to take off the disguise. Essentially it is Clive Sinclair's "small is beautiful" philosophy which is at fault. To some extent, this has been corrected on later machines which at least have a built-in disk drive* (but see last September's On Spec . . .) *however, I don't think that the add-on situation is catered for any better. It will still become a spaghetti junction which is unsuitable for use in the home environment.*

Mr. Harper has raised many interesting points. I am well aware that a number of regular readers have adapted/rebuilt the basic Spectrum for their own use and wonder whether any would care to offer some details of their own trials and tribulations? Furthermore, if anyone else can offer a solution to the motherboard problem, I would be extremely grateful to hear from them. Subject to the response, I would be more than happy to suggest a compromise backplane arrangement and provide some p.c.b. artwork which represents the considered thinking of a number of Spectrum devotees.

Next Month: we shall be tackling another *On Spec Project* in the form of a Simple EPROM Programmer. In the meantime, if you would like a copy of our *"On Spec Update"*, please drop me a line enclosing a large (250mm×300mm) ***adequately*** stamped addressed envelope. Mike Tooley, Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

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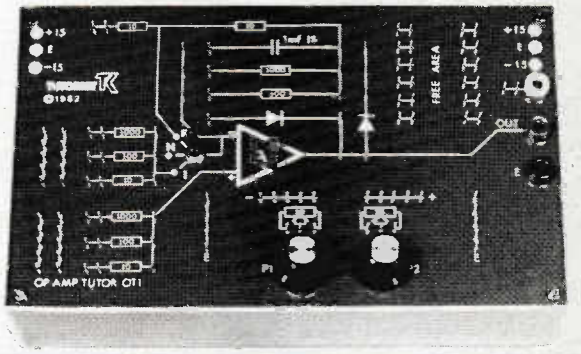

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8 PIN SKTS	0.02
14 PIN SKTS	0.03
16 PIN SKTS	0.03
24 PIN SKTS	0.07
28 PIN SKTS	0.08
40 PIN SKTS	0.11

RECTIFIER DIODES

1N4007	0.01
1N4001	0.01
1N5400	0.04
1N5402	0.05
1N5404	0.06
1N5406	0.07
1N5408	0.08

SIGNAL DIODES

1N4148	0.01

MEMORY DEVICES

4116 (THOM)	0.40
41464 (NEC)	2.56
6116 (HIT)	0.95

LINEAR DEVICES

CA1352E	1.00
CA3130E	0.49
CA3018A	1.03
CA3018	0.62
CA3046E	0.37
CA3081E	0.33
CA3085	0.42
CA3088E	1.38
CA3089E	0.72
CA3090A	0.97
CA3094E	0.54
CA3141E	0.41
CA3146E	0.75
CA3160E	0.45
CA3189E	0.78
CA3140E	0.27
CA3240E	0.49
ICL7107	3.00
ICM7556	0.79
LF347	0.60
LF351	0.79
LF353	0.35
LF398N	2.00
LM2902	0.38
LM2907N	2.10
LM2917N	2.22
LM2917N-14	2.22
LM301AN	0.40
LM301AH	0.71
LM304H	2.60
LM305H	0.93
LM307H	1.06
LM307N	0.50
LM308AH	3.75
LM308AN	0.52
LM309K	1.52
LM310H	2.05
LM310N	1.33
LM311N	0.25
LM317HVK	5.50
LM317K	2.94
LM317T	0.62
LM317MP	0.67
LM319N	2.67
LM323K	3.15
LM324N	0.26
LM331N	2.94
LM337MP	0.94
LM339AN	1.25
LM339N	0.18
LM345K5.0	7.14
LM348N	0.71
LM358N	0.24
LM359N	1.35
LM360N	4.18
LM361N	2.40
LM377N	2.01
LM380N-16	0.90
LM380N8	0.90
LM383T	1.68
LM384N	1.78
LM386N1	0.67
LM3302N	0.76
LM3914N	2.30
LM3916N	2.00
LM748CH	0.26
LM318H	1.63
MC1408L	1.75
MC1408P	1.25
MC3357	1.02
MC3240	2.02
MC3423P	0.55
MC3441P	2.18
MC3446P	2.19
NE531N	0.97
NE544N	1.18
NE556N	0.44
NE558N	0.87
NE565N	0.69
NE570N	1.35
NE571N	1.18
NE572N	1.30
NE592N14	0.45
RC4558	0.33
SP0256AL2	3.75
SL490	[illegible]
[illegible]	[illegible]
TBA120S	[illegible]
TCM5089	[illegible]
TDA1072	[illegible]
TDA2002	[illegible]
TDA2004	[illegible]
TDA2030	[illegible]
TDA2006	[illegible]
TDA4500	[illegible]
TL071	[illegible]
TL072	[illegible]
TL074	[illegible]
TL081	[illegible]
TL082	[illegible]
[illegible]	[illegible]
ULN2803	[illegible]
Z80A CPU	[illegible]
Z80A CTC	[illegible]
Z80A DMA	[illegible]
Z80A PIO	[illegible]
Z80A SIO	[illegible]
ZN1034E	[illegible]
ZN1040E	[illegible]
ZN414N	[illegible]
ZN425E	[illegible]
ZN426E	[illegible]
ZN427E	[illegible]
ZN428E	[illegible]
ZN447N	[illegible]
ZN448E	[illegible]
ZN459E	4.20

LATEST ADDITIONS

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

VOLTAGE REGULATORS

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	0.26
[illegible]	0.26
7905	[illegible]
[illegible]	0.33
[illegible]	[illegible]
7915	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	0.17
[illegible]	0.17

DISCRETE DEVICES

BC107	0.06
BC108	0.06
BC109	0.06
[illegible]	0.30
[illegible]	0.09
[illegible]	0.02
[illegible]	0.03
[illegible]	0.05
BC184L	0.05
BC212	0.03
[illegible]	0.05
[illegible]	0.02
[illegible]	0.05
BC214L	0.06
BC237	0.03
BC238B	0.03
BC307	0.03
BC328	0.03
BC337	0.03
BC338	0.03
BC546	0.03
BC547C	0.03
BC548	0.02
BC549	0.03
BC550C	0.03
BC556	0.04
BC557	0.03
BC558	0.02
BC559	0.03
BC560B	0.03
TIC225M	0.42
TIC246D	1.16
TIP41A	0.24
2N706	0.14
2N3053	0.12
2N3819	0.19
2N5060	0.14
2N5061	0.15
2N5062	0.15
2N5064	0.16
2N2646	0.66
2N3704	0.06
2N3702	0.07
ZTX108	0.10
ZTX109	0.13
ZTX300	0.10
ZTX301	0.14
ZTX302	0.14
ZTX303	0.11
ZTX310	0.11
ZTX312	0.12
ZTX313	0.13
ZTX314	0.16
ZTX341	0.12
ZTX450	0.16
ZTX500	0.10
ZTX530	0.13
ZTX632	0.11
ZTX650	0.20
ZTX750	0.21
ZTX753	0.27
BD131	0.23
BD135	0.12
BD136	0.13
BD138	0.13
BD139	0.15
BCY71	0.19
BFX84	0.18
BFX85	0.38
BU806	0.60
BU807	0.55
C106D	0.22
MPSA06	0.09
MPSA13	0.09
MPSA42	0.12
MPSA64	0.14
TIC206D	0.35
TIC225D	0.42

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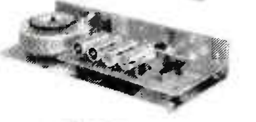

OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz-100KHz −3dB, Damping Factor 80. Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. −125dB. Size 300×123×60mm.
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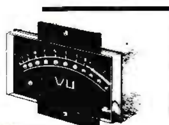
NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV). If required, PA version (50KHz bandwidth & Input Sensitivity 775mV) Order−Standard or P.A.



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Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens 101dB. PRICE £73.26+£4.00 P&P.
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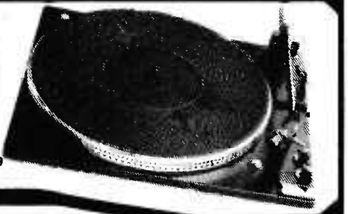

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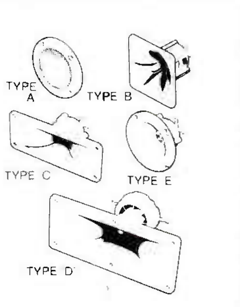

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