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Magenta's Catalogue has been carefully designed for Electronics Constructors. Product data and illustrations make the Magenta Catalogue an indispensable guide for the constructor. Catalogue includes ELECTRONIC COMPONENTS, HARDWARE, TOOLS, CASES, TEST EQUIPMENT. Details of advertised items and CIRCUIT IDEAS for you to build.

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An easy to follow book suitable for all ages, ideal for beginners. No Soldering. Uses an 'S Dec' breadboard. Gives clear instructions with lots of pictures. 16 projects—including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-Dec and the components for the projects.

Adventures With Electronics. £1·75.

Component Pack £16·72 less battery.

ADVENTURES WITH MICROELECTRONICS

Same style as above book; 11 projects based on integrated circuits—includes: dice, two-tone doorbell, electronic organ, MW/LW radio, reaction timer, etc. Component pack includes a Bimboard, 1 plug-in breadboard and the components for the projects.

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Ideal for beginners—learn the basics of computing from scratch, without spending a fortune. Kit is supplied with a comprehensive manual which describes construction, basic theory, initial use, machine code programming, hardware and troubleshooting. An appendix covers soldering and op codes. Kit uses the RCA COSMAC 1802μP. 256 bytes of memory, pcb + 20 switch keypad included. Requires a 5 or 6V 0·5A power supply—can be batteries.

EDUKIT, including manual: £40·98.

Kit includes socket for μP only—Set of IC sockets for support ICs: £2·81 extra.

Power Supply Kit—simple kit gives 5V 0·5A—includes case and circuit details: £7·98.

DOING IT DIGITALLY

A popular educational series for digital TTL circuits (7400 series). Appeared in E.E. in 12 parts—Oct. 78-Sept. 79. A "TTL Test Bed" is constructed and then used to perform the experiments in the series. Experiments include circuits for digital games, a light detector, a sound operated alarm, a moisture sensor, timers + a stopclock, binary/digital decoders, a dice, etc.

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KIT: £18·97. Headphones extra £3·28.

TEACH-IN-80

E.E. 12 part series. Oct '79–Sept '80. Covers the basics of electronics—lots of practical work. Circuits are built on a plug-in Eurobreadboard, which is built into a wooden console which houses the power supplies, speaker, meter, pots and LED indicators. The series uses a range of electronic components in the experimental work including a photocell, I.C.s, transistors etc.

Wooden Console (Tutor Deck) kit £5·98 extra, includes all the wood, glue, feet and strap handle.
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You've seen the reviews...you've heard the excitement...now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything!*

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, the world's most popular computer language for beginners and experts alike.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV...link it to an appropriate power source*...and you're ready to go.

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- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOADed on to a portable cassette recorder.)
- FREE course in BASIC programming and user manual.

Optional extras
- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately–see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available–see coupon).

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability–takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input-to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

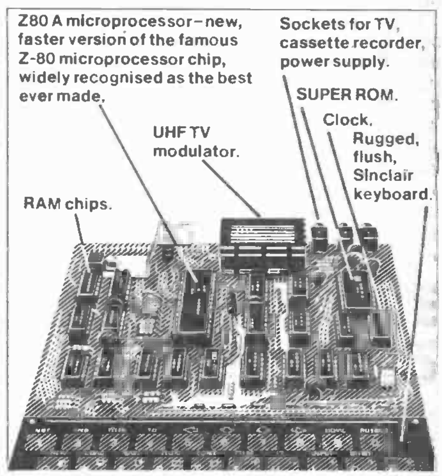
Fewer chips, compact design, volume production–more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer–typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



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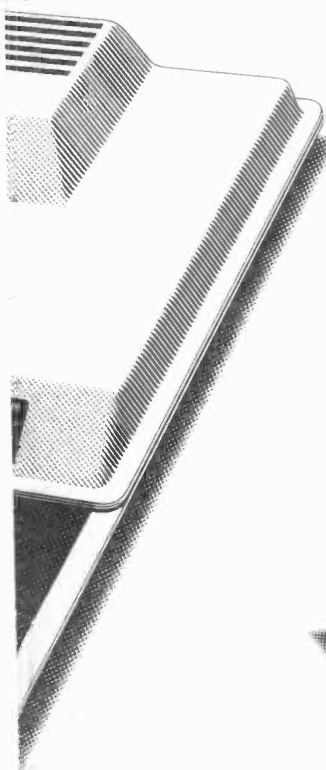

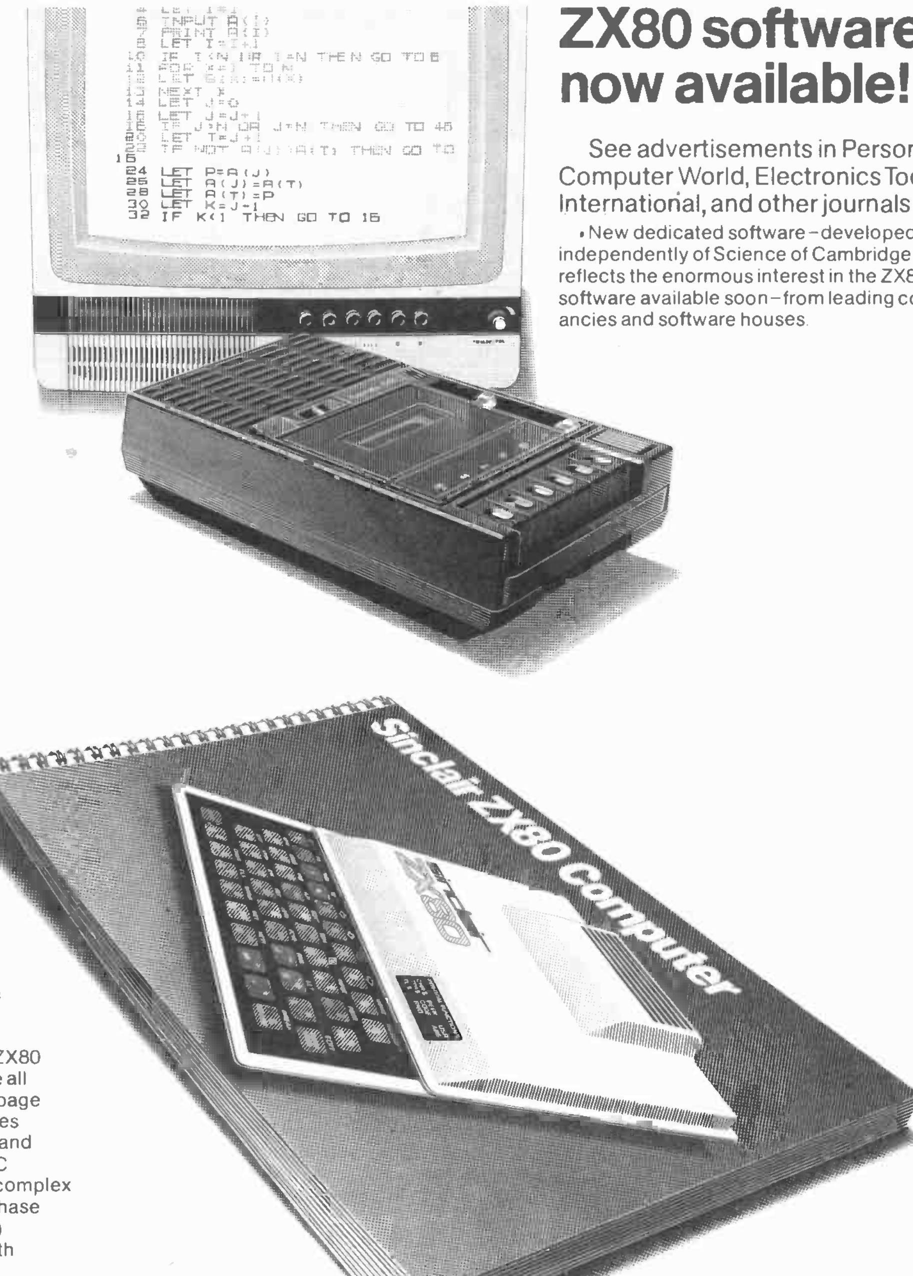

ZX80 software – now available!

See advertisements in Personal Computer World, Electronics Today International, and other journals.

• New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.

The Sinclair teach-yourself ɜASIC manual.

If the specifications of the Sinclair ZX80 nean little to you – don't worry. They're all ·xplained in the specially-written 128-page ɪook *free* with every kit! The book makes ɜarning easy, exciting and enjoyable, and epresents a complete course in BASIC ırogramming – from first principles to complex ırograms. (Available separately – purchase ırice refunded if you buy a ZX80 later.) ،hardware manual is also included with very kit.

The Sinclair ZX80. Kit: £79.95. ،ssembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't ·ait to have a ZX80 up and running? No roblem! It's also available, ready assembled nd complete with mains adaptor, for nly £99.95.

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NB. Your Sinclair ZX80 may qualify as a business expense.		**TOTAL**	£

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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
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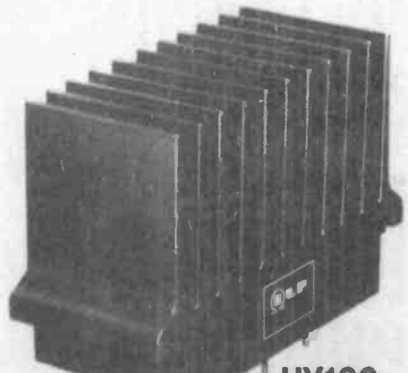
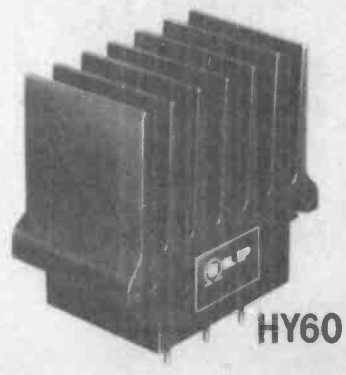
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15



HY120



HY60

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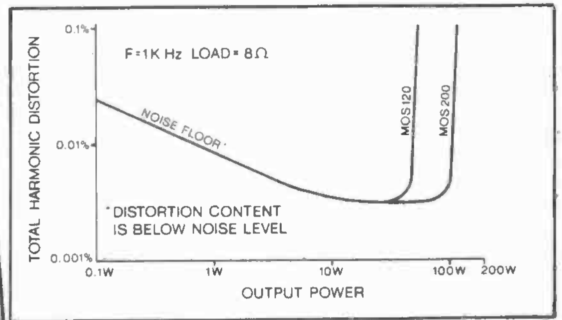
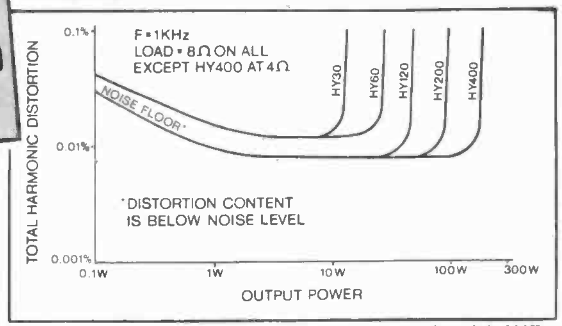
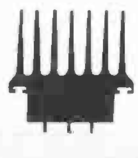


Load impedance both models 4Ω-∞ Input sensitivity both models 500mV. Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4Ω-∞ Input sensitivity all models 500mV. Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz - 3dB



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The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.

Projects... Theory...

and Popular Features...

Whatever else may be said about the consumer age, it has undeniably brought about a more comfortable and enjoyable life-style for most. The main impetus behind our materialistic society comes of course from electronics. This all pervading technology reveals itself in our homes in the more obvious forms like television sets and music centres, but has even wider influence through behind-the-scenes operations such as the calculating, measuring and controlling functions performed in factories, supermarkets, banks, transport, medicine... but there is hardly a single facet of modern life that is not dependent to some degree upon electronic wizardry to achieve what yesterday would have been miracles but today are perfectly ordinary happenings.

There is another side to this highly organised automated world that applied electronics is making for us. The human involvement is diminishing in many industrial and commercial operations. The workperson's role is being reduced to that of a video screen watcher and button pusher. At home relaxation and entertainment is derived increasingly from TV viewing. On the other hand video games provide a modicum of individual participation while the home computer offers infinite scope for intellectual exercise but is clearly for only a dedicated minority.

What is all too clear from today's scene is the importance of pastimes requiring exercise of personal skills to provide an active counterpart to passive entertainment. It is essential that the old or traditional handicrafts continue to flourish, no matter how far automation and the robots advance.

Amongst the long-established handicrafts we include electronics construction, for this pastime is as old as electronics itself. (The home construction of wireless sets was a booming amateur activity in the 1920s.) The constructor of today is in a very favoured position. The scope is greater than ever before, and miniaturisation of components has simplified building.

With the evenings now lengthening, thoughts naturally turn towards indoor pastimes. Those wishing to exercise their manual skills and at the same time acquire a basic understanding of the technology that plays such an important part in our lives couldn't do better than to take up electronic construction. It's fun and instructive, and the range of projects that can be built without difficulty or great expense is extensive and satisfies all tastes.

Fred Bennett.

Our December issue will be published on Friday, November 21. See page 719 for details.

Readers' Enquiries

We cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. All letters requiring a personal reply should be accompanied by a stamped self-addressed envelope.

We cannot undertake to engage in discussions on the telephone.

Component Supplies

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

Everyday ELECTRONICS

VOL. 9 NO. 10 NOVEMBER 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

FREE WITH THIS ISSUE MARSHALL'S COMPONENTS CATALOGUE

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Certain back issues* of EVERYDAY ELECTRONICS are available worldwide price 80p inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.
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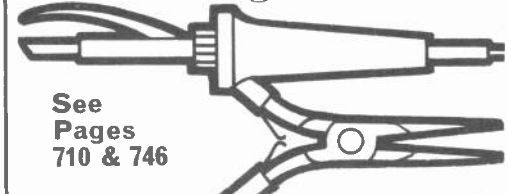
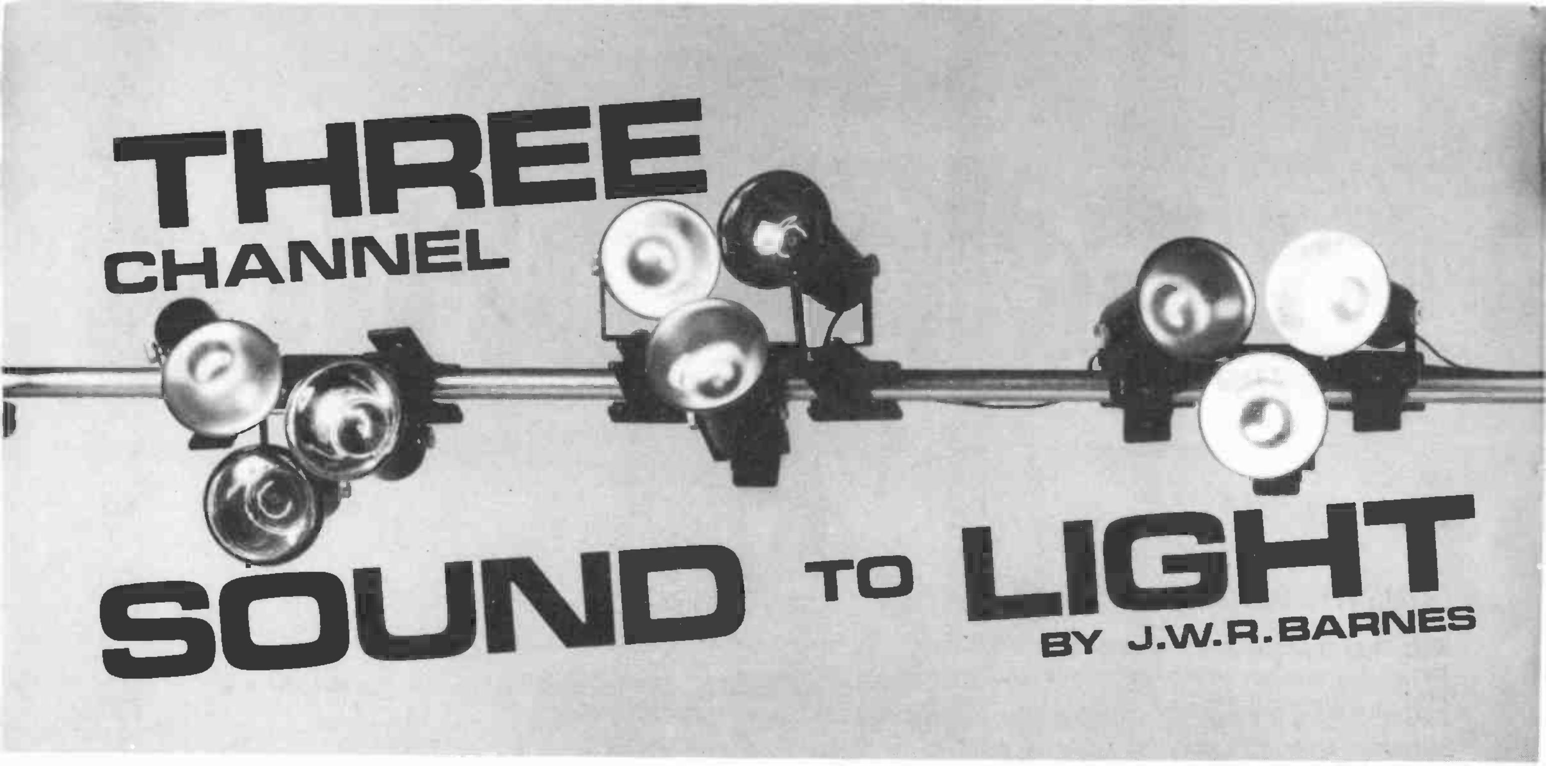
For Beginners



See Pages 710 & 746

Soldering & Tools



THREE CHANNEL SOUND TO LIGHT

BY J.W.R. BARNES

IN THESE post-Travolta days no disco is quite complete without its complement of flashing lights and special effects. The most common of these is the sound-to-light converter and despite its simplicity, the unit described here compares favourably with many other designs.

For those people unfamiliar with this kind of equipment, the principle of operation is quite simple. An audio signal is used to trigger an electronic switch which illuminates a light.

Usually the system is arranged such that only the loudest peaks trigger the light and quite often the audio spectrum is split up into bands using filters so that different frequency peaks trigger different lights. This is what has been done here.

CIRCUIT

The full circuit diagram of the sound-to-light unit is shown in Fig. 1 and can be seen to consist of six distinct sections: input isolator, low pass filter, bandpass filter, high pass filter, three identical power switches and mains rectification.

An audio signal is taken from one of the loudspeaker sockets on the amplifier and fed into SK1. The speaker is then connected up via SK2 thus avoiding the necessity for split leads.

SECONDARY

This audio signal is fed via the master level control VR1 to the primary of T1, which is in fact the intended secondary of this low voltage mains transformer. Besides providing the necessary isolation, it also offers some degree of voltage gain.

The "secondary" of T1 is fed to each of the three filters. The first one, a low pass filter, is made up of R1 and C2. As the frequency increases the reactance of C2 decreases. This results in the potential at the junction of R1 and C2 being progressively reduced with increasing frequency.

BANDPASS FILTER

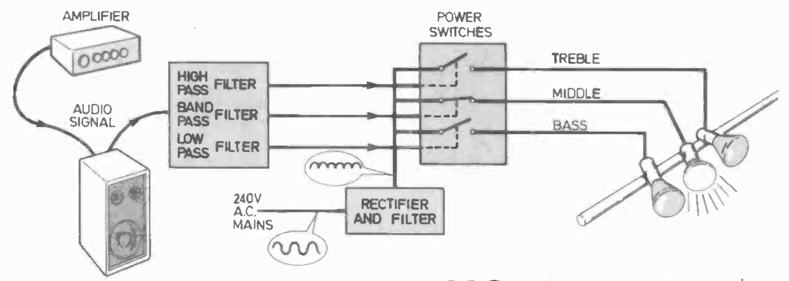
A bandpass filter is made up of R2, C3 and C4. As the frequency increases the reactance of C3 decreases allowing more current to flow into the network. This is counterbalanced by the shunting action of C4 and the combination of the two components gives the desired filter characteristic.

Finally C5 and R3 are used to provide a high pass filter. As the frequency increases, the reactance of C5 decreases thus allowing the top end of the frequency spectrum through.

The graph in Fig. 2 illustrates this clearly.

THYRISTORS

Each filter output is passed via a control potentiometer to the gate terminal of its respective thyristor. These are connected via a fuse to the main output socket.



HOW IT WORKS

The audio signal is fed into the unit. It passes through an isolating transformer and is then split up into three frequency bands using simple *RC* filters.

The voltage peaks in each frequency band trigger a thyristor switch which in turn illuminates a lamp.

The mains input to these lamps is passed through a rectifier and filter before going to the thyristors in order that they may fire on negative half cycles as well as positive ones, and not cause mains borne interference.

Since the trigger signal is not amplified in any way it is essential to use the thyristor type specified as other less sensitive types may not work in this circuit.

INTERFERENCE SUPRESSION

The actual mains power applied to the lamps is fed through a filter network (C1 and L1) and then through a diode bridge. The filter minimises interference passing back down the mains and the bridge is used so that the thyristors will fire on what would have been negative half cycles as well as positive ones.

As a further refinement each channel is provided with a monitor l.e.d. (D5 to D7), which indicates when its respective channel is live. This is a great help when setting up the system and enables the user to keep a continuous check on the performance of the unit.

View of completed unit showing front panel layout and lettering.

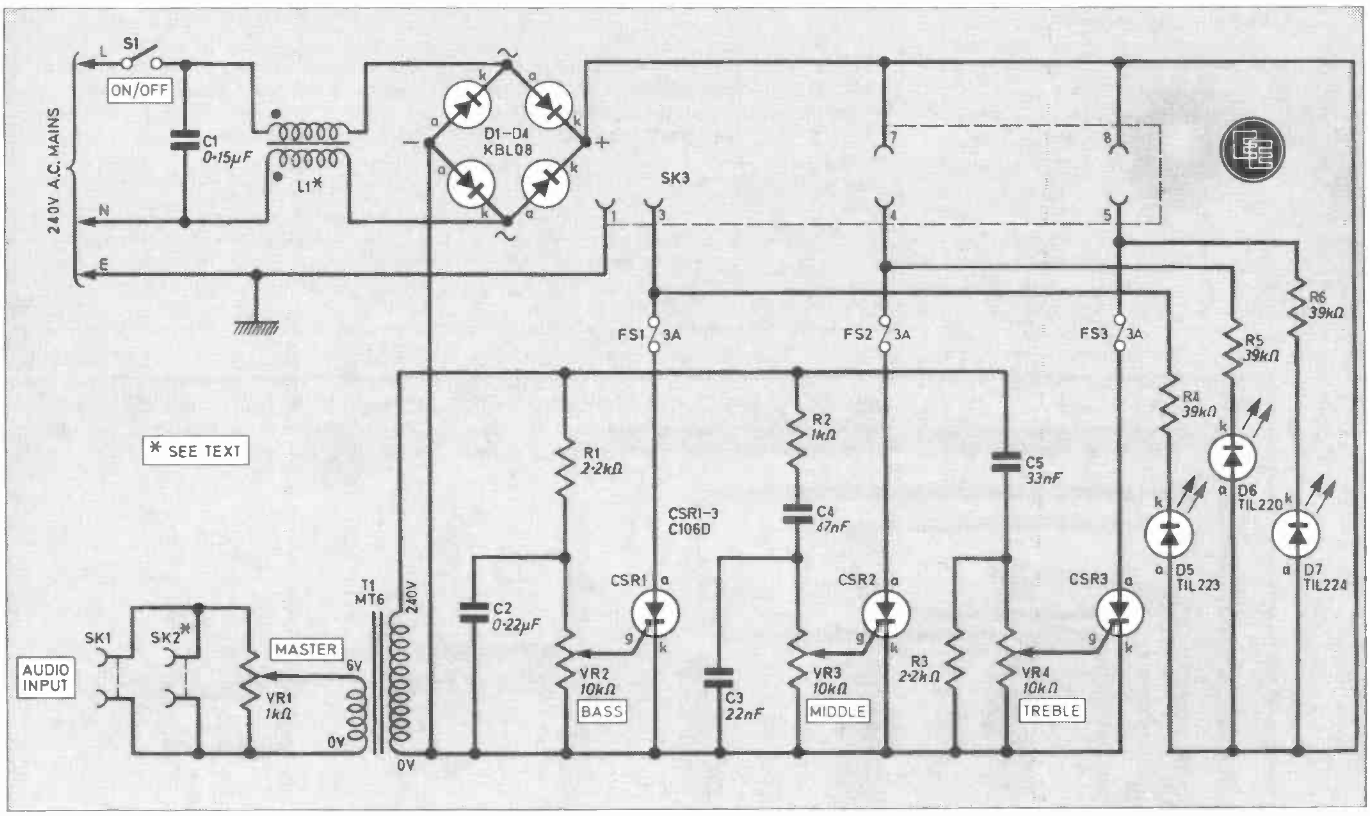
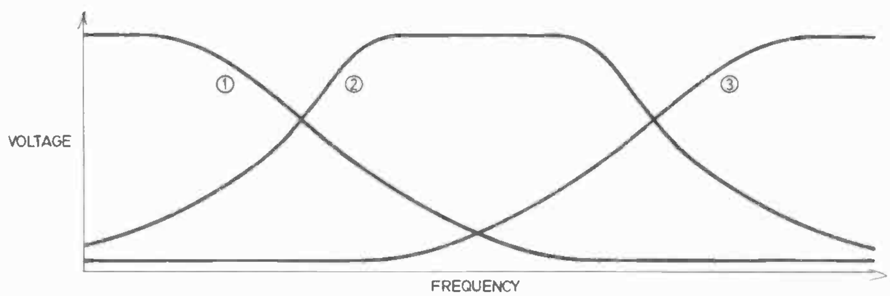


Fig. 1. (above) Full circuit diagram of the Three Channel Sound to Light.

Fig. 2. (right) Graph of output voltage plotted against frequency for the three filter stages in the unit. Curve 1 is the low pass filter, curve 2 is the band pass filter, and curve 3 is the high pass filter.



CONSTRUCTION starts here

CIRCUIT BOARD

Begin construction with the printed circuit board (p.c.b.). Although not essential a p.c.b. makes the final product more reliable and reduces the possibility of errors during construction. The foil pattern and component layout are shown in Figs. 3 and 4.

The filter inductor L1 is home made by winding two separate lengths of insulated connecting wire side by side in a "bifilar" fashion. In the prototype a toroidal ferrite core (Siemens type 29830) was used as a former and this was wound with 20 turns of the wire.

The components are then inserted in the board and soldered according to Fig. 4. The inductor L1 is fastened to the board with cable ties and the flying leads are connected into the circuit with Veropins at the appropriate locations. Note that the anode connections on the thyristors are made using the mounting tag rather than the middle pin. This makes the p.c.b. layout easier to design. The unwanted pin is simply snipped off.

COMPONENTS

Resistors

R1 2·2kΩ
R2 1kΩ
R3 2·2kΩ
R4-R6 39kΩ (3 off)
All ¼W carbon ±5%

Potentiometers

VR1 1kΩ lin. carbon miniature
VR2–VR4 10kΩ log. carbon miniature (3 off)

Capacitors

C1 0·15μF plastic 630V a.c. working
C2 0·22μF polyester type C280
C3 22nF polyester type C280
C4 47nF polyester type C280
C5 33nF polyester type C280

Semiconductors

D1–D4 400V 6A bridge rectifier type KBL08
D5 TIL223 or similar 0·2 inch green l.e.d.
D6 TIL220 or similar 0·2 inch red l.e.d.
D7 TIL224 or similar 0·2 inch yellow l.e.d.
CSR1-3 400V 4A thyristor type C106D (3 off)

Miscellaneous

T1 mains primary/6V 100mA secondary, Eagle MT6 or similar
S1 single-pole mains toggle 6A
L1 20 turns bifilar wound on ferrite torroid (see text)
SK1,2 two-pin DIN speaker socket (2 off)
SK3 Bulgin type P552 eight-way socket
PL1 Bulgin type P551 eight-way plug
FS1-3 3A 20mm cartridge fuses and p.c.b. mounting clips (two per fuse) (3 off)

Copper clad glass-fibre board for p.c.b. size 150 × 100mm; metal case, size 200 × 125 × 50mm, type PJ3 (Watford Electronics); ferrite ring, Siemens type 29830, 25mm diameter for L1; insulated 1/0·6mm connecting wire for L1; four-knobs; three-core mains cable; four-core mains cable for connecting light displays; 6BA nuts and bolts for mounting circuit board; 6mm plastic spacers (4 off); rubber feet (4 off); materials for lighting display; veropins.

See Shop Talk page 705

COMPONENTS approximate cost £16

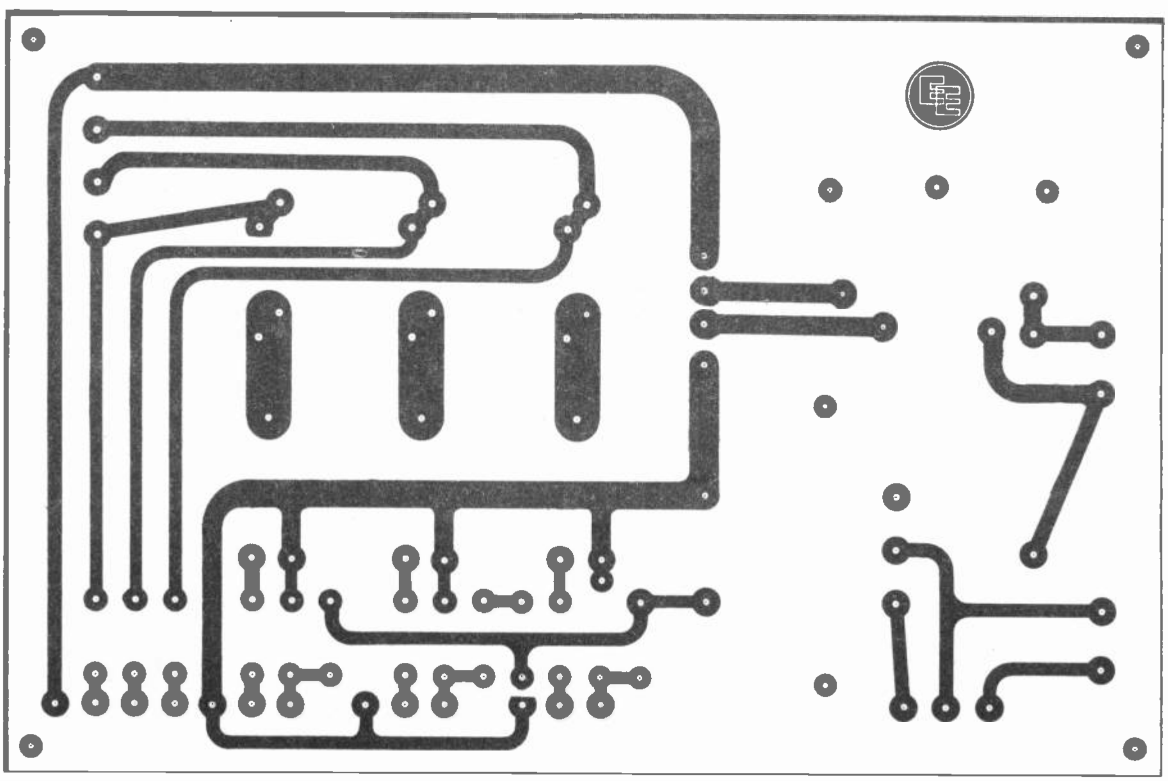


Fig. 3. The foil pattern for the p.c.b. This is reproduced full size.

THREE CHANNEL SOUND TO LIGHT

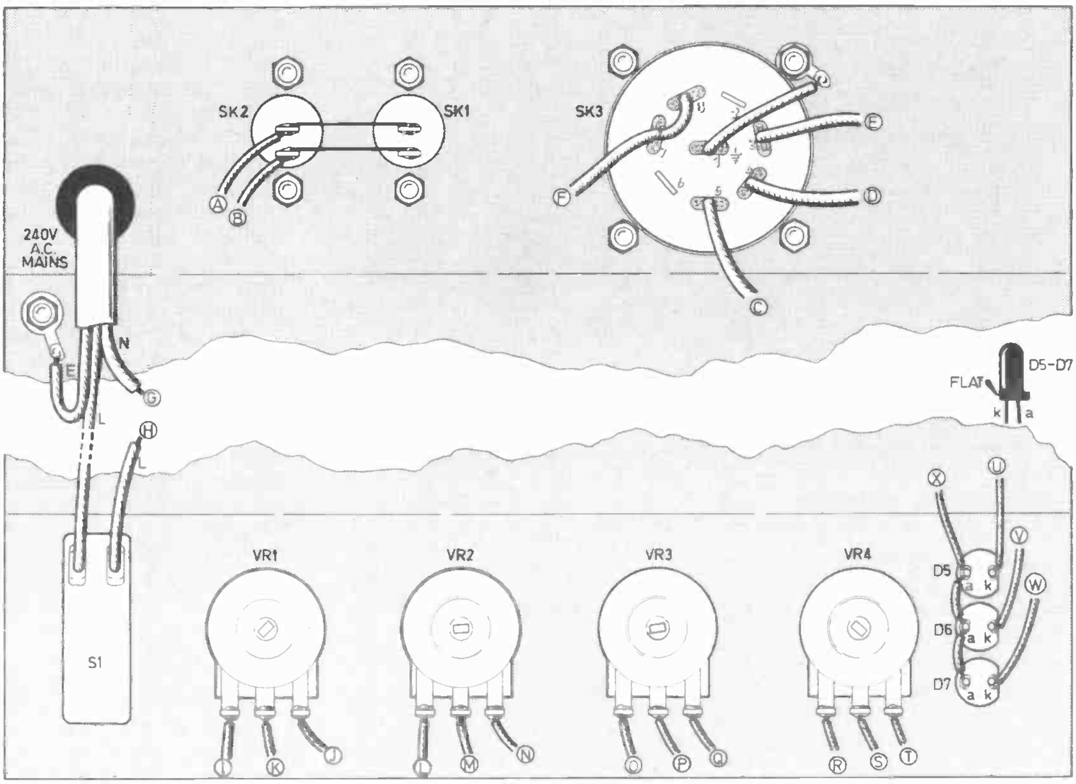


Fig. 4. Drawing above shows connections to off-board components. All mains wiring must be with 10A mains cable. Drawing below shows circuit board layout. Note that the anode connection to the thyristors is via the mounting tag. The centre pin connection has been snipped off.

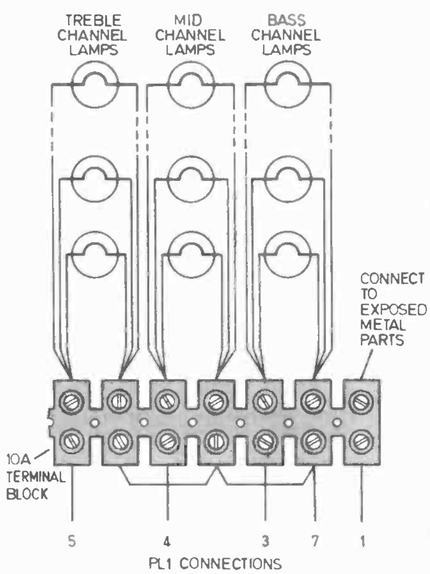
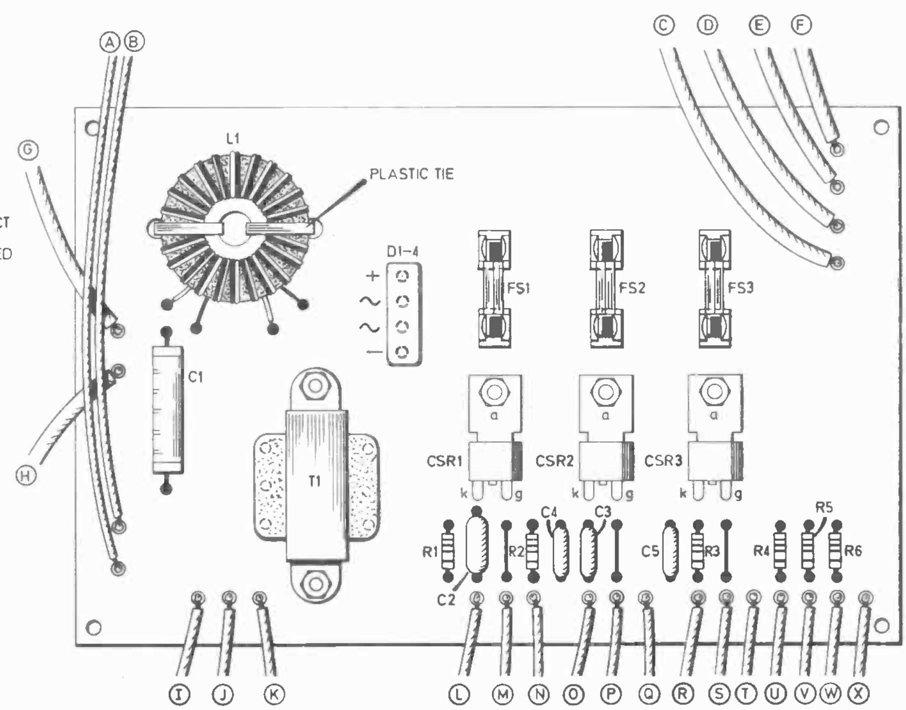
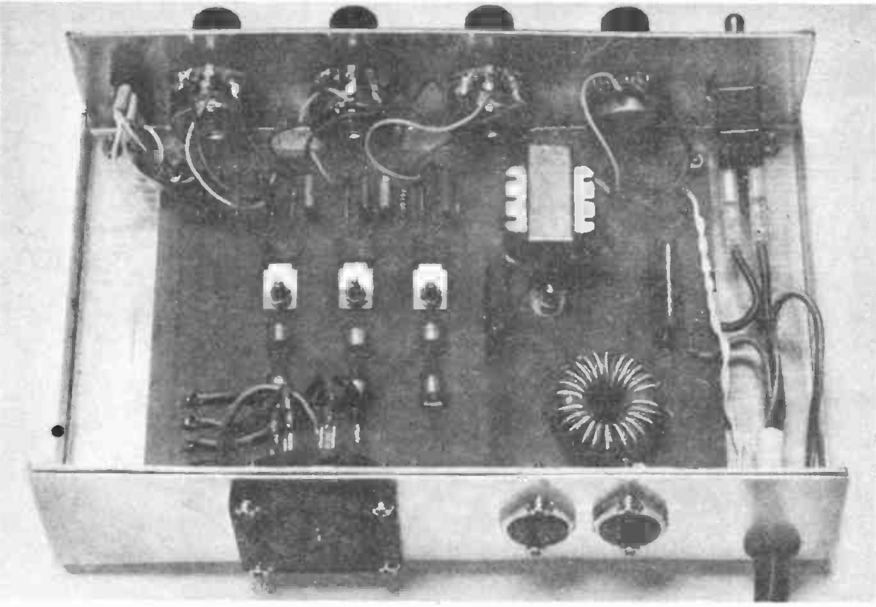
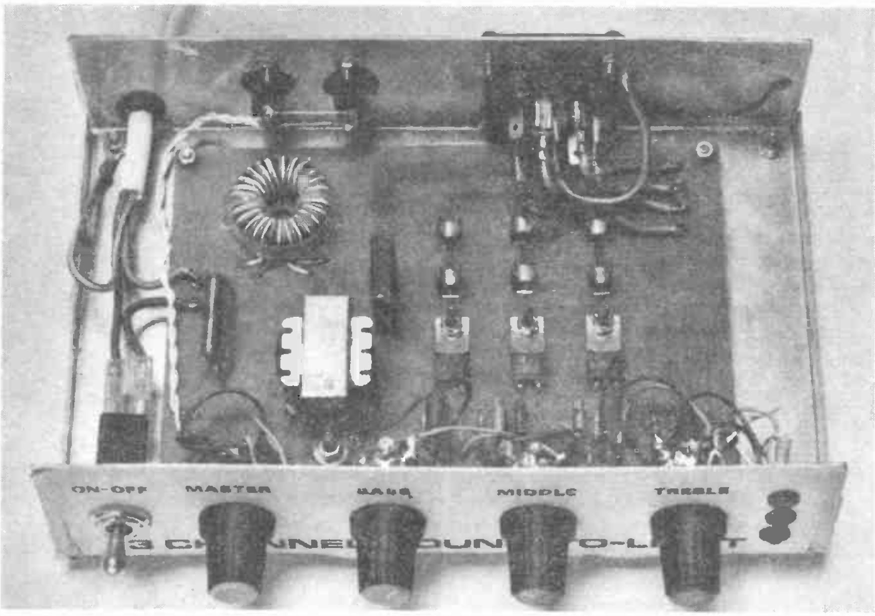


Fig. 5. One suggested wiring diagram for the display lamps. The terminal block must be housed in a protective plastic box or mounted inside the display housing.





The front panel mounted components wiring is shown above and below the wiring to SK3 and other rear panel mounted components can be seen.



THE CASE

Once the board is complete the next stage is to mark and drill the case to take the off-board mounted components. The prototype is housed in a metal case with detachable vinyl covered lid size 200 x 125 x 50mm.

The output socket to the lamps is a Bulgin type P552. This is strongly recommended as the output socket *must* have shrouded contacts and this is one of the very few multi-way sockets that satisfy this criterion.

A quick look at the circuit diagram will confirm that mains voltages are present on the output pins and so for this reason cheap substitutes such as terminal strips should *not* be used.

The large hole for SK2 can be made by drilling a series of smaller holes and finishing with a file.

FINISHING OFF

Before mounting the front panel components, the panel should be lettered, preferably using dry transfers such as Letraset. These components can then be fastened in position and wired up to the circuit board according to Fig. 4.

For safety ensure that the case is securely earthed and the p.c.b. is mounted on 6mm insulated pillars with a thick piece of card underneath.

DISPLAYS

No doubt constructors will be full of ideas when it comes to designing their own lighting displays, but certain points should be remembered.

First of all the sound-to-light unit is limited to a maximum rating of 500 watts per channel. Also remember that whatever bulbs are used they must be provided with adequate ventilation.

The 500 watts can be made up of a few large bulbs or a lot of small ones and you can use either home made light boxes or even the clip on spot light lamps which are very popular nowadays.

The diagram in Fig. 5 shows one method of wiring up the lights. If a light box has been constructed then this will most likely have been terminated with a four pin connector of some sort, that is, one common connection and a separate lead to each channel.

In fact it is safer to hard wire a four-core cable straight into the light box rather than fit a make-shift termination on the box. Four-way chassis mounting plugs are rare and a makeshift connection such as a four-way terminal block mounted on the outside of the box is quite unsuitable. Of course any exposed metal parts must also be earthed and this will involve running a fifth wire to PL1.

SPOTLIGHTS

Alternatively separate clip-on type spotlights may be used. In this case connecting up poses something of a problem and the easiest way of achieving this is to use a small plastic box with a terminal strip inside as a junction box.

The cables from each lamp are fed into the box and the necessary connections made at the terminal strip.

The four-way cable can then be attached to the terminal block and plugged into the unit in the usual way. Lamp fittings of this type are usually double insulated and do not need earthing.

TESTING

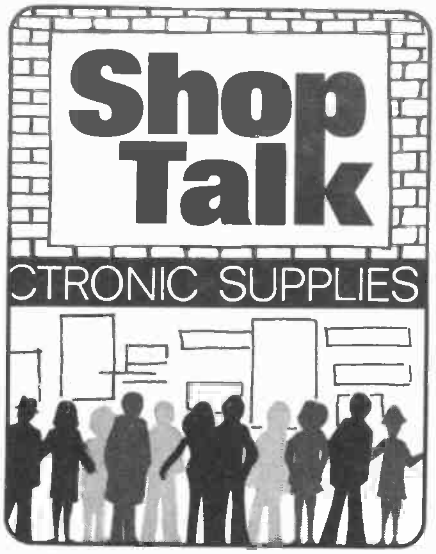
The sound-to-light converter should first be tested on its own without lamps being connected. Connect up an audio source and turn the unit on.

With some adjustment of the controls the monitor l.e.d.s should flash on and off in sympathy with the music. If this test is satisfactory, the unit can be tried with the lamps attached. Obviously some experimentation will be necessary with the controls to achieve the best results and each record may well require a slightly different setting.

Warning

One word of warning is necessary should you want to service the unit whilst it is running. The anode tags of the thyristors are all at mains potential as will be the connections to SK3.

Obvious precautions MUST be taken to ensure that accidents do not happen. ⌑



By Dave Barrington

It's A Gift

To help readers source components for our constructional projects we are always recommending that they should write-off for as many components catalogues as they can.

This month we take great pleasure in presenting Free (UK only) with this issue the latest edition of the well known Marshall's Components Catalogue. This is the result of an exclusive arrangement between this component supplier and EE.

Apart from the saving of 65p, we are sure readers will find this 60-page catalogue invaluable in tracking down some of those "hard-to-find" components. Marshall's catalogue contains a very extensive range of transistors and integrated circuits.

All-in-all their catalogue covers items for the beginner to the advanced experimenter and, we hope, will meet with the approval of all and be a welcome addition to the enthusiasts reference literature.

On the shop front

Readers in the London area will, no doubt welcome the opening of Maplin's new double-fronted shop at 259-261 King Street, Hammersmith, London, W6. The new shop stocks such items as complete organ and microprocessor kits down to the humble resistor and capacitor.

CONSTRUCTIONAL PROJECTS

Guitar Practice Amplifier

Standard components are used throughout the *Guitar Practice Amplifier* and no buying problems are envisaged.

The case used in this project is one of the all-steel "Pack Flat" cases manufactured by Perancea Ltd and available through Bi-Pak and Electrovalue. However, any case with similar dimensions may be used but the one specified was chosen for its robustness.

If headphone listening is to be incorporated then a standard stereo jack socket must be purchased and wired as indicated in the article.

Reaction Tester

Most components for the *Reaction Tester* should be readily available from most advertisers. The push button switches used in the prototype were printed circuit board mounting keyboard types with square shaped "button". These seem to be fairly expensive and only stocked by a few advertisers and we suggest that you use any of the generally available miniature push switches with mounting "collar". Also one of the Castelco table light switches could be used provided it was of the press to make (on) and release to break (off) type.

Three Channel Sound to Light

The only source of supply we have been able to locate for the ferrite ring for L1 in the *Three Channel Sound to Light Unit* is Electrovalue. The eight-pin plug and socket is stocked by Home Radio and Watford Electronics.

Note than an extra lead terminated with a loudspeaker DIN plug at each end is required to connect the unit to the speaker. The existing speaker lead from the amplifier is taken to the effects unit.

The lighting arrangement will obviously vary according to individual taste but we can stronly recommend the units shown on our cover which were kindly loaned to us by Maplin Electronic Supplies Ltd. Also a visit to one of the disco specialists who advertise would be well worth the trip for ideas on latest lighting units.

Transistor Tester

We cannot foresee any purchasing difficulties for the *Transistor Tester*. When obtaining the LM3900N integrated circuit be sure to specify the "N" as this denotes the package outline and although other 3900 types are suitable it would mean altering the wiring layout.

Precision Timer

The one per cent resistors called for in the *Precision Timer* are stocked by most of our advertisers and are important for accurate timing.

The case shown in the prototype unit was a "cast-off" type not generally available, however the one called for in the components list is more readily available.

Soil Moisture Monitor

No problems should be encountered in locating and purchasing components for the *Soil Moisture Monitor*.

Because of space limitations a miniature push switch *must* be used for S1.

in My Class

by T.R. de Vaux-Balbirnie

WE HAD been talking about resistors. The class had learned the Colour Code and had a working knowledge of Ohm's Law. James came along later with two resistors both marked BROWN BLACK RED, one large and one small. He could see that they were both 1 kilohm in value but could not understand the difference in physical size.

I told him that ordinary carbon resistors, like those he had brought, were made in several sizes according to their "wattage rating". I reminded him that, in use, a resistor will always give off heat—although in many cases this will be negligible.

Where excessive heat is produced there is a chance that a small resistor could overheat and change its value. It might crack and even split right down the middle. In a case like this a physically larger resistor would be needed. The bigger surface area would be able to dissipate the heat without the component overheating.

I went on to say that the heat produced each second is measured in watts. If I is the current flowing in the resistor in amps, R the value of the resistor in Ohms and V the voltage across it, then the watts (W) may be given by either one of two formulae:

$$W = I \times V$$

$$\text{or } W = I^2 \times R.$$

We looked at a few resistors and he saw that a $\frac{1}{2}$ watt component was quite small whereas a 1 watt and a 2 watt were much bigger. Manufacturers even make $\frac{1}{8}$ watt resistors but these are so small that they tend to be fragile. I told James that we only kept a few of these in stock to replace resistors in miniature equipment—they would not stand up to experimental work.

It is normal to use $\frac{1}{2}$ watt resistors in circuits even when a lower rating would do. Our large stock of $\frac{1}{2}$ watt resistors covers most situations.

Even larger ratings may be built up from $\frac{1}{2}$ watt resistors by connecting them in series or in parallel. For instance, a 1 watt 1 kilohm resistor could be made up (near enough) from either two 470 ohm resistors in series or two 2·2 kilohm resistors in parallel. The resistors need to be of equal values so that the heat is shared equally between them.

James nodded, smiled, picked up his resistors and went off to his next class.

GUITAR PRACTICE AMPLIFIER

BY E.M.LYNSELL

Most of the guitars used in pop groups now are of the solid electric variety. When played without an amplifier very little volume is produced. So when a musician wishes to practise at home for example, some sort of amplification is required. The choice is between the use of a second, acoustic guitar, needing no amplification, bringing the stage equipment into the house, or use a small guitar practice amplifier such as that described in this article.

Besides its intended use a small amplifier is an invaluable piece of equipment to have at hand in the workshop. It can also be used as a final stage in many of the radio designs published in EE that are usually intended for headphone or earpiece listening, allowing reception in a loudspeaker.

The amplifier is simple to construct and mains powered. It is capable of output powers up to about 3 watts into speakers of between 8 and 15 ohms.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Guitar Practice Amplifier is shown in Fig. 1.

The circuit requires a split d.c. power supply. This is derived from the a.c. mains which is applied via S1 across the primary of T1. This is stepped down by the action of T1 to produce 24V a.c. across the centre-tapped secondary winding. A bridge rectifier used in conjunction with a centre-tapped transformer provides two pulsating d.c. pulses of opposite polarity. Smoothing capacitors (C4 and C5) across each results in smooth d.c. levels of about +16V and −16V respectively, suitable for powering the audio section.

The audio section consists of two stages (i) preamplifier (ii) driver/current amplifier.

The preamplifier consists of IC1 having a constant gain set by the ratio (R2 + R3)/R2 which equals about times nine for the values chosen. The input impedance is fixed at 100 kilohms by R1 across the input which is at SK1 through d.c. blocking capacitor C1. The amplified signal appears across the volume control VR1 which is the signal source for the power stage consisting of IC2, TR1 and TR2 and local components.

Transistors TR1, TR2 are biased to the verge of conduction by the quiescent supply current to IC2 which is about 3mA. With no input signal, pin 6, IC2 sits at 0V and sees a load of 47 ohm (R8).

A voltage input at pin 2 is amplified by a factor of 10 causing pin 6

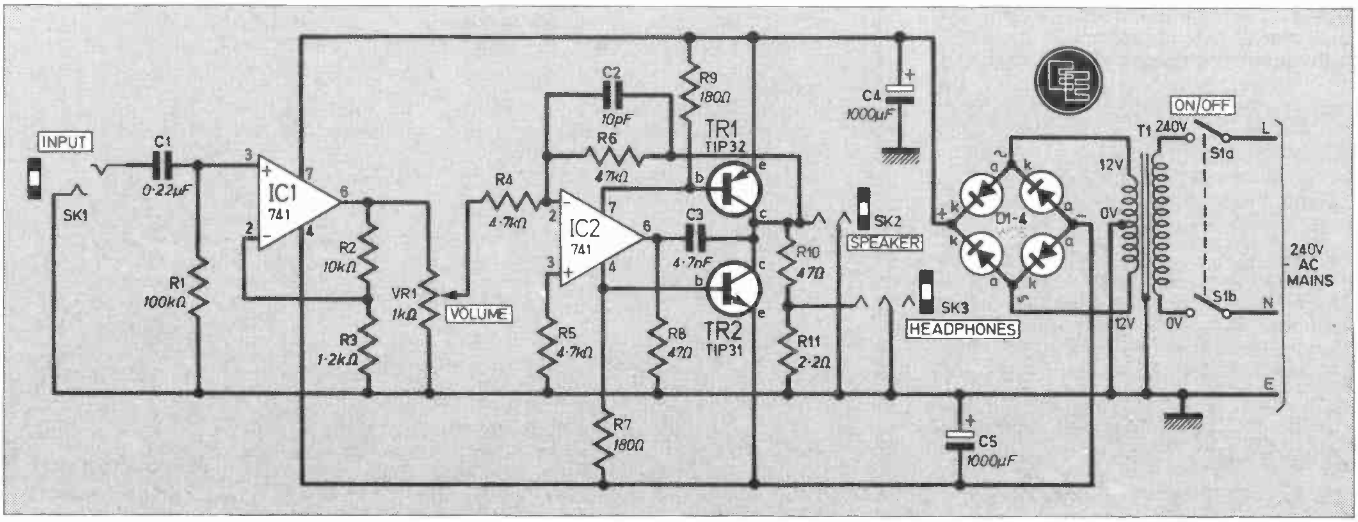


Fig. 1. Circuit diagram of the Guitar Practice Amplifier and its mains power supply.

to move away from 0V. This causes a current increase through R8 which is drawn from the supply rails via either R7 or R9. Consequently a higher voltage is dropped across either R7 or R9 which causes TR1 or TR2 to be biased or resulting in current flowing through the collector load connected to SK2. Thus small voltage variations presented to the input causes power to be developed in the loudspeaker in sympathy.

Although not included on the prototype, the circuit diagram contains details for fitting a socket to take a pair of stereo headphones in case "private" listening is desired.

SK3 is used for this facility. The output from the amplifier is loaded with the series combination of R10 and R11. This is used as a potential divider to limit the power available at the headphone socket to approximately 4·5 per cent of normal output level set by VR1. Thus for an output of 2 watts, approximately 100mW is available for the phones. Output impedance is a little over 2 ohms which allows 8 ohm phones to be used. The socket is wired so as to connect the two phone channels in series i.e. 16 ohms for 8 ohm phones. Higher impendance phones can also be used.

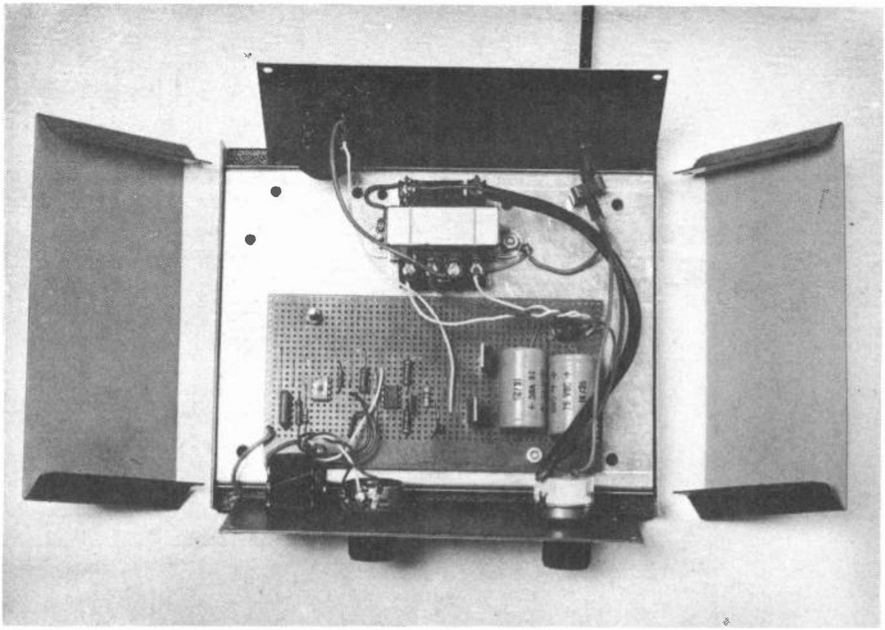
CONSTRUCTION starts here

CASE AND BOARD

The amplifier circuitry was housed in a black vinyl covered steel case type FP1B. This is a rugged case ideally suited to this application and helps make construction simple. All six panels are removeable exposing a formed aluminium chassis to which the circuit board is fitted with the transformer.

The circuit board consists of a piece of 0·1 inch matrix stripboard size 24 strips by 53 holes. This is fitted to the chassis by means of four 4BA fixings using a full nut as a spacer beneath the board at each fixing position. The layout of the components on the topside of the board and the breaks to be made on the underside are shown in Fig. 2.

Begin by drilling the chassis to suit the transformer and board fixings and then make the breaks on the underside of the board. Drill the front and rear panels as indicated and secure the components in place. Fit the transformer including the solder tags under the fixings.



POWER SUPPLY

Assemble only the power supply components on the board, D1 to D4, C4 and C5 and link wires. With the board fitted in place wire up the power supply section according to Fig. 2 and check that the power supply section is working before proceeding. Readings in the order of +16V and −16V should be obtained across C4 and C5 respectively. If all is well the remainder of the components may be assembled and wired up as shown in Fig. 2. If an 8 ohm speaker is to be used small heatsinks may be necessary for TR1 and TR2. Details of these are seen in Fig. 3. These were not fitted to the prototype since operation with a 15 ohm speaker was planned.

The specified transistors have their collectors internally connected to their metal mounting tabs but no mica washers or insulating bushes are necessary unless the heatsinks are likely to, or made to be in contact with the chassis or case, then these insulation sets are imperative.

Thoroughly check out your wiring before testing.

COMPONENTS

Resistors

R1	100kΩ	R4	4·7kΩ	R8	47Ω
R2	10kΩ	R5	4·7kΩ	R9	180Ω
R3	1·2kΩ	R6	47kΩ	R10	47Ω
All ¼W carbon ±5%		R7	180Ω	R11	2·2Ω

Capacitors

C1 0·22µF polyester
C2 10pF plastic or ceramic
C3 4·7nF plastic or ceramic
C4,5 1000µF 16V elect. (2 off)

Semiconductors

D1-D4 50V 1A bridge rectifier type W005
TR1 TIP32 silicon *pnp*
TR2 TIP 31 silicon *npn*
IC1,2 741 differential op-amp 8-pin d.i.l. (2 off)

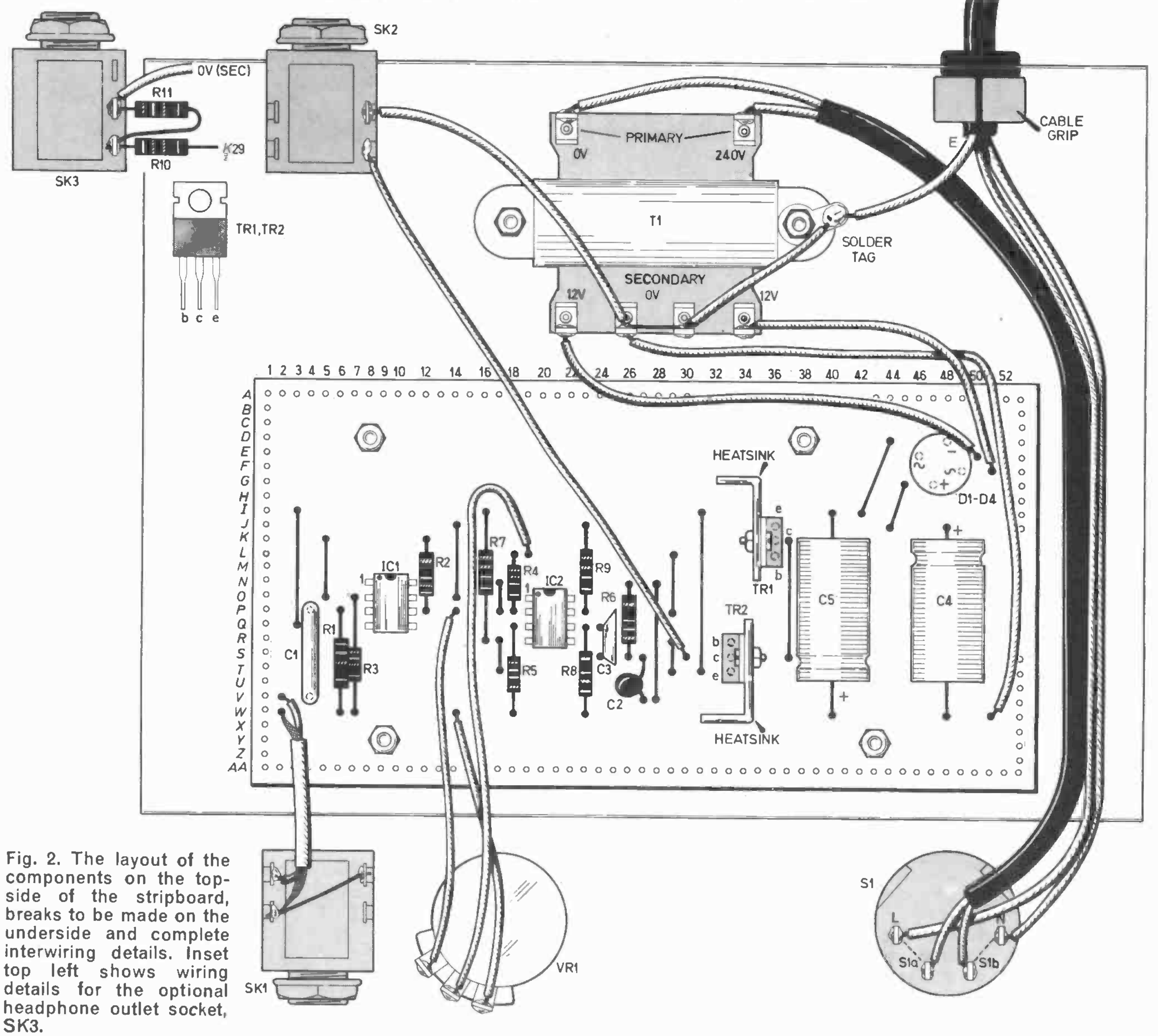
Miscellaneous

VR1 1kΩ carbon lin. shafted type
S1 d.p.d.t. mains rotary switch
SK1,2 standard jack sockets (2 off)
SK3 stereo jack socket (optional, see text)
T1 mains primary/12-0-12V 500mA secondary
Stripboard: 0·1in. matrix 24 strips × 53 holes; control knobs (2 off); mains cable; cable grommet; case type FP1B or similar; 4BA fixings and solder tags; aluminium for heatsink size 40 × 25 × 2mm (2 off).

COMPONENTS approximate cost £7·50 excluding case

See Shop Talk page 705

GUITAR PRACTICE AMPLIFIER



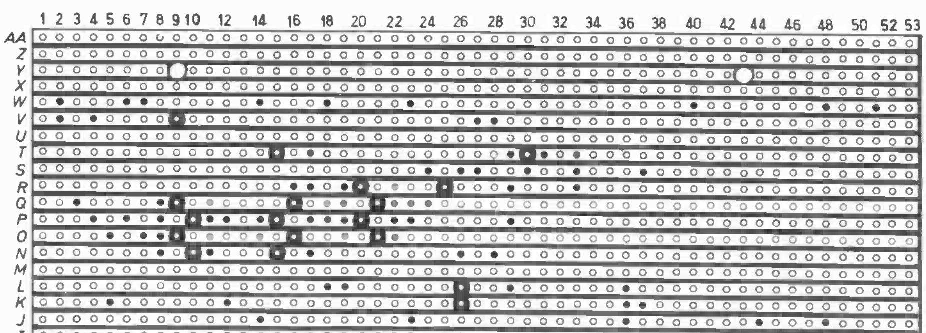


Fig. 2. The layout of the components on the top-side of the stripboard, breaks to be made on the underside and complete interwiring details. Inset top left shows wiring details for the optional headphone outlet socket, SK3.

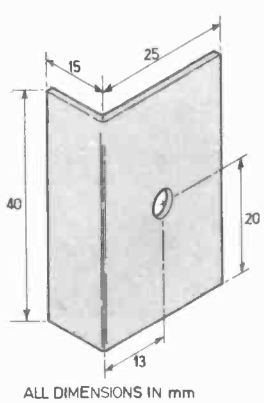
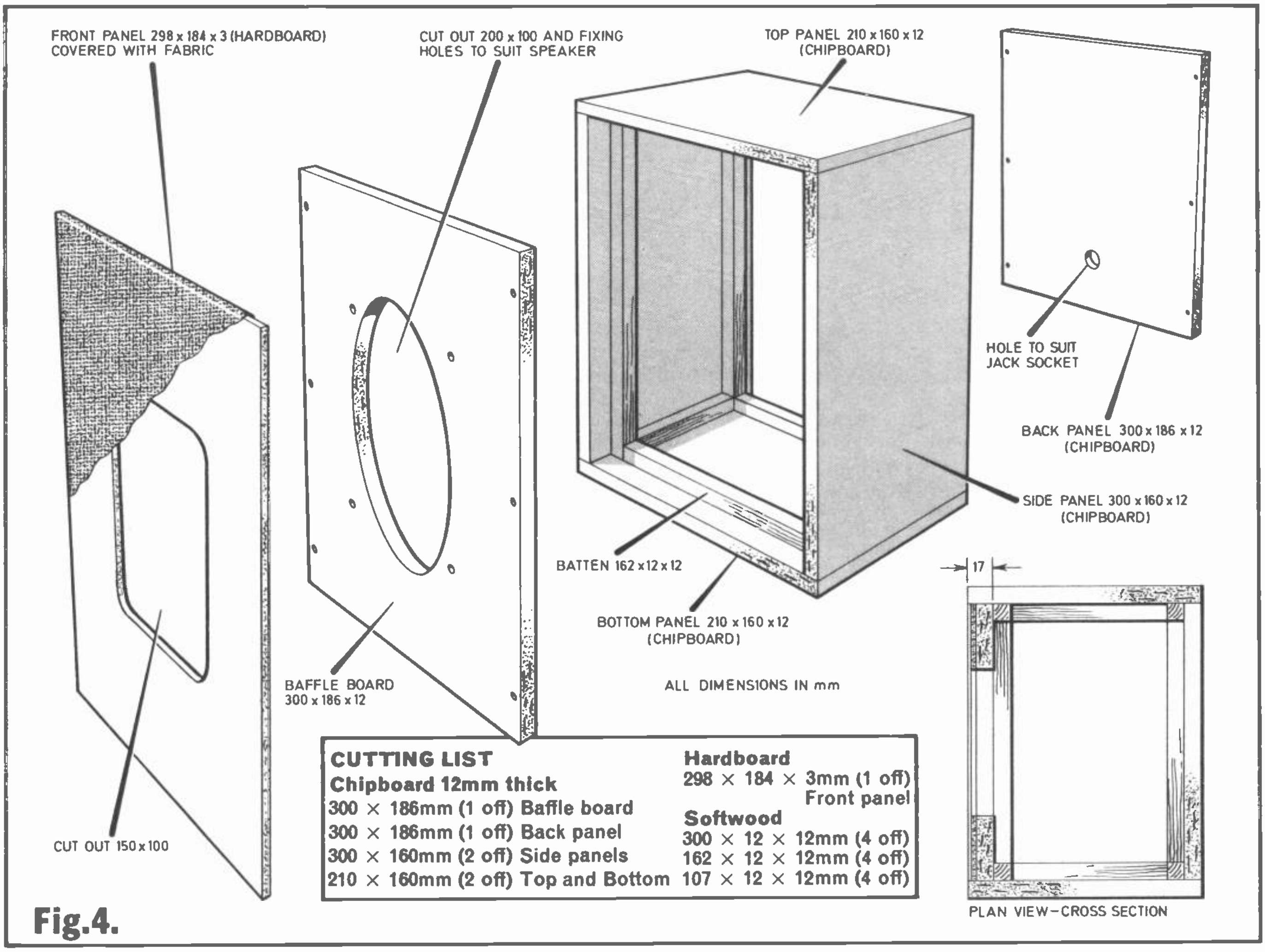


Fig. 3. Details for heatsink construction.



CUTTING LIST

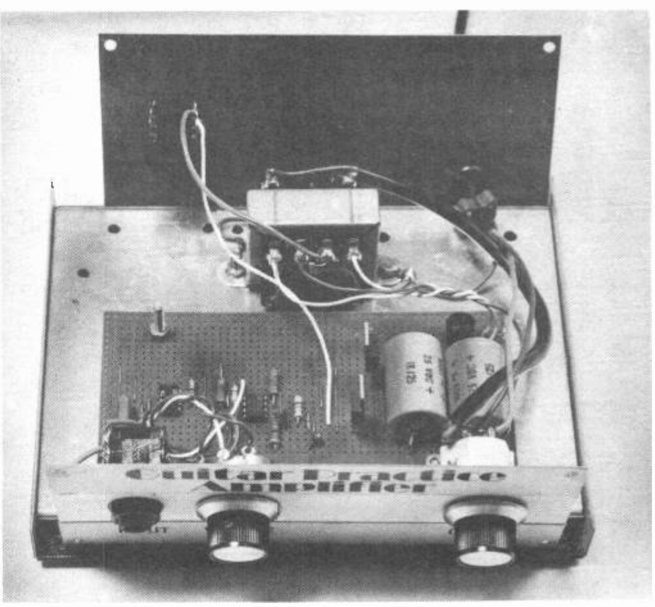
Chipboard 12mm thick	Hardboard
300 × 186mm (1 off) Baffle board	298 × 184 × 3mm (1 off) Front panel
300 × 186mm (1 off) Back panel	**Softwood**
300 × 160mm (2 off) Side panels	300 × 12 × 12mm (4 off)
	162 × 12 × 12mm (4 off)
210 × 160mm (2 off) Top and Bottom	107 × 12 × 12mm (4 off)

Fig.4.

TESTING AND USE

Do not connect a speaker at this stage. Before switching on check that there is not a short across the two connections on the output jack socket.

Place a voltmeter set to 20 volts d.c. across the output socket. Before plugging into the mains and switching on remember that mains voltages are exposed so great care should be taken not to touch these points which could be lethal. After turn on, the voltage should be close to, if not equal to, 0V. Reduce the voltmeter range to make sure that the output reads very close to 0V. If not, turn off and investigate for errors or faulty components.



If all is well so far, connect a speaker by means of a jack plug into SK2, leaving the meter probes connected. Turn on again to ensure the reading is still 0V.

Plug in a guitar at SK1 and check that clockwise rotation of VR1 increases the volume heard. If so, the assembly of the case can be completed and the unit is ready for use.

Letraset may be used to label the controls and rubber feet fitted to the base to enhance the appearance and afford protection to its mounting surface.

Any suitably rated loudspeaker may be used. Better performance will be achieved if the speaker is mounted in a cabinet. Construction details for a suitable speaker enclosure to suit a 6 × 4 inch elliptical speaker are shown in Fig. 4.

Alternatively a hi fi bookshelf speaker/enclosure may be used. Also good results were obtained using wedge-shaped shelf speakers intended for use with in-car entertainment. These are usually black with silver trim and would match the case.

One final point, always have the amplifier switched off when inserting and removing the speaker jack plug to avoid the possibility of an output short circuit which is possible when a jack plug is being removed from its socket.

SQUARE one FOR BEGINNERS

THE ART OF SOLDERING

IT IS seldom if ever necessary to understand the operation of an electronic circuit in any of our "Constructional Projects" to produce a satisfactory working model. What is required is only the ability to follow the plans provided and to be able to "make a good soldered connection". This last point cannot be overstressed.

Some joints may appear to be made, being mechanically rigid, but electrically these are not connected and will be equivalent to an open circuit or a high value resistor between the two points. This is known as a "dry joint".

IRON AND SOLDER

If you are a newcomer to the hobby, then you will need to buy a soldering iron. A mains type is recommended that has a power rating of between 15 and 25 watts. The iron should come complete with a removeable bit of size between 1 and 3mm diameter.

The type of solder suitable for electronic construction is known as Multicore solder and has flux/resin cores throughout its length. This is available on reels and in dispensers, the latter being more modestly priced, although the reels are more economical on a cost per cm basis. On no account should any other type of solder be used.

Newcomers are advised to learn the art of soldering with scraps of circuit board and old components, and not plunge in straight away on a project board.

TINNED LEADS

Both surfaces to be joined should ideally be tinned for best results and ease. This is accomplished by heating the lead/wire/tag or whatever via the bit, and melting solder onto the two touching surfaces so that it flows evenly over the combination. When this happens, remove the solder followed by the iron.

Most component "connectors" are tinned during manufacture and therefore do not require tinning before soldering. However, this tinning does become contaminated during its life and should this be the case, this must be removed prior to soldering. This is easily carried out with a small piece of emery cloth, and later tinned as described above. A damp sponge should be at hand to occasionally "wipe" the bit during use to remove any excess solder, oxidised flux and any other matter that may have accumulated there.

COMPONENT BOARD

When soldering a component to a circuit board, the cleaned/tinned component lead should be snipped off about 2mm above the surface it is to connect to and the lead bent (except in the case of i.c.s) so as to be in contact with the surface. Bending the leads in different directions will hold the component steady in the board when the latter is turned over for soldering. This also forms a semi-mechanical joint for added strength.

The tinned bit should be placed in contact with both surfaces to be joined and solder applied to the joint —not the bit! When the solder is seen to flow, remove the solder followed by the iron, and allow the joint to cool without disturbance. A distinct texture change will be observed as the solder solidifies.

A mechanical joint is recommended when joining lead to tag or lead to lead. A pair of long-nose pliers are used to form a hook at the lead(s) end(s) and then one hooked over the other (or a tag) and then squeezed to lock the two together. The iron is applied to heat the joint and solder applied as described above.

GOOD AND BAD JOINTS

A good joint is easily recognised by its shiny smooth appearance. A bad or dry joint will appear to be dull and ragged. This is produced when insufficient heat has been applied to the joint, and/or the surfaces have moved during the solder setting time or were not clean prior to soldering.

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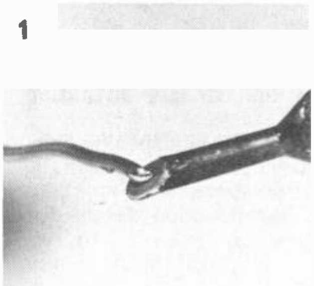

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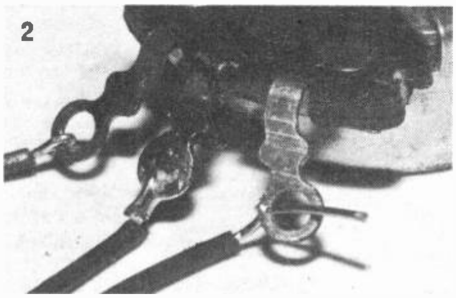

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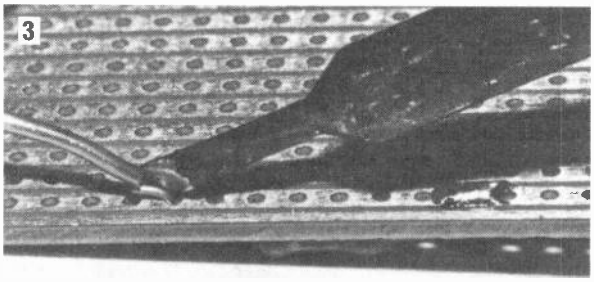

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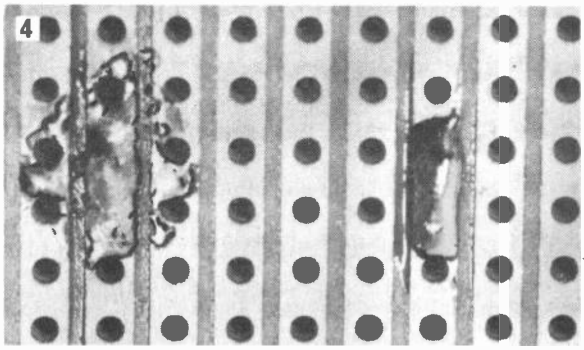

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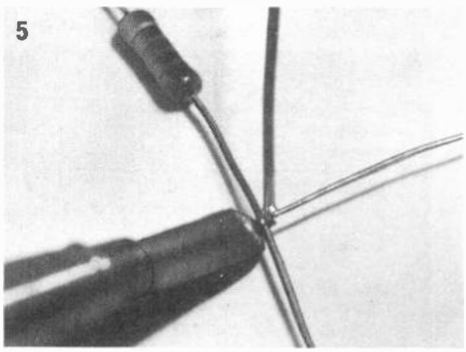
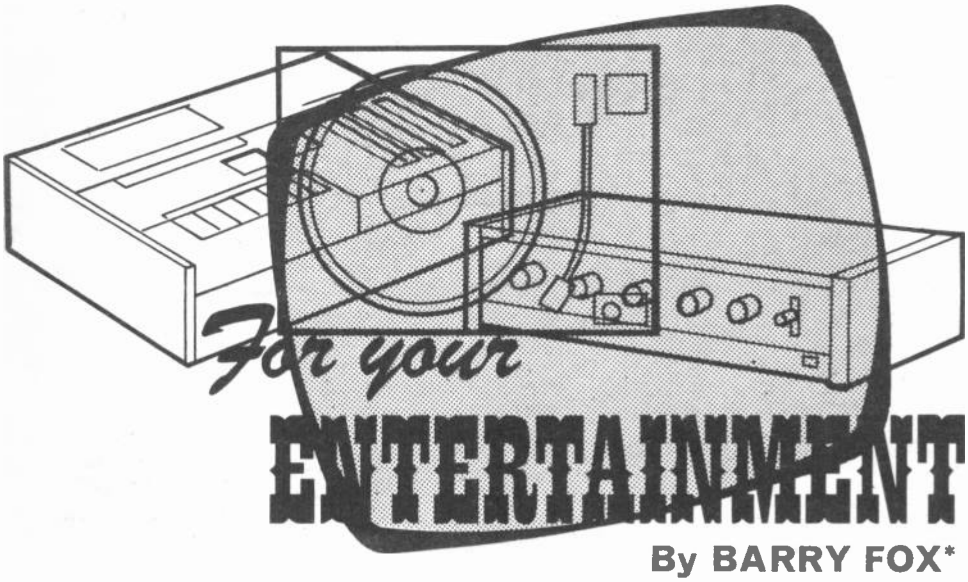


1. Tinning the iron.
2. Soldering wire to metal tags.
3. Soldering component to circuit board.
4. Messy dry joint on the left, good neat joint on the right.
5. Soldering one wire to another.



For your ENTERTAINMENT

By BARRY FOX*

Natural Selection

It's fascinating to stay on the touch lines and watch the once-booming hi-fi industry undergoing the process of natural selection, almost exactly as explained by Charles Darwin. Just as animals—like the Dinosaur—which fail to adapt to a changing environment become extinct, so hi fi firms which fail to move with the times must expect to go out of business.

The changing face of the annual hi fi exhibition at Harrogate in Yorkshire says it all. Ten years ago the Harrogate exhibition occupied a few rooms in just one Harrogate hotel where a few specialist hi fi firms proudly showed off their wares. As the hi fi trade boomed the exhibition got larger and larger.

This year five hotels, an exhibition centre and marquee extension are needed to house all the exhibitors. With a bit of luck the giant new Exhibition Centre now being built in Harrogate (running over a year behind schedule and costing many millions of pounds more than anticipated) will be finished in time for next year's Autumn show.

But wherever next year's exhibition is staged, one thing is certain. It won't be a hi fi show any more; it will be an all electronics extravaganza. The reason is very simple. Hi fi, video, digital audio, and TV game technology are now all competing on the same commercial front, which is probably best summed up as—"home electronic entertainment".

Buy British

No one knows this better than the Federation of British Audio, the trade body (now a part of BREMA) which tries to put over the message that it makes good consumer sense to buy British hi fi. Although the FBA is not a new organisation it has been in half-hearted limbo for the last few years and is only now making a concerted effort to spread the buy-British message.

Very sensibly the FBA has now restricted membership to those British firms who actually *manufacture*. In the past firms which simply import foreign made products have been able to boast FBA membership. It had been claimed in some quarters that the obvious anomaly, whereby a member of the Federation of British Audio sells Japanese-made equipment had tended to undermine the Association's credibility.

Sad state

It is no secret that the hi fi trade is in a sad state. Although many firms put on a brave face, for instance exhibiting lavishly at Harrogate, only the largest Japanese giants are cushioned against the current recession.

Manufacturers and dealers alike are suffering from cash flow problems. These were most honestly summed up by Jon Soyka, who for several years now has sold super high fidelity recordings, e.g. direct cut and digital, to the hi fi trade and public first as Quadramail and then as Sonic Masters. Soyka is now quitting England for his native Canada.

He is frank, and happy to be quoted on his experience of selling super high fidelity discs, often at £10 each. "I do a roaring trade direct with the public at exhibitions like Harrogate" he says "and I've only lost a few hundred pounds on bad debts in five years of trading. But dealers now have such a cash flow problem that in August I am still waiting for some dealers to settle their bills for discs I've supplied to them back in January. I can no longer afford to play banker for the British hi fi trade."

Serious Listeners

The FBA took Harrogate as an opportunity to put across some interesting points of view.

The Federation of British Audio believes that the UK hi fi trade has made a serious mistake in failing to recognise that their falling sales are merely symptomatic of the overall recession.

There is more and more competition now for the fewer spare pounds which the consumer has to spend on "home entertainment" equipment. Anyone lucky enough to have 500 or 600 spare pounds sterling will spend them on a video recorder before replacing an existing hi fi which works perfectly well.

Only a very few large electronics companies are still sticking solely with audio and hi fi production. Sony, JVC, Philips, Grundig, Sharp, Mitsubishi, Toshiba, Akai, Sanyo and Hitachi are all now heavily into video production as well as audio.

Even Pioneer, previously an audio-only company, is making and selling laser-based video disc players in the USA. Thorn (now Thorn-EMI) in the UK is of course heavily committed to video, albeit still only with the sale of VHS equipment manufactured for them by JVC in Japan.

The FBA is recommending that its members (all relatively small hi fi firms) adopt the quite different approach of staying well clear of the video-based revolution. The FBA estimate that there will always be a market share of around 5 or 10 per cent made up from people who are serious about listening to music and do not want it to be accompanied by video pictures or tricked up with exotic gadgetry.

This band of "serious listeners" will generally be prepared to pay a reasonable price for a quality product. What's more many of them actively try and avoid the virtually identical (in terms of price, looks and performance) equipment which is now being mass produced by all the large Japanese companies.

"The serious listener is a long term customer" says the FBA, "You can get too old for hobbies like wind surfing, but can never get to old for listening to music at home."

The most likely casualties in the hi fi market place will be those manufacturers and dealers who cling to the belief that there is still room for the mass production of almost identical equipment and mass sales of this year's new model to customers who already own last year's.

New Show

Quite independently of the FBA's comments at Harrogate, the exhibition organisers were already talking about retitling the show to give the public a clear idea of what a wide range of electronic equipment they can expect to see.

"I can remember when we were only allowed to show genuine hi fi" said one exhibitor with a trace of nostalga. He had found himself surrounded by video-discs, video recorders, Space Invader TV games, go-go dancers, mock-up motor cars, raffles, competitions and brochure-distributing hostesses employed for their beauty rather than their knowledge or interest in the products on display.

A long established exhibition like Harrogate cannot afford to get smaller. But, who knows, perhaps in a few years time when the Harrogate Home Electronics Show (or whatever title is chosen) has become established in the new giant exhibition centre, we may see a completely fresh new show. This will be aimed at the five or ten per cent serious music listeners who the FBA sees as a life-line for what by then remains of the UK hi fi industry.

**Barry Fox is the true name of the author of this regular feature. Barry is contributor to numerous specialist magazines and past Audio Writer of the Year. He has now decided to abandon his nom de plume of Adrian Hope and will in future write under his true name.*

NEW SERIES

I.C.s EXPLAINED PART 2

OP-AMPS AND AUDIO AMPS

by J.B. DANCE M.Sc.

LAST month we considered the basic operational amplifier circuits using the 741 and 709 devices. We will now look at further devices and practical circuits in which they can be used.

OTHER OP-AMPS

Quite a number of op-amps are similar to the 741. For example, the 747 is a dual device in a 14-pin dual-in-line package, each of the two amplifiers being similar to a 741. The 1458 and 1558 devices contain two amplifiers similar to a 741 in an 8-pin dual-in-line package, but there are not enough connecting pins to permit offset null connections.

In some applications the internal frequency compensation incorporated into the 741 is unsuitable. One may then select a 748 device which incorporates the advantages of the 741, but requires external frequency compensating components. The MC1437P is a device rather like the 709, but contains two amplifiers in a 14-pin dual-in-line package.

The LM358 devices and the CA324 devices are respectively dual 8-pin and quad 14-pin op-amps which have been specifically designed to operate from a single power supply over the wide supply range of 3V to 30V. Unlike most other devices, they will operate satisfactorily when the input voltage falls to the potential of the negative supply line. They will also operate from balanced supplies.

BIFET AND BIMOS

One of the disadvantages of the op-amps already discussed is that they require some input current, although this input current is usually in the nanoamp (one thousandth of a microamp) region. In circuits where such an input current is unacceptable, one may select one of the types of operational amplifier which employ field effect transistors in their input stages. Two main types of f.e.t. input op-amps are available at economical prices. Bifet devices employ junction f.e.t. input devices, whereas BIMOS amplifiers use MOSFET input devices. BIMOS devices tend to have the higher input impedance, but some BIFET products have characteristics which vary less with temperature changes. Input currents of the order of 1pA (1 pico amp or micro-micro-amp) can be obtained using these products.

SENSITIVE AMMETER

The circuit of Fig. 2.1 shows the use of the economical RCA CA3140 device in a very sensitive meter circuit which provides a full scale deflec-

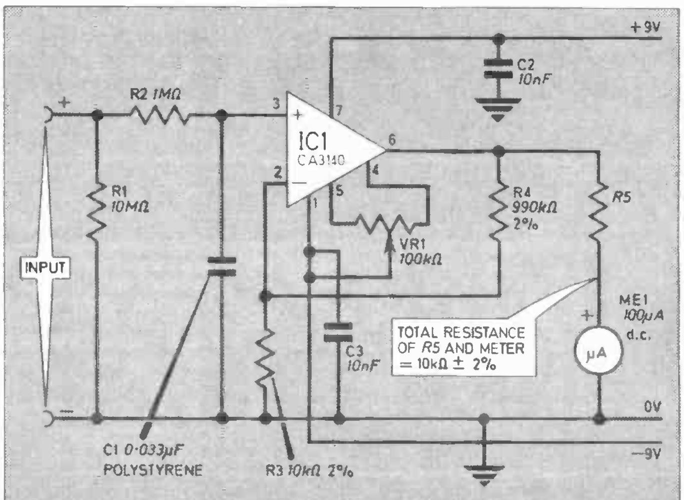


Fig. 2.1. A sensitive meter circuit providing a full scale deflection with an input current of 1nA or an input voltage of 10mV.

tion of 1nA. The same circuit can be used as a voltmeter having a full scale deflection of 10mV. The input impedance is 10megohm (corresponding to 1GΩ/V=1000MΩ/V!).

An input current of 1nA flowing through the resistor R1 will produce a voltage of 10mV across this resistor. This voltage is applied to the non-inverting input of the CA3140 at pin 3. The components R2 and C1 help to prevent instability. The input impedance of the CA3140 is quoted as 1·5 tera-ohms (TΩ) (1·5 million megohms), so the current passing to pin 3 is negligible. A 741 device cannot be used in this circuit, since it requires too much input current.

GAIN

The gain of this non-inverting circuit is equal to (1+R4/R3) or 100 with the values shown. Thus a 10mV input voltage is converted into a 1V output voltage. It is important that R4 and R3 should have a close tolerance or the gain will not be exactly 100. R4 can be made using a number of close tolerance resistors in series.

The 1V output at pin 6 will drive a current of 100μA through *R5* and ME1 only if *R5* is chosen so that the total resistance of *R5* and ME1 is accurately 10 kilohm. The circuit can be modified to provide other ranges; for example, if R4 is reduced to 90 kilohm, the gain of the circuit will be 10 times and the full scale deflection will be equivalent to an input of 10nA and 100mV.

Constructors who have a multi-range meter may wish to use this, switched to its 1V range, instead of *R5* and ME1. The potentiometer VR1 sets the quiescent output voltage and is used to adjust the zero reading. The CA3140 device is available in an 8-pin dual-in-line package and also in a TO-99 circular metal package.

NOTCH FILTER

The circuit of Fig. 2.2 shows the use of the LF355 BIFET device as a notch filter to remove an unwanted frequency whilst leaving other frequencies almost unaffected. The component values shown are for the rejection of 50Hz mains hum, but the circuit will not reject the 100Hz second harmonic or other harmonics of the hum.

Accurate values must be employed in the input "twin-T" circuit such that R1=R2=2R3 and C1=C2=C3/2 if a sharp rejection notch is to be obtained at the 50Hz frequency. Components having a 1 per cent tolerance are desirable.

The advantage of using the BIFET op-amp is that its high input impedance enables high values of R1, R2 and R3 to be used and therefore relatively low values of the capacitors for any required frequency of rejection. Close tolerance capacitors of low value are reasonably priced, but the use of a device with a lower input impedance would involve the use of relatively high values.

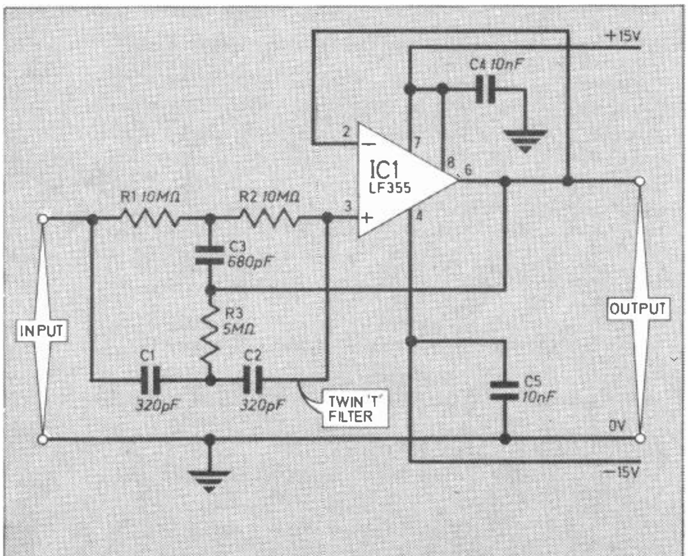


Fig. 2.2. A circuit providing a high rejection of 50Hz hum frequency.

CURRENT DIFFERENCING AMPLIFIERS

Another type of amplifier is especially attractive to the home constructor, since four of the devices are available in a cheap 14-pin dual-in-line package. This device is the LM3900 "Norton" current differencing amplifier. It is not suitable for extremely low-noise operation, but can replace conventional operational amplifiers in many applications.

The LM3900 is convenient to use, since it is internally compensated and is designed to operate from a single power supply line. However, it has an open loop gain (about 2,800) which is much lower than that of true operational amplifiers. The output voltage is proportional to the difference between the currents at its two input terminals rather than to the voltage difference. A current fed to either input should pass through a series resistor in the input lead.

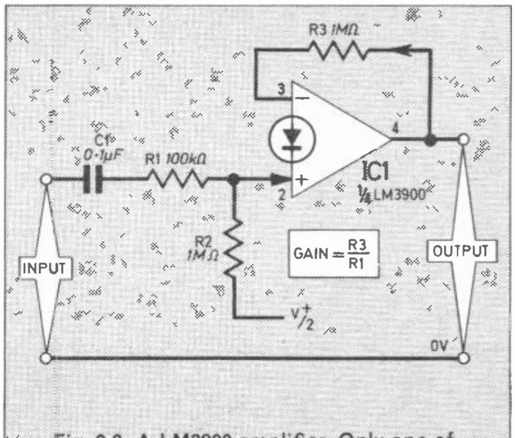


Fig. 2.3. A LM3900 amplifier. Only one of the four amplifiers in the chip are used.

An LM3900 non-inverting amplifier with a voltage gain of 10 is shown in Fig. 2.3. The special symbol shown is recommended for this type of amplifier to distinguish it from a conventional amplifier.

The value of R3 should be equal to R2, since the mean output voltage is half the supply rail voltage and one requires similar currents at the two inputs. The gain of this circuit is equal to R3/R1, a voltage gain of 100 (40dB) being possible at frequencies up to about 1MHz.

The use of two of the amplifiers of an LM3900 device in the circuit of Fig. 2.4 enables both triangular and square waves to be generated. The frequency is determined by the values of R1 and C1.

POWER AMPLIFIERS

Integrated circuit audio power amplifiers are easy to use and can save the constructor a great deal of trouble designing and making a power amplifier from discrete components. Power amplifiers are therefore the first type of integrated circuit which many home constructors meet.

Many types of power amplifier are now available, some of the best known types being covered in Table 2.1. The early types required a potentiometer in the external circuit for centering the output voltage at half the supply voltage, but this centering is performed automatically in modern devices.

All audio power amplifiers are basically a form of operational amplifier which can give a high output power, but they do not all have inverting and non-inverting inputs.

The power output which an audio amplifier can deliver to a loudspeaker

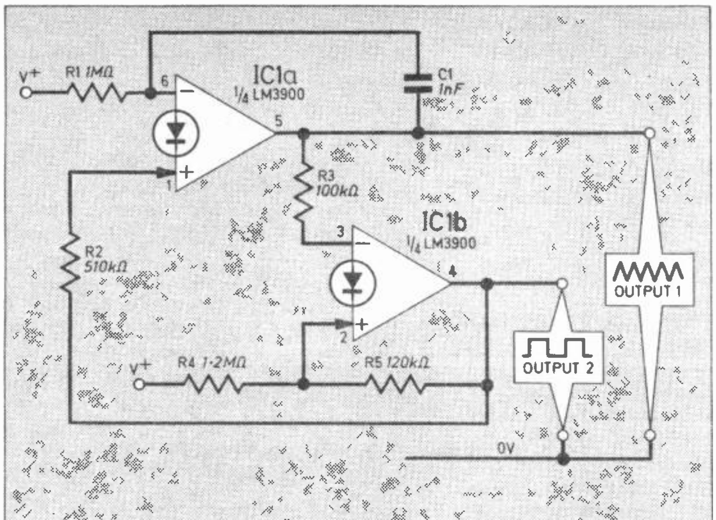


Fig. 2.4. A circuit which generates triangular and square waves.

of suitable impedance is determined by the maximum voltage and current which the output transistors of the device can handle. The TBA800, for example, is a relatively high voltage device which may be used with a 24V supply, but its output current cannot exceed 1·5A with safety. This device is designed for use with a higher impedance loudspeaker than the TBA810S which can deliver up to 2·5A but which normally operates from a 16V supply.

MARGIN OF SAFETY

It is always wise to operate amplifier devices from a supply voltage appreciably below the absolute maximum permissible value, since one needs a margin of safety to accommodate any slight variations of the supply voltage, etc. Supply voltages above the absolute maximum value may damage the device.

Power amplifiers can be operated with supply voltages well below the normal maximum operating voltage, but the maximum power will be much reduced. The TBA820 can operate from a supply of only 3V, but the maximum output power is then only about 0·2W.

The maximum r.m.s. output power is equal to $V^2/2R$ where R is the speaker impedance and V is the maximum output swing on either side of the centre voltage. If balanced power supplies are used, V is a little less than either supply voltage. If a single power supply is employed, the maximum r.m.s. output power is somewhat less than $V^2/8R$ where V is the power supply voltage used.

PROTECTION

An integrated circuit power amplifier can be destroyed if the silicon chip becomes too hot. Many of the high power devices incorporate thermal shut down circuits which effectively switch off the power to the output stage if the chip becomes too hot. An additional advantage obtained with such protective circuits is that one does not need to incorporate a considerable margin of safety in the size of the heat sink used.

Devices can also be destroyed if the output current becomes excessive when the output of the device is accidentally shorted to either of the power supply lines. Some of the higher power devices therefore include a circuit which limits the output current to a safe value. This is very useful when one is experimenting with the devices and in car radio receivers where shorts may occur.

Cheap, low power devices do not incorporate protection circuits partly because the chances of them being destroyed at the low voltages employed is much smaller than in the case of high power devices.

Short circuit protection in the TDA2020 and TDA2010 devices is particularly effective. The internal circuit includes components which monitor both the voltage and current in each output transistor. If both become high simultaneously, the output transistor base current is diverted to shut down this stage.

All power devices (like many other integrated circuits) are likely to be destroyed in a fraction of a second if a supply of a reversed polarity is applied to them. Readers may therefore wish to include a diode in one of

Table 2.1 Parameters for some Audio Power Devices

Device	Output Power (W)	Speaker Load(Ω)	Supply Voltage(V)	Max. Supply Voltage(V)	Peak Current(A)	Encapsulation	Protection	Remarks
LM380	2·5	8	18	22	1·3	14 and 8-pin d.i.l.	Thermal; short circuit	Simple circuit
LM386	0·5	8	9	15	—	8 pin d.i.l.	—	Low voltage (4V)
MC1306P	0·5	8	9	12	0·4	8-pin d.i.l.	—	Economical
MFC4000B	0·25	16	9	12	—	4-pin special	—	Economical
MFC6070	1	16	16	20	—	6-pin special	Short circuit(max. 10sec)	—
μA706	5·5	4	14	25	2·5	14-pin d.i.l.	—	—
SN70008	10	4	20	22	2·5	5-lead, plastic	—	Minimum 10V; 1 hole mounting
SN76013	4	8	24	28	—	Metal fins, d.i.l.	—	
SN76023	5	15	24	28	—	Metal fins, d.i.l.	—	Same as "Super IC 12"
TAA300	1	8	9	10·5	0·6	10-pin circular metal	—	Minimum 4·5V
TBA800	5	16	24	30	1·5	FIN-DIP	—	Minimum 5V
TBA810S/AS	7	4	16	20	2·5	FIN-DIP or short tabs	Thermal	Minimum 4V
TBA820	2	8	12	16	1·5	14-pin	—	Low voltage (3V)
TCA760	1·2	8	10	14	1	16-pin d.i.l.	—	—
TCA830S	4·2	4	14	20	2	FIN-DIP	Thermal	Minimum 4V
TCA940	·10	4	20	24	3	FIN-DIP, short tabs	Thermal; short circuit	Minimum 6V
	5·6	8	20					
TCA940E	6·5	8	20	24	3	FIN-DIP	Thermal; short circuit	Minimum 6V
TDA1042	10	2	14	18	3·5	14-pin; bracket	Thermal; short circuit	Max. power from 12V car radio
TDA2010	15*	4	±14	±18	3·5	14-pin d.i.l.	Thermal; short circuit	Minimum ±5V
	12*	8	±14					
TDA2020	20*	4	±18	±22	3·5	14-pin d.i.l.	Thermal; short circuit	Minimum ±5V
	16·5*	8	±18					
DUAL AMPS (STEREO)								
LM377	2/channel	8	20	26	1·5	14-pin d.i.l.	Thermal; short circuit	4W as bridge
LM378	4/channel	8	24	35	1·5	14-pin d.i.l.	Thermal; short circuit	8W as bridge
LM379	6/channel	8	28	35	1·5	16-pin special d.i.l.	Thermal; short circuit	14W as bridge

* at 1 per cent distortion

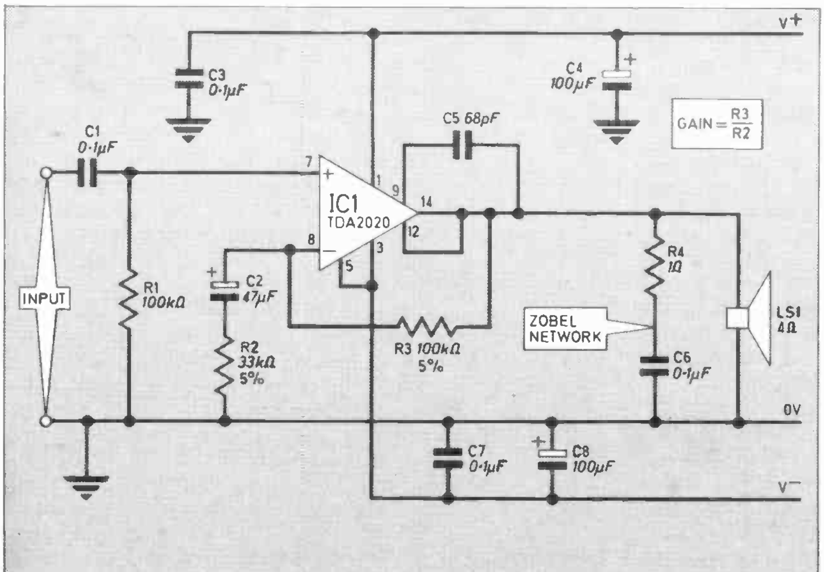


Fig. 2.5. A power amplifier able to deliver about 20W r.m.s. to a 4 ohm loudspeaker or other load.

the supply leads during experiments, but it must be connected with the correct polarity.

THE TDA2020

The TDA2020 can provide more output power than any other currently available integrated circuit. It gives up to about 20W into a 4 ohm loudspeaker at 1 per cent distortion. At power levels below about 14W the distortion level is around 0·2 per cent. Two of these amplifiers operating in an anti-phase bridge circuit can deliver up to about 36W into an 8 ohm load at 1 per cent distortion.

The circuit of a TDA2020 amplifier is shown in Fig. 2.5. It is a typical operational amplifier with inverting and non-inverting inputs and a gain determined by the ratio of the feedback resistors R3/R2. the capacitor C2 ensures that the full feedback voltage is applied at zero frequency, whilst only a fraction is applied at the audio frequency. This results in the mean voltage at pin 14 being very close to the ground potential.

The TDA2010 is a lower voltage, more economical version of the TDA2020. Both require a heat sink.

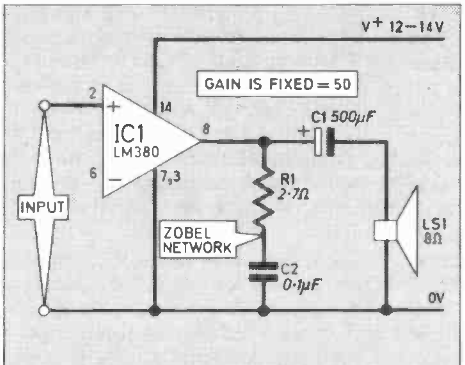


Fig. 2.6. A simple LM380 audio amplifier able to deliver about 2W to an 8 ohm load.

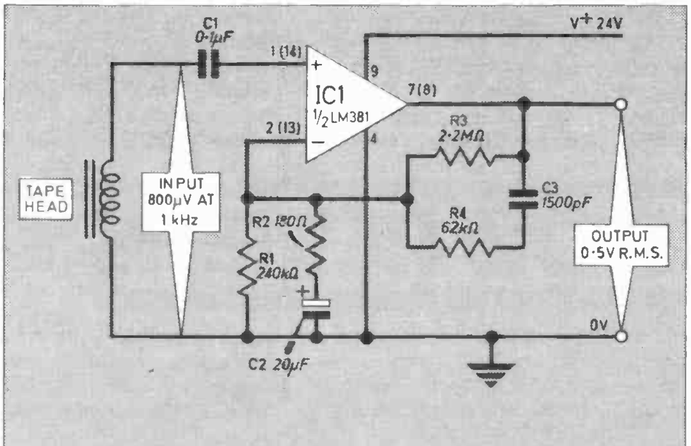


Fig. 2.7. A magnetic tape replay amplifier using the LM381.

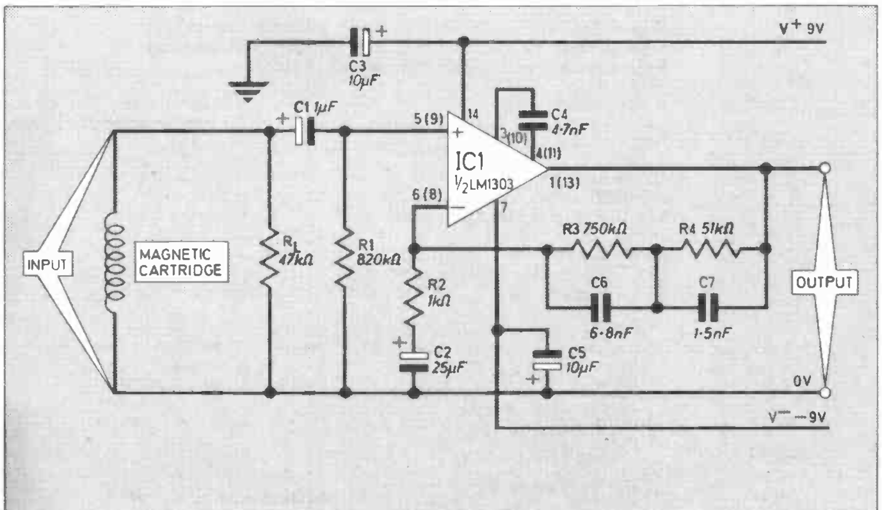


Fig. 2.8. An RIAA record replay preamplifier using the LM1303 device.

THE LM380

The LM380 device can be used in the extremely simple circuit shown in Fig. 2.6; this is about the simplest possible high gain audio amplifier. As with most other power amplifiers, a capacitor C1 is used to couple the output to the speaker so that a single power supply line can be used.

The components R1 and C2 assist stability at high frequencies, but are often unnecessary. They form a Zobel network which keeps the impedance across the load almost like a pure resistance as the frequency varies. Components R4 and C6 are used in Fig. 2.5 for the same purpose.

STEREO POWER DEVICES

The stereo power amplifiers shown in Table 2.1 each contain two separate protected power amplifiers in a single package, one amplifier being used for each stereo channel. Alternatively the two amplifiers may be used in a single channel bridge circuit to drive a load of higher impedance at higher power.

AUDIO PREAMPLIFIERS

Very low-noise dual audio preamplifier devices are available which are suitable for tape and magnetic pick-up stereo preamplifiers and for tone control preamplifier circuits. These devices, which are essentially specially designed operational amplifiers, also have instrumentation applications.

One well-known low-noise dual preamplifier is the National Semiconductor LM381 which is supplied in a 14-pin dual-in-line package. This may be employed in the circuit of Fig. 2.7 to amplify the signals from a magnetic tape recorder head with an output of 800μV at 1kHz. The circuit provides the standard NAB response characteristic.

A similar, but slightly simpler circuit, can be made using the LM382 which has suitable resistors fabricated on its chip to provide the required NAB response. However, external capacitors must be employed and the LM382 is not quite so versatile as the LM381, since the values of its on-chip resistors cannot be altered.

The circuit of Fig. 2.8 shows the use of another dual audio preamplifier device, the LM1303, for amplifying the signals from a magnetic record player pick-up head and for providing the required RIAA frequency response characteristic.

In the circuit of Fig. 2.9, the LM381 device is used in an audio mixer circuit which contains variable resistors for controlling the signal amplitudes from each of the four inputs *A*, *B*, *C* and *D* at the output.

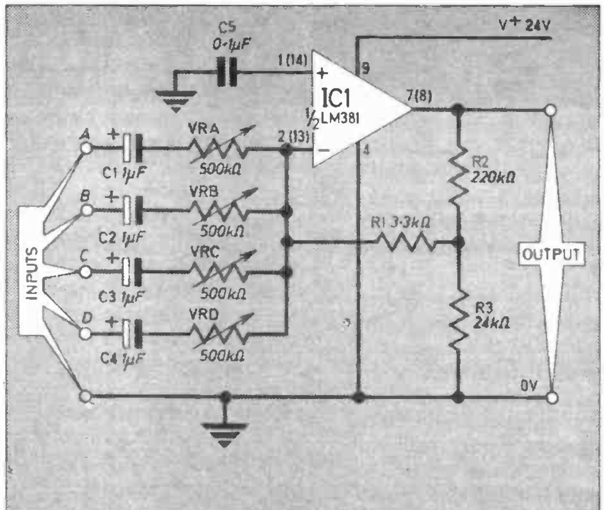


Fig. 2.9. An audio mixer circuit.

In the circuits of Figs. 2.7 to 2.9 inclusive, only one of the two amplifiers in the integrated circuit is used.

Next month. *In the next part of this series we shall consider devices used in radio receivers.*

BOOK REVIEWS

ELECTRONIC PROJECTS

Book 1 Cost Effective Projects Around the Home
Author John Watson
Price £3·95 Limp
ISBN 0 333 25700 6

Book 2 Projects for the Car and Garage
Author Graham Bishop
Price £3·50 Limp
ISBN 0 333 25639 5

Book 3 Audio Circuits and Projects
Author Graham Bishop
Price £4·95 Limp
ISBN 0 333 27513 6

Book 4 Test Gear Projects
Author Terry Dixon
Price £3·95 Limp
ISBN 0 333 26396 0
Size 214 × 135mm
Publisher Macmillan Press

If you were to gauge the arrival of the leisure age by the number of electronic project books published then you could say that it was well and truly here.

With this set of four books, Macmillan have jumped firmly into the centre of what is already a densely populated area of publishing, so how do they stand up to the competition?

Each volume contains a wide range of projects within its chosen field although because of this the authors have had to leave out some of the finer points in the constructional details. To an experienced person this would present few problems but the raw beginner might find things something of a struggle in a few cases.

For the most part layouts are given for Vero VQ board instead of the usual stripboard—an interesting approach when you consider that no cuts are necessary in the copper tracks but not so good when you realise that VQ board is only available in one size.

Another novel idea is to put all the component lists at the back of the book. Very convenient when going shopping but rather less so when it comes to putting the project together especially when components on some layout diagrams are identified solely by their value.

However, these points aside, this is a well printed, informative and useful set of books. Certainly they aren't cheap, but the quality of the paper and printing probably justify the extra cost.

S.E.D.

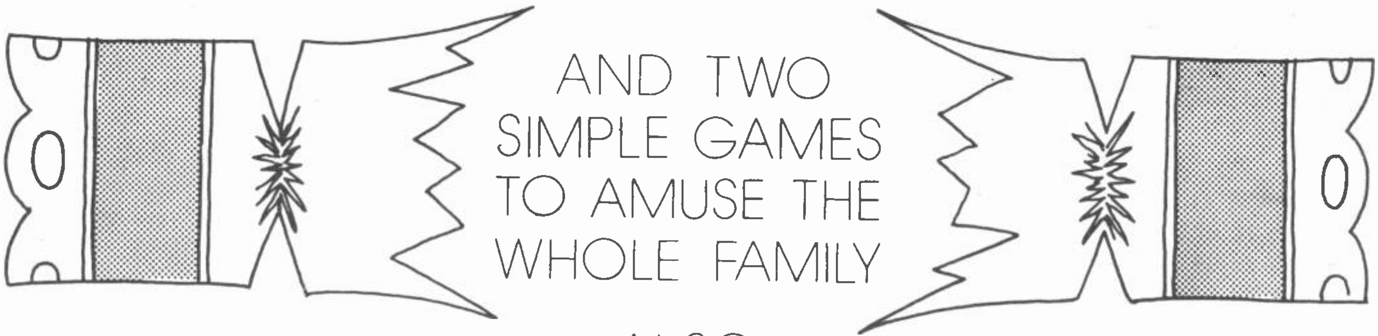
PLEASE TAKE NOTE

Lights Failure Monitor
(September 1980)
Please note that the values of R1 and R2 have been transposed in both component list and circuit diagrams.

Our December Issue shows how to add more sparkle to the FESTIVE SCENE

TREE LIGHTS FLASHER

TABLE DECORATION



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Everyday ELECTRONICS

DECEMBER 1980
ISSUE ON SALE FRIDAY, NOVEMBER 21

quick as a flash

REACTION Tester

By O.J.Foldöy

THE device to be described here could be used for fun, or if set up to run at a known frequency, put to a more serious and useful purpose of measuring response or reaction time to a visual stimulus.

Construction is made easy by the use of a printed circuit board and the unit is powered by a single PP3 battery. The completed unit is small enough to be carried in the pocket and could provide much fun and amusement for one or more players.

Once initialised a variable delay occurs before the counting sequence is started. In some instances there is a tantalising wait of 10 seconds or more, and one wonders whether the unit is operating or not, and just when you are off-guard, the count starts.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Reaction Tester is shown in Fig. 1. IC3 is a decade counter which has ten separate outputs. All except one of these are at a low level (logic 0), the one on being selected by the number of pulses received by the clock input, pin 14. Thus if a train of pulses are fed to pin 14, the outputs sequentially turn on and in doing so cause the l.e.d.s connected to light up. When the l.e.d.s are arranged as in this project, a running light effect is produced.

This will only occur if the clock enable input, pin 13 and the reset input pin 15 are low. If clock enable is taken high, the count is inhibited.

When the reset is made high the counter is reset whereupon the "0" output l.e.d., D9, will be lit. With the clock enable low and the clock input fed with pulses, the l.e.d.s will step on, but when D18 lights, the high level at pin 11 is coupled through D7 to pin 13. This stops the count and D18 remains lit.

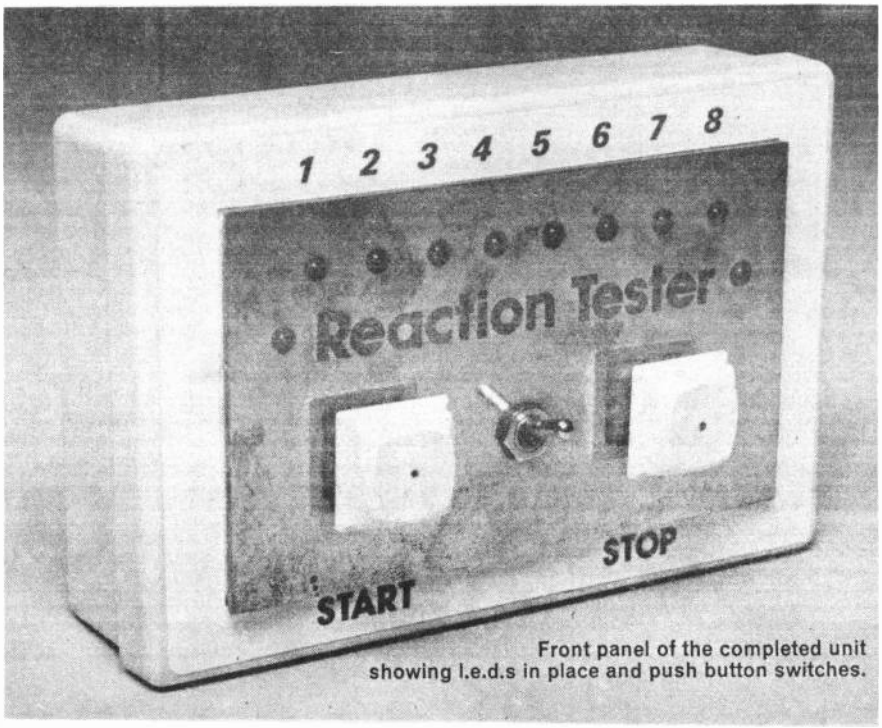
CLOCK PULSE

The clock pulse generator is constructed from IC1d with components C4, R8 and VR1, their values determining the oscillating frequency. The square wave output is coupled direct to the clock input, pin 14.

Whether these pulses are "counted" or not is determined by the level at the clock enable input which is controlled by the two bistables formed by the four NOR gates in IC2. An output from each of the bistables is ORed with the last l.e.d. The 3-input OR gate is made from diodes D5, D6 and D7 with R9 positioned to control the clock enable input of IC3.

The bistable formed with IC2c and IC2d is itself controlled by the output of IC1c. This is a Schmitt NAND gate and provides a low output only when both inputs are high. For all other combinations at the input, the output is high. While there is a high at IC1c output, the output at IC2c and therefore at IC3 enable input is also high. Consequently the clock pulses are not being counted.

The levels at the inputs to IC1c are changing since they are fed from two slow running oscillators formed by IC1a, IC1b and associated components. When both oscillators are outputting a high level, a low is produced at IC1c output which sets the lower bistable so that IC3 pin 13 receives a low and the clock pulses



Front panel of the completed unit showing l.e.d.s in place and push button switches.

cause the l.e.d.s to light sequentially as described earlier. Further changes in IC1c output have no effect.

Pressing S1 sets bistable IC2a/IC2b producing a high at IC2b pin 3 which is directly coupled to IC3 clock enable input. This prevents IC3 from counting further and one of the l.e.d.s stays alight.

START/STOP

Pressing the start button, S2, resets the upper flip-flop to place a high level on IC2a pin 4. This level change is differentiated by C3 to produce a short duration positive spike which is fed to the reset pin on IC3 causing D9 (the first l.e.d. in the chain) to light up. This spike also resets the lower flip-flop which inhibits the counter. The other output of the upper flip-flop is of course at a low level, requesting a clock enable for IC3 but is overridden via the discrete gate OR output of the lower bistable. The latter allows an enable when the oscillators again coincide to produce an output to set this bistable.

Thus a random time delay occurs after pressing the start button before IC3 starts counting. The count is halted by pressing the stop button and the position of the lit l.e.d. will give a measure of your reaction time

COMPONENTS

Resistors

R1	10kΩ
R2	4·7MΩ
R3	10kΩ
R4	3·3MΩ
R5	1MΩ
R6	1MΩ
R7	1MΩ
R8	10kΩ
R9	1MΩ
R10	1·5kΩ

All $\frac{1}{8}$ watt carbon ±5%

Capacitors

C1	22μF 9V elect.
C2	22μF 9V elect.
C3	0·047μF polyester or ceramic (C280 not suitable)
C4	4·7μF 9V elect. radial leads

See Shop Talk page 705

Semiconductors

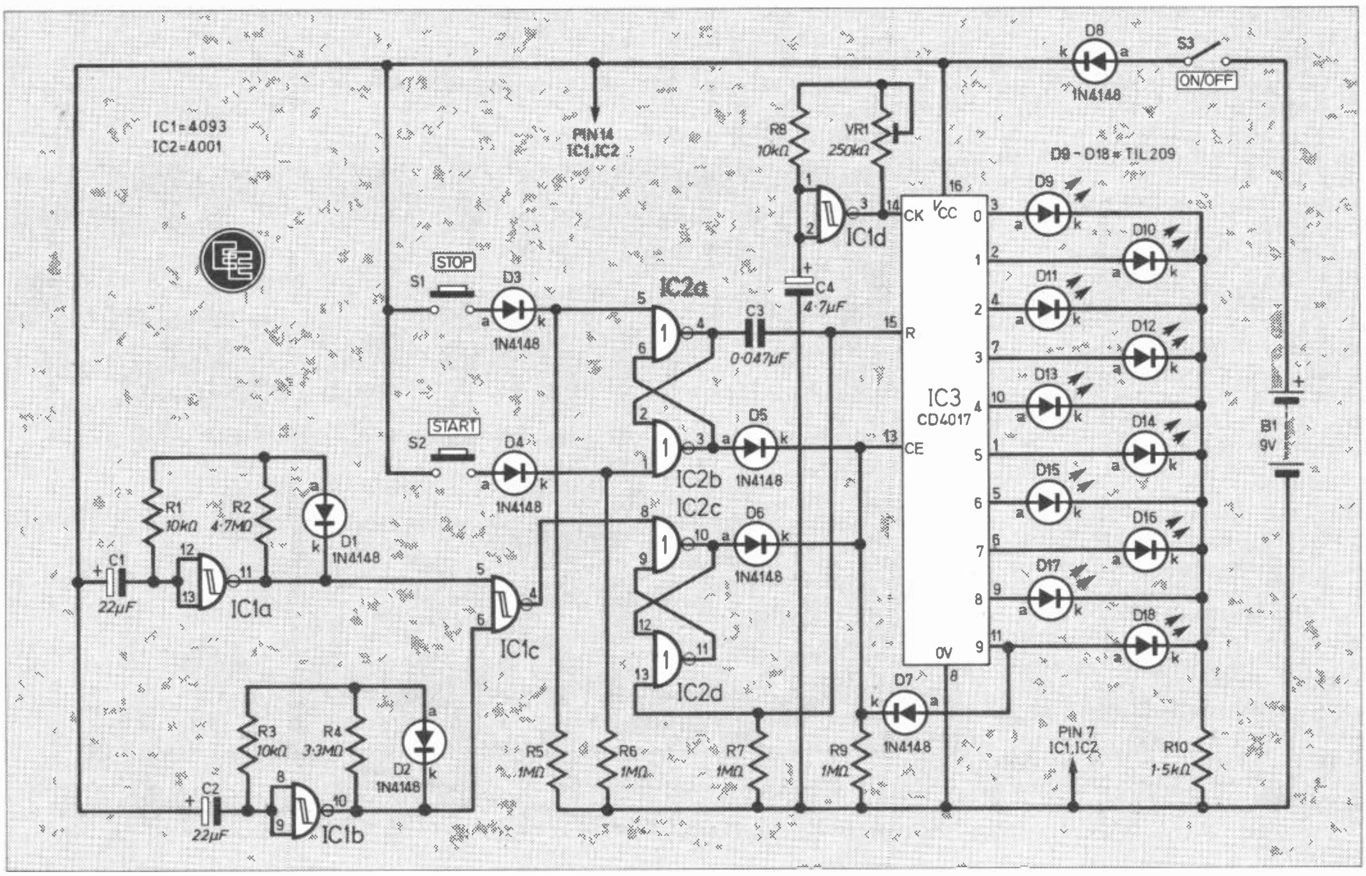
D1-D8	1N4148 small signal silicon (8 off)
D9-D18	TIL 209 red l.e.d. (10 off)
IC1	CD4093 CMOS Quad 2-input NAND Schmitt trigger
IC2	CD4001 CMOS Quad 2-input NOR gates
IC3	CD4017 CMOS decade counter/divider

Miscellaneous

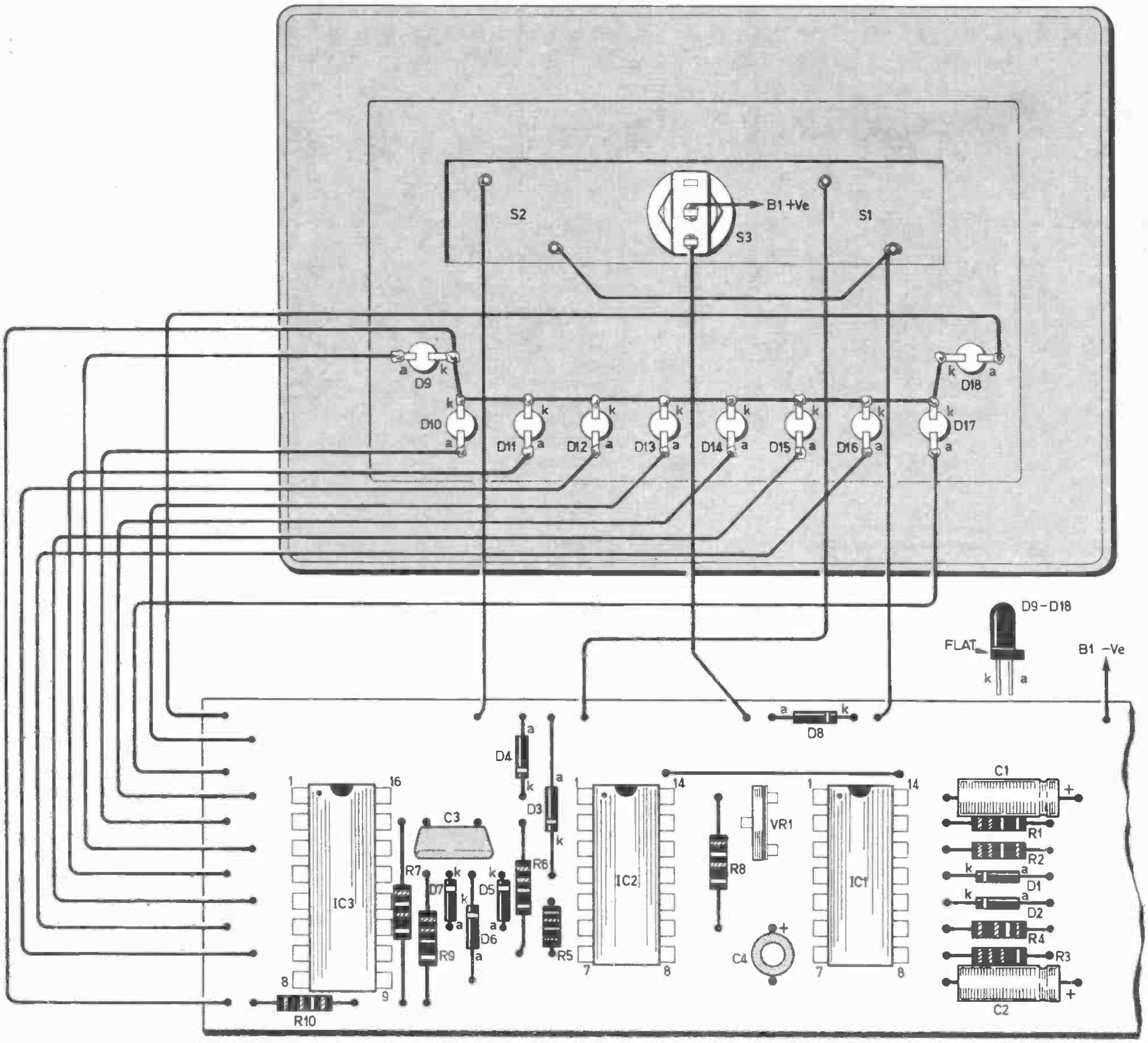
S1,S2	push-to-make release-to-break button switch (2 off)
S3	miniature on-off toggle
B1	9V type PP3
VR1	250kΩ sub-minature vertical preset

Printed circuit board, 108 × 32mm; PP3 battery clips; l.e.d. mounting clips (10 off—optional); Soldercon pins to make 16 pin d.i.l. (1 off), 14 pin d.i.l. (2 off); printed circuit board for fascia 100 × 60mm; case, plastic size 120 × 80 × 30mm

Fig. 1. Complete circuit diagram of the Reaction Tester.



REACTION TESTER



COMPONENTS
approximate
cost £4·50

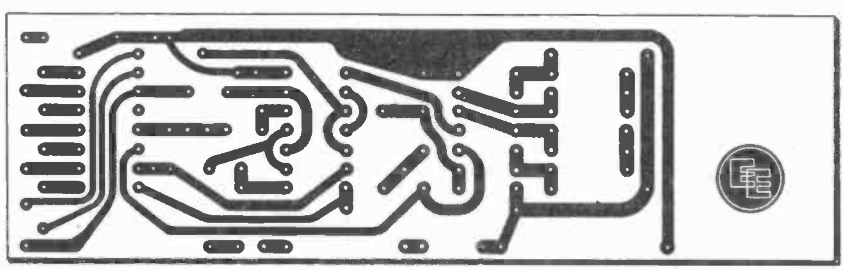
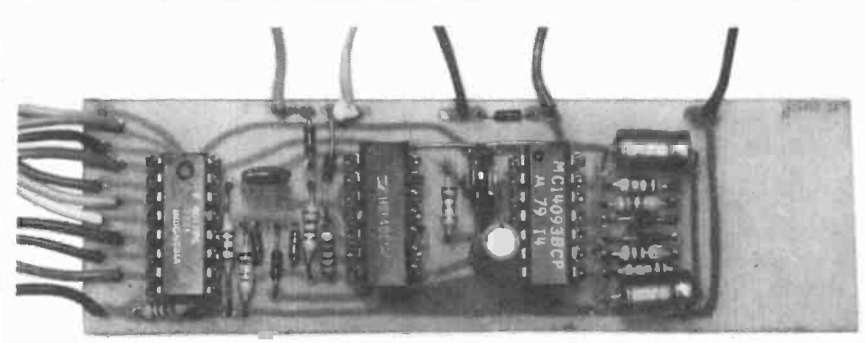


Fig. 2. Circuit board layout and interconnecting diagram. Note that the foil pattern has been reproduced full size and is not to scale with the rest of the drawing.

from the onset of the count. If the count is allowed to reach D18 then this itself stops the count requiring the stop and then the start buttons to be pushed to repeat.



Topside of the completed p.c.b. showing components mounted in place.

CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

To make for easy construction a printed circuit board has been designed. The full-size master of this is shown in Fig. 2. The black areas represent the regions of copper to remain after etching.

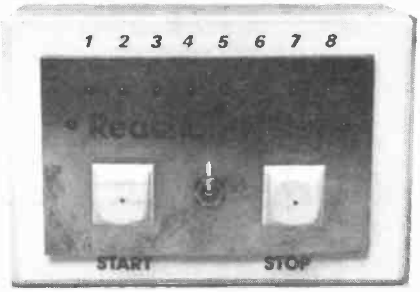
Soldercon pins are used to hold the i.c.s and due to limited space these are recommended although one might be able to use low profile d.i.l. sockets for this purpose. Begin by assembling the sockets, link wires resistors, preset, capacitors and diodes in this order. Pay special attention to the orientation of the latter and try not to overheat these devices while soldering. Do not insert the i.c.s at this stage.

The remainder of the components are fitted to the lid of the case, or more specifically to a piece of polished printed circuit board to give a more substantial base to these components and enhance the appearance of the finished unit.

A slot and a series of holes were made in the lid at the switch and l.e.d. positions to allow easy access to the connections on these components. The drilled fascia (p.c.b.) was glued to the drilled lid using Araldite and the l.e.d.s glued in place. Alternatively l.e.d. clips and bushes could be used. The two push switches, p.c.b. mounting types, were also glued to the copper fascia with holes for their lead-outs should be made large enough so that they do not short circuit via the copper.

FINISHING OFF

All the l.e.d.s should be aligned so that the common bus-bar connecting their cathodes is straight. It only remains now to interwire the board and case mounted components according to Fig. 2. When this has been done to your satisfaction the i.c.s may be carefully mounted in their sockets. These are CMOS devices and extra care needs to be taken. You should as far as possible avoid touching the pins when handling these devices. It is recommended that the interconnecting strip on the Soldercon pin be left intact until the i.c.s are mounted, and then snapped off.



IN USE

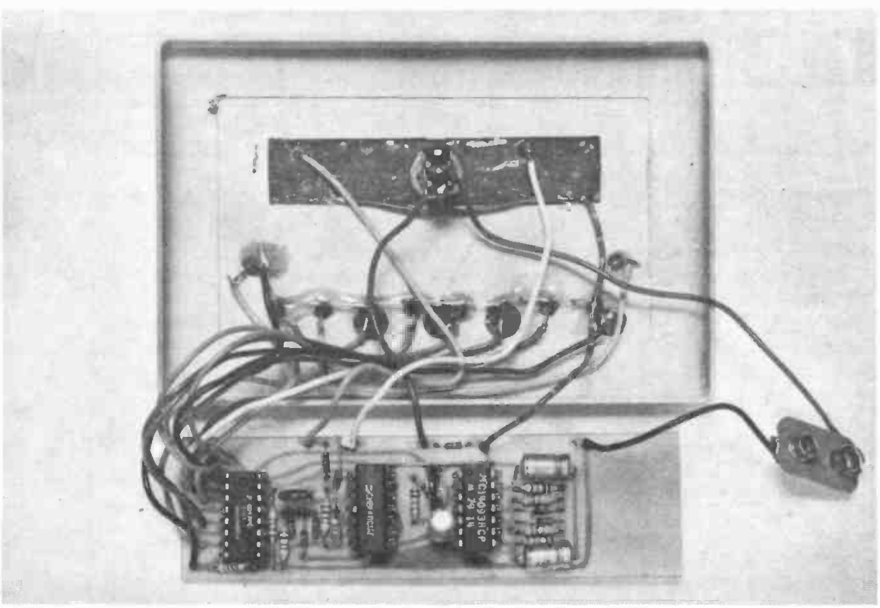
Current drain is very small, in the order of 3mA so a PP3 type 9 volt battery will give many hours of use. This is a small battery and can comfortably be fitted in the specified case. Double sided adhesive foam is useful for holding the battery securely to the case.

After switching on, the l.e.d.s will light in sequence, and unless the STOP button is pressed, will reach the last position and then stop. The STOP button must then be pressed in order to discharge capacitor C3 before the START button has any effect. The START button will cause the first l.e.d. in the chain to light (adjacent to START) and a time will elapse before counting starts. Push the STOP button as soon as possible to halt the "mounting" light. If STOP is operated before the counting sequence starts, the START button needs to be pressed again to initiate the sequence.

The "speed of movement" should be set by means of VR1 so that the average halt position is midway, position 4 or 5.

It only remains to label the front panel as suggested in the photographs. The oscillator frequency could be set so that the numbers (1 to 8) represent hundreds of milliseconds; the clock would need to run at 100Hz. A coating of laquer or varnish should be applied to the polished copper fascia to prevent tarnishing. ⌑

Rear view of the front panel showing the interwiring between p.c.b., switches and l.e.d.s.



Missing Components

After a year of endeavouring to amuse and instruct my kind and patient readers, and causing my good Editor to wince occasionally, I decided to take a short holiday, and finished up in a cottage in a little village in North West Wales called Abersoch. The natives talk a strange language, since most of their words consist almost entirely of consonants and limited mainly to "L's" and "W's" with the odd "Y" thrown in for good measure.

As I was usually delegated to do the shopping, I thought I would look for the local Electronic Component Shop. I remember several years ago in Venice where nine out of ten shops are devoted to either ladies fashions, jewellery, wine or pastries, I came across a tiny little shop full of speakers, capacitors, resistors and other familiar objects to gladden the eye.

I was curious to find out what the Welsh for transistor was, but I was out of luck. I suppose in a country where they can use fifty eight digits to name a Railway Station they gave up when faced with electronic terms.

Young and Old

I am always delighted to receive letters from readers and I always answer every one.

Some of my readers who are perhaps older and have better memories than I have, can tell some amusing stories of the old days in radio. I had one recently from a Mr. Adams, telling me about the amusing patter of Captain R. P. Eckersley delivered after the evening programmes had finished, (he was the Chief Engineer of the BBC).

He was engaged at the time on increasing the power of the 2LO transmissions, so that, to quote his words, "You should be able to receive a good signal with a wet clothes line, a knife and a bit of cheese".

Around holiday times, I have one little lad, aged I should guess about ten or twelve, who comes into our shop clutching his copy of *Everyday Electronics*, and accompanied by a rather comely and delectable young mum. He is usually about to construct one of the projects, and of course mum pays.

What is particularly delightful is, that he always buys two sets of everything, one for himself and one for his Grandfather. I wonder if I shall ever see the day when my grandchildren buy me some electronic toys!

Touch of the Paranormals

I was pleased to see that the programme *A Leap in the Dark* is again back on the box. These programmes deal with the paranormal, and while I have an open mind on the subject, I would not like to dabble in it myself.

I knew an inventor once and he showed me two things he was designing for use at seances. One was a morse key with a very light touch, so that spirits who were familiar with the morse code, could get their messages over in this way, and the other was a special light that could be used during a seance, so that people could see each other without upsetting the conditions necessary for the medium.

Mind you if there is anything in it, and I would be the last one to say there is not, I am sure that electronics are going to play a big part. They are already being extensively used in ESP and psycho kinetic tests.

You may also of heard about experiments that one big electronics company were carrying out, running tape recorders over a period with a piece of wire and a diode connected to the input. They claim that they picked up several voices from the past. I know if I tried experimenting all I would receive would be the sound channel of the nearest TV transmitter!

Postal Squeeze

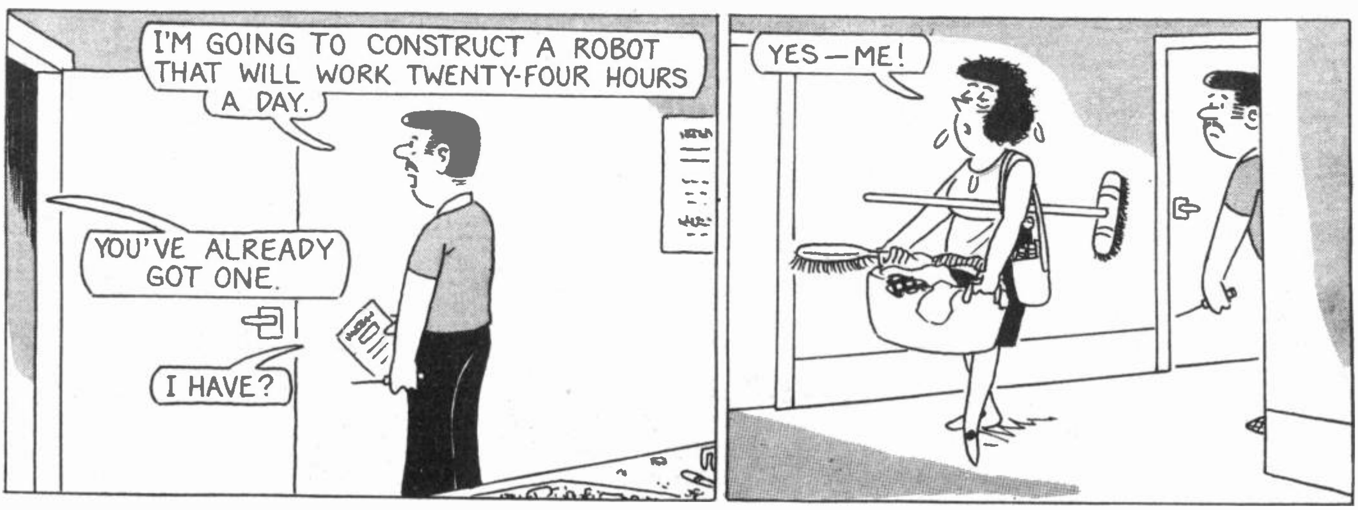
In the course of a week, I and many of my colleagues get bombarded with advertising offers. Hundreds of people implore us to try their photocopiers and hundreds more to rent their coffee dispensing machines. They must think we spend all our time, either copying photos or drinking coffee.

Quite often one can spot an advert without even stopping to open it and pop it straight into the waste paper bin. However, advertisers are getting wise to this because I have just received one which says on the outside of the envelope, "If you throw this in your waste basket unopened, a capsule of water will break, spilling into a dehydrated boa constrictor. He will then crawl out of the envelope and crush you to death."

So if my column is empty next month you will know the reason why.

JACK PLUG & FAMILY...

BY DOUG BAKER



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6v	½ amp	TM 3	£1·03	50p
6·3v	2 amp	TM 4	£2·36	60p
6·5v	½ amp	TM 37	£1·06	50p
6·5v	200 mA	TM 21	£2·02	50p
6·5v-0-6·5v	100 mA	TM 21	£2·02	50p
6·5v-0-6·5v	750 mA	TM 7	£2·70	55p
6·3v-0-6·3v	100 mA	TM 33	£2·02	50p
8·5v	1 amp	TM 12	£2·02	50p
8·5v + 8·5v sep. winding	½ amp	TM 12	£2·02	50p
9v	1 amp	TM 5	£2·02	55p
9v	1 amp 'c' core	TM 6	£2·36	50p
9v	3½ amp	TM 11	£3·37	60p
9v	5 amp	TM 38	£4·05	70p
10v	25 amp	TM 15	£6·07	£1·45
10v-0-10v	4 amp	TM 50	£4·72	£1·45
10v-0-10v	12½ amp	TM 15	£6·07	£1·45
12v	½ amp	TM 9	£1·31	60p
12v p.c.b. mounting	½ amp	TM 61	£1·15	50p
12v	1 amp	TM 10	£2·36	60p
12v-0-12v	50 mA	TM 19	£2·02	50p
12v-0-12v	1 amp	TM 41	£4·05	60p
13v	100 mA	TM 21	£2·02	50p
13v	½ amp	TM 7	£2·70	60p
15v tapped 9v	2 amp	TM 11	£3·37	60p
15v	4 amp	TM 50	£3·45	60p
17v	½ amp	TM 12	£2·02	60p
18v	½ amp	TM 13	£2·30	60p
18v	28 amp	TM 60	£11·50	£2·00
20v	½ amp	TM 14	£2·02	60p
20v	1 amp	TM 51	£2·87	60p
20v (with 6v ½ amp winding)	2 amp	TM 50	£4·72	£1·45
20v	6 amp	TM 46	£5·40	£1·45
20v	12½ amp	TM 15	£6·07	£1·45
20v-0-20v	6 amp	TM 15	£6·07	£1·45
24v—centre tapped	½ amp	TM 61	£1·15	50p
24v	1½ amp	TM 16	£2·65	70p
24v-0-24v	1 amp	TM 52	£8·05	£2·45
24v	2 amp	TM 17	£3·37	70p
24v + 2v 7 amp	2 amp	TM 39	£3·71	80p
25v	1½ amp	TM 18	£3·03	70p
25v-0-25v	½ amp	TM 62	£3·46	60p
26v	2 amp	TM 39	£3·72	70p
30v-0-30v	1 amp	TM 59	£3·45	60p
30v	8 amp	TM 15	£6·07	£1·45
35v-0-35v	2½ amp	TM 48	£6·25	£1·45
36v—centre tapped	14 amp	TM 60	£11·50	£2·00
37v	37 amp	TM 34	£39·82	enquire
40v	3 amp	TM 46	£5·40	£1·45
40v tapped 30v, 20v & 10v	6 amp	TM 15	£6·07	£1·45
48v—centre tapped	1 amp	TM 52	£8·05	£2·45
50v—centre tapped 'C' core	½ amp	TM 62	£3·48	60p
50v	2 amp	TM 22	£4·00	£1·00
50v	8 amp	TM 29	£14·56	£1·95
55v	16 amp	TM 53	£23·00	enquire
60v tapped 40v & 20v	2 amp	TM 46	£5·40	£1·45
70v	2½ amp	TM 48	£6·27	£1·45
70v	4·5 amp	TM 24	£8·77	£2·80
75v—3 amp with 6·3v shrouded		TM 23	£10·12	£2·20
75v	4½ amp	TM 24	£8·77	£2·80
80v tapped 60v & 75v	4 amp	TM 24	£8·77	£2·80
70v	2½ amp	TM 48	£6·27	£1·45
80v centre tapped	750 mA	TM 52	£8·05	£2·45
100v	1 amp	TM 25	£8·77	£1·95
100v-0-100v	½ amp	TM 25	£8·77	£1·95
110v centre tapped	8 amp	TM 53	£23·00	enquire

2½" ROUND PANEL METERS
All flush mounting through 2½" round hole, with flange makes item 3" wide approx. Made to stringent Ministry specifications. We have the following types in stock, all are moving coil unless otherwise stated. **VOLTMETER** Scaled 0-200 volts, res. 2,500 o.p.v. Price £2 + 30p. **MICRO AMPMETER** 500 UA—scaled 0-5. Price £2·50 + 38p. **MILLIAMP METER** 500 MA—scaled 0·500 mA. Price £2 + 30p. **AMPERE METER** Hot wire, scaled 0-9 amp. Price £2 + 30p. **DUAL RANGE** Scale calibrated 0-10v and 0-500v. Price £3·00 + 45p.

SPIT MOTORS These are powerful mains operated induction motors with gear box attached the final shaft is a ½" rod with square hole, so you have alternative coupling methods—final speed is approx. 5 revs per min., price £5·25 post 60p—similar motors but with final speed 110 rpm and 80 rpm same price.

VU METER
Edgewise mounting, through hole size 1¾" × ½" approx. These are 100 micro amp f.s.d. and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price £2·50 + 38p.

BALANCE METER
Edgewise mounting 100 UA centre zero. Price £2·00 + 30p.

BE PREPARED For possible blackouts and interruptions in electricity supply this winter. Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12" or 21" tubes from 12V car battery and the price is £4·65 80p post complete with tube, please state which.

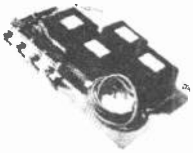
BLEEPERS 6 or 12v battery or transformer operated, ideal for using in most alarm circuits but for car and motor cycle alarms. These give a loud shrill note. American made by Delta Alarm. Price 87p. Large quantities available.

MOTORISED LIGHT FLASHER Christmas is coming, so you've got to think about your decorative lighting, to make this flash we can offer two motorised units both capable to 2000 watts of light. One ½ second flasher changes every ½ second and the 2 second flasher changes every 2 seconds. Either type £6·90.

FRIGHTENING FUEL BILLS Could lose some of their sting if you fit double glazing, also you will have a more comfortable home, less draughts etc. Double glazing frames, movable in the Spring, can be quite easily made using rigid PVC sheeting. We have this it is as clear as glass and virtually as everlasting. It is easy to fit as you can cut it, bend it, nail it etc. A recent purchase enables us to offer this at well below current price. It is 600 mm (23½" wide) and available in any length (it rolls up like lino), price 10p per ft (approx. 2 sq. ft.). Minimum order 10ft. for £1·25 post £1, orders over £10 post free, longer lengths price negotiable.

CAR BATTERY POWER UNIT Made for Rank Radio. This unit has been designed to operate 6 volt battery powered equipment from a 12 volt car battery, it provides a reliable source of stabilised voltage and gives protection to your equipment in case of accidental reversal of connections also against excessive car battery voltage should this occur. The unit is very robust and virtually everlasting if used sensibly. It uses a negative earth circuit but it will operate in a positive earth car providing the instrument being played is not connected to the car chassis. A real bargain at £2·50.

MULLARD UNILEX



A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field, this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £16 including VAT and postage.
FREE GIFT—Buy this month and you will receive a pair of Goodman's elliptical 8" × 5" speakers to match this amplifier.

THIS MONTH'S SNIP

3 CHANNEL SOUND TO LIGHT KIT Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.

The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special snip price is £13·50 in kit form or £17·50 assembled and tested.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 46p each.

WATERPROOF HEATING ELEMENT
13 yards length 70W. Self-regulating temperature control. £1·50.

PRECISION MAINS OPERATED CLOCK
For only £1·50 + 22p. Sounds unbelievable but that's what you can have if you send your order right away. The clocks which have large clear dials were made by the famous Smiths Company for use with their domestic cooker switch and are brand new and guaranteed.

SAFE BLOCK

Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit £1·70 + 25p or made up £3·00 + 45p.

HORSTMANN "Time and Set" SWITCH
(A 15 amp Switch.) Just the thing if you want to come home to a warm house without it costing you a fortune. You can delay the switch on time of your electric fires, etc., up to 14 hours from setting time or you can use the switch to give a boost period of up to 3 hours. Equally suitable to control processing £3·45.

NEW KITS

5 WAVE BAND SHORT WAVE KIT Bandspread covering 13·5 to 52 metres. Complete kit includes case, materials, six transistors and diodes, condensers, resistors, inductors, switches etc. Nothing else to buy, if you have an amplifier to connect it to or a pair of high resistance headphones. Special price is £11·95 inc.

SUB-MIN MICROPHONE
Size only ½" × ¾" × 3/16" so small enough for a bugging device, ex-hearing aids but guaranteed. Price £1·50.

TRANSMITTER SURVEILLANCE
Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox —all electronic parts and circuit. £2·30.

RADIO MIKE
Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £8·50.

EXTRACTOR FAN

Ex-Computer made by Woods of Colchester, ideal also as blower, central heating systems, fume extraction etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes 5" £5·50, 6" £6·50 post £1 per fan.

MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0-100 mA.
Continuity and resistance 0-1 meg ohms in two ranges.
Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.
Unbelievable value only £6·75 + 50p post and insurance.

FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one, send £2·50.

TERMS: Cash with order—but orders under £10 must add 50p to offset packing, etc.
BULK ENQUIRIES INVITED. PHONE: 0444-54563.
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IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—its an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

TELEPHONE RINGING MAINS UNIT Rather novel unit as it not only reduces mains to 50 volts but also reduces the mains frequency to 25 Hz, this frequency gives correct ringing note for GPO bells. These units were made for the GPO so obviously are first class. Completely enclosed and safe to mount on the wall or stand on a shelf. Price £4·60.

TELEPHONE EXTENSION BELLS in bakelite wall box, these will save you missing calls when you are out in the garden or shed, etc. Price £4·60 post £1.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful break-down parcel we have ever offered. Consists of 50 nearly all different computer panels on which you will find: Over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensors, multi turn pots, rectifiers, SCR etc. etc. for only £8·50, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel, + £1·27 VAT + £2 post (its a big parcel).

AUTUMN IS ALMOST WITH US and if the year lives up to its reputation, we will have chilly evenings—so don't put off those heating jobs any longer. While stocks last, we will supply the tangential heater units at last season's prices, namely £5·95 + £1·50 post for the 2 KW and £6·95 + £1·50 post for the 3KW. These prices include VAT but not the control switch, which is the three interlocked rocker type for the 2 KW, price 0·65p and the four interlocked rocker type for the 3 KW, price 0·95p.

12v MOTOR BY CROUZET—a powerful motor virtually impossible to stop by hand, size approx 2½" long and 2½" dia., this is a permanent magnet field type so is reversible simply by changing polarity and has a relatively constant speed with or without load. Fitted with a splined shaft which could directly engage a toothed gear wheel or to which a pulley could be attached. Ideal for large models, or small machines etc. Price £3·95.

12v MOTOR BY SMITHS INDUSTRIAL made for use in cars, these are series wound and become more powerful as load increases—they will in fact burn themselves out if over-loaded to stopping point—not polarity reversible—but if you are prepared to do a little unsoldering and rewiring then they will reverse at the flick of a switch. Being series wound they will also work off a.c. mains through a step down transformer and if you use a variable voltage type then the motor speed can be varied by the voltage. Size approx. 3½" long by 3" dia. these have a good length of ¼" dia. spindle—price £3·50. Ditto but double ended £4.

MAINS OPERATED LOW SPEED MOTORS 2 watt type as fitted into time switches, machine controllers etc. we have a good selection and can offer the following final speeds: 1 r 24 hrs—1 r 8 hrs—1 r 4 h—1 r h—2 r h—3 r h—4 r h—12 r h—20 r h—30 r h—1 r min—2 r m—4 r m—8 r m—15 r m—200 r m, all at £2·85.

WALL MOUNTING THERMOSTAT by Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0—30c—13 amp 250v contacts. Price £4·60.

EXTENSION SPEAKER CABINETS Teak look black front, size 11" × 8" × 4½" approx. Price £2·00 Post £1·00 (We have larger ones). If you can call and collect these cabinets you can save yourself the quite considerable postage and you only have to buy a few to get a discount as well. The quantity discount for these is a special rate of 25% if you buy ten or more. Note these cabinets are very good quality (made for Rank Audio Systems) the grill material is Dacron.

MERCURY BATTERIES Bank of 7 mercury cells type 625 which are approximately ⅝" dia. in plastic tube, giving a total voltage of 10.7. Being a plastic tube it is very easy to break up the battery into separate cells which could be used for radio control and similar equipment. Carton of 25 batteries £1·15 + 85 post.

½ PRICE CABLE OFFERS We have good stocks of:

Size	Type	Price 100 metres	Carriage
1·5mm	Single	£4·00	£1·75
1·5 mm	Flat twin	£6·50	£2·75
1·5 mm	Flat three core & E	£9·75	£3·50
4 mm	Single	£7·50	£2·75
4 mm	Flat twin	£11·50	£4·00
6 mm	Flat three core	£32·50	£5·00
16 mm	Twin & E	£79·00	£10·00

ONCE AGAIN IN STOCK ex-G.P.O. resistance bridge. It is in fact an electronic megger, which tests at a voltage of around 250, thus revealing any leaky points. These must have cost at least £150 each to make. In a portable light weight case, size approx. 9" × 9" × 9" with a carrying handle. Has two moving coil panel meters which give clear readings of resistance from fractions of an ohm right up to 100 megs and then to infinity. We have two versions of these instruments 1) is as good as new and checked and tested before despatch price £22·50 × £3·38, post £2·50. 2) Secondhand models complete and believed to be in working order but not checked nor guaranteed £12·50 × £1·87, post £2·50.

MAKING A CONVECTOR HEATER? We can offer a bank of four 1 KW metal clad elements all mounted on a 3" square iron plate. By comparatively simple switching 8 heat outputs ranging from approximately 250 watts to 4000 watts can be achieved. The elements, which have push on tag connectors, extend to a length of approx. 17" from their mounting plate, so a relatively compact simple convector heater could be made using this. Price £2·87 + post £1·50.

G.P.O. HIGH GAIN AMP/SIGNAL TRACER in case measuring only 5½" × 3½" × 1½" is an extremely high gain (70DB) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4½v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp, etc. An absolute bargain at only £1·85p. Suitable 80 ohmn earpiece 69p.

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £11·50 + £2·50 post.

MOUTH OPERATED SWITCH Made for washing machines to control water level etc. this is a *sensitive low pressure* device which operates three 1 pole changeover switches at different levels of pressure but all within a normal persons blowing capacity—blow gently into it and No.1. switch operates, blow a little stronger and No. 2. operates, blow harder still and No. 3. operates. The switch is airtight so the weight of water or other fluid substance could operate it. Undoubtedly a switch with very many applications. Disc type construction, this is approx. 3½" dia. × 1⅜" thick—the air entry is a pipe approx. 3/16" dia.—electrical contacts we estimate a 10 amp c/O a 230 volt—connection by push on tags. Order ref. PS.4. Price £2·88.

PRECISION TIMER

This timer, unlike those based on the ubiquitous NE555, is potentially very accurate over long periods of time. It uses the ZN1034E i.c. which boasts a low current consumption of 5mA and a repeat timing accuracy of 0·01 per cent.

In practice the accuracy is determined by the external components and method of calibration used, and in this circuit the total current used during the timing period is about 15mA.

It was decided, for ease of operation, to use components which would enable exact numbers of hours and minutes to be set, the hours by means of a rotary switch and the minutes by means of a potentiometer.

For longer periods a third switch has been added which multiplies the time set by a factor of two or three.

The circuit is designed for nine volt operation, and the timer i.c. includes its own voltage regulator. A battery could be used, but as the prototype was to be used almost continuously, a mains power supply was included.

THEORY

An external capacitor C_t and resistor R_t determine the frequency of an oscillator contained in IC1. A binary divider counts the pulses and activates the output at pin 2 after 4095 pulses. The total time t may be calculated from the formula:

$$t = K \times 4095 \times R_t \times C_t$$

where t is in seconds, R_t in ohms and C_t in farads.

Note that R_t should be between 5 kilohms and 5 megohms and C_t should be greater than 3300 picofarads.

K is determined by a "trimming preset", used in this case to allow for variations in the components used. In this circuit it should be assumed that K is 0·8324.

Thus if R_t is 224·7 kilohms, and C_t is 4·7 microfarads, the value of t is 3600 seconds or one hour. The trimming preset VR2 will provide values of K from 0·668 to 0·91 to allow for the tolerance of the capacitor.

The value of 224·7 kilohms for R_t was chosen, (a) in order for C_t to be low enough for a non-electrolytic capacitor to be used, and (b) the value corresponds to an available potentiometer (220 kilohms) plus a series resistor (4·7 kilohms) to ensure that R_t never falls below 4·7 kilohms.

A rotary switch can therefore be used for the hours, each hour adding an extra 224·7 kilohms onto R_t with a 220 kilohm potentiometer added for minutes up to sixty.

CIRCUIT

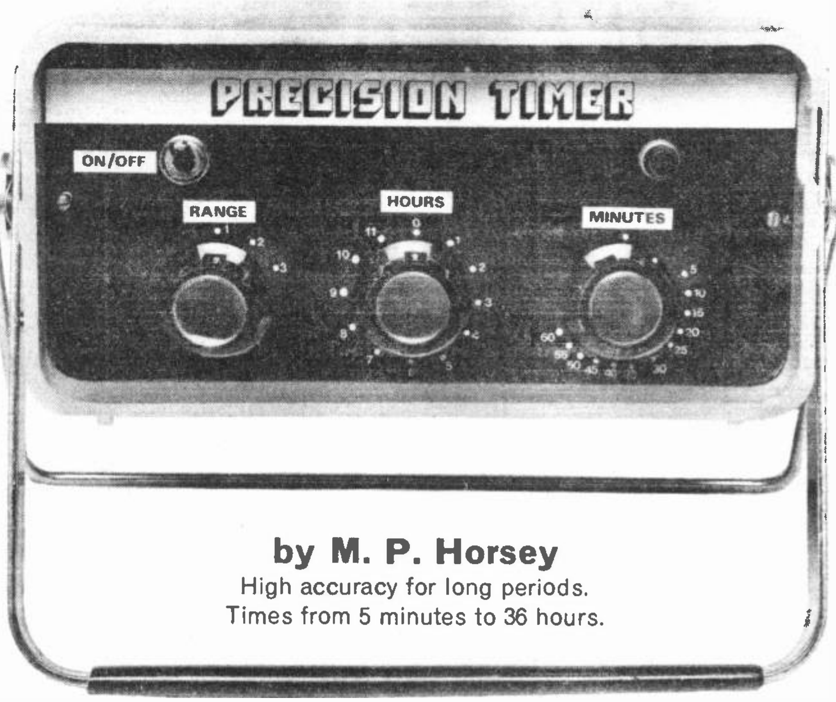
The external circuitry is quite simple (see Fig. 1). No "set" or "reset" switches are required. The on/off switch S1 resets and starts the timing period. Power is fed into the circuit via D5 to ensure that no damage can be done to the i.c.s should the power supply be accidentally reversed.

Preset VR2 is used to vary the total time by a limited amount for the purpose of setting up the timer. The resistance R_t is the sum of the resistances set by S3, VR1 and R1. The 220 kilohm fixed resistors should be one or two per cent tolerance types. The other 4·7 kilohm resistors need not have quite such a high tolerance since they only represent two per cent of 220 kilohms anyway.

The capacitor C4 (together with C2 and C3 when switched in circuit) forms the timing capacitor C_t. This is a polyester type.

The output from pin 2 of IC1 is then fed via R3 and TR1 which in turn switches on the two tone oscillator based on IC2.

To multiply the time period by two, capacitor C2 is switched in parallel with C4 using S2 thereby doubling the value of C_t. Similarly the time period can be trebled by switching in C3 in addition to C2 and C4. This has the effect of trebling the value of C_t.



by M. P. Horsey

High accuracy for long periods.
Times from 5 minutes to 36 hours.

TWO TONE OSCILLATOR

The components that form the audible warning section of the circuit are connected to right of TR1 in Fig. 1. This is in fact the *Two Tone Audio Oscillator* featured in the February 1976 issue of EVERYDAY ELECTRONICS and is based on the 7413 dual 4-input NAND Schmitt trigger.

The first gate IC2a is connected to form a low frequency (about 1Hz) oscillator. The second, IC2b, is connected to form a switchable frequency audio multivibrator whose frequency depends on either C7/R6 or C8/R4.

At switch on, C7/R6 controls the frequency and continues to do so until the positive end of C7 is held low when the output of IC2a goes low in which case C8/R4 takes over.

When pin 8 goes high again C7/R6 take over again as timing components.

Of course, if this sort of alarm is not required a 12V solid state buzzer could be connected across points *A* and *B* or even a suitable relay or indicator lamp.

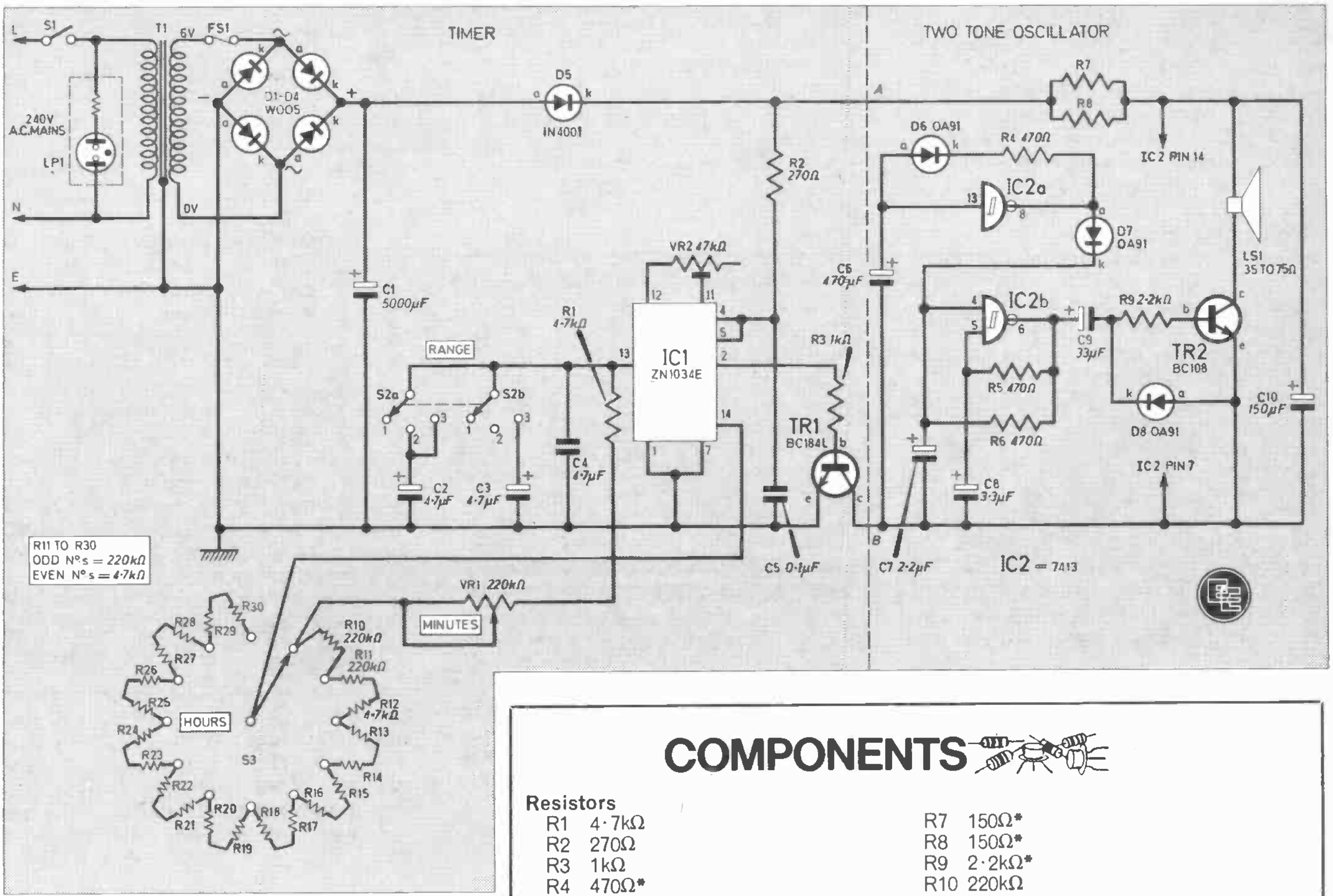


Fig. 1. Full circuit diagram of the Precision Timer. The two-tone oscillator section of the circuit is to the right of the dotted line and can be replaced by a different form of warning device connected to points *A* and *B*. Range switch S2 switches in extra capacitors doubling the time set in position 2 and trebling it in position 3. The extra capacitors are disconnected in position 1.

COMPONENTS

Resistors

R1 4·7kΩ
R2 270Ω
R3 1kΩ
R4 470Ω*
R5 470Ω*
R6 470Ω*
R7 150Ω*
R8 150Ω*
R9 2·2kΩ*
R10 220kΩ
R11 220kΩ
R12 4·7kΩ
R13, 15, 17, 19, 21, 23, 25, 27, 29 220kΩ ± 1% (9 off)
R14, 16, 18, 20, 22, 24, 26, 28, 30 4·7kΩ (9 off)
All ¼W carbon ± 5% unless otherwise stated

See Shop Talk page 705

Potentiometers

VR1 220kΩ carbon lin.
VR2 47kΩ skeleton horizontal preset

Capacitors

C1 5000µF 16V elect.
C2 4·7µF tantalum bead 16V
C3 4·7µF tantalum bead 16V
C4 4·7µF polyester
C5 0·1µF polyester
C6 470µF 9V elect.*
C7 2·2µF 9V elect.*
C8 3·3µF 9V elect.*
C9 33µF 9V elect.*
C10 150µF 9V elect.*
Several low value capacitors to trim C2 and C3 to exactly 4·7µF (see text)

Semiconductors

IC1 ZN1034E precision timer i.c.
IC2 7413TTL dual 4-input NAND Schmitt trigger*
TR1 BC184L *npn* silicon
TR2 BC108 *npn* silicon*
D1-D4 W005 50V 1A bridge rectifier
D5 IN4001 50V 1A silicon diode
D6, D7, D8 OA91 small signal germanium diode (3 off)*

Miscellaneous

S1 1A mains toggle
S2 2-pole 3-way rotary (2 poles from a 4-pole, 3-way switch)
S3 1-pole 12-way rotary
T1 mains primary/6V 500mA secondary
LP1 mains neon indicator
FS1 500mA cartridge fuse with chassis mounting holder
LS1 miniature loudspeaker, 35 to 75 ohms impedance*
Case, 230 × 110 × 170mm (case such as Verobox type 75-1412K would be suitable); 0·1 inch stripboard, one piece 18 strips by 42 holes, one piece 20 strips by 44 holes; small off-cut of 0·15 inch stripboard to mount bridge rectifier; three knobs; connecting wire; mains cable; 6BA nuts, bolts and insulated support pillars to mount circuit boards and other components in place.
*These components used only in two tone oscillator part of circuit (see text)

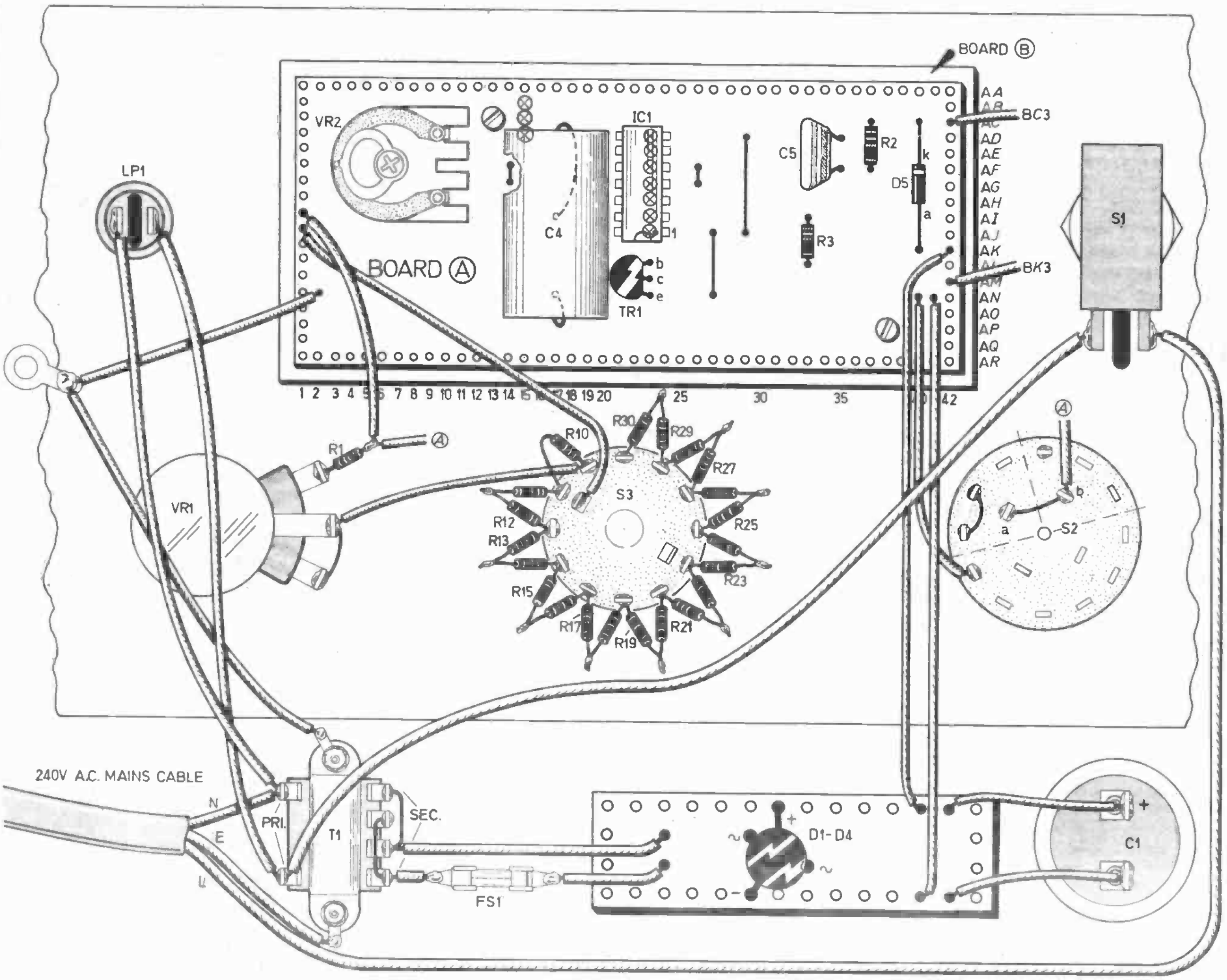
COMPONENTS approximate cost £18·00 complete

POWER SUPPLY

The power supply is conventional in design and the usual precautions of fusing and earthing should be taken, especially when you consider that the timer may be left for long periods unattended. The components chosen provide a more than adequate supply for the timer and the power is also available to operate a bleeper, should you decide to fit one.

The transformer specified is able to provide up to 500mA of current to the circuit, and a true value of FS1 should be no greater than this.

PRECISION TIMER



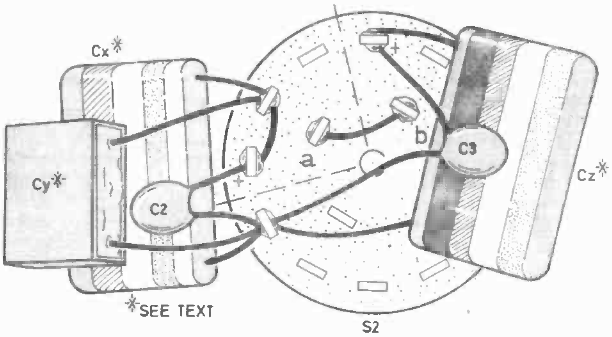
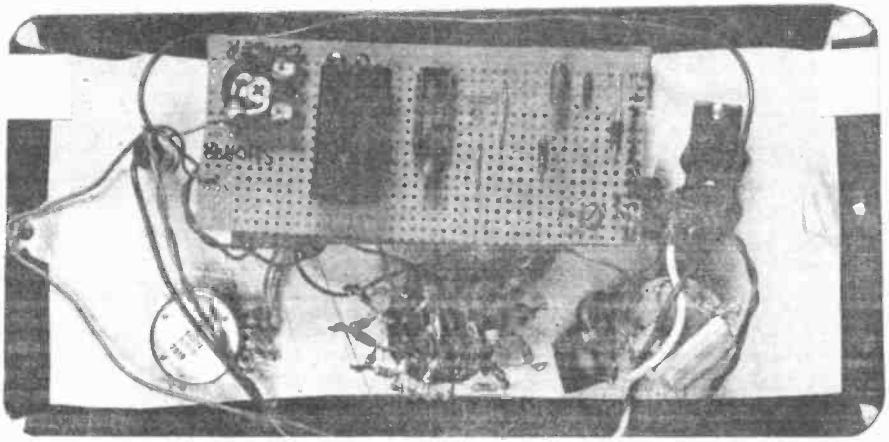


Fig. 2. Complete interwiring and component layout for Board A (Timer). Inset shows detailed wiring of S2. Note that Cx, Cy and Cz are trimming capacitors for C2 and C3 as explained in the text. Note that the two separate transformer secondary windings are shown connected in parallel. The breaks in the copper strip on Board A are shown by a ⊗ sign. There are ten in all.

CONSTRUCTION starts here



Close up view of the rear of the front panel showing circuit boards and controls in position.

CIRCUIT BOARDS

The majority of the circuit components are mounted on two pieces of 0·1 inch stripboard.

Board A (18 strips by 42 holes) carries the timer components and board B (20 strips by 44 holes) carries the two-tone oscillator. These are mounted one above the other on the rear of the front panel separated by plastic mounting pillars (see Fig. 2).

Drill the mounting holes as indicated. These can be used later to locate the correct position of the stripboards in the case. Break the copper strips where shown using a twist drill or spot face cutter.

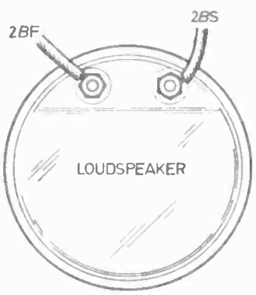
An i.c. socket for IC1 is virtually essential bearing in mind the cost of this device. Socket strips are especially easy to use. Solder the i.c. socket, wire links, preset, resistors and capacitors in place on board A.

Transistor TR1 is a BC184L type and this should be inserted last. Note that if a BC184 is used the leads are in a different order. Diode D5 should also be inserted at this stage. Finally the flying leads may be attached. Board B can also be assembled (Fig. 3).

CASE

Once the circuit boards have been completed, attention can be focused on the case. In the prototype a redundant plastic case size 230×110×170mm from another piece of electronic equipment was used. However a suitable alternative would be a Verocase type I number 75-1412K or the NJHC4 type from Watford Electronics. Neither of these cases are quite as deep as the prototype but this excessive depth is not necessary anyway.

Mark and drill the front panel to take the switches, neon indicator control switches and circuit boards.



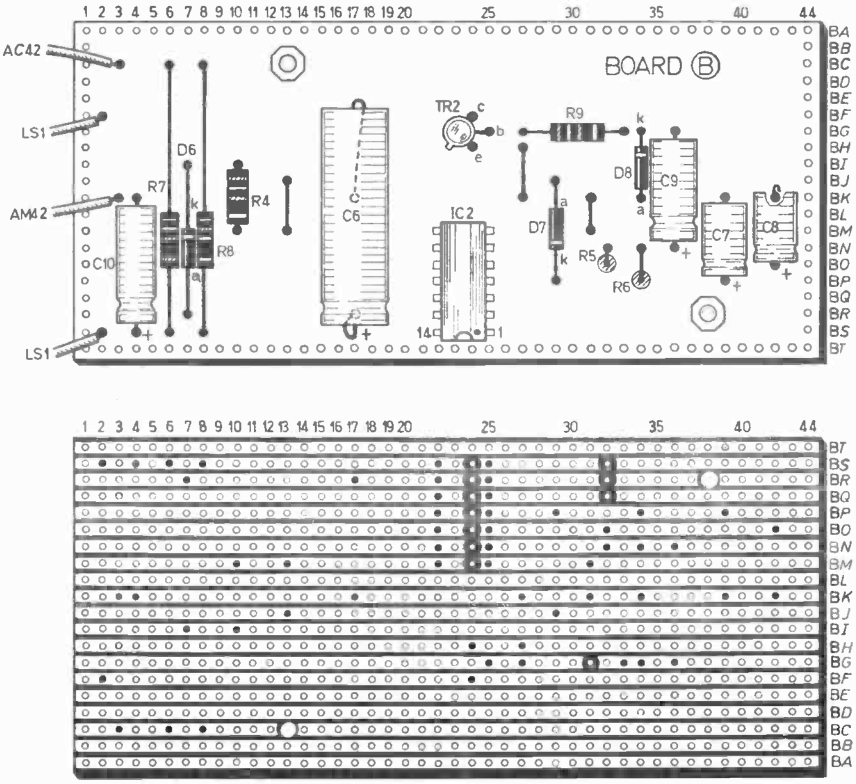


Fig. 3. Component layout for Board B (Two-tone oscillator). Board B can be replaced by another warning device connected to positions AC42 and AM42 if required.

These latter items should not be positioned too close to mains wires or components or you could get false triggering problems. Do not wire in VR1 at this stage.

Next solder the resistors indicated onto S3, trimming the wires to make them as neat as possible, but avoiding damage to the resistor bodies. Any other interwiring between front panel components and the circuit boards can also be completed at this stage.

The rest of the case should next be drilled to take the remainder of the off board components. Note that diode bridge D1-D4 is mounted on a small off-cut of 0·15 inch stripboard for ease of construction.

The unit is finished off by mounting the rest of the components in place and wiring them up to the rest of the unit as shown in Fig. 2. VR1 is still disconnected at this stage.

CALIBRATION

Potentiometer VR1 must first be calibrated to give accurate minutes settings. This should be done by using an ohmeter and whilst it may be possible to calibrate by trial and error when the timer has been built, that can be a very laborious process.

Start by soldering R1 in place, as shown in Fig. 4. Since 224·7 kilohms produces one hour of time, five minutes is achieved with a resistance of 18725 ohms. Using an ohmeter connected as shown in the diagram, mark the position of the knob at each of the resistances given in Table 1. This will give the precise calibration for each of the five minute intervals up to one hour.

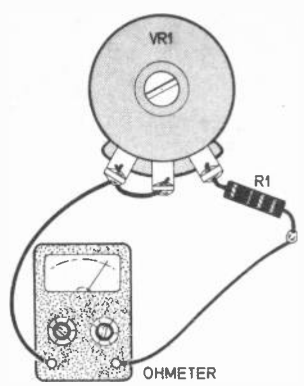


Fig. 4. Calibration circuit for VR1.

TABLE 1

Time (*minutes*)	*Resistance* (*ohms*)
5	18725
10	37450
15	56175
20	74900
25	93625
30	112350
35	131075
40	149800
45	168525
50	187250
55	205975
60	224700

Once calibration is completed VR1 and R1 can then be wired into the rest of the circuit.

SETTING UP AND TESTING

Turn the preset VR2 to a position about midway between its two extremes. Set S3 to zero hours and turn potentiometer VR1 fully anticlockwise. This reduces the total timing resistance to about 4·7 kilohms enabling a "short test" to be made.

Connect the power supply to the mains and switch on the timer. With the aid of a stop watch note how long it takes for the timer to activate. This should be exactly 76 seconds. Adjust VR2 until this is spot on.

Next switch S3 to the one hour position and check this for accuracy. Assuming the time period is not perfect, VR2 must now be adjusted to produce one hour.

A useful mathematical short cut here is to note the actual time period obtained at the one hour setting (x minutes). The number of seconds required for the short test time can now be calculated from the formula:

$$\text{seconds required} = \frac{76 \times 60}{x}$$

With the controls set at zero once again VR2 should now be adjusted until the "short test" time interval equals the "seconds required" calculated from the above formula. The other settings of S3 should also be checked.

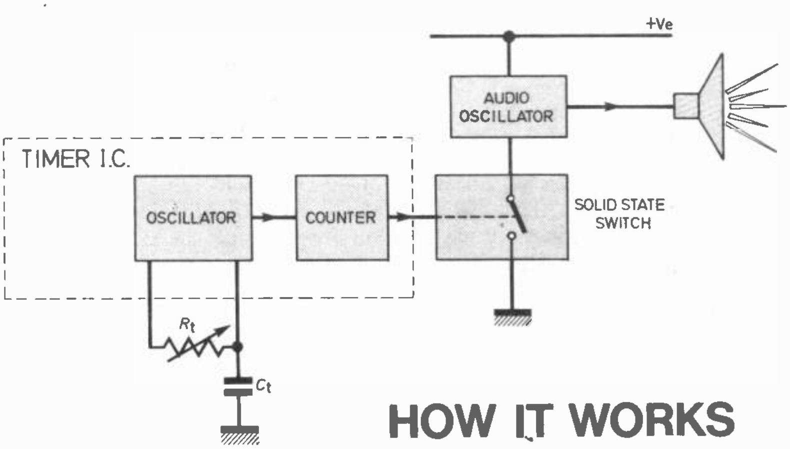
The calibration of VR1 should now be checked after the position of VR2 is finalised. When all is well label the scale clearly.

The accuracy of the range switch S2 can also be checked. In the prototype, capacitors C2 and C3 were tantalum bead types to save space. They were mounted on the tags of S2 with a spare tag being used as the earth connection.

Whichever type of capacitor is used for C2 and C3, it is unlikely to be identical in value to C4 and if accurate results are required the following steps may be taken.

Set VR1 to turn on the alarm after five minutes. With S2 set to the position 2, the unit should switch on after 10 minutes. If it does not you will have to solder low value capacitors in parallel with C2 until the time is exactly right.

Capacitor C3 is adjusted in a similar way.



HOW IT WORKS

The timer is based on a single i.c. This contains an oscillator whose frequency is governed by external timing components *R*t and *C*t. The timing period can be varied by altering the value of these components.

The output of the oscillator is fed to an internal counter. When this has counted 4095 pulses, the output of the chip is activated and this is fed to a transistor switch which in turn switches on an audible alarm.

In this case the alarm is a simple oscillator built around a 7413 chip. The timer is reset by interrupting the power supply.

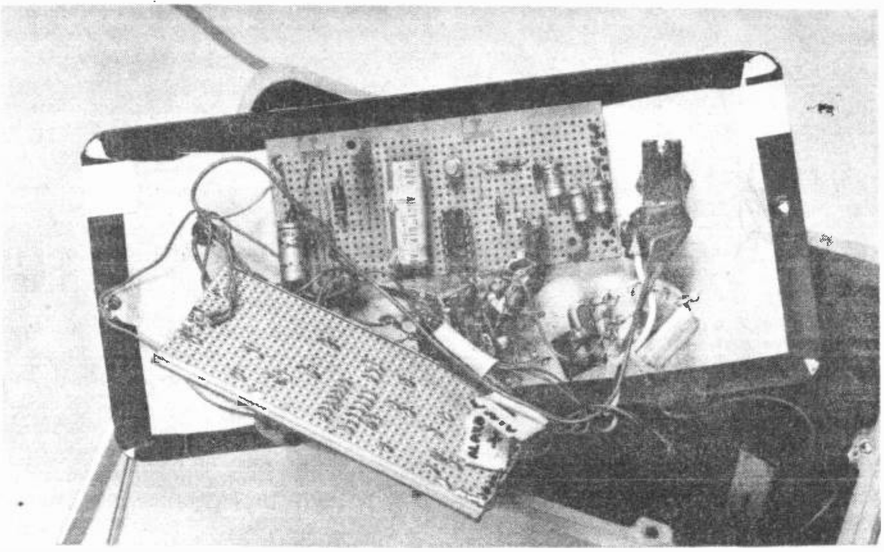
FAULT FINDING

While one always hopes that a project will work first time, a timer circuit which does not work is more frustrating than most. A little thought given to the tests made can save a great deal of time. Assuming the "short test" does not work, first recheck the stripboard for shorted tracks and dry joints. Check the positions of components and breaks in the tracks. Next check that the timing resistance consists of R3 alone—if necessary the timer i.c. may be removed, and an ohmeter used to measure the resistance between socket pins 13 and 14. With the controls at their minimum settings, this should be 4·7 kilohms.

Assuming all is well so far, replace the i.c., switch on and check the voltage between pins 5 and 7. This should be 5 volts. During the timing period the voltage on pin 2 is almost zero, and pin 3 about 3·5 volts. With the controls set as before, wait at least 2 minutes for the timing period to end and re-check these voltages. Pin 2 should now be about 3·5 volts, and pin 3 almost zero. If this section is working properly the fault lies in the output transistor section, or audio oscillator section.

OSCILLOSCOPE

An immediate indication of correct operation may be obtained if an oscilloscope is available. The input to the oscilloscope should be connected across the timing capacitor (C4), ensuring that the oscilloscope "earth" connects with the earth side of C4. Set the oscilloscope to 0·2 volts/cm, and the timebase to 1mS/cm, switch on the timer, and with its controls at their minimum settings, observe the screen. If all is well, the trace should show many waves as the voltage across the capacitor rises and falls. The longer timing periods may also be checked in this way, it being more convenient to switch off the timebase, and simply observe the dot pulsing vertically at regular intervals.



Rear of front panel showing Board A moved to one side to reveal Board B.

Once set up correctly, the timer should prove reliable and accurate, and will prove an invaluable aid to all those of us who continually "forget" the time, and miss an important event—perhaps through being too engrossed in the next project! ⌑

BOOK REVIEWS

ELECTRONICS—Build and Learn

Author R. A. Penfold
Price £2·80 Paperback
Size 215 × 135mm 104 pages
Publisher Newnes Technical Books
ISBN 0 408 004541

Followers of the E.E. Teach-In Series will feel quite at home with this book, for the pattern and purpose are similar. Planned for the absolute beginner, the text presents a short but thorough course extending from the basic circuit elements to complete circuits incorporating semiconductors and i.c.s.

The first chapter describes the construction of a Demonstrator Unit which is to be used for experiments described in the successive chapters to prove, in practical terms, the theory.

Useful hints on construction and soldering are given and this building task should not be beyond the capabilities of the average beginner. In fact, this constitutes all the actual "building work" in this book—for the subsequent experiments are performed simply by plugging in wires and components. The techniques of circuit construction, as used in practice everyday, are not covered in this book. The title may be a little misleading in this respect.

The Demonstrator Unit is very reminiscent of the EE Teach-In 80 Tutor Deck, though the use of Soldercon pins on the circuit board is not perhaps the ideal choice.

The second chapter introduces passive components, which are described in practical terms, along with the appropriate circuit theory. Simple circuits for setting-up on the Demonstrator Unit are included.

This pattern is followed in the remaining four chapters, dealing with semiconductor devices (discrete), op-amps, oscillators and radio circuits and pulse and logic circuits.

This well illustrated and nicely presented book will meet the requirements of the non-electronics person who wishes to get to grips with this subject in a comparatively painless way, and will be ideal for home study. Its author is a well known contributor to this magazine.

F.E.B

A GUIDE TO AMATEUR RADIO

Author Pat Hawker, G3VA
Price £2·40 Limp
Size 245 × 182mm 140 pages
Publisher Radio Society of Great Britain
ISBN 0 900612 50 9

The high standing of the hobby of amateur radio must owe quite a lot to the RSGB's impressive "recruiting sergeant" *Guide to Amateur Radio*. This publication now appears in its eighteenth edition (the first was published in 1933) and provides further testimony to the sustained interest in this hobby despite other possible counter attractions offered in the electronics field.

This edition of "the guide" incorporates details of the World Administration Radio Conference 1979, and states how the new regulations will affect amateur operations. New h.f. bands for the amateur will "present a rewarding challenge to amateurs . . . to exploit fully these new frequencies." There is no fear then that ham radio will become a stagnant or predictable pursuit. Hams have thrived on challenges: to design receivers, transmitters and aerials, and to apply such equipment diligently in making radio contact via frequencies previously little explored. These are the activities which have given amateur radio its great fascination and appeal over the years.

Everything today's would-be ham wants to know is to be found in this book: operating an amateur station; details of the licence examinations; theory of radio transmission and reception; constructional information with practical examples of home-built equipment. Every electronics enthusiast (whether he gets hooked or not) should have a copy in his personal reference library.

F.E.B.

Everyday News

TALKING SWITCHBOARD FOR THE BLIND

On receiving a prototype "Speaking Switchboard" from the National Research Corporation recently, the Chairman of the Royal Institute for the Blind, Mr Duncan Watson, said "This development will be very important to the many hundreds of blind telephonists around the UK."

About three years ago, NRDC became aware that the development of new telephone exchanges threatened the employment opportunities of the thousand or so blind people who are currently employed in the UK as telephone operators. These operators rely on tactile indicators to provide information.

The new telephone exchanges, however, use too little electric current to activate tactiles, and they also provide more information than earlier models. This information cannot easily be accessed using tactiles, and an alternative technique of providing data to the blind operators was therefore needed.

The Switchboard Advisory Module (SAM) was designed and developed at Imperial College with the support of the National Research Development Corporation (NRDC). It is an attachment for a Telephone Switchboard to enable a blind person to work as an Operator.

The main feature which distinguishes this from existing adaptions for blind telephonists is that it uses a synthesised voice to "speak" to the Operator. Essentially this voice conveys the same information which a sighted telephonist would observe from the lamps on a switchboard console.

The unit itself is connected by a cable to the Operator's console. It uses a microprocessor to continuously monitor the state of the lamps and keys on the console. The lamps provide information on switchboard traffic and the position of keys indicates the Operator's actions. With this information the system is able to follow an Operator's progress through the handling of each call.

The microprocessor is also used to control the voice synthesiser which presents audible prompts to inform the Operator of such things as impending traffic, the correct keying of extension digits, and the status of extensions if required. Letter abbreviations are used to represent specific relevant words eg "E" for engaged.

Safe Call

After two years' engineering and market research, Plessey's have produced, they hope, a vandal proof payphone featuring visual readout of amount inserted, push-button dialling and coin validator. The PP2000, as it is known, was selected by British Telecom from other British and foreign designs as part of their modernisation drive.

The weakest part, the handset lead, is clad in flexible metal tubing. The main body case is stainless steel claimed to resist vigorous attack by sledgehammer, crowbar and chisel and, if under attack, a 999 emergency call is automatically originated.

Technically the new payphone is microprocessor controlled and has a liquid crystal display and automatic coin validator (to detect fraud) and refunds any change due after completion of a call. It also automatically reports when the cash box is getting full.

The latest De La Rue desk-top MPU-controlled banknote counter and verifier counts both loose and bundled banknotes at the rate of 100 every four seconds.

Sealed for Life

Battery manufacturer Chloride has developed a sealed-for-life battery which needs no periodical "topping up". It uses a lead-calcium alloy for the plates resulting in a decreased water loss and an improvement in cold-starting performance.

Bring Back the Trolleys

With their low energy consumption and lack of pollution, trollybuses are making a comeback on the streets of Czechoslovakia.

It is claimed that power consumption has been reduced by using thyristor switching and that trial runs have shown a saving of up to 30 per cent.

ANALYSIS

BEATING THE BADDIES

More than two million people a year in the UK are found guilty by the courts of offences of all types ranging from murder to petty crime. Add in all the offences which escape conviction and we have a dreary picture of social life which has so far defied reasonable explanation by educationalists, social scientists, the clergy, the police and welfare workers. It is no consolation that this phenomenon is worldwide.

Electronic security equipment in all its forms must by now be the biggest growth sector in the industry. While deploring the necessity we shall all be grateful to the new Post Office programme to re-equip all public payphones with a new model which, as well as being better technologically, is as vandal-proof as human ingenuity can achieve.

Plessey Telecommunications was the successful bidder for the public call box re-equipment programme and the PP2000 payphone plus a share in a renters version could result in £125 million of business in the UK alone, not counting exports, over the next five years or so.

Intruder alarms are now almost universal in business premises but there is still a huge as yet untapped market for houses. Then there is the personal panic warning alarm, a tiny radio transmitter worn like a wrist watch and no larger, which can be used as an anti-mugging device.

Another novel idea is to use an ordinary TV set to automatically examine the identity of a caller through CCTV. When the caller rings the door bell his or her picture appears on the screen, interrupting the programme.

The converse is also true. Many criminals, both full professionals and amateurs, enlist electronics as a tool of the trade.

In fact one wonders how the electronics industry would survive without crime. If crime didn't already exist in increasing measure perhaps it would have to be invented.

Brian G. Peck.

Weather Buoy

The replacement of weather ships, which are considered expensive to man and operate, may soon be possible if the first results of an experimental satellite data collection platform (DCP) are confirmed.

The equipment was installed on a buoy by McMichael Ltd, a subsidiary of GEC, and is moored off the Isle of Wight. Data is collected, processed and stored from the on-board sensors and at regular time intervals is transmitted back to home base in Slough via satellite, satellite receiving station in West Germany and then by Telex.

A wide-beam aerial on the buoy mast ensures that data is still transmitted even during rough weather, which was simulated in trials by using a buoy with a shortened keel.

Such data buoys can be moored anywhere in the world, including large lakes and inland waters, whilst the user receives his information at the home base.

Such has been the interest in these experiments from Europe that the Dutch Water Authority have asked for an extension to the trial period whilst they undertake some of their own measurements.

Sailing by MPU

A merchant sailing ship with sails automatically adjusted by microcomputer has been developed in Japan as a potential energy saver. An auxiliary diesel engine comes into use only when there is insufficient wind or if it is so strong that the sails have to be furled.

The ship, reported as the 699 ton *Shin Aiboku Maru*, is on proving trials in Japanese waters.

DISCO NEWS

After many months of bad news coming upon more bad news in terms of the recession hitting the disco industry, it is good news indeed that disco retailer, Roger Squire's is fighting back with the announcement of more shop openings in 1980.

Their latest offering is a new Squire's Disco Shop in Ilford, Essex. The premises, located at 415 Ilford Lane, utilises around 2,000 square feet with roughly half the space devoted to showroom display and the rest of the space being allocated to Service facilities and Stockroom areas.

Britain's major electronics and aerospace companies are all enjoying overall growth, high exports, increased turnover and full order books despite the world recession in trade.

Pay-TV Coming

The Government is considering allowing Pay-TV systems to be operated in the UK by cable companies. Radio Rentals has already declared interest.

Pay-TV will allow subscribers to view the latest feature films for a fee. Similar systems have proved popular with viewers and profitable for companies in the USA.

Russian Robots

The USSR is planning extensive use of industrial robots. They will be introduced during the next two five-year plans up to 1990.

The programme is expected to benefit the West in terms of sales of control systems and know-how, at least in the early stages.

A device intended to protect radio controlled models from unwanted interference, the PP1M 4CH "Fail-safe" made by Chromatronics of Harlow, played a key part in a scene from Southern Television's highly successful Worzel Gummidge *series, in which Saucy Nancy, played by Barbara Windsor, appeared to zoom through the streets at high speed.*

The secret of Saucy Nancy's "magic" propulsion was a radio-controlled trolley concealed under Miss Windsor's voluminous garments, and the "Fail-safe" device was designed to prevent the trolley (and Miss Windsor) from careering out of control in the event of some unforeseen interference.

Saucy's Magic

RADIO WORLD

By Pat Hawker, G3VA

Neither Open nor Shut!

The recent Home Office decision that users of model control equipment, metal detectors and pipefinders will be freed from the need to have their equipment licensed is surely a valuable breakthrough: for the first time it becomes possible in the UK to use short-range radio transmission with a minimum of formalities. But does this dispensation include garage-door openers and vehicle security systems? Recently I asked a Home Office senior official whether these could now be legally used in the UK. Off the cuff he was unable to give me a direct yes or no.

This lack of precision seems to extend to industry. One firm advertises a theft warning system based on a small transmitter but adds in very small print "no licence available in the UK". But another, with a 400-yard "computerised" garage door unit now being sold in the UK, claims: "it is fitted with British-made radio controls which have been approved by the Radio Regulatory Division of the Home Office" and uses a "long wave frequency".

Personally, I remain thoroughly confused!

Television in 1990

By the time these notes appear the 1980 International Broadcasting Convention at Brighton will be over. But I have been taking a sneak preview by looking through the 80 or so technical papers to see what changes are being forecast for home entertainment this decade.

Indeed the opening session is devoted to high-class futurology, even though one still gets the impression that engineers see in their crystal balls those things they would like to happen, without much thought on whether we ordinary mortals will be able to afford to buy them.

The other day I walked past a large car parked outside a West End hotel. In the back seat the waiting chauffeur was comfortably watching a small-screen TV set. But on the basis of this incident it would be rash to forecast that in a few years time every car, as a matter of course, will carry TV! I remember that in the early 1950s several British firms marketed special TV sets for cars, but the demand turned out to be very small indeed.

Electronic Living

At IBC '80 Michael Butler of Philips painted a picture of home viewing in 1990. Every room had its set:

"The parents can watch remotely-controlled TV in bed. The children are playing TV games in one child's bedroom and there is a combined TV, radio and cassette recorder in the other.

Downstairs there is a large projection TV receiver in the lounge. A home terminal for information in the study, while in the kitchen and garage there are other terminals displaying recipes and how to repair the car".

To fill these screens he postulates national TV broadcasts; satellite broadcasting including European services; video recorders; video record players; video games; a home video camera; teletext; viewdata; Telesoftware (turning a teletext receiver virtually into a home computer by broadcasting the software programs). Nothing in his list is not already at an advanced stage of development and he omits such items (standard by 1990?) as a two-way radio console; a room fitted up for "surround sound" listening; and there is no sign even of stereo on his TV sets. The bookcase seems to be filled with video discs rather than those "old-fashioned" information providers called books.

Maybe it will all happen, maybe not—though I am sure the set makers hope there will be such a market for their products!

Better TV Audio

An Engineer from Philips of Sweden described work (the sets are already marketed in the UK) on improving the quality of TV sound in the home, including the use of a compact loudspeaker in a bass-reflex enclosure and tweeter, an improved demodulator that gets rid of video buzz on sound, an internal 10-watt amplifier plus outlet sockets for a tape recorder or an external hi-fi amplifier. It is claimed that the market has responded very positively and that other firms are improving audio quality in their latest sets.

The European Broadcasting Union has been studying various techniques for providing stereo sound on TV, with sufficient channel separation (i.e. absence of crosstalk) to allow the system to be used also to provide two different languages in mono. Since 1978 there have been dual-channel transmissions in Japan using an "f.m./f.m." system with the extra sound channel carried on a subcarrier at twice line-frequency.

In West Germany there are already experimental transmissions using a "double carrier" system and a regular public service is to start at the time of the German Broadcasting Exhibition next year. The German trials seem to show that the double carrier system is very effective, even when used with receivers having "intercarrier" sound (as almost all u.h.f. receivers do in the UK). It is claimed that the extra cost in a receiver would be low.

In Japan, NHK engineers have developed a 1125-line high-definition-video TV system, though it needs a video bandwidth of some 20 to 30MHz. Even the engineers concerned admit "high-definition TV in the 1980s is at present the dream and vision of broadcast engineers".

One suspects that the only real chance of this type of TV would be in some future satellite system on frequencies much higher than 12GHz, since that band (at least in Europe) has already been defined in terms of the 625-line system. Alternatively, it could come with cable systems based on glass fibres.

More likely would be its use in a new generation of video cinemas: a number of people have commented on the lack of resolution of the pictures projected in some of the small cinemas currently using video techniques. Again, one remembers the efforts of a firm called High-Definition Films almost 30 years ago to produce films using 1000-line video.

Another long-awaited development is also forecast at IBC'80 in the form of a really lightweight ENG (electronic news gathering) camera based on a single pick-up tube yet providing broadcast quality pictures. Colour cameras of this type are already available for closed-circuit applications, and now the Sony engineers seem fairly confident that a broadcast camera is on its way.

Prestel and the Future

I see that Mr Richard Hooper, director of British Telecom's computerised public information service "Prestel" has urged British industry to "keep faith" in the future growth of the system. He has reminded industry of past occasions on which Britain's commercial nerve has failed when faced with projects that have reached the stage of "early, slow advance before sales accelerate".

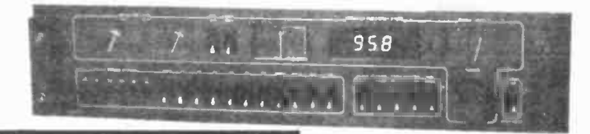
Certainly he has highlighted a very real problem: how to introduce a quite expensive system at a time when business and individuals are looking for ways of cutting rather than increasing their outgoings.

One cannot be surprised that some people are now looking a bit grim when anybody mentions Prestel. Despite massive promotion of the system, including many full-page advertisements in the "quality" press, the number of people using Prestel remains low: not much above 5,000 at the time of writing and that figure seems to include British Telecom's own terminals and those of the "information providers".

This is all a long way from some of the grandiose claims and forecasts made by the Post Office (now British Telecom) in the early days. If one looks back at some of the market research forecasts, it does suggest that this is still far from a definitive craft.

The broadcast teletext systems are doing rather better with getting on for a 100,000 decoders now in use in UK homes and a recognised social need for improving the service of subtitling programmes for the benefit of the deaf and hard of hearing.

Complete Audio/Tuner Kits



Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

Mark III A series	'Reference series' tuner modules	........£171.35 inc.
Mark III B series	'Hyperfi' modules, with switched IF BW, pilot cancel decoder	........£198.95 inc.

A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W-100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works.
Only one version of this item: Complete kit ....£178.25 inc. Carr. £5.

Preamplifier

More features and facilities, thanks to DC switching and control design

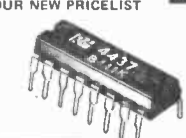
Previewing the most comprehensive audio preamplifier yet...... DC switching of 7 inputs, plus two tape in/outs. 2 low pass, 2 high pass active filters, genuine volume related loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. Suitable for bus/remote control, tape dubbing, switched monitor etc. 80dB S/N+, THD -75dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Semiconductors

Radio/Communications ICs

FOR COMPLETE LISTINGS – SEE OUR NEW PRICELIST

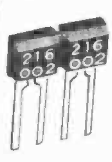
CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16



SL1610	1.84	SL1626	2.80
SL1611	1.84	SL1630	1.86
SL1612	1.84	SL1640	2.17
SL1613	2.17	SL1641	2.17
SL1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

VARICAP DIODES........
A section from our PL:

BA102	0.35	16:1 ratio AM tuning	
BB204	0.41	KV1215 9v triple	2.93
BB105	0.41	KV1211 9v dual	2.01
BB109	0.31	KV1225 25v triple	3.16
MVAM2	1.93	BB212 9v dual	2.25



POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

2SK133	120v N-ch 100W MOSFET	£6.33	2SJ48 Pch complement	£6.33
2SK135	160v N-ch 100W MOSFET	£7.29	2SJ50 Pch complement	£7.39
PA101B	Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)			

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC. 30mW out (amplifyable) -£2.30 inc
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555,NE556, etc

Coming Soon..........

Contain yourselves, RF fans ! Not yet ready for a full launch until autumn, but previewed here:-

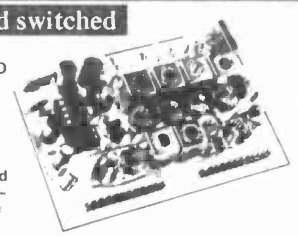
SSB transceiver system : 10kHz to 1000MHz !!

A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP. 0.2uV basic sensitivity in HF, Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

Radio/Audio/Communications Modules

LW-MW-SW-SW DC tuned and switched

91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands
MW/LW: £15.58 +1SW £16.73



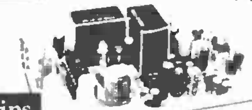
VHF Tunerheads

Europes largest stock range for broadcast and communications. Probably also the world's – details in the catalogues and PL. Specials are also supplied in the region 30-220MHz.

Pilot Cancel PLL Stereo decoders

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output

944378-2 £26.45

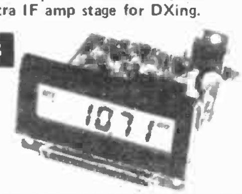


Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system)
Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

Various digital frequency displays

The World's largest range of receiver DFMs is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility. 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75



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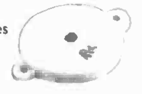

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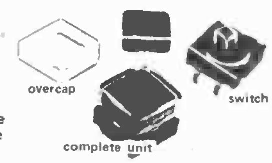

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TRANSISTOR TESTER

BY R.A. PENFOLD

MANY transistor tester designs have been published in the past, but when one considers that a number of transistors are employed in most electronic constructional projects, it is easy to see why this should be. Apart from testing newly purchased devices prior to use, a transistor tester can be extremely useful when trouble shooting on modern electronic equipment.

For amateur use there is normally no need for a complicated transistor tester which provides highly accurate measurements of numerous parameters. The cost of such a unit could not be justified in most cases, and a simple tester that will provide a rough idea of the gain of the test transistor is a much more practical choice.

The unit described in this article falls into the above category, and it has the unusual feature that no meter is used. This substantially reduces the cost of the unit. Also, the finished tester requires no adjustment or calibration, unlike most other transistor checkers.

BASIC PRINCIPLE

An ordinary bipolar transistor has three terminals and these are called the base, emitter and collector. A transistor will not conduct between its collector and emitter terminals unless a small bias current is fed into its base. This base current causes a much larger current to flow between the collector and emitter terminals and in this way a transistor provides current amplification. The current gain of a transistor is equal to the collector current divided by the base current.

A simple circuit configuration which can be used for d.c. transistor current gain (h_{FE}) measurement is shown in Fig. 1. Here the variable resistor is adjusted to produce a predetermined level of collector current, and the meter is used to monitor the level of collector current. The base current that flows is inversely proportional to the resistance of the variable resistor,

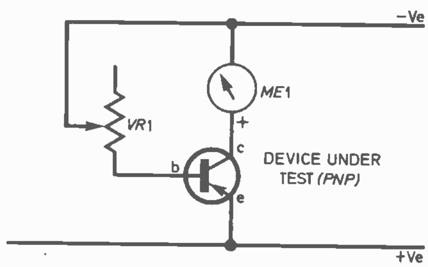


Fig. 1. Simple transistor tester circuit.

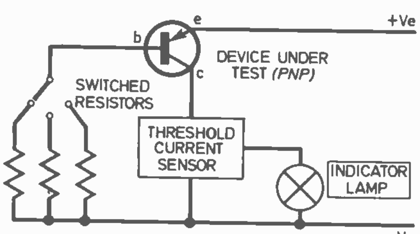


Fig. 2. Transistor tester with threshold current sensor.

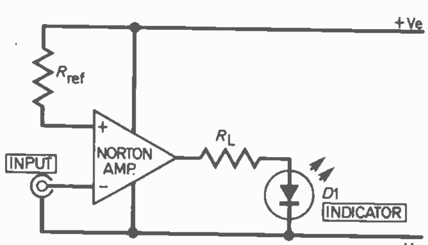


Fig. 3. Theshold current sensor based on a Norton Amplifier.

provided the supply voltage remains reasonably stable. Thus, if this control is always adjusted to produce the same level of collector current when making a measurement, it can be fitted with a scale calibrated directly in h_{FE} values.

There are three main drawbacks to this simple arrangement, one of which is the relatively high cost of a suitable meter. Another is that it is necessary to have a sensitive multimeter in order to calibrate the unit properly. Lastly, the scale tends to be well spread out at the high value end and extremely cramped at the low value end.

THRESHOLD CURRENT

All three problems can be overcome by using the arrangement shown in Fig. 2. The variable resistor has been replaced by a series of switched fixed value types, and the meter has been replaced by a threshold current indicator. The latter is simply an electronic device which switches on an indicator lamp if it is fed with a current which exceeds some predetermined level.

The principle of this system is very simple. Assume, for example, that the circuit has a threshold current of 2mA and that two of the resistors have their values chosen to produce base currents of 10 and 20 microamps. If the indicator lamp comes on when the 10 microamp base current is used, but not when the 20 microamp one is applied, this indicates that the test device has a current gain of between 100 and 200 times.

This must be so since a 20 microamp base current produced a collector current of 2mA or more, and this necessitates a gain of at least 100 times ($20\mu A \times 100 = 2{,}000\mu A$ or 2mA). A $10\mu A$ base current produced a collector current of less than 2mA, which means that the test device must have a gain of less than 200 as $10\mu A \times 200 = 2{,}000\mu A$ or 2mA.

A practical circuit has numerous switch positions so that the gain of the device under test can be gauged to within reasonable limits. The resistor values are chosen so that the gain threshold figures are sensibly spaced out, and the scale cramping which occurs if a potentiometer is used is thus avoided.

The fact that a precise h_{FE} value cannot be obtained is usually of no consequence, and most simple transistor testers have rather poor resolution in this respect. In practice a very precise reading is not needed in order to show whether or not a device meets its specification. Transistors are only guaranteed to have h_{FE} values which fall within very broad limits and, for instance, the popular BC108 transistor can have a gain of between 125 and 900 at a collector current of 2mA.

The circuits of Figs. 1 and 2 are for testing *npn* devices. The same circuits can be used for checking *pnp* devices, but the supply polarities must be reversed.

CURRENT INDICATOR

A Norton amplifier is used as the basis of the threshold current indicator. This type of amplifier has two inputs; a non-inverting (+) one and an inverting (−) one. If the current flow into the non-inverting input is significantly higher than the flow into the inverting input, the output voltage becomes virtually equal to the positive supply rail voltage. Conversely, if the inverting input current is higher than the non-inverting input current, the output assumes virtually the negative supply rail voltage.

The inverting input is connected to the positive supply rail via a resistor, R_{REF} which has its value chosen to produce a current flow equal to the required threshold current, see Fig. 3. This causes the output to be normally low, and the l.e.d. is not supplied with a current until the test device passes a current which exceeds the threshold current. The output then goes high, the l.e.d. is supplied with power through current limiting resistor R_L, and it lights up in consequence.

PRACTICAL CIRCUIT

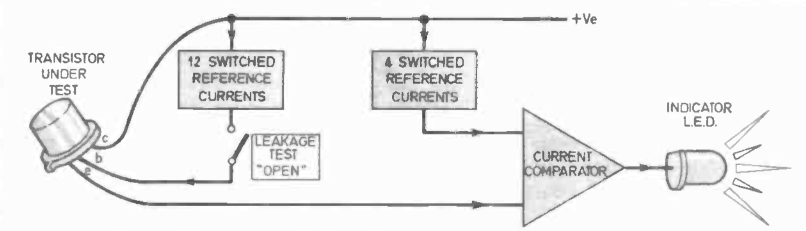
The complete circuit diagram of the tester appears in Fig. 4. It is based on an LM3900N i.c. which actually contains four Norton amplifiers. The three unused amplifiers have their inverting input connected to the positive supply rail through R19. This is merely done in order to reduce the current consumption of the unused amplifiers, and results in a total reduction of about 3mA.

Depending upon the position of S3, the inverting input of the used amplifier is biased by R13, R14, R15, or R16, and these provide threshold currents of 2μA, 20μA, 200μA, and 2mA respectively. The 2mA reference current is used when measuring current gain.

The other three are used to give some idea of the leakage current of the device under test. This is the current which flows between the collector and emitter terminals of a transistor even when there is no base current. For silicon transistors this current will normally be extremely small (a fraction of a microamp), but for germanium devices it can be of significant proportions. This is dealt with more fully in the section dealing with use of the tester.

D1 is the front panel l.e.d. indicator and R18 is its current limiting resistor.

Resistors R1 to R12 provide twelve possible base currents with the desired resistor being selected by means of S1. They provide h_{FE} threshold

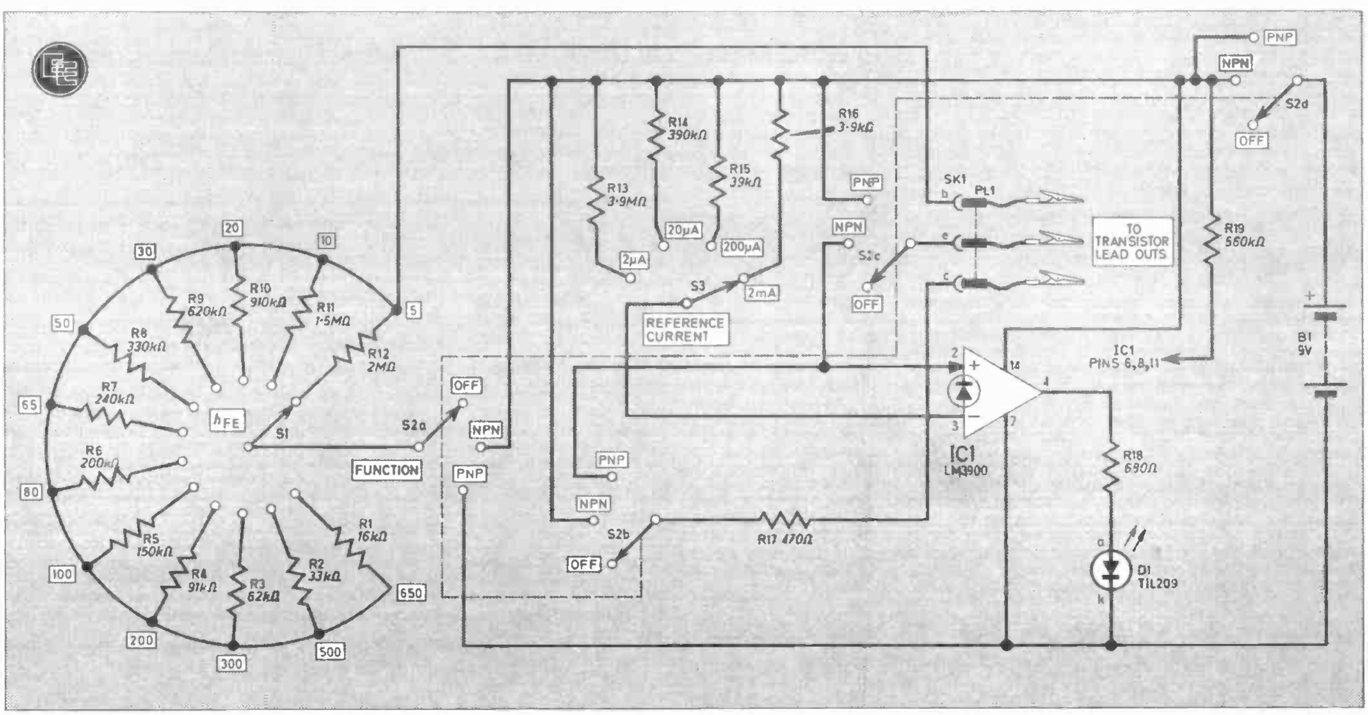


HOW IT WORKS

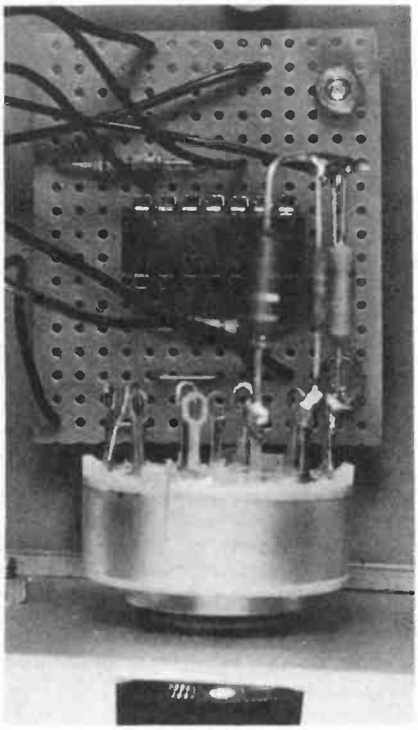
A transistor should pass only a small current through its collector and emitter terminals (base unconnected). The tester compares this current with four reference currents and operates a lamp if this "leakage current" is the larger current. This shows if there is an excessive leakage current.

Twelve reference currents can be applied to the base of the test device. This causes an amplified current to flow into the tester for comparison with a reference current. Each of the twelve reference currents represents a level of amplification, and if the lamp comes on it shows that the device has a higher gain than the selected level. This enables an estimation of the device gain to be made.

Fig. 4. The full circuit diagram of the Transistor Tester.



TRANSISTOR TESTER



Close up view of the topside of the circuit board with S3 above.

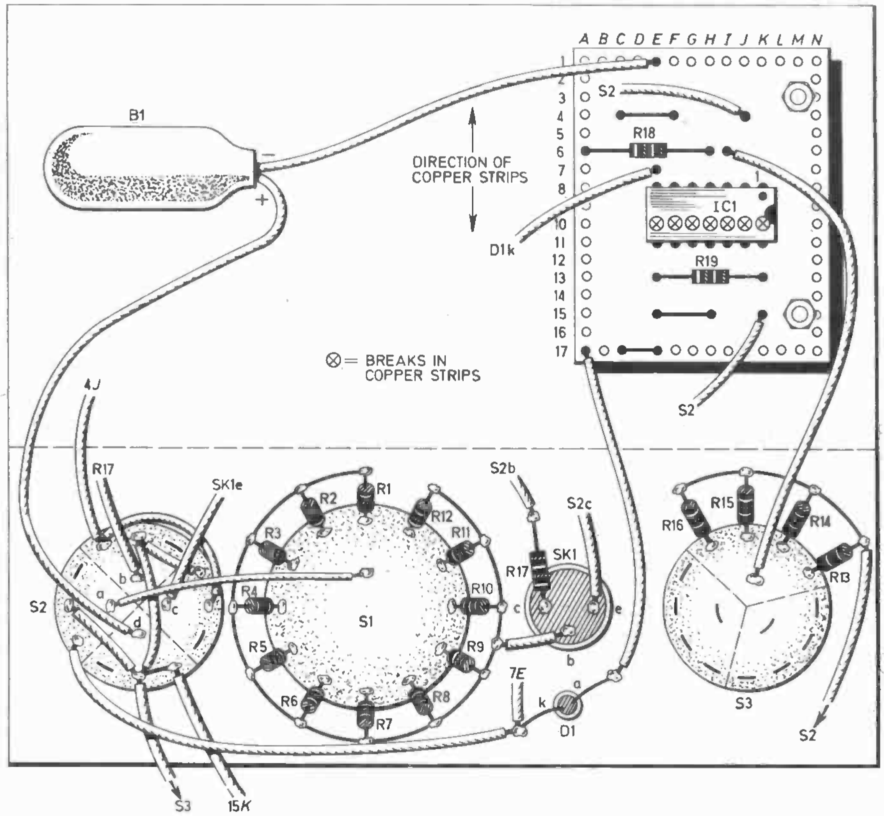
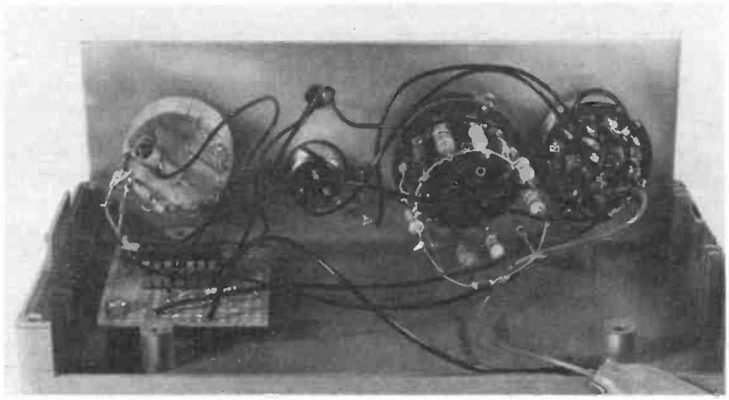


Fig. 5. Circuit board layout and component interwiring. Note the breaks on the underside of the circuit board, there are seven in all.



View of the interior of the unit seen from the rear.

COMPONENTS

Resistors

R1	16kΩ	R11	1·5MΩ
R2	33kΩ	R12	2MΩ
R3	62kΩ	R13	3·9MΩ
R4	91kΩ	R14	390kΩ
R5	150kΩ	R15	39kΩ
R6	200kΩ	R16	3·9kΩ
R7	240kΩ	R17	470Ω
R8	330kΩ	R18	680Ω
R9	620kΩ	R19	560kΩ
R10	910kΩ	All ¼ watt carbon ±5%	

Semiconductors

IC1 LM3900N quad Norton amplifier
D1 TIL209 or similar l.e.d. with panel mounting clip

Switches

S1 12-way 1-pole rotary switch
S2 4-pole 3-way rotary switch
S3 3-pole 4-way rotary switch (only one pole used).

Miscellaneous

SK1 3-pin DIN socket
PL1 3-pin DIN plug
B1 9V type PP3
Stripboard: 0·1 inch matrix, 14 strips × 17 holes; control knobs (3 off); case, Verotype III (202-21041C) or similar size 154 × 85 × 60mm; PP3 battery connector; crocodile clips (3 off).

See Shop Talk page 705

COMPONENTS approximate cost £8

levels of 5, 10, 20, 30, 50, 65, 80, 100, 200, 300, 500, and 650 respectively. The values of these resistors may seem to be slightly on the low side, but this is necessary in order to compensate for the base/emitter voltage developed across the test transistor, and for the fact that the inverting input of a practical Norton amplifier tends to be a little more sensitive than the non-inverting input.

S1 is the function switch and one pole of this (S2d) provides on/off switching. The other three poles are for *npn/pnp* switching, and they simply reverse the emitter and collector terminals so that the supply polarity is appropriate to the type of device being tested. They also ensure that the base bias is of the correct polarity.

NPN MODE

There is a slight flaw in this arrangement in that in the *npn* mode the current sensor is fed with the emitter current (which is the sum of the collector and base currents) rather than the collector current. This obviously results in some loss of accuracy on the lowest gain settings of S1 when the unit is used in the *npn* mode, but in practice this is not really of any consequence.

Resistor R17 is a current limiting resistor and is needed to protect both the non-inverting input of the Norton amplifier and the device under test from passing an excessive current.

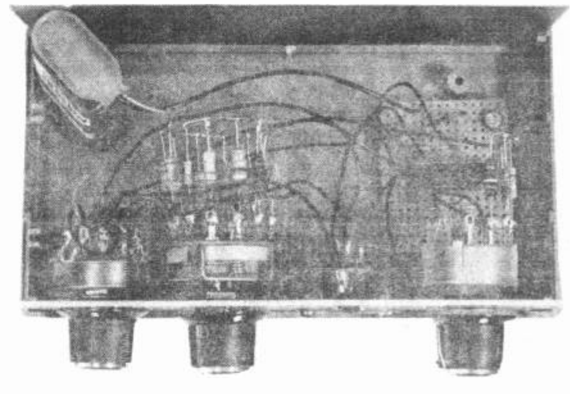
CONSTRUCTION starts here

CASE

A type III Verocase, size 154 × 60mm, makes a good housing for the unit, but any case of about this size should be perfectly suitable. The general layout of the tester is not critical. Only three of the components are wired up on a small piece of 0·1 inch matrix stripboard and the rest are wired to the switches and output socket. This wiring is all detailed in Fig. 5.

Make the breaks on the underside and solder the components in place. Attach suitable lengths of flying leads to reach the off board mounted components. Next prepare the front panel to accept the switches, socket and l.e.d. and interwire as shown. Finally secure the board in place and connect the flying leads. The output socket is a three-way DIN type.

Most of the wiring is quite straightforward and should not be difficult provided the component tags and resistor leadout wires are tinned with solder prior to making connections. If a 2 megohm resistor proves to be difficult to obtain, R12 can consist of two 1 megohm resistors connected in series.



Completed tester with lid removed.

USING THE UNIT

Many small signal transistor leadout wires will readily fit the three way DIN socket, but in order to test power types and certain small types it will be necessary to make up a set of test leads. These merely consist of a three-way DIN plug to which three short crocodile clip leads are connected. The leads should be of different colours for identification purposes.

Before connecting a transistor to the tester S1 should be set to NPN or PNP, as appropriate. Initially only the collector and emitter leads are connected, and if the device being tested is a silicon type, D1 should not come on with S3 at any of its four settings. If it does, the test device is probably faulty.

GERMANIUM DEVICES

Germanium transistors have comparatively high leakage currents, and D1 may well come on with the threshold current at 2 or 20μA. It is also possible that a functional device will cause D1 to switch on with the threshold current set to 200μA, especially if it is an output type. However, if this does occur, any gain reading that is obtained will be somewhat higher than the true figure.

In order to make a gain measurement S1 is switched to the 2mA position and the base test lead is connected to the device being tested. S1 is then adjusted to find the range in which the h_{FE} of the test device lies. If the indicator is off, then the gain of the test device is less than the value represented by that switch position. If the l.e.d. is on, the gain is equal to or higher than the value represented by that position.

POWER DEVICES

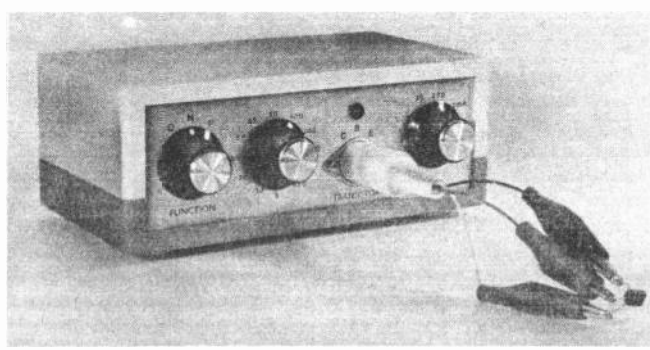
It is difficult to test power transistors using a simple transistor tester as power devices are designed to operate at fairly high collector currents.

The gain of a transistor varies somewhat with changes in collector current, and for normal types h_{FE} increases with rises in collector current. This tester measures gain at a collector current of only 2mA, and may give a rather pessimistic reading for some power devices. Also, power transistors tend to have higher leakage currents than low power types, although this should still be no more than a few microamps for a silicon type.

The unit will normally be able to indicate whether or not a power device is functional, but beyond that results cannot be absolutely relied upon for accuracy.

A rough check can be made on diodes and rectifiers by connecting the anode to the emitter test lead and the cathode to the collector test lead. The indicator lamp should come on with S2 at the PNP setting, but not when it is in the NPN position.

When testing silicon devices the setting of S3 should be irrelevant. However, germanium devices have lower reverse resistances, and this will probably result in the lamp coming on with S2 in either position when S3 is set for a 2μA current, and possibly also when it is set for a 20μA reference current. ¤



LETTERS

Gas Sentinel

Whilst applauding the *Gas Sentinel* (E.E. April 1980) as a safety device I feel you have made a serious omission in the section "Location of Sensor".

The gases being monitored i.e. propane, butane, methane, etc. are heavier than air and therefore tend to collect at the lowest point of the area being monitored, the bilges of a boat or the floor of a caravan for example. In a house any gas leakage will find its way into the space beneath the floorboards therefore the sensor unit should be positioned in the lowest possible position and with the sensor upright as the heaters main purpose is not to improve sensitivity as such but to create an airflow through the TGS head by creating convection currents.

The main unit should be positioned as high as possible and use a spark-proof sounder to avoid igniting the gas if present.

Could you also verify that it is possible to increase the number of detector heads by repeating the circuit from SK2 to S3 (mute). This would enable several areas to be monitored simultaneously.

R. A. Thomas,
Cowes, I.O.W.

You are quite right to point out that many gases are heavier than air and tend to accumulate initially at floor level. In many cases it may be a good idea to position the sensor near to floor level, in order that an earlier warning of a gas build-up may be achieved.

I did overlook this aspect in my text and I thank you for taking the trouble of pointing this out.

However the gas detector head should be positioned somewhere where it will be reasonably protected against knocks and other mechanical damage. Also, in marine applications, care needs to be exercised to ensure that the TGS unit will not be drenched in water or liquid fuels, etc.

In caravans it makes sense to position the detector cell low down, near to floor level, but in any case adjacent to gas appliances. Again due consideration must be given to the possibility of physical damage arising accidentally, or eventual blockage of the sensor due to dust and dirt accumulating on the mesh window.

Your next point relates to the purpose of the heating element within the TGS detector. Without this heater, the semiconductor assumes a resistance of at least 100 kilohms, and does not noticeably react to any change in ambient gas levels. By heating the tube to several hundred degrees centigrade the semiconductor oxidises, and the resistance drops dramatically to about 4 to 5 kilohms. Sensitivity is then greatly increased and the detector reacts sharply to increased gas content in the surrounding air, as the gas chemically reduces the semiconductor element. The same sort of principle is used in many types of industrial explosimeters.

I would think that the convection currents to which you refer have only a very minor effect, if any, upon the operation of the TGS sensor. The heater may however assist to a limited extent in drawing air through.

For this reason the user can disregard convection currents and there is certainly no need to mount the remote sensor upright with the window facing uppermost. The Gas Sentinel is equally effective when you mount the detector on a vertical surface.

Regarding the positioning of the main unit. The audible warning device specified is fully solid-state, with no arcing contacts (unlike conventional electro-mechanical buzzers, of course); the device therefore represents no risk as far as igniting gas is concerned.

If you set up the sensitivity control (VR1) properly, the alarm system will operate well before a gas level of explosive proportions can arise. At this stage there should be no danger at all of igniting gas from sparks arising in alarm bells, buzzers, relays, etc.

Should you wish to be absolutely safe, if you decide to use an additional alarm then I agree a sparkproof sounder must be used. I would recommend the utilisation of a piezo-electric siren.

A. R. Winstanley.

Lights Failure Monitor

Whilst I would congratulate C. R. Birrell on the ingenuity and simplicity of his design, I do question the practicability of the installation layout.

The instructions and connection diagram presuppose that most cars have individual feed wires from the appropriate switch to each bulb. In point of fact it is more usual, if not universal, to use the "loop in" method, that is one feed wire for each service from the fuse box to the near side rear lighting cluster then onwards to the off-side cluster, and similarly for the front lights.

As few of your readers intending to construct this project would be prepared to rewire the entire lighting system for that purpose only, may I suggest an alternative layout. Instead of trying to instal the D5A-J diodes as near as possible to the display, put both them, and their associated TR1 and R2, near to each monitored bulb and take a lead from each emitter and collector back to the monitor unit which can now contain in one small box, D1, D3, D4, R1 and the l.e.d. for each monitored bulb as well as the test facility.

One advantage of this arrangement is the enormous reduction of rewiring under the instrument panel, rarely a pleasant place to conduct such activities.

I see no reason why this otherwise excellent design cannot be extended to include direction indicators, main beams and number plate light.

A. J. Soame
Sprowston

In contrast to the published article, my "power silicon diodes" (D5A-J) were all positioned at convenient points in the wiring, that is where each "loop wire" separated from the harness to run to its appointed lamp, effectively about one foot from each.

I required only two supplies from the dashboard, that is a positive supply and earth. The other fourteen wires pass straight through the dashboard to the DIN plugs. This part of the assembly I found easy.

I considered monitoring of the direction indicators unnecessary. When an indicator lamp fails, the current through the flasher unit is reduced. This in turn alters the frequency of the operation and/or the on/off periods in the cycle of operations. The tell-tale indicator warning lamp on the dashboard will display this malfunction.

Excluding the courteous head-light flash, I have always considered that the use of "main beam" is for dark country roads and empty carriageways on motorways and trunk roads. A lamp failure in these conditions would be self evident in the form of reduced visibility.

Consequently these two features were omitted to reduce the project cost. Monitoring of the number plate lamps however I feel is a good idea. *C. K. Birrell.*

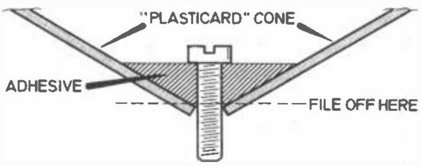
It is possible that Mr Soame and other readers have become a little confused by our suggestion added to Mr Birrell's article to install the "power diodes" D5A-J as near to the display unit as possible.

Most cars do in fact use the "loop in" method of wiring as Mr Soame describes, so obviously the optimum place to put the diodes is going to be quite close to the lamps. However it is to the best advantage in terms of money saved and possibly accessiblity not to have the diodes any closer to the lamps than is absolutely necessary.

This is what we meant by placing the diodes as close to the display unit as posible.—Ed.

Weather Cone

I am very interested in your current project the *Weather Centre* having made a rather cruder version than Mr. Judd's a few years ago. However, one aspect of the anemometer causes me some concern as it is in many respects of size and material similar to the one I made and I found it caused interference to TV signals, i.e. fading, the effect being not unlike the one given by a low aircraft. This was very noticeable at low wind speeds and affected a neighbours set at a distance of 30 metres or so, my "gear" being about 15 to 20 degrees offset from direct "line of fire" of his aerial.



I got round the problem by using p.v.c. (?) sheet, the trade name being "Plasticard" as far as I remember, available from most model shops in a variety of thicknesses. It is not as strong as aluminium sheet but I found it quite adequate.

I don't remember what gauge I bought but it's very easy to use, the shop had the adhesive to go with it. I enclose a sketch of my anemometer cups, see drawing.

The cone is made as per aluminium cone except scissors were used to cut the shape. Glue seam with adhesive (special). Block hole in apex and "puddle" in some adhesive (I think I used "Cataloy" resin or possibly "Araldite" as the "puddle").

When set use coarse file to "flat" the point, drill through adhesive to accept screws, nuts and washers as required. More adhesive can be put over screw head as extra security if required.

D. Daniels,
Kilburn, Derbys

I Can't Do Maths!

BY GEORGE HYLTON

DON'T DESPAIR. THIS FOUR-PART SERIES PROVIDES A GUIDE TO BASIC CONCEPTS

1 - WORDS AND ARITHMETIC

THE Red Queen questioned Alice about her educational achievements:

Can you do addition?

Yes.

What's one-and-one-and-one-and-one-and-one-and-one?

Well, er, I don't know. You see . . .

Can't do addition!

Carroll in real life was an Oxford don who taught maths. His works are full of mathematical jokes. This one makes the point that even the simplest arithmetical task—adding one to one—becomes impossible to a human being if he is asked to do it too quickly. A computer, of course, would have no trouble—and in Carroll's day there was much talk of computers, mechanical ones like Charles Babbage's Analytical Engine.

From the point of view of this article, however, the significant word in the Red Queen's arithmetic test is the word "and." It obviously means "add" or "plus". The *words* "one-and-one-and-one" mean the same thing as the symbols "1+1+1".

Other words can also be translated into mathematical instructions. If you can do the translation it makes maths easier to understand. I'll begin with a story.

A certain Arab died, leaving as his fortune 31 camels. His will was simple: "To my son Ali, half of my camels; to my daughter Yasmin, a quarter; to my brother Ahmed, an eighth; to my nephew Musa, a sixteenth; and to my niece Jamila, a thirty-second." He also left a note saying that in case of difficulty his family should consult his wise friend Suleiman.

The family puzzled over the will. How could they divide the 31 camels into two, to give Ali his halfshare? Half of 31 is $15\frac{1}{2}$. What use is half a camel? A quarter of 31 is $7\frac{3}{4}$. What use is three-quarters of a camel . . . and so on.

So they consulted Suleiman, who reflected on the problem then said: "Friends! I have but a single camel, but I give it to you to add to your thirty-one. Now you can divide your inheritance. Half of 32 is 16; a quarter is 8; an eighth is 4; a sixteenth, 2; and a thirty-second, 1. Take your inheritances. You will find that having taken them there is one camel left. Perhaps you would be good enough to give that one to me!"

Which shows that Suleiman was a wise old bird, as befits his name. (Suleiman is the same as Solomon, a figure noted for his wisdom in Muslim, Jewish and Christian societies alike.) But the story shows something else, too.

It shows that the expression, in words "half of thirty-two" means "half times thirty-two" or $\frac{1}{2}\times 32$. This may not be very apparent, put like that. Why "times"?

It becomes clearer when a basic rule of oridinary arithmetic is brought to bear on the problem. This is the rule which says that 4×3 is the same as 3×4, and so on. When numbers have to be multiplied it doesn't matter which one you begin with. The answer is always the same: $4\times 3=12$, but $3\times 4=12$ also.

Apply this rule to the case in hand and you can see that $\frac{1}{2}\times 32=32\times\frac{1}{2}$. Now, "$32\times\frac{1}{2}$" makes sense. Thirty-two halves make sixteen "wholes". This proves that in expressions like "half of 32" the "of" means "times". Half of $32=\frac{1}{2}\times 32=32\times\frac{1}{2}=16$. When you see "of" in an arithmetical instruction something has to be *multiplied*. When you can't quite see how to do it, use the "$4\times 3=3\times 4$" dodge, and very often it will look simpler.

Another word that crops up in mathematical statements is "per". Most commonly it is seen in "per cent." This means "per hundred". If, for example, you have to pay value-added tax at 15 per cent, then for every hundred pence you spend another fifteen pence is added to your bill.

To work out the VAT you can divide the amount you spend by 100, to see how many hundreds of pence there are then multiply this figure by fifteen to work out the tax.

If the goods you buy total £5, then there are five lots of 100p and each lot incurs 15p tax, so the tax comes to $5\times 15=75$p. Writing the same thing down in figures,

$$\text{Total tax}=\frac{£5\cdot 00}{100}\times 15=\frac{500\text{p}}{100}\times 15=5\text{p}\times 15=75\text{p}$$

So to work out a percentage you must first divide by 100, then multiply by the figure for the rate—in this case, 15. The "per" in "percentage", "per cent", "%", etc, means "divide". Whenever you see a "per" in a mathematical statement such as the figures in a performance specification it shows that something has to be divided.

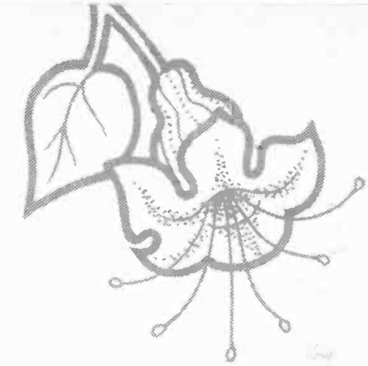
If you are thinking of buying a multimeter, for example, you'll find that the performance "spec." for the sensitivity of the meter is usually expressed in "kilohms per volt".

A common figure for a good meter is twenty kilohms per volt, usually written "20kΩ/V", where the "/" means "per". The meaning, in this case, is that on the "1-volt" range the meter has a resistance of 20kΩ; on the 10V range its resistance is 200kΩ, and so on.

"Per volt" here means just "per 1V" so the arithmetic is easy. Instead of dividing by 100 then multiplying by the rate as you do when calculating percentages, with "per voltages" it is only necessary to divide by 1 before multiplying by the rate.

Since dividing anything by 1 leaves it unchanged the arithmetic is simple, Let's take an example. If a meter sensitivity is 20kΩ/V and it has a 30V range then on that range its resistance is:

$$\frac{30\times 20\text{k}\Omega}{1}=30\times 20\text{k}\Omega=600\text{k}\Omega$$



SOIL MOISTURE MONITOR

BY A.R.WINSTANLEY

THOSE of us with green fingers know exactly when to water potted plants, and how much water to pour on without drowning the plant.

This device has partly a novelty value, but also definitely does give some indication of when the soil that it is measuring is "wet" or "dry". It may therefore help to give more consistent and successful results, assisting those who don't have much luck with potted plants.

The unit comprises a small case with two "probes" protruding outwards. The probes are pushed into the pot-plant soil and a push button is pressed. One of two lamps, one red and the other green, will then illuminate to indicate if the soil is dry or wet respectively.

One advantage is that this unit does actually measure the soil several inches below the surface; this is obviously better than just going on the appearance of the soil surface alone.

CIRCUIT DESCRIPTION

Only seven electronic components, plus a battery and switch, are required in this simple design and the full circuit is shown in Fig. 1. Most of the work is done by IC1, a cheap and readily available 741C op-amp.

This has two inputs. Pin 2 has the negative symbol and is called the inverting input, pin 3 is the non-inverting input and is marked with a positive sign.

The variable resistor VR1, is wired between the supply lines and its wiper is connected to the inverting input. The setting of VR1 therefore determines the voltage at pin 2, and this can be altered from +9V to 0V.

At the non-inverting input we have the same sort of thing. The two probes, when inserted into soil, in effect form a resistor. The value of this "resistor" is dependent upon the moisture within the soil: the more moisture there is, the lower the value of this resistance.

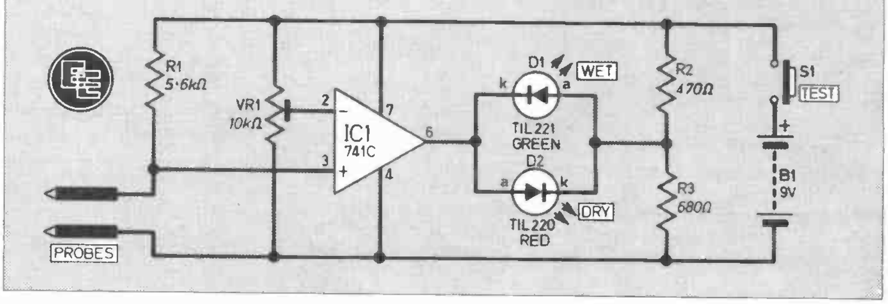
The "soil resistor" together with R1 forms a potential divider, the output of which goes to the non-inverting input of IC1. As the value of the soil resistance decreases (the water content increases) then the voltage at pin 3 gradually moves towards the 0V supply rail, and vice versa.

COMPARATOR

The operational amplifier in this application compares the voltage at the two inputs.

In fact it is used as a comparator here, and it amplifies by a very large factor (many thousands) the voltage difference between the two input terminals. In effect this means that when the voltage at pin 3 exceeds that at pin 2, the output is high (nearly 9V). Similarly when the potential at pin 3 is less than that at

Fig. 1. Circuit diagram of the Soil Moisture Monitor.



pin 2, the output is low, approximately 0·5V.

Assuming that VR1 is at mid-position, when the soil is wet, we can say that the voltage at pin 3 will be lower than at pin 2. Therefore the output of IC1 is low. Current can therefore flow through R2 and D1, and "sink" into the output pin causing the green l.e.d. to light up. This is labelled WET.

Similarly with dry soil, the high resistance of the soil ensures that pin 3 is at a greater voltage than pin 2. The output pin therefore swings high, and it allows current to flow through the red l.e.d. D2 and R3 to 0V lighting up the diode. This is labelled DRY.

Only one l.e.d. can glow at a time: when one l.e.d. is forward-biased (therefore illuminated) the other l.e.d. is reverse-biased and cannot light up.

By adjusting VR1, the switching point of the op-amp can be controlled. This effectively means that you can alter the unit to signal WET or DRY at your own desired levels of moisture content. This can be worked out over a period of time.

The circuit operates from a 9V PP3 battery. Power is only applied when S1 is pressed to take a reading, and so battery life should be long.

CIRCUIT BOARD

Assembly of this unit is relatively simple, although to the absolute novice it may be just a little fiddly. This is because the components are soldered on a rather small piece of 0·1 inch pitch stripboard measuring 6 strips × 18 holes.

The component layout is shown in Fig. 2. There are seven breaks to be made in the copper strips and these should be made before assembly starts. For IC1 use an 8-pin d.i.l. socket so that the i.c. will not be damaged by overheating during soldering. The order of assembly is not important but joints should be firm and bright.

A Bimbox type BIM2002/12 houses the unit. This handy-sized box measures 100×50×25mm. The stripboard then slots into vertical p.c.b. guides moulded into the interior of the case.

Any other plastic case can be used, although it may be necessary to find some other means of fixing down the stripboard. For example, a longer piece could be used, the excess being drilled to take standard mounting hardware and spacers.

FINISHING OFF

The case should next be drilled and off-board components mounted in position. Flying leads made of flexible stranded wire should be connected in accordance with Fig. 2.

It is important that the case is drilled such that there is room inside for the battery and switch once the stripboard and l.e.d.s have been positioned.

The two probes are made of 4BA threaded brass rod about 120mm long. Connections to the probes are made by solder tags placed under the mounting nuts within the case.

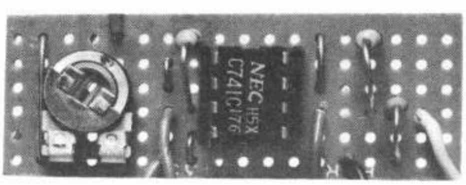
The two light-emitting diodes can be secured in position with either an appropriately-coloured lens-clip or a standard plastic fixing clip.

Finally the battery can be held in place with double-sided tape or a small adhesive foam pad.

SETTING UP

With construction completed, set VR1 to approximately midway, connect up a battery and press S1. The red l.e.d. should glow. Bend the two probes together at their tips so that they short together: the red lamp should extinguish and the green l.e.d. illuminate.

If this happens the unit is ready to use. Set VR1 to give the desired switchover point of the two indicators. Here it may prove useful if you have some small containers of soil available. The individual samples should have various levels of water content, ranging from dry to saturated. It should then be possible to eventually adjust VR1 until a desired sensitivity is obtained.



Close up view of the components in place on the circuit board.

Interior of the case. Note the solder tag connections to the probes.

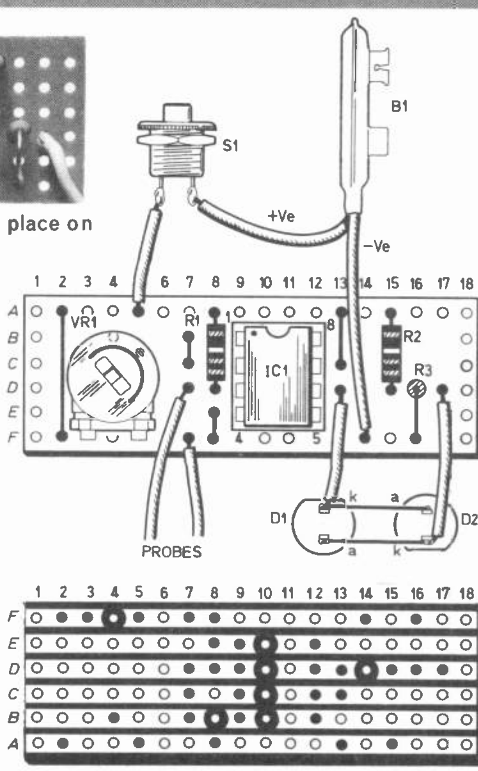


Fig. 2. Stripboard layout and interwiring diagram.

COMPONENTS

Resistors
R1 5·6kΩ
R2 470Ω
R3 680Ω
All ¼W carbon ±5%

See **Shop Talk** page 705

Semiconductors
IC1 741C 8-pin d.i.l. operational amplifier
D1 TIL221 0·2 inch green l.e.d.
D2 TIL220 0·2 inch red l.e.d.

Miscellaneous
VR1 10kΩ miniature horizontal skeleton preset.
S1 single-pole push-to-make, release-to-break
B1 9V type PP3
0·1 inch matrix stripboard: 18 holes by 6 strips; case, 100 × 50 × 25mm, Bimbox BIM2002/1 or similar; battery connector; 4BA fittings, threaded brass rod for probes; 8 pin d.i.l. socket; connecting wire; mounting clips for D1 and D2.

Guidance only Approx. cost **£5** excluding case

WORKSHOP MATTERS

By Harry T. Kitchen

Hibernate or Hobby

Now that the summer days are almost over, the thoughts of many of us will be turning to the matters that will occupy our minds over the weary winter months. There is much in favour of hibernation, particularly to those of us who have been toiling long and arduously for our monthly pay slips.

But what of those with active minds? They will be planning their leisure activities when howling gales, frost or snow, keep them firmly indoors. Let us not be sluggardly. Let us join them!

Welcome the Newcomer

Many of you reading this magazine will be newcomers to electronics and may be looking for advice on how to start. All hobbies require tools, so let us start with these, and assume you have none at all.

Tools come in all sorts of guises, and at all sorts of prices, and you may be tempted to buy the cheaper items. Stop. Think. These tools could well have to last you a lifetime, and so most of the cheaper ranges can be dismissed.

Buy the best you can afford; they will be an investment. If you go for a "household name" tool you will rarely go wrong. Such firms cannot afford any bad publicity and so their quality control is high. This is more than can be said of a lot of imported tools, particularly those from certain undefined areas of the Far East.

So, having accepted the need for the highest quality tools, what precisely do we need?

Basic Tool Kit

A basic tool kit must contain at least two screwdrivers, a pair of pliers, a pair of wire cutters, a soldering iron, and, of course, solder. Two screwdrivers? Yes. One, with a small blade for the traditional "grub" screws, the other with a wider blade for larger screws.

A quick measurement of screwdrivers to hand shows tip widths of 2·5mm and 6mm; say ⅛in and ¼in for those not yet metricated. The dimensions are for guidance only.

The pliers should be fine needle nosed types which, if held up to the light, do not show any light at all, the sign of good close, parallel jaws. Such pliers will enable work to be done on fine wires, and will also make excellent heat-shunts if clamped firmly onto any wire that has heat applied to it—a transistor "leg" for instance—so preventing overheating of any component at its extremity.

The fine needle nose can be pushed amongst tightly grouped components to insert or winkle out as necessary, to adjust wires, and to generally act as an extension of your good hand on a tightly populated circuit board.

The wire cutters should also show no light through their jaws if checked as the pliers were. This is most essential, for if the jaws are not exactly parallel they will not cut the fine wires we can expect to find. They should have fairly small jaws so that they can be inserted into areas where space is at a premium, though there are special wire cutters which will be dealt with later on.

The soldering iron will have to be one of those known somewhat off handedly as "general purpose". This implies one with a element rated somewhere between 15 Watts and 25 Watts, with a bit having a diameter around 2mm to 3mm.

Such an iron will enable the beginner to tackle a fairly good range of work, but as the sphere of interest grows, so too will the number of soldering irons. Screwdrivers, pliers, and cutters, too, come to think of it.

Advancing Tool Kits

Having acquired the basic tool kit, we can now begin to explore further afield.

Additions to our screwdrivers ought to include screwdrivers with blade widths of around 4mm and 7mm. Then, too, we ought to invest in a pair of cross head screwdrivers; Phillips set the standard, but this is now obsolescent, with the Posidriv system taking over. Whilst basically similar, there are differences; two, a small and medium should suffice, but if funds permit, a larger, screwdriver could be added.

Apart from blade form, i.e. straight and cross head, screwdrivers also come in a selection of shaft lengths, and it is wise to duplicate some, possibly even triplicate those you use most. Thus we could well end up with a "chubby" screwdriver with a short shaft, a medium shaft, and a long shaft for screws sited in cunningly inaccessable places. It is also possible to purchase plastic screw holders which hold a screw firmly in place, at the end of the screwdriver, until it can be started, and these may be worth looking at.

In addition to the needle nosed pliers already considered, further additions can now be made. A duck-bill plier has a wide, flat nose—hence the name—and will soon be almost indespensible.

Also in this category come the round nose pliers, having jaws of a circular cross section, tapering to a point. These are exceedingly useful for bending wires into circles, ready for inserting over a screw. A pair of heavy electricians pliers is useful for all the rough work that may be found, but having serrated jaws will mark all soft materials it may be used on.

Our fine wire cutters are fine—for just that. For anything exceeding the diameter of component leads, prudence dictates the use of a separate, and sturdier, pair of cutters. For work on very heavily populated circuit boards, a pair of cutters with the cutting edges set at the ends of a longish pair of jaws is invaluable.

Soldering

To our general purpose soldering iron should now be added two others; a small iron of around 10 to 12 watts with a small diameter bit for use on very fine work, and one of very large capacity with suitable bit for heavy duty soldering. For work on i.c.s having IGFET input stages, a low voltage iron, run off a transformer, is ideal as the leakage currents are so much lower; whatever the power source, the iron should be guaranteed to be a low leakage type.

There is little to choose between modern solders as all are excellent, but the gauge of solder used is important. For general purpose work around 18 s.w.g. is ideal, whilst for very fine work a gauge as fine as 24s.w.g. may be necessary, and one of around 12s.w.g. for heavy duty soldering.

The constitution of solders varies according to application, but a 60/40 solder is normal for general purpose work. This is one where the proportions of tin and lead are 60:40. Components that get hot require a high melting point solder, and there the proportions are 40:60.

Modern tools are without doubt better than older ones, even as recent as 20 years ago. Designers have used ergonomics to provide a high degree of user comfort. What more could one want than the wherewithall with which to buy them?

"Ah well, back to the drawing board"

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Positive resist 75cc	£1·67	Eurobreadboard	£6·56 net
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SINCLAIR PRODUCTS New 10MHz scope £145, pfm200 £51·95, case £2·07, adaptor £4·20, connector kit £13·95. Microvision tv £89, adaptor £6·88. pdm35 £34·23, adaptor £4·20, case £2·07. dm350 £76·70, dm450 £102·17, dm235 £55·55, rechargeable batts £8, adaptor £4·28. case £9. enterprise prog calculator + accessories £19·95. TG105 £87. Bench frequency counter £150.
COMPUTER GAMES Chess champion 6 £49·95. Chess challenger 7 £79. New Sensory chess challenger 8 £119. Atari videocomputer £129. cartridges £14·85.
TV GAMES AY-3-8550 + kit £9·26. AY-3-8600 + kit £12·98. stunt cycle chip + kit £20·95. Colour generator kit £9·95.
IC AUDIO AMPS with pcb. JC12 6W £2·50. JC20 10W £3·54.
BATTERY ELIMINATORS 3-way type 6/7½/9v 300ma £3·45. 100ma radio type with press-studs 9v £4·77. 9+9v £5·98. car convertor 12v input, output 4½/6/7½/9v 800ma £3·64.
BATTERY ELIMINATOR KITS 100ma radio types with press-studs 4½v £1·64, 6v £1·64, 9v £1·64, 4½—4½v £2·30, 6+6v £2·30, 9+9v £2·30. stabilized 8-way types 3/4½/6/7½/9/12/15/18v 100ma £3·12, 1Amp £7·80. stabilized power kits 2-18v 100ma £3·12, 1-30v 1A £8·10, 1-30v 2A £14·52. 12v car convertor 6/7½/9v 1A £1·62.
T-DEC AND CSC BREADBOARDS s-dec £3·79, t-dec £4·59, exp 4B £2·64, exp300 £6·61, exp350 £3·62, exp 325 £1·84.
BI-PAK AUDIO MODULES s450 £27·90, AL60 £5·62. pa100 £19·24. spm80 £5·26. bmt80 £6·06. stereo 30 £23·94. AL30A £4·53.

SWANLEY ELECTRONICS
Dept. EE, 32 Goldsel Rd., Swanley, Kent
Post 35p extra. Prices include VAT unless stated. Official and overseas orders welcome. Lists 27p post free. Mail order only.

BI-PAK SEMICONDUCTORS,

TRANSISTORS

Type	Price
AC126	£0·23
AC127	£0·23
AC128	£0·22
AC128K	£0·30
AC132	£0·23
AC134	£0·23
AC137	£0·23
AC141	£0·25
AC141K	£0·35
AC142	£0·23
AC176	£0·21
AC176K	£0·30
AC178	£0·29
AC179	£0·29
AC180	£0·23
AC180K	£0·32
AC181	£0·23
AC181K	£0·32
AC187	£0·23
AC187K	£0·32
AC188	£0·23
AC188K	£0·32
AD140	£0·69
AD142	£0·98
AD143	£0·86
AD149	£0·69
AD161	£0·40
AD162	£0·40
AD161/162MP	£0·81
AF124	£0·35
AF125	£0·35
AF126	£0·35
AF127	£0·37
AF139	£0·40
AF186	£0·58
AF239	£0·47
AL102	£1·38
AL103	£1·36
AU104	£1·61
AU110	£1·61
AU113	£1·61
BC107A	£0·09
BC107B	£0·10
BC107C	£0·12
BC108A	£0·09
BC108B	£0·11
BC108C	£0·12
BC109A	£0·09
BC109B	£0·10
BC109C	£0·12
BC147	£0·08

Type	Price
BC148	£0·08
BC149	£0·08
BC157	£0·12
BC158	£0·12
BC159	£0·12
BC167	£0·14
BC168	£0·14
BC169	£0·12
BC169C	£0·12
BC170	£0·10
BC171	£0·10
BC172	£0·10
BC173	£0·10
BC177	£0·18
BC178	£0·18
BC179	£0·18
BC180	£0·29
BC181	£0·10
BC182L	£0·10
BC183	£0·10
BC183L	£0·10
BC184	£0·10
BC207	£0·13
BC208	£0·13
BC209	£0·10
BC212	£0·10
BC212L	£0·10
BC213	£0·10
BC213L	£0·10
BC214	£0·10
BC214L	£0·10
BC227	£0·18
BC238	£0·18
BC251	£0·17
BC251A	£0·17
BC301	£0·32
BC302	£0·32
BC303	£0·32
BC304	£0·44
BC327	£0·18
BC328	£0·17
BC337	£0·17
BC338	£0·17
BC440	£0·35
BC441	£0·35
BC460	£0·44
BC461	£0·44
BC477	£0·23
BC478	£0·23
BC479	£0·23
BC546	£0·12
BC547	£0·12
BC548	£0·12

Type	Price
BC549	£0·12
BC550	£0·16
BC556	£0·16
BC557	£0·15
BC558	£0·14
BC559	£0·16
BD115	£0·58
BD116	£0·92
BD121	£0·75
BD124	£0·81
BD131	£0·40
BD132	£0·40
BD133	£0·46
BD135	£0·44
BD136	£0·40
BD137	£0·40
BD138	£0·41
BD139	£0·41
BD140	£0·41
BD155	£0·92
BD175	£0·69
BD176	£0·69
BD177	£0·78
BD178	£0·78
BD179	£0·86
BD203	£0·92
BD204	£0·92
BDY20	£0·92
BF457	£0·43
BF458	£0·43
BF459	£0·44
BF594	£0·35
BF596	£0·32
BFR39	£0·28
BFR40	£0·29
BFR79	£0·32
BFR80	£0·32
BFX29	£0·25
BFX30	£0·35
BFX84	£0·25
BFX85	£0·28
BFX86	£0·29
BFX87	£0·25
BFX88	£0·25
BFY50	£0·20
BFY51	£0·20
BFY52	£0·20
BFY90	£0·95
BIP19	£0·44
BIP20	£0·44
BIP19/20MP	£0·92

Type	Price
BRY39	£0·51
BU105	£1·84
BU105/02	£2·24
BU204	£1·61
BU205	£1·61
BU208/02	£2·58
MJE2955	£1·04
MJE3055	£0·69
MJE3440	£0·60
MPF102	£0·64
MPF104	£0·40
MPF105	£0·40
MPSA05	£0·23
MPSA06	£0·23
MPSA55	£0·23
MPSA56	£0·23
OC22	£1·73
OC23	£1·73
OC24	£1·55
OC25	£1·15
OC26	£1·15
OC28	£0·92
OC29	£1·09
OC35	£1·03
OC36	£1·03
OC70	£0·27
OC71	£0·17
TIC44	£0·33
TIC45	£0·40
TIP29A	£0·46
TIP29B	£0·48
TIP29C	£0·51
TIP30A	£0·46
TIP30B	£0·48
TIP30C	£0·50
TIP31A	£0·46
TIP31B	£0·48
TIP31C	£0·50
TIP32A	£0·46
TIP32B	£0·48
TIP32C	£0·50
TIP41A	£0·50
TIP41B	£0·52
TIP41C	£0·55
TIP42A	£0·50
TIP42B	£0·52
TIP42C	£0·55
TIP2955	£0·69
TIS43	£0·25
TIS90	£0·20
UT46	£0·23
ZTX107	£0·11

Type	Price
ZTX108	£0·11
ZTX109	£0·11
ZTX300	£0·13
ZTX500	£0·14
2N1613	£0·23
2N1711	£0·23
2N1889	£0·51
2N1890	£0·51
2N1893	£0·35
2N2147	£0·86
2N2148	£0·81
2N2160	£1·15
2N2192	£0·44
2N2193	£0·44
2N2194	£0·44
2N2217	£0·25
2N2218	£0·25
2N2218A	£0·23
2N2219	£0·23
2N2219A	£0·25
2N2904	£0·23
2N2904A	£0·24
2N2905	£0·20
2N2905A	£0·23
2N2906	£0·18
2N2906A	£0·21
2N2907	£0·23
2N2907A	£0·25
2N2926G	£0·10
2N2926Y	£0·09
2N29260	£0·09
2N2926R	£0·09
2N2926B	£0·09
2N3053	£0·20
2N3054	£0·46
2N3055	£0·46
2N3614	£1·15
2N3615	£1·21
2N3616	£1·21
2N3646	£0·10
2N3702	£0·09
2N3703	£0·09
2N3704	£0·08
2N3705	£0·08
2N3706	£0·09
2N3707	£0·09
2N3708	£0·08
2N3709	£0·08
2N3710	£0·08
2N3711	£0·08
2N3819	£0·21

74 SERIES TTL

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0·10	7427	£0·28	7472	£0·23	74105	£0·43	74163	£0·71
7401	£0·13	7428	£0·30	7473	£0·29	74107	£0·28	74164	£0·78
7402	£0·13	7430	£0·13	7474	£0·28	74110	£0·41	74165	£0·78
7403	£0·13	7432	£0·25	7475	£0·33	74111	£0·67	74166	£0·98
7404	£0·13	7433	£0·35	7476	£0·29	74118	£0·92	74174	£0·75
7405	£0·13	7437	£0·24	7480	£0·51	74119	£1·36	74175	£0·71
7406	£0·25	7438	£0·24	7481	£0·98	74121	£0·28	74176	£0·67
7407	£0·25	7440	£0·14	7482	£0·78	74122	£0·45	74177	£0·66
7408	£0·23	7441	£0·58	7483	£0·67	74123	£0·46	74180	£1·73
7409	£0·15	7442	£0·46	7484	£1·01	74136	£0·60	74181	£0·67
7410	£0·13	7443	£0·81	7485	£0·78	74141	£0·63	74182	£0·81
7411	£0·20	7444	£0·81	7486	£0·35	74145	£0·63	74184	£0·81
7412	£0·17	7445	£0·75	7489	£1·96	74150	£0·78	74190	£0·78
7413	£0·28	7446	£0·69	7490	£0·37	74151	£0·55	74191	£0·71
7414	£0·58	7447	£0·55	7491	£0·74	74153	£0·55	74192	£0·69
7416	£0·26	7448	£0·64	7492	£0·40	74154	£0·94	74193	£0·67
7417	£0·26	7450	£0·13	7493	£0·35	74155	£0·58	74194	£0·71
7420	£0·13	7451	£0·13	7494	£0·86	74156	£0·58	74195	£0·69
7421	£0·23	7453	£0·13	7495	£0·58	74157	£0·58	74196	£1·21
7422	£0·18	7454	£0·13	7496	£0·58	74160	£0·67	74197	£1·21
7423	£0·24	7460	£0·12	74100	£0·98	74161	£0·71	74198	£2·13
7425	£0·22	7470	£0·29	74104	£0·45	74162	£0·71	74199	£2·13
7426	£0·26								

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0·16	CD4015	£0·94	CD4026	£1·70	CD4043	£1·01	CD4070	£0·19
CD4001	£0·23	CD4016	£0·49	CD4027	£0·58	CD4044	£0·94	CD4071	£0·20
CD4002	£0·18	CD4017	£0·94	CD4028	£0·78	CD4045	£1·61	CD4072	£0·20
CD4006	£1·06	CD4018	£0·98	CD4029	£0·98	CD4046	£1·50	CD4081	£0·19
CD4007	£0·26	CD4019	£0·48	CD4030	£0·55	CD4047	£1·00	CD4082	£0·25
CD4008	£1·06	CD4020	£1·04	CD4031	£2·30	CD4049	£0·52	CD4510	£1·27
CD4009	£0·32	CD4021	£0·94	CD4035	£1·38	CD4050	£0·52	CD4511	£1·44
CD4010	£0·55	CD4022	£0·94	CD4037	£1·09	CD4054	£1·27	CD4516	£1·15
CD4011	£0·23	CD4023	£0·22	CD4040	£1·01	CD4055	£1·15	CD4518	£1·15
CD4012	£0·22	CD4024	£0·75	CD4041	£0·87	CD4056	£1·55	CD4520	£1·15
CD4013	£0·48	CD4025	£0·22	CD4042	£0·83	CD4069	£0·20	CD4014	£0·92

LINEAR

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£1·13	CA3123	£1·27	MC1352	£1·61	72710	£0·35	SN76660	£0·86
CA3014	£1·55	CA3130	£1·07	MC1469	£3·39	UA711C	£0·37	TAA550B	£0·40
CA3018	£0·75	CA3140	£0·81	MC1496	£1·04	72711	£0·37	TAA621A	£2·30
CA3020	£1·16	CA3065E	£0·95	NE536	£3·06	UA723C	£0·52	TAA621B	£2·88
CA3028	£0·92	LM301	£0·33	NE550	£1·09	72723	£0·52	TAA661	£1·73
CA3035	£1·61	LM308	£1·15	NE555	£0·28	UA741C	£0·28	TAD100	£1·50
CA3036	£1·15	LM309	£1·73	NE556	£0·69	72741	£0·27	TBA540	£2·42
CA3042	£1·73	LM380	£0·98	NE565	£1·73	741P	£0·20	TBA810S	£0·86
CA3043	£2·12	LM381	£1·67	NE566	£1·38	UA7447C	£0·69	TBA810	£1·13
CA3046	£0·80	LM3900	£1·67	NE567	£1·96	72747	£0·69	TBA820	£0·81
CA3052	£1·84	LM3914	£2·45	UA702C	£0·73	UA748	£0·40	TBA9200	£2·88
CA3054	£2·13	LM3915	£2·45	72702	£0·73	748P	£0·40	TCA270S	£2·30
CA3075	£1·81	MC1304	£2·19	UA703	£0·29	SN76013N	£2·01	TBA800	£0·92
CA3081	£1·72	MC1310	£1·09	UA709	£0·29	SN76023	£2·01	TBA120	£0·60
CA3089	£2·30	MC1312	£2·19	72709	£0·63	SN76110	£1·73	TBA641A	£1·84
CA3090	£4·14	MC1350	£1·38	UA710C	£0·46	SN76115	£2·19	ZN414	£1·15

THYRISTORS

Volts No.	Price	Volts No.	Price
10THY600ma/10v	£0·17	50 THY7A/50	£0·55
20 THY600ma/20v	£0·18	100 THY7A/100	£0·58
30 THY600ma/30v	£0·23	200 THY7A/200	£0·65
50 THY600ma/50v	£0·25	400 THY7A/400	£0·71
100 THY600ma/100v	£0·29	600 THY7A/600	£0·89
200 THY600ma/200v	£0·44	800 THY7A/800	£1·05
400 THY600ma/400v	£0·51		

Volts No.	Price	Volts No.	Price
50 THY1A/50	£0·29	50 THY10A/50	£0·58
100 THY1A/100	£0·32	100 THY10A/100	£0·65
200 THY1A/200	£0·36	200 THY10A/200	£0·71
400 THY1A/400	£0·43	400 THY10A/400	£0·80
600 THY1A/600	£0·51	600 THY10A/600	£1·13
800 THY1A/800	£0·66	800 THY10A/800	£1·40

Volts No.	Price	Volts No.	Price
50 THY3A/50	£0·32	50 THY16A/50	£0·62
100 THY3A/100	£0·34	100 THY16A/100	£0·66
200 THY3A/200	£0·37	200 THY16A/200	£0·71
400 THY3A/400	£0·48	400 THY16A/400	£0·88
600 THY3A/600	£0·57	600 THY16A/600	£1·03
800 THY3A/800	£0·74	800 THY16A/800	£1·59

Volts No.	Price	Volts No.	Price
50 THY5A/50	£0·41	50 THY30A/50v	£1·36
100 THY5A/100	£0·51	100 THY30A/100v	£1·64
200 THY5A/200	£0·57	200 THY30A/200v	£1·87
400 THY5A/400	£0·65	400 THY30A/400v	£2·06
600 THY5A/600	£0·79	600 THY30A/600v	£4·03
800 THY5A/800	£0·93		

BT101/500R £0·92. BT102/500R £0·92. BT106 £1·44. BT107 £1·07. BT108 £1·13. 2N3228 £0·81. 2N3525 £0·89. BTX30/50L £0·38. BTX30/400L £0·54. BT116 £1·73. C106/4 £0·69.

SILICON RECTIFIERS

200mA	
IS920 50V	£0·07
IS921 100V	£0·08
IS922 150V	£0·09
IS923 200V	£0·10
IS924 300V	£0·11
1 Amp	
IN4001 50V	£0·05
IN4002 100V	£0·05
IN4003 200V	£0·07
IN4004 400V	£0·08
IN4005 600V	£0·09
IN4006 800V	£0·10
IN4007 1000V	£0·11
1·5 amp	
IS015 50V	£0·10
IS020 100V	£0·11
IS021 200V	£0·12
IS023 400V	£0·14
IS025 600V	£0·16
IS027 800V	£0·18
IS029 1000V	£0·23
IS031 1200V	£0·28
3 Amp	
IN5400 50V	£0·16
IN5401 100V	£0·17
IN5402 200V	£0·18
IN5404 400V	£0·19
IN5406 600V	£0·24
IN5407 800V	£0·28
IN5408 1000V	£0·34
10 Amp	
IS10/50 50V	£0·21
IS10/100 100V	£0·24
IS10/200 200V	£0·26
IS10/400 400V	£0·40
IS10/600 600V	£0·48
IS10/800 800V	£0·58
IS10/100 1000V	£0·69
IS10/1200 1200V	£0·79
30 Amp	
IS30/50 50V	£0·64
IS30/100 100V	£0·79
IS30/200 200V	£1·06
IS30/400 400V	£1·43
IS30/600 600V	£2·02
IS30/800 800V	£2·23
IS30/1000 1000V	£2·65
IS30/1200 1200V	£3·31
60 Amp	
IS70/50 50V	£0·86
IS70/100 100V	£0·96
IS70/200 200V	£1·38
IS70/400 400V	£2·01
IS70/600 600V	£2·58
IS70/800 800V	£2·87
IS70/1000 1000V	£3·45

TRIACS & DIACS

2 amp TO5 case

volts	No.	Price
100	TR12A/100	£0·36
200	TR12A/200	£0·59
400	TR12A/400	£0·82

6 amp

volts		
100	TR16A/100	£0·59
200	TR16A/200	£0·70
400	TR16A/400	£0·88

10 amp

volts	No.	Price
100	TR110A/100	£0·88
200	TR110A/200	£1·06
400	TR110A/400	£1·29

10 amp Plastic to 220
volts
400 TR110A/400P £1·29

DIACS
BR100 £0·23 D32 £0·23

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	BR1/50	£0·23
100v RMS	BR1/100	£0·25
200v RMS	BR1/200	£0·29
400v RMS	BR1/400	£0·41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2/50	£0·52
100v RMS	BR2/100	£0·55
200v RMS	BR2/200	£0·60
400v RMS	BR2/400	£0·67

SILICON 10 amp

Type	No.	Price
50v RMS	BR10/50	£1·50
200v RMS	BR10/200	£1·70

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£1·90
200v RMS	BR25/200	£2·20

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	0·09	BY100	0·25	BYZ11	0·52	OA90	0·11
AA120	0·09	BY101	0·25	BYZ12	0·46	OA91	0·11
AA129	0·09	BY105	0·25	BYZ13	0·46	OA95	0·11
AAY30	0·10	BY114	0·25	BYZ16	0·47	OA182	0·15
AAZ13	0·17	BY124	0·25	BYZ17	0·41	OA200	0·09
BA100	0·12	BY126	0·17	BYZ18	0·41	OA202	0·09
BA102	0·37	BY127	0·18	BYZ19	0·41	SD10	0·07
BA148	0·17	BY128	0·18	OA5	0·69	SD19	0·07
BA154	0·14	BY130	0·20	OA10	0·40	IN34	0·08
BA155	0·16	BY133	0·24	OA47	0·09	IN34A	0·08
BA173	0·17	BY164	0·58	OA70	0·09	IN914	0·07
BB104	0·46	BY176	0·86	OA79	0·12	IN916	0·07
BAX13	0·08	BY206	0·34	OA81	0·12	IN4148	0·07
BAX16	0·09	BYZ10	0·52	OA85	0·12	IS44	0·06
						IS920	0·07

LEDS

O/no.	Size	Colour	
1501	125	RED	£0·10
1502	125	GREEN	£0·16
1503	125	YELLOW	£0·16
1504	2	RED	£0·10
1505	2	GREEN	£0·16
1506	2	YELLOW	£0·16
1509	2	CLEAR (Ill Red)	£0·12
SUPER 'Hi-Brite' Type			
1521	125	RED	£0·11
1522	2	RED	£0·11
1514	ORP 12 Light dependent resistor		£0·70
1520	OCP 71 Photo transistor		£0·40

CLIPS

1508/125 pack of 5 125 clips £0·17
1508/2 pack of 5 2 clips £0·20

DISPLAYS

DL307. 7 segment D.P. left (30" height) common anode single digit O/NO 1523 £0·80

DL707 RED 7 segment D.P left (0·3" height) common anode single digit O/ND 1510 £0·92

DL527 RED 7 segment D.P. left (50" height) common anode. Two digit reflector O/NO 1524 £1·95

DL727 RED 7 segment D.P. right (510" height) common anode. Two-digit light pipe O/NO 1521 £2·53

DL747 RED 7 segment D.P. left (630" height) common anode Single-digit light pipe O/NO 1511 £1·72

OPTO-ISOLATORS

Isolation Breakdown — voltage 1500 — continuous two current 100mA

CIL74 Single-channel 6 pin DIP standard type – optically coupled pair with infra red LED emitter and NPN silicon photo transistor O/NO 1497 £0·57

CILD74 Multi-channel 8 pin DIP two isolated channels O/NO 1498 £1·15

CILQ74 Multi-channel 16 pin DIP four isolated channels O/NO 1499 £2·53

SECOND GRADE LED PACK

A pack of 10 standard sizes and colours which fail to perform to their very rigid specification, but which are ideal for amateurs who do not require the full spec. O/NO 1507 £1·04

SOCKETS

1611 8 pin DIL £0·09
1612 14 pin DIL £0·11
1613 16 pin DIL £0·12
1720 18 pin DIL £0·18
1721 20 pin DIL £0·20
1722 22 pin DIL £0·22
1614 24 pin DIL £0·24
1615 28 pin DIL £0·26
1723 40 pin DIL £0·34
1616 TD18transistor £0·13
1617 T03 transistor £0·37
16117TO5 transistor £0·13
1724 14 pin DIL Wire wrap gold plated Cambion £0·26

G.P. SILICON DIODES

300mW 40PIV (min) sub min FULLY TESTED ideal for Organ builders.
30 for 57p – 100 for £1·72 – 500 for £5·75 – 1,000 for £10·35.

G.P. SWITCHING TRANSISTORS

To 18sim to 2N706/8 BSY27 28, 95A ALL useable devices no open and shorts ALSO available in PNP sim to 2N290 BCY70.
20 for 57p; 50 for £1·15; 100 for £2·07; 500 for £9·20; 1,000 for £16·10; when ordering state NPN/PNP.

VOLTAGE REGULATORS

Positive Case	Price
uA7805 T0220	£0·85
uA7812 T0220	£0·85
uA7815 T0220	£0·85
uA7824 T0220	£0·85
uA7818 T0220	£0·85
Negative Case	**Price**
uA7905 T0220	£0·92
uA7912 T0220	£0·92

uA7915 T0220 £0·92
uA7924 T0220 £0·92
uA7818 T0220 £0·92

72723 14 pin DN £0·52
uA723C T099 £0·52
LM309K T03 £1·72
ZTK 33B £0·12

ZENER DIODES

400 mw (Bzy88) D007. Glass encapsulated range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v. **No. Z4 10p**

1w-1·5w Plastic and metal encapsulated. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No.Z13 18p**

10w metal stud type S010 case. Range of voltages available as above. **No.Z10 44p**

BARCLAYCARD VISA

Access & Barclaycard accepted. Giro a/c no. 388 7006. All prices include VAT.

Add 50p postage per order

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VISIT OUR SHOP AT: 3 BALDOCK ST, WARE, HERTS. Tel: 0920 3182, Telex 817861

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm × 5mm chassis mounting	506	£0·18
1¼in. × ¼in. chassis mounting	507	£0·14
1¼in car inline type	508	£0·18
Panel mounting 20mm	509	£0·23
Panel mounting 1¼in.	510	£0·37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1·5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2·5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1/6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in.

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2/5A	638	4A	641
2A	637	3A	639	5A	642

All 6p each

NUTS AND BOLTS

BA BOLTS–packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in. OBA	839	£1·38	½in. 4BA	846	£0·37
½in. OBA	840	£0·86	¼in. 4BA	847	£0·29
1in. 2BA	842	£0·75	1in. 6BA	848	£0·46
½in. 2BA	843	£0·52	½in. 6BA	849	£0·24
¼in. 2BA	844	£0·60	¼in. 6BA	850	£0·20
1in.4BA	845	£0·51			

BA NUTS–packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	855	£0·83	4BA	857	£0·35
2BA	856	£0·55	6BA	858	£0·28

BA WASHERS–flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	859	£0·16	4BA	861	£0·14
OBA	860	£0·14	6BA	862	£0·14

SOLDER TAGS–Not tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	851	£0·46	4BA	853	£0·25
2BA	852	£0·32	6BA	854	£0·25

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V–0–6V 100mA	£1·04
2022	9V–0–9V 100mA	£1·04
2023	12V–0–12V 100mA	£1·29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280–0–6V–0–6V RMS	£1·84
2025	MT150–0–12V 0–12V RMS	£1·84

1 AMP MAINS Primary 240V

No.	Secondary	Price
2026	6V–0–6V 1 amp	£2·88 P & P 45p
2027	9V–0–9V 1 amp	£2·30 P & P 45p
2028	12V–0–12V 1 amp	£2·00 P & P 55p
2029	15V–0–15V 1 amp	£3·16 P & P 66p
2030	30V–0–30V 1 Amp	£3·97 P & P 86p

STANDARD AMINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0–19–25–33–40–50V. Voltages available by use of taps. 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25–0–25V

No.	Rating	Price
2031	½ amp	£3·91 P & P 85p
2032	1 amp	£5·06 P & P 85p
2033	2 amp	£6·27 P & P £1
2035	240V Primary 0–55V 2A Secondary	£7·30 P & P £1

VEROBOARD

2201 2.5"x5" .1 copper £0·71	2211 2.5"x3.75" .15 copper £0·53
2202 2.5"x3.75" .1 copper £0·61	2212 3.75"x17" .15 copper £2·39
2203 2.5"x17" .1 copper £2·14	2213 3·75"x5" .15 copper £0·90
2205 3·75"x3·75" .1 copper £0·71	2217 3.75"x17.9" .1 Plain £1·79
2206 3.75"x17".1 copper £2·76	2218 3.75"x2.5" 1" Plain £0·44
2207 4.75"x17.9".1 copper £3·61	2219 5"x3.75" .1 Plain £0·68
2208 2.5"x1" .5 in pack £0·85	2223 2.5"x5" .15 Plain £0·37
2204 3·75"x5".1 Copper £0·79	2225 5"x3.75" .15 plain £0·56
2210 2·5"x5" .15 copper £0·64	

TANTALUM CAPACITORS

3137	1MFD 35V	£0·13	3142	4·4MFD 35V	£0·21
3138	22MFD 35V	£0·13	3157	3·3MFD 25V	£0·21
3139	47MFD 35V	£0·13	3143	10MFD 35V	£0·25
3140	1·0MFD 35V	£0·13	3144	22MFD 16V	£0·25
3141	2·2MFD 35V	£0·14	3145	47MFD 6·3V	
			3156	33MFD 35V	£0·13

ELECTROLYTIC CAPACITORS

3185	1,000uF 25V	£0·32			
3186	1,000uF 63V	£1·27	3190	4,700uF 25V	£0·92
3187	2,200uF 25V	£0·69	3191	4700uF 63V	£2·42
3188	2200uF 40V	£0·69	3192	2,200uF 100V	£2·88
3189	3,300uF 100V	£3·61	3196	100uF 100V	£0·09

POTENTIOMETERS

CARBON POTS (Linear Track)
Single gang with wire and terminations, 6mm × 50mm plastic shaft 10mm bushes supplied with shake proof washer and nut. Tolerance 20% of resistance.

1831 1k ohms	1835 22k ohms	1839 470k ohms
1832 2k2 ohms	1836 47k ohms	1840 1 Meg
1833 4k7 ohms	1837 100k ohms	1841 2M2
1834 10k ohms	1838 220k ohms	All at 33p each

CARBON POTS (Log Track)

1842 4k7 ohms	1846 100k ohms	1850 2M2
1843 10k ohms	1847 220k ohms	All at
1844 22k ohms	1848 470k ohms	33p each
1845 47k ohms	1849 1 Meg	

DUAL CARBON POTS (Log Law)

1860 4k7 ohms	1864 100k ohms	1868 2M2
1861 10k ohms	1865 220k ohms	All at
1862 22k ohms	1866 470k ohms	99p each
1863 47k ohms	1867 1 Meg	

SINGLE GANG SWITCHED (Lin Law)
These potentiometers are fitted with double pole on-off switches. The switch is incoporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1·5 amps at 250v AC.

1870 4k7 ohms	1874 100k ohms	1878 2M2
1871 10k ohms	1875 220k ohms	All at
1872 22k ohms	1876 470k ohms	83p each
1873 47k ohms	1877 1 Meg	

SWITCHED POT (Log Track)
Specification as VC2 but track having (log) law.

1879 4k7 ohms	1883 100k ohms	1887 2M2
1880 10k ohms	1884 220k ohms	All at
1881 22k ohms	1885 470k ohms	83p each
1882 47k ohms	1886 1 Meg	

DUAL GANG LONG-ANTI-LOG POT
1888 Track specification as dual gang pots VC3, but tracks mounted to log-anti-log action 100k ohms £0·98.

SPECIAL VOLUME CONTROLS
A miniature 16mm type replacement volume control, incorporating single pole on-off switch. Resistance value 5k ohms. Tolerance 20% 1/8 watt rating.
1889 £0·31 VC8

MINIATURE ROTARY VOLUME CONTROL
5k ohms log law with on-off switch. 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.
1890 £0·62 VC9

WIRE WOUND POTS
A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shake-proof washer and nut.
VC6

1891 10 ohms	1895 220 ohms	1899 4k7 ohms
1892 22 ohms	1896 470 ohms	All at
1893 47 ohms	1897 1k ohms	92p each
1894 20 ohms	1898 2k2 ohms	

PRE-SET POTS HORIZONTAL MOUNTING
Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screw driver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2·54mm. All tracks are linear law.
VC7

1801 100 ohms	1807 10k ohms	1813 1M ohms
1802 220 ohms	1808 22k ohms	1814 2M2 ohms
1803 470n ohms	1809 47k ohms	1815 4M7 ohms
1804 1k ohms	1810 100k ohms	All at
1805 2k2 ohms	1811 220k ohms	10p each
1806 4k7 ohms	1812 470k ohms	

PRE-SET POTS VERTICAL MOUNTING
Miniature type for transistor circuits. Wiper adjustment is made by a screw driver slot.
Designed to fit 2·54mm pitch board. All tracks are linear law.
VC7

1816 100 ohms	1822 10k ohms	1828 1 Meg ohms
1817 220 ohms	1823 22k ohms	1829 2M2 ohms
1818 470 ohms	1824 47k ohms	1830 4M7 ohms
1819 1k ohms	1825 100k ohms	All at
1820 2k2 ohms	1826 220k ohms	10p each
1821 4k7 ohms	1827 470k ohms	

ANTEX IRONS

1943	15 watt high quality soldering iron totally enclosed element in a ceramic shaft fitted with 3/32" bit	£4·83
1947	Replacement element for 1943 iron.	£2·19
1944	Iron coated bit 3/32" for 1943 iron.	£0·53
1945	Iron coated bit ⅛" for 1943 iron.	£0·53
1946	Iron coated bit 3/16" for 1943 iron.	£0·53
1948	General purpose 18 watt iron fitted with iron coated bit.	£4·54
1952	Replacement element for 1948 iron.	£2·19
1949	Iron coated bit 3/32" for 1948 iron.	£0·53
1950	Iron coated bit ⅛" for 1948 iron.	£0·53
1951	Iron coated bit 3/16" for 1948 iron.	£0·53
1931	Highly popular × 25, 25 watt quality soldering iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3-5uA and another shaft of stainless steel to ensure strength.	£4·83
1935	Replacement element for 1931 iron.	£1·84
1932	Iron coated bit ⅛" for 1931 iron.	£0·58
1933	Iron coated bit 2/16" for 1931 iron.	£0·58
1934	Iron coated bit 3/32" for 1931 iron.	£0·58
1953	SK1 soldering kit–This kit contains 15 watt soldering iron fitted with a 3/16" bit plus two spare bits, a reel of solder heat-sink and a booklet 'How to solder.. In presentation display box.	£6·38
1939	ST3 soldering iron stand. Stand made from high grade bakelite material chromium plated strong steel spring suitable for all models, includes accommodation for six spare bits and two sponges which serve to keep the soldering iron bits clean.	£1·73

CASES AND BOXES

INSTRUMENT CASES in two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5¼in	2in	£1·73
156	11in	6in	3in	£2·92
157	6in	4¾in	1¾in	£1·79
158	9in	5¼in	2½in	£2·43

ALUMINIUM BOXES made from bright alli, folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5½in	2½in	1½in	£0·85
160	4in	4in	1½in	£0·85
161	4in	2½in	1½in	£0·85
162	5½in	4in	1½in	£0·97
163	4in	2½in	2in	£0·87
164	3in	2in	1in	£0·60
165	7in	5in	2½in	£1·43
166	8in	6in	3in	£1·83
167	6in	4in	2in	£1·18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front—strong construction easily accessible.

169	2½in 5½in	2¼in	12in	3½in	8in	£5·45
168	2¾in 7½in	4in	16in	4½in	11in	£8·21

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4·35
171	140mm	75mm	205mm	£4·85
172	140mm	110mm	205mm	£6·30

AUDIO LEADS

No.	Type	Price
107	FM Indoor Ribbon Aerial	£0·69
113	3·5mm Jack plug to 3·5mm Jack plug length 1·5m	£0·86
114	5 pin DIN plug to 3·mm Jack connected to pins 3 & 5 length 1·5m	£0·98
115	5 pin DIN plug to 3·5mm Jack connected to pins 1 & 4 length 1·5m	£0·98
116	Car aerial extension screened insulated lead. Fitted plug and socket.	£1·44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0·78
118	5 pin DIN phono plug to stereo headphone. Jack socket	£1·21
119	2 + 2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones. Length 0·2m	£1·04
120	Car stereo connector. Variable geometry plug to fit most car cassettes. 8-track cartridge and combination units. Supplied with inlined fuse power lead and instructions	£0·69
123	6·6m Coiled Guitar Lead Mono Jack plug to Mono Jack plug Black	£1·72
124	3 pin DIN plug to 3 pin DIN plug. Length 1·5m	£0·85
125	5 pin DIN plug to 5 pin DIN plug. Length 1·5m	£0·85
126	5 pin DIN plug to Tinned open end. Length 1·5m	£0·85
127	5 pin DIN plug to 4 Phono Plugs. All colour coded Length 1·5m	£1·49
128	5 pin DIN plug to 5 pin DIN socket. Length 1·5m	£0·92
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1·5m	£1·21
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5. Length 1·5m	£0·95
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1·13
133	5 pin DIN plug to 2 Phono plugs. Connected pins 3 & 5. Length 1·5m	£0·86
134	5 pin DIN plug to 2 Phono sockets. Connected pins 3 & 5. Length 23cm	£0·78
135	5 pin DIN socket to 2 Phono plugs. Connected pins 3 & 5. Length 23cm	£0·78
136	Coiled stereo headphone extension lead. Black length 6m	£2·01
178	AC mains lead for calculators, etc.	£0·52

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0·16
DPDT standard slide	1974	£0·17
Toggle switch SPST 12 amp 250V ac	1975	£0·38
Toggle switch DPDT 1 amp 250V ac	1976	£0·48
Rotary on-off mains switch	1977	£0·58
Push switch–Push to make	1978	£0·16
Push switch–Push to break	1979	£0·21

ROCKER SWITCH

	Colour	No.	Price
A range of rocker	RED	1980	£0·35
switches SPST–moulded	BLACK	1981	£0·35
in high insulation	WHITE	1982	£0·35
material available in a	BLUE	1983	£0·35
choice of colours ideal	YELLOW	1984	£0·35
for small apparatus	LUMINOUS	1985	£0·35

Description	No.	Price
Miniature SPST toggle 2 amp 250V ac	1958	£0·81
Miniature SPST toggle 2 amp 250V ac	1959	£0·86
Miniature DPDT toggle 2 amp 250V ac	1960	£0·91
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1·07
Push-button SPST 2 amp 250V ac	1962	£1·04
Push-button SPST 2 amp 250V ac	1963	£1·09
Push-button DPDY 2 amp 250V ac	1964	£1·34

MIDGET WAFER SWITCHES
Single bank wafer type-suitable for switching at 250V ac 100mA or 150V dc non-reactive loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30 indexing.

Description	No.	Price	Description	No.	Price
1 pole 12 way	1965	£0·55	3 pole 4 way	1967	£0·55
2 pole 6 way	1966	£0·55	4 pole 3 way	1968	£0·55

MICRO SWITCHES

	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0·29

Terms cash with order. Cheques/Postal Orders made payable to Bi-Pak at above address.

Access
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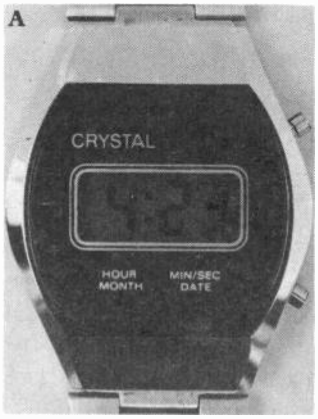
KEELMOOR Quality...

Keelmoor Ltd is a company which has been established for a long time – we supply the products you have often bought from other companies. Our precision watches and electrical goods are renowned for their superb quality and reliability.
We differ from other companies in that we import direct world-wide – that difference is passed on to you at unbeatable prices. You receive the goods faster and we provide a service and no catch guarantee of which we are justly proud.
We employ experts world-wide whose job it is to seek out products of the highest quality at the lowest possible prices. Illustrated here is just a tiny selection of our comprehensive range. Just compare these items with those seen elsewhere – we are confident the prices will amaze you. You can save ££££'s.

GENTS 5 FUNCTION LCD

A



This is the foundation of our range and is ideal for the man requiring the basic functions of hours, minutes and seconds, with month and date. A backlight is included and the stainless steel strap provided is fully adjusted to suit any size of wrist. Guaranteed for one year, this watch represents fantastic value at only

£4.95p

ILLUSTRATED BELOW IS THE LADIES 5 FUNCTION LCD.
This watch has the same time and auto calendar functions as the basic gents model described above, together with backlight and adjustable strap to suit the daintiest of wrists. It's compact, pleasing appearance makes it a very practical day watch and it is also often used for boys and girls. Available in black or white face.

HERE IS THE AMAZING 12/24 HOUR ALARM/CHRONOGRAPH

D

Along with the usual time and date displays, this multi-functional timepiece has a 24 hour alarm and a 1/10 second stopwatch. The time may be set to operate in 12 or 24 hour mode and the date can be in English or American format. The day of the week is continuously indicated and the stopwatch display may, on command, be frozen to show split/laptime while the stopwatch continues to run. Stopwatch operation does not effect normal time keeping. £12.95 only for this model. Also available with solar energy panel to conserve energy during daylight hours for £14.95

FROM **£12.95p**

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B

£5.95p

GENTS LCD ALARM WATCH

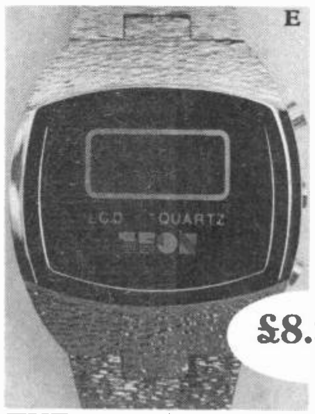
C

This model represents fantastic, incredible value for money. The 6 digit display continuously shows hours, minutes and seconds, or may be changed at will to hours, minutes and date. Its effective alarm is extremely useful and may be set to any time within a 24 hr. period. In addition, there is an alarm indicator, 4 year calendar and snooze repeater.

£8.95p

LADIES QUARTZ LCD DRESS WATCH

E



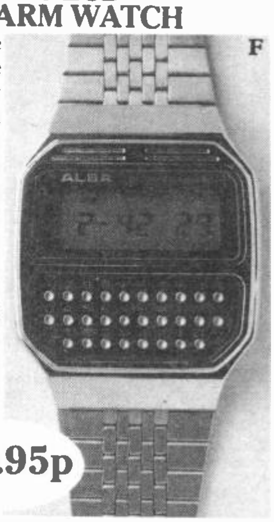
This attractive ladies model with the standard 5 functions of hours, minutes, seconds, month and date has literally sold in tens of thousands. Available in gold or silver colours with 'sugar coated' finish. Please state first and second choice of square, round or oval design.

£8.95p

THE ULTIMATE GENTS LCD CALCULATOR/ALARM WATCH

If you want a watch from the top end of the market this is the one for you. Full calculator functions plus memory and percentage are combined with time and alarm functions to make this item an outstanding buy. Manufactured in Japan at the same factory that produces models for probably the most famous name in the watch business, this device represents sheer quality at an unbelievable price. Comes complete with backlight and button operating tool carried in the strap clasp. We advise you to order quickly whilst stocks last.

F



£39.95p

FULLY GUARANTEED
We must emphasize all these items are fully guaranteed for one year. All electronic goods come complete with demonstration batteries which cannot be guaranteed. New batteries are available for only 60p.

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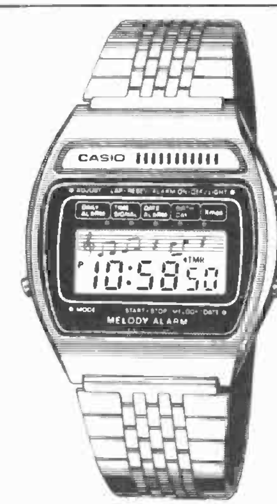

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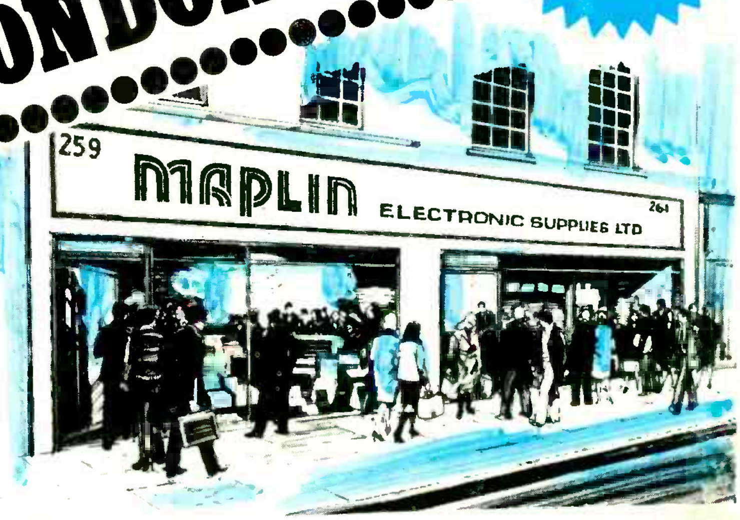

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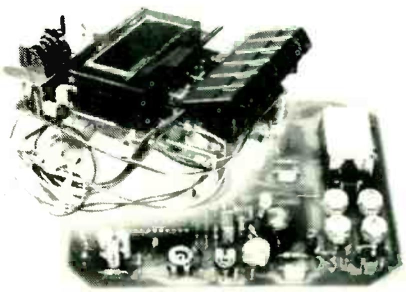

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