

# EVERYDAY ELECTRONICS

FEBRUARY 1989

INCORPORATING ELECTRONICS MONTHLY

£1.30

## FIRE ALARM

## SIMPLE PSU

## FOUR CHANNEL LIGHT DIMMER



The Magazine for Electronic & Computer Projects



### No. 1 LIST BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

- BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
  - BD7 4 In flex switches with neon on/off lights, saves leaving things switched on.
  - BD9 2 6V 1A mains transformers upright mounting with fixed clamps.
  - BD11 1 6 1/2in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
  - BD13 12 30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
  - BD22 2 25 watt loudspeaker two unit crossovers.
  - BD29 1 B.O.A.C. stereo unit is wonderful value.
  - BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
  - BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
  - BD34 4 2 meter length of connecting wire all colour coded.
  - BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
  - BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day, original cost £40 each.
  - BD49 10 Neon valves, with series resistor, these make good night lights.
  - BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
  - BD59 2 Flat solenoids—you could make your multi-tester read AC amps with this.
  - BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
  - BD91 1 Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated.
  - BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
  - BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
  - BD122 10m Twin screened flex with white pvc cover.
  - BD128 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
  - BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
  - BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
  - BD139 6 Microphone inserts—magnetic 400 ohm also act as speakers.
  - BD148 4 Reed relay kits, you get 16 reed switches and 4 coils sets with notes on making c/o relays and other gadgets.
  - BD149 6 Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
  - BD180 6 Neon indicators in panel mounting holders with lens.
  - BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
  - BD196 1 in flex simmerstat—keeps your soldering iron etc. always at the ready.
  - BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
  - BD201 8 Keyboard switches—made for computers but have many other applications.
  - BD210 4 Transistors type 2N3055, probably the most useful power transistor.
  - BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
  - BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
  - BD242 2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
  - BD252 1 Panostat, controls output of boiling ring from simmer up boil.
  - BD259 50 Leads with push-on 1/4in tags—a must for hook-ups—mains connections etc.
  - BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
  - BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
  - BD283 3 Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
  - BD293 50 Mixed silicon diodes.
  - BD305 1 Tubular dynamic mic with optional table rest.
- VERY POWERFUL 12 VOLT MOTORS—1/2rd HORSEPOWER.** Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £15.00 plus £2.00 postage. Our ref. 158.
- WHITE CEILING SWITCH** 5 amp 2 way surface mounting with cord and tassel. Made by the famous Crabtree Company. Price £1 each. Our ref BD528.
- 13A SWITCH SOCKETS** Top quality made by Crabtree, fitted in metal box with cutouts so ideal for garage, workshop, cellar, etc. Price £2 each. Our ref 2P37.

**THREE CAMERAS** All by famous makers, Kodak, etc. One disc and two different instant cameras. All in first class condition, believed to be in perfect working order but sold as untested. You can have them for £10 the three, including VAT, which must be a bargain—if only for the lenses, flash gear, etc. Our ref 10P58.



**ATARI 65XE COMPUTER** At 64k this is most powerful and suitable for home and business. Brand new, complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 insured delivery.

**DATA RECORDERS** ACORN for Acorn Electron, etc., reference number ALF03, with TV lead, manual and PSU. Brand new. Price £10 plus £1.50 post. Order ref 10P44.

**ATARI XC12** for all their home computers. With leads and handbook. Brand new. Price £10 plus £2 post. Order ref 10P53.

**JOYSTICK FOR ATARI OR COMMODORE** for all Atari and Commodore 64 and Vic20. New. Price £5. Order ref 5P126.

**EXTRA SPECIAL OFFER** We will supply the Atari 65XE, data recorder XC12, joystick and six games for £57.50 plus £4 insured delivery.

**SUB-MIN TOGGLE SWITCH** Body size 8mm x 4mm x 7mm SBOT with chrome dolly fixing nuts. 4 for £1. Order Ref. BD649.

**VENNER TIME SWITCH.** Mains operated with 20 amp switch, one on and off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95 without case, metal case—£2.95, adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/off per 24hrs. This makes an ideal controller for the immersion heater. Price of the adaptor kit is £2.30.

**SOUND TO LIGHT UNIT.** 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 1/4in. sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form.

**MINI MONO AMP** on pcb, size 4in x 2in approximately. Fitted with volume control and place for a tone control should you require it. The amplifier has three transistors and we estimate output to be 3w. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1. Our ref BD495.

**RE-CHARGEABLE NICADS 'D' SIZE** These are tagged for easy joining together but tags, being spot welded, are easy to remove. Virtually unused, tested and guaranteed. £2.00 ref 2P141 or 6 wired together for £10.00 ref 10P47.

**LEAD LAMP** Normal hand-grip type plastic holder, with glass cover to protect the lamp and further protection in the form of a wire guard with a hook for hanging. Ideal as light for or car repairs, etc. Takes 60w lamp. Has good length flex. Price £4. Our ref 4P31.

**2.5kw TANGENTIAL BLOW HEATER** has an approximate width of 3in. (plus motor), elements made up of two 1.2kw sections so with switch available you can have 2.5kw, 1.2kw or cold blow. Over-heat cutout eliminates fire risk should fan stop or air flow be impeded. Fan blades are metal. Price £5 plus £2.50 post. Our ref 5P62. Switch 50p.

**ALBA TWIN CASSETTE RECORDER AND PLAYER WITH STEREO RADIO** This is a mains/battery portable made to sell, we understand, at about £50 but the ones we have are line rejects. They are brand new still in the manufacturers' boxes but have a slight defect associated with the cassette section. The radio and amplifier section, both mono and stereo, is perfectly OK. If you are handy at mending things then this should be for you. Price £20 or two for £38 plus £3 insured post, either package. Our ref 20P7 or 2 x 20P7.

### LASER TUBE

Made by Philips Electronic. New and unused. This is helium-neon and has a typical power rating of 1.6mW. It emits random polarised light and is completely safe provided you do not look directly into the beam when eye damage could result. **DON'T MISS THIS SPECIAL BARGAIN!** Price £29.95 plus £3 insured delivery. **POWER SUPPLY FOR PHILIPS LASER** available in kit form, Price £15 plus £2 postage.

**PAPST AXIAL FAN—MANUFACTURERS REF NO. TYP4580N.** This is mains operated. 15 watt rating and in a metal frame with metal blades so OK in high temperatures. Body size approx. 4 3/4" square x 1 5/8" thick. £6.00 each, plus £1.00 postage. Our ref 6P6.

**VERY POWERFUL MAGNETS** Although only less than 1" long and not much thicker than a pencil these are very difficult to pull apart. Could be used to operate embedded reed switches, etc. Price 50p each, 2 for £1.00. Ref BD642.

**ORGAN MASTER** is a three octave musical keyboard. It is beautifully made, has gold plated contacts and is complete with ribbon cable and edge connector. Brand new, only £12 plus £3 postage. Order ref. 12P5.

**MUSIC FROM YOUR SPECTRUM 128** We offer the Organ Master three octave keyboard, complete with leads and the interface which plugs into your 128. You can then compose, play, record, store, etc., your own music. Price £19 plus £3 special packing and postage. Order ref. 19P1.

**20A DOUBLE POLE RELAY WITH 12V COIL** complete with mounting brackets. Made by the Japanese Omron Company. Price £2 each. Our Ref. 2P173A.

**TOROIDAL MAINS TRANSFORMER** with twin outputs. 6.3V 2A and 12V 600mA, so ideal for F00 power supply. Price £5. Our Ref. 5P122.

**QUICK FIX MAINS CONNECTOR** A must for your workshop. Saves putting on plugs as you just push the wires under the spring clips. Automatically off when lid is up. Price £7.50. Our Ref. 7P5/1.

**BT HANOSSET** with curly lead terminating with flat BT plug. Colour cream. Price £5. Our Ref. 5P123.

**RUBBER FEET** Stick on. Ideal for small instruments and cabinets. Pack of 56 for £1. Our ref BD603.

### J & N BULL ELECTRICAL

Dept. E.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, PO or cheque with order. Orders under £20 add £1.50 service charge. Monthly account orders accepted from schools and public companies. Access and B/card orders accepted. Brighton (0273) 734648 or 203500

### POPULAR ITEMS

Some of the many items described in our current list which you will receive if you request it

**3 1/2in FDD CHINON** 80 track 500k. Shugart compatible interface. Standard connections, interchangeable with most other 3 1/2in and 5 1/4in drives. Brand new. £28.50 plus £3 insured post.

**CASE NOW AVAILABLE FOR THE CHINON F353** This is the 80 track, single sided one which we have been selling at £28.50. The case is sheet metal, finished in hammer-beige with ample ventilation and rubber feet. Overall size 4 1/4in x 7in x 1 1/2in approx. Designed to take the ribbon cable and 3 core power lead. Price £8. Our ref 8P21.

**3in FDD HITACHI HFD3055XA** Shugart compatible interface. 500k on 3in disc. Recommended for many Amstrads but interchangeable with most drives. £29.50 plus £3 insured post.

**FDD CASE AND POWER SUPPLY KIT** for the 3in or 3 1/2in. £11.00. Ref 11P2 for the Chinon, 11P3 for the Hitachi.

**5in MONITOR** made for ICL, uses Philips black and white tube. Brand new and complete but untested. £16.00 plus £5.00 post.

**ACORN COMPUTER DATA RECORDER REF ALF03** Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. Ref. 10P44.

**POWERFUL IONISER** Uses mains transformer. Generates approx. 10 times more ions than the normal diode/cap ladder circuits. Complete kit £11.50 plus £3.00 post.

**FREE POWER!** Can be yours if you use our solar cells—sturdy made modules with new system bubble magnifiers to concentrate the light and so eliminate the need for actual sunshine—they work just as well in bright light. Voltage input is .45—50 joule in series to get desired voltage—and in parallel for more amps. **Module A** gives 100mA, Price £1, Our ref. BD631. **Module C** gives 400mA, Price £2, Our ref. 2P199. **Module D** gives 700mA, Price £3, Our ref. 3P42.

**SOLAR POWERED NI-CAD CHARGER 4 Ni-Cad batteries AA (HP7)** charged in eight hours or two in only 4 hours. It is a complete, boxed ready to use unit. Price £6. Our ref. 6P3.

**50V 20A TRANSFORMER 'C'** Core construction so quite easy to adapt for other outputs—tapped mains input. Only £25 but very heavy so please add £5 if not collecting. Order Ref. 25P4.

**SWITCH AC LOADS WITH YOUR COMPUTER** This is easy and reliable if you use our solid state relay. This has no moving parts, has high input resistance and acts as a noise barrier and provides 4kW isolation between logic terminals. The turn-on voltage is not critical, anything between 3 and 30V, internal resistance is about 1k ohm. AC loads up to 10A can be switched. Price is £2 each. Ref. 2P183.

**METAL PROJECT BOX** Ideal size for battery charger, power supply, etc., sprayed grey, size 8in x 4 1/4in x 4in high, ends are louvred for ventilation other sides are flat and undrilled. Price £2. Order ref. 2P191.

**BIG SMOOTHING CAPACITOR.** Sprague powerlytic 38,000uF at 50V. £3. Our ref. 3P41.

**4-CORE FLEX CABLE.** Cores separately insulated and grey PVC covered overall. Each copper core size 7/0.2mm. Ideal for long telephone runs or similar applications even at mains voltage. 20 metres £2. Our ref. 2P196 or 100 metres coil £8. Order ref. 8P19.

**6-CORE FLEX CABLE.** Description same as the 4-core above. Price 15 metres for £2. Our ref. 2P197 or 100 metres £9. Our ref. 9P1.

**TWIN GANG TUNING CAPACITOR.** Each section is 0005uF with trimmers and good length 1/4in spindle. Price £1 each. Our ref BD630.

**13A PLUGS** Pins sleeved for extra safety, parcel of 5 for £2. Our ref. 2P185.

**13A ADAPTERS** Takes 2 13A plugs, packet of 3 for £2. Order ref. 2P187. **20V-0-20V** Mains transformers 2 1/2 amp (100 watt) loading, tapped primary, 200-245 upright mountings £4. Order ref. 4P24.

**BURGLAR ALARM BELL**—6" gong OK for outside use if protected from rain. 12V battery operated. Price £8. Ref. 8P2.

**VERY RELIABLE CAPACITOR** 4.7uF 400V not electrolytic so not polarised, potted in ali can, size 1 3/4 x 3/4 x 1 1/2in high, with axial leads. A top grade capacitor made for high class instrument work. Ideal for PCB mounting. 2 for £1. Our ref BD667.

**USEFUL MAINS TRANSFORMER** Upright mounting, normal tapped primary, has two secondaries. One gives 20v at 1.5 amps if used alone, or the other gives 10V at 3 amps if used alone. Join the two in series for 30v at 1 amp. Price £2. Our ref 2P214.

**CAPACITOR BARGAIN**—axial ended, 4700uF at 25V. Jap made, normally 50p each, you get 4 for £1. Our ref. 613.

**SINGLE SCREENED FLEX** 7.02 copper conductors, pvc insulated then with copper screen, finally outer insulation. In fact quite normal screened flex. 10m for £1. Our ref BD668. Ditto, but solid conductor. 10m for £1. Our ref BD668a.

**M.E.S. BULB HOLDERS** Circular, base batten type fitting. 4 for £1. Our ref BD127a.

**SPRING LOADED TEST PRODS**—Heavy duty, made by the famous Bulgin company. Very good quality. Price 4 for £1. Ref. BD059.

**ASTEK P.S.U.**—Switch mode type. Input set for +230V. Output 3.5 amps at +5V, 1.5 amps at +12V, and 3 amps at +5V. Should be OK for floppy disc drives. Regular price £30. Our price only £10. Ref. 10T34. Brand new and unused.

**APPLIANCE THERMOSTATS**—Spindle adjust type suitable for convector heaters or similar. Price 2 for £1. Ref. BD0582.

**3-CORE FLEX BARGAIN No. 1**—Core size 5mm so ideal for long extension leads carrying up to 5 amps or short leads up to 10 amps. 15mm for £2. Ref. 2P189.

**3-CORE FLEX BARGAIN No. 2**—Core size 1.25mm so suitable for long extension leads carrying up to 13 amps, or short leads up to 25A. 10m for £2. Ref. 2P190.

**ALPHA-NUMERIC KEYBOARD**—This keyboard has 73 keys giving trouble free life and no contact bounce. The keys are arranged in two groups, the main area is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13" x 4"—brand new but offered at only a fraction of its cost, namely £3, plus £1 post. Ref. 3P27.

**WIRE BARGAIN**—500 metres 0.7mm solid copper tinned and p.v.c. covered. Only £3 plus £1 post. Ref. 3P31—that's well under 1p per metre, and this wire is ideal for push on connections.

**INTERRUPTED BEAM KIT**—This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components—relay, photo transistor, resistors and caps, etc. Circuit diagram but no case. Price £2. Ref. 2P15.

**1/8th HORSEPOWER 12 VOLT MOTOR** Made by Smiths, the body length of this is approximately 3in, the diameter 3in and the spindle 5/16th of an inch diameter. It has a centre flange for fixing or can be fixed from the end by means of 2 nuts. A very powerful little motor which revs at 3,000rpm. We have a large quantity of them so if you have any projects in mind then you could rely on supplies for at least two years. Price £6. Our ref 6P1, discount for quantities of 10 or more.

### OVER 400 GIFTS YOU CAN CHOOSE FROM

There is a total of over 400 packs in our Baker's Dozen range and you become entitled to a free gift with each dozen packs. A classified list of these packs and our latest 'News Letter' will be enclosed with your goods, and you will automatically receive our next news letter.



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# EVERYDAY ELECTRONICS

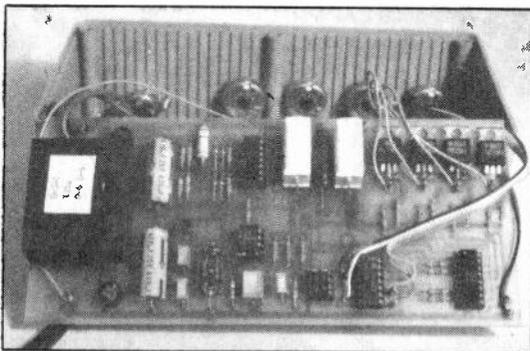
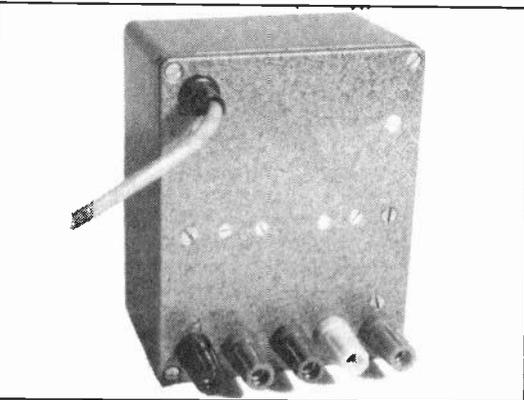
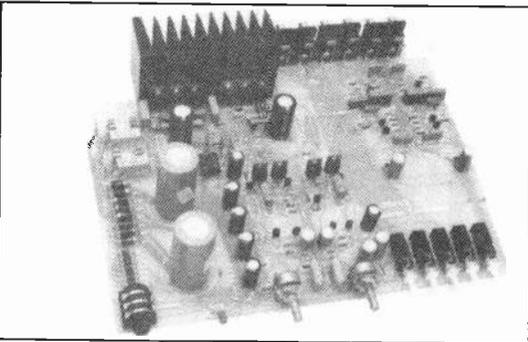
INCORPORATING ELECTRONICS MONTHLY



The Magazine for Electronic & Computer Projects

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PROJECTS ... THEORY ... NEWS ...  
COMMENT ... POPULAR FEATURES ...



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# HIGH GRADE COMPONENT PARCELS

Unless otherwise stated, all the clearance parcels we offer contain brand new, top grade components. If some of the offers look too good to be true, all I can say is that the optimists will get some stunning bargains, the cynics will never know what they've missed, so everybody will be happy! All offers apply only while current stocks last - watch out for next month's parcels or, better still, be the first to hear about any new offers by putting your name on our mailing list. (Please write in, or phone Pete Leah on 0272 522703 after 6.30 pm).

**EVERYTHING MUST GO!**

## UNIVERSAL EVERYTHING PARCEL

This one contains some of just about any component you care to name! There are passives (resistors, capacitors, tants, presets), opto devices (couplers, LEDs of all shapes and sizes, infra-red components, 7-segment displays), semiconductors (transistors, diodes, ICs, rectifiers), and all kinds of other odds and ends (relays, VDRs, neons, battery connectors, mixed components packs). A stunning range of components - enough to get a workshop or lab. started - at a ridiculously low price.

The components are of excellent quality, in packs originally intended to sell at £1 each. To make sure you get a good variety, the 20-pack parcel will have no more than two of any one pack, the 100 pack parcel will have at most five of any one pack. Packs supplied as they come - our choice.

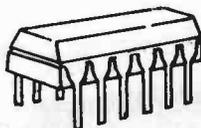
**PARCEL 1A: 20 PACKS for £10**  
**PARCEL 1B: 100 PACKS for £39!**



## INTEGRATED CIRCUITS

This parcel contains nothing but ICs. The mixture offers TTL and CMOS logic, interface ICs, linear, data converters, op-amps, special functions, and so on. Some of the ICs are pre-packed with data sheets, some (TTL, CMOS, op-amps) we expect you to identify for yourself, others will be covered by the free *data pack* provided, and the rest you'll have to identify under your own steam. If you know your ICs you'll be in for a few nice surprises.

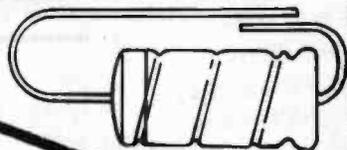
**PARCEL 3A: 200 ICs for £12!**  
**PARCEL 3B: 500 ICs for £49!**



## ELECTROLYTICS

A first class selection of good, modern electrolytics. The mixture ranges from small coupling caps up to huge power supply electrolytics - you'll be hard pressed to find any value between 1µF and 2200µF that isn't represented. A wide range of very useful components. Go for it!

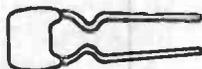
**PARCEL 5A: 1000 ELECTROLYTICS for £8**  
**PARCEL 5B: 2500 ELECTROLYTICS for £16**



## TANTALUM CAPACITORS

A nice range of tants in values up to 47µF. Lots of useful caps, and we're not mean with the most expensive ones. A fine selection.

**PARCEL 4A: 100 TANTS for £6.80**  
**PARCEL 4B: 500 TANTS for £29!**



## TRANSISTORS

A mix of general purpose silicon transistors, mostly bipolar NPN and PNP, with a few FETs and unijunctions thrown in (when available) to spice the mixture. The contents vary from month to month - at the moment there are BC212s, BC213s, BC548s, BC238Bs, MTJ210s, and so on. Next month - who knows? All top quality components.

**PARCEL 6A: 200 TRANSISTORS for £6!**



## MASSIVE CLEARANCE SALE

Once again, a general purpose parcel containing a huge variety of components: resistors, capacitors, ICs, transistors, electrolytics, tants, triacs, LEDs, diodes, thermistors, trimmers, VDRs, all sorts. All new, top quality components. This is mostly remainders from our own stock - stuff we forgot to advertise, or have in too small a quantity to sell individually. Guaranteed to be worth at least eight times the price if valued from any standard component catalogue! What more can I say?

**PARCEL 2A: 1000+ top grade components for £12!**  
(Value £100+)

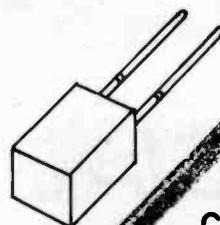
**PARCEL 2B: 5000+ top grade components for £49!**  
(Value £500+)



## LEDs

All shapes, sizes and colours of LEDs. Round ones in various sizes, rectangular ones, red, green, amber and yellow ones, clear and tinted lenses, all sorts.

**PARCEL 7A: 100 LEDs for £5.90**  
**PARCEL 7B: 500 LEDs for £24.90**



## CAPACITORS

An exciting selection of capacitors. There are ceramics for decoupling and general use, Polystyrenes for high performance circuits, dipped and moulded polyesters in values from a few nF up to 2.2µF (very expensive!), tants and aluminium electrolytics - just about any capacitor you'll ever need. Don't miss this one!

**PARCEL 8A: 1000 CAPACITORS for £6.50**

**PARCEL 8B: 2500 CAPACITORS for £14.90**



**HIGHGRADE COMPONENTS LTD**

Unit 11, 8 Woburn Road, Eastville, Bristol BS5 6TT

### UK Orders:

Please add £2.50 towards postage and packing

### Europe and Eire:

Please add £6.00 carriage and insurance

### Outside Europe:

Please add £12.00 carriage and insurance

# LEAD TEST

Anyone who plays an electric guitar, keyboard, or other electronic musical instrument, or who uses hi-fi or recording equipment, will have had the frustrating experience of having a jack lead with an intermittent fault of some kind. Typical is the lead which buzzes and crackles, but works fine if it is held in a particular position.

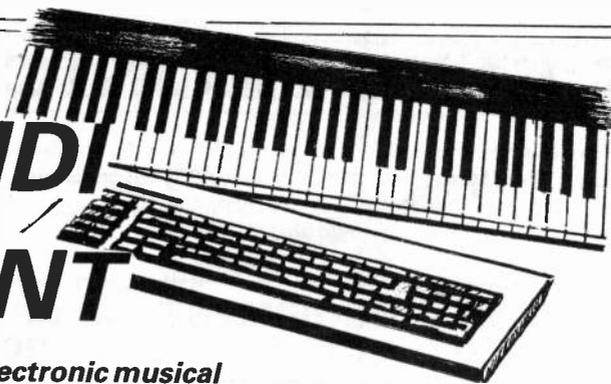
The simple piece of test equipment presented here allows quick diagnosis of faulty mono audio leads. The lead is simply plugged in, and the tester reset. A permanent fault is immediately indicated, an intermittent fault being latched as soon as it occurs. Three types of fault are indicated; core to screen short circuit, open circuit core, and open circuit screen.



# CALL ALERT

This doorbell warning device was designed as an aid for the deaf. However, it will also be of interest to those working out of earshot of the doorbell—when gardening, for example. In use a flashing mains lamp, or lamps, come on when the bell push is operated. Flashes continue at two second intervals for some preset time between 3 and 30 seconds approximately—these timings are easily increased if required.

# SPECIAL MIDI SUPPLEMENT



The adoption of MIDI by all the major electronic musical instrument manufacturers, and the inclusion of MIDI sockets on an increasingly wide range of equipment, has certainly revolutionised electronic music making. MIDI stands for "Musical Instruments Digital Interface", and it is a means of exchanging information between electronic musical instruments, or any equipment related to electronic music production.

Although MIDI is regarded by many as nothing more than a more modern alternative to the old gate/CV method of interfacing synthesisers, or a means of synchronising drum machines, it actually has capabilities which go well beyond this.

Next month we devote extra pages to three different MIDI projects which can take you into this fascinating area quite cheaply.

# EVERYDAY ELECTRONICS

MARCH ISSUE ON SALE FEBRUARY 3

EVERYDAY ELECTRONICS

# PROFESSIONAL SURVEILLANCE EQUIPMENT KITS

- **MTX** Micro-miniature VHF transmitter. The smallest kit on the market, measuring an incredible 17mm x 17mm including on-board mic. Super sensitive. Fully tuneable over FM band. 9V operation with range up to 1000m. **£10.95**
- **VT500** High power version of the MTX with on-board PA stage providing 250mW of RF. Measures just 20mm x 40mm, power requirements 9-15V. Excellent sensitivity and stability. Fully tuneable over FM band. Ranges over 3000m can be expected. **£12.95**
- **VOX75** Voice-activated transmitter. Variable sensitivity trigger level switches transmitter on when sounds are detected. Stays on for time delay variable between 1-20 sec. Fully tuneable output covers all FM band. Vary sensitive and low standby current through CMOS circuitry. 9V operation, range up to 1000m. Measures 30mm x 40mm. **£18.95**
- **CTX900** Sub-carrier scrambled transmitter. Audio is double modulated providing very secure transmissions. Any unauthorised listener will not be able to demodulate signal without DSX900 Decoder unit. Variable modulation on-board. Fully tuneable output covering FM band. 9V operation, range up to 1000m. Measures 30mm x 40mm. **£18.95**
- **DSX900** Decoder unit for CTX900. Connects to earphone output of receiver to descramble signal from CTX900. Monitor using small speaker or headphones. Variable decode frequency on-board for best resolution. 9-12V operation. Measures 35mm x 50mm. **£17.95**
- **TLX700** Micro size telephone transmitter. Connects onto line at any point and requires no batteries. Clearly transmits both sides of conversations on both incoming and outgoing calls. Undetectable by phone users. Fully tuneable output covering FM band. Range up to 1000m. Measures just 20mm x 20mm. **£5.95**
- **ATR2** Micro size telephone recording unit. Connects onto line at any point and connects into ANY normal cassette recorder, standard or micro having MIC and REM sockets. Requires no batteries. Switches recorder on silently when phone is used for incoming or outgoing calls, switches off when phone replaced. Clearly records both sides of conversations. Undetectable by phone users. Measures 10mm x 35mm. **£10.95**
- **XML900** RF Bug Detector/Locator. Wide band input circuitry detects presence of RF field and triggers flashing LED and piezo bleeper. Variable sensitivity enables source of transmission to be pinpointed to within 6 inches. Max sensitivity will detect MTX or similar transmitter at around 15-20 feet. 9V operation. Measures 55mm x 55mm. **£21.95**

All kits come fully documented with concise assembly and setting-up instructions, high quality fibreglass PCB and all components necessary to complete the module. All prices are inclusive but please add £1.50 to cover P&P. Orders over £50.00 post free. Please state requirements clearly and enclose cheque or PO to cover.

Phone orders on ACCESS or AMEX accepted. Tel: 0827 714476  
NOTE: It is illegal to operate a transmitter in the UK without a licence  
Send 9x4 SAE for full catalogue of these and other surveillance kits

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## TRANSFORMERS

### MAINS ISOLATORS

Pri 120V x 2 or 220/240V or 415/440V Sec 440 or 240V or 110V Centre Tapped Secs

20VA	£	7.58	P	2.28
60	12.37	&	2.45	
100	14.43	P	2.65	
200	20.45		3.20	
250	24.73		3.30	
500	38.10		3.85	
1000	69.10		4.85	
1500	89.13		5.95	
2000	107.24		5.95	
3000	150.38		D/A	
6000	321.20		D/A	

### 30/15V or 15-0-15V

2x15V Tapped Secs  
Volts available: 3, 4, 5, 6, 8, 9, 10, 18, 18, 20, 27 or 30V

30V	15V	£	P&P	
0.5	1	4.14	1.65	
1	2	5.63	1.80	
2	A	9.10	2.00	
3	M	10.55	2.20	
4	P	12.59	2.30	
5	S	10	16.11	2.40
6	12	17.65	2.65	
8	16	23.59	2.75	
10	20	27.22	2.95	
12	24	30.39	3.05	
15	30	34.03	3.65	
20	40	46.46	5.95	

### 50/25V or 25-0-25V

2x25V Tapped Secs  
Volts available: 5, 7, 8, 10, 13, 17, 20, 25, 33, 40, 50V or 20-0-20V or 25-0-25V

50V	25V	£	P&P	
0.5	1	5.38	1.90	
1	2	6.54	2.00	
2	A	11.65	2.50	
3	M	13.48	2.50	
4	P	18.46	2.95	
6	S	12	23.47	2.95
8	16	33.20	3.25	
10	20	39.40	3.70	
12	24	47.16	3.90	

### 60/30V or 30-0-30V

2x30V Tapped Secs  
Volts available: 16, 18, 36, 40, 60, 24-0-24 or 30-0-30V

60V	30V	£	P&P	
0.5	1	6.11	1.90	
1	2	9.32	2.00	
2	A	11.98	2.30	
3	M	17.32	2.40	
4	P	19.75	2.50	
5	S	10	24.97	2.90
6	12	28.48	3.10	
8	16	40.04	3.75	
10	20	46.62	4.00	
12	24	53.72	4.75	

### INVERTERS

12/24V DC to 240V AC  
Sine-Wave or Square Wave  
Outputs from 60VA

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## EX STOCK

24/12V or 12-0-12V  
2x12V Secs Pri 240V

24V	12V	£	P&P	
0.15	0.03	3.13	1.70	
0.25	0.05	3.31	1.70	
0.5	1	3.97	1.70	
1	2	5.53	1.90	
2	A	6.38	2.00	
3	M	10.99	2.15	
4	P	11.70	2.20	
6	S	12	14.20	2.40
8	16	16.90	2.80	
10	20	22.75	3.20	
15	30	28.38	3.30	
20	40	40.37	3.75	
30	60	57.96	4.45	
41	83	66.74	5.75	

### AUTOS

105, 115, 220, 230, 240V  
For step-up or down

80VA	£	6.29	P&P	1.75
150	9.12			1.90
250	11.14			2.10
500	17.32			2.80
1000	30.94			3.35
1500	36.73			3.80
2000	54.92			4.65
3000	93.39			5.75
4000	121.23			D/A
5000	141.17			D/A
7500	217.91			D/A
10kVA	257.49			D/A

### CASED AUTOS

240V Cable Input  
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20VA	£	8.96	P&P	1.85
80	12.17			1.95
150	15.77			2.30
250	19.21			3.25
500	31.51			3.25
1000	44.23			4.55
2000	78.82			5.58
3000	113.15			D/A

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## ELECTRONIC TEST EQUIPMENT — CALIBRATION CERTIFICATES SUPPLIED AT EXTRA COST PHONE FOR DETAILS

This is just a small sample of our vast range of equipment. If the instrument you require is not listed please give us a call as we can probably help you.

**BECHMAN** Digital Multimeter model DM20L (we recommend this as excellent value for money) 3½ digit display, 28 RANGES, 20MHz logic probe built in, transistor gain testing. Direct reading 200-2000Mohm ranges, Continuity Bleeper 10Mohm input impedance, Pocket size. Ideal for the home constructor or experienced engineer, extremely versatile and exceptionally easy to use. **PRICE £46.00**

**THANDAR** Oscilloscope model SC110. Bench. Portable, low power, 10MHz band width, 10mV, 10mV sensitivity, 12 attenuator/voltage settings, 21 time base ranges. Small screen (1in x 1¼in) but very useful instrument operates on batteries or mains. Comes with mains adaptor and x 1 probe. **PRICE £209.95**

**ROBIN** Analogue multimeter model OM20NB. 2000ohm per volt multimeter DC Voltage to 1000V AC. Voltage to 500V DC current to 250mA. Resistance to 500kohms. **PRICE £10.00**

**FLOPPY DISKS** Double sided, double density, 96 tpi, high quality. Pretested computer disks suitable for Amstrad and any other P.C.'s with 5¼in drives. **PRICE** per box of 10 disks **£7.00** Inclusive of price — **FREE** labels & Notch stickers & the box acts as a stand. Please add £1 for postage.

**HITACHI** Oscilloscope model V212. Large clear 6in screen DC to 20MHz Dual channel, max vertical sensitivity = 1mV/DIV, Fastest sweep rate = 100ns/DIV Calibrator output. This instrument has in our experience proved to be an exceptional piece of equipment, being very reliable and durable. We were impressed by its bright clear and crisp display making the instrument a pleasure to use. **PRICE** inclusive of 2 probes **£334.00**

### Optional Extras

Hard front cover price £16.  
Soft dust cover price £26.

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# ELECTROVALVE

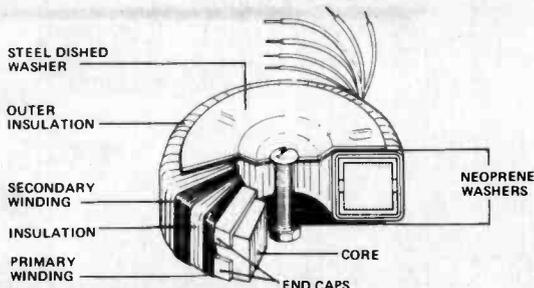
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POLYESTER CAPACITORS		ELECTROLYTIC RADIAL		ELECTROLYTIC CANS		CONNECTORS		BRIDGES		BUZ		CFY19-18		7491		Variable		I.C. analogue		Dual	
5mm PCM	63v 10%	µF V	µF V	µF V	µF V	DIN AUDIO	250V ac	1A W04 0.20	BC141 0.40	BF244B 0.40	BU407 1.05	CFY19-17	7491	LM329 0.80	LM317K 2.40	SAS2317K	ILD1 0.85	ILD30 1.40	I.C. threshold	Quad	
4.7nF 0.06	2.2	100 0.06	100 350 1.65	2.2 63 0.06	220 350 2.21	2-way 0.08	3-way 0.18	3A BF34 0.80	BC149 0.18	BF254 0.17	BUX26 3.78	CFY19-27	7493	LS279 0.55	LM337T 1.80	LS280 0.55	LS281 1.10	723-T05 1.07	723-dip14	0.55	3.25
10nF 0.06	4.7	63 0.06	220 100 2.01	15nF 0.07	22 63 0.06	4-way 180°	5-way 180°	5A BF64 0.75	BC159 0.15	BF420 0.30	BUX82 1.30	MJ2955 0.95	7494	LS375 0.80	TBA120T 1.37	LS376 0.80	LS377 0.80	UAA170 2.92	UAA180 2.92	LM301AN	9.70
15nF 0.07	22	63 0.06	1000 63 1.98	22nF 0.07	47 18 0.06	5-way 240°	5-way 360°	25A BF2506	BC161 0.40			MJE340 0.48	7495	LS390 0.55	TBA120T 1.37	LS391 0.55	LS392 0.55	UAA180 2.92	UAA180 2.92	LM301AN	9.70
22nF 0.07	47	18 0.06	2200 40 1.70	33nF 0.07	47 40 0.06	5-way 240°	5-way 360°		BC167B 0.21			MJE2955 0.95	74100	LS393 0.70	TBA120T 1.37	LS394 0.70	LS395 0.70	UAA180 2.92	UAA180 2.92	LM301AN	9.70
47nF 0.07	100	16 0.07	2200 100 4.01	47nF 0.07	100 16 0.07	5-way 240°	5-way 360°		BC168C 0.21			MJE3055 0.70	74104	LS396 1.00	TBA120T 1.37	LS397 1.00	LS398 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
68nF 0.08	100	25 0.08	4700 40 2.11	68nF 0.08	100 25 0.08	5-way 240°	5-way 360°		BC169C 0.27			MJE340 0.48	74107	LS399 1.00	TBA120T 1.37	LS400 1.00	LS401 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
150nF 0.12	100	63 0.12	4700 100 6.78	150nF 0.12	100 63 0.12	5-way 240°	5-way 360°		BC177B 0.21			MJE2955 0.95	74107	LS402 1.00	TBA120T 1.37	LS403 1.00	LS404 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
220nF 0.10	220	25 0.12	10000 18 2.02	220nF 0.10	220 25 0.12	5-way 240°	5-way 360°		BC182 0.17			MJE3055 0.70	74121	LS405 1.00	TBA120T 1.37	LS406 1.00	LS407 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
330nF 0.17	220	63 0.16	10000 26 2.61	330nF 0.17	220 63 0.16	5-way 240°	5-way 360°		BC182L 0.17			MJE2955 0.95	74121	LS408 1.00	TBA120T 1.37	LS409 1.00	LS410 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
470nF 0.22	470	6 0.08	10000 40 3.99	470nF 0.22	470 6 0.08	5-way 240°	5-way 360°		BC183 0.17			MJE340 0.48	74125	LS411 1.00	TBA120T 1.37	LS412 1.00	LS413 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
680nF 0.22	470	16 0.12	10000 63 6.57	680nF 0.22	470 16 0.12	5-way 240°	5-way 360°		BC183L 0.17			MJE2955 0.95	74125	LS414 1.00	TBA120T 1.37	LS415 1.00	LS416 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1µF 0.32	470	25 0.16	22000 16 3.36	1µF 0.32	470 25 0.16	5-way 240°	5-way 360°		BC184 0.17			MJE340 0.48	74125	LS417 1.00	TBA120T 1.37	LS418 1.00	LS419 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1.5µF 0.40	470	40 0.30	22000 25 5.48	1.5µF 0.40	470 40 0.30	5-way 240°	5-way 360°		BC184L 0.17			MJE2955 0.95	74125	LS420 1.00	TBA120T 1.37	LS421 1.00	LS422 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1000V 10%	1000	16 0.16		1000V 10%	1000 16 0.16	5-way 240°	5-way 360°		BC212L 0.17			MJE3055 0.70	74191	LS423 1.00	TBA120T 1.37	LS424 1.00	LS425 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1000V 0.08	1000	25 0.33		1000V 0.08	1000 25 0.33	5-way 240°	5-way 360°		BC213L 0.17			MJE2955 0.95	74191	LS426 1.00	TBA120T 1.37	LS427 1.00	LS428 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
150nF 0.09	1000	25 0.33		150nF 0.09	1000 25 0.33	5-way 240°	5-way 360°		BC214 0.17			MJE340 0.48	74191	LS429 1.00	TBA120T 1.37	LS430 1.00	LS431 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
220nF 0.10	1000	25 0.33		220nF 0.10	1000 25 0.33	5-way 240°	5-way 360°		BC214L 0.17			MJE2955 0.95	74191	LS432 1.00	TBA120T 1.37	LS433 1.00	LS434 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
330nF 0.13	1000	25 0.33		330nF 0.13	1000 25 0.33	5-way 240°	5-way 360°		BC217A 0.13			MJE3055 0.70	74191	LS435 1.00	TBA120T 1.37	LS436 1.00	LS437 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
470nF 0.17	1000	25 0.33		470nF 0.17	1000 25 0.33	5-way 240°	5-way 360°		BC238B 0.13			MJE2955 0.95	74191	LS438 1.00	TBA120T 1.37	LS439 1.00	LS440 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1nF 0.08	1000	25 0.33		1nF 0.08	1000 25 0.33	5-way 240°	5-way 360°		BC238C 0.13			MJE340 0.48	74191	LS441 1.00	TBA120T 1.37	LS442 1.00	LS443 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1.5nF 0.08	1000	25 0.33		1.5nF 0.08	1000 25 0.33	5-way 240°	5-way 360°		BC258B 0.17			MJE2955 0.95	74191	LS444 1.00	TBA120T 1.37	LS445 1.00	LS446 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
2.2nF 0.08	1000	25 0.33		2.2nF 0.08	1000 25 0.33	5-way 240°	5-way 360°		BC267 0.26			MJE3055 0.70	74191	LS447 1.00	TBA120T 1.37	LS448 1.00	LS449 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
3.3nF 0.08	1000	25 0.33		3.3nF 0.08	1000 25 0.33	5-way 240°	5-way 360°		BC300 0.40			MJE2955 0.95	74191	LS450 1.00	TBA120T 1.37	LS451 1.00	LS452 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
4.7nF 0.06	1000	25 0.33		4.7nF 0.06	1000 25 0.33	5-way 240°	5-way 360°		BC301 0.35			MJE340 0.48	74191	LS453 1.00	TBA120T 1.37	LS454 1.00	LS455 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
6.8nF 0.06	1000	25 0.33		6.8nF 0.06	1000 25 0.33	5-way 240°	5-way 360°		BC303 0.40			MJE2955 0.95	74191	LS456 1.00	TBA120T 1.37	LS457 1.00	LS458 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
10nF 0.06	1000	25 0.33		10nF 0.06	1000 25 0.33	5-way 240°	5-way 360°		BC307 0.18			MJE3055 0.70	74191	LS459 1.00	TBA120T 1.37	LS460 1.00	LS461 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
15nF 0.06	1000	25 0.33		15nF 0.06	1000 25 0.33	5-way 240°	5-way 360°		BC328 0.20			MJE2955 0.95	74191	LS462 1.00	TBA120T 1.37	LS463 1.00	LS464 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
22nF 0.06	1000	25 0.33		22nF 0.06	1000 25 0.33	5-way 240°	5-way 360°		BC337 0.20			MJE340 0.48	74191	LS465 1.00	TBA120T 1.37	LS466 1.00	LS467 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
33nF 0.06	1000	25 0.33		33nF 0.06	1000 25 0.33	5-way 240°	5-way 360°		BC338 0.20			MJE2955 0.95	74191	LS468 1.00	TBA120T 1.37	LS469 1.00	LS470 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
47nF 0.07	1000	25 0.33		47nF 0.07	1000 25 0.33	5-way 240°	5-way 360°		BC413 0.17			MJE3055 0.70	74191	LS471 1.00	TBA120T 1.37	LS472 1.00	LS473 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
100V 10%	1000	25 0.33		100V 10%	1000 25 0.33	5-way 240°	5-way 360°		BC414 0.27			MJE2955 0.95	74191	LS474 1.00	TBA120T 1.37	LS475 1.00	LS476 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
100V 0.08	1000	25 0.33		100V 0.08	1000 25 0.33	5-way 240°	5-way 360°					MJE340 0.48	74191	LS477 1.00	TBA120T 1.37	LS478 1.00	LS479 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
150nF 0.09	1000	25 0.33		150nF 0.09	1000 25 0.33	5-way 240°	5-way 360°					MJE2955 0.95	74191	LS480 1.00	TBA120T 1.37	LS481 1.00	LS482 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
220nF 0.10	1000	25 0.33		220nF 0.10	1000 25 0.33	5-way 240°	5-way 360°					MJE3055 0.70	74191	LS483 1.00	TBA120T 1.37	LS484 1.00	LS485 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
330nF 0.13	1000	25 0.33		330nF 0.13	1000 25 0.33	5-way 240°	5-way 360°					MJE2955 0.95	74191	LS486 1.00	TBA120T 1.37	LS487 1.00	LS488 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
470nF 0.17	1000	25 0.33		470nF 0.17	1000 25 0.33	5-way 240°	5-way 360°					MJE340 0.48	74191	LS489 1.00	TBA120T 1.37	LS490 1.00	LS491 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1nF 0.08	1000	25 0.33		1nF 0.08	1000 25 0.33	5-way 240°	5-way 360°					MJE2955 0.95	74191	LS492 1.00	TBA120T 1.37	LS493 1.00	LS494 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
1.5nF 0.08	1000	25 0.33		1.5nF 0.08	1000 25 0.33	5-way 240°	5-way 360°					MJE3055 0.70	74191	LS495 1.00	TBA120T 1.37	LS496 1.00	LS497 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
2.2nF 0.08	1000	25 0.33		2.2nF 0.08	1000 25 0.33	5-way 240°	5-way 360°					MJE2955 0.95	74191	LS498 1.00	TBA120T 1.37	LS499 1.00	LS500 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
3.3nF 0.08	1000	25 0.33		3.3nF 0.08	1000 25 0.33	5-way 240°	5-way 360°					MJE340 0.48	74191	LS501 1.00	TBA120T 1.37	LS502 1.00	LS503 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
4.7nF 0.06	1000	25 0.33		4.7nF 0.06	1000 25 0.33	5-way 240°	5-way 360°					MJE2955 0.95	74191	LS504 1.00	TBA120T 1.37	LS505 1.00	LS506 1.00	UAA180 2.92	UAA180 2.92	LM301AN	9.70
6.8nF 0.06	1000	25 0.33		6.8nF 0.06	1000 25 0.33	5-way 240°	5-way 360°					MJE3055 0.70	74191	LS507 1.00	TBA120T 1.37	LS508 1.00	LS				



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- \* Sizes from 15VA to 625VA
- \* Dual 120v primaries allowing 110/120v or 220/240v operation



TYPE	SERIES NO.	SEC VOLTS	RMS CURRENT	TYPE	SERIES NO.	SEC VOLTS	RMS CURRENT
15VA £9.30	03010	6+6	1.25	160VA £16.85	53011	9+9	8.89
	03011	9+9	0.83		53012	12+12	6.66
	03012	12+12	0.63		53013	15+15	5.33
	03013	15+15	0.50		53014	18+18	4.44
	03014	18+18	0.42		53015	22+22	3.63
	03015	22+22	0.34		53016	25+25	3.20
	03016	25+25	0.30		53017	30+30	2.66
30VA £10.60	03017	30+30	0.25	53018	35+35	2.28	
	13010	6+6	2.50	53026	40+40	2.00	
	13011	9+9	1.66	53028	110	1.45	
	13012	12+12	1.25	53029	220	0.72	
	13013	15+15	1.00	53030	240	0.66	
	13014	18+18	0.83	225VA £18.40	63012	12+12	9.38
	13015	22+22	0.68		63013	15+15	7.50
13016	25+25	0.60	63014		18+18	6.25	
13017	30+30	0.50	63015		22+22	5.11	
50VA £12.20	23010	6+6	4.16		63016	25+25	4.50
	23011	9+9	2.77		63017	30+30	3.75
	23012	12+12	2.08		63018	35+35	3.21
	23013	15+15	1.66	63026	40+40	2.81	
	23014	18+18	1.38	63025	45+45	2.50	
	23015	22+22	1.13	63033	50+50	2.25	
	23016	25+25	1.00	63028	110	2.04	
80VA £13.50	23017	30+30	0.83	63029	220	1.02	
	23028	110	0.45	63030	240	0.93	
	23029	220	0.22	300VA £20.10	73013	15+15	10.0
	23030	240	0.20		73014	18+18	8.33
	33010	6+6	6.66		73015	22+22	6.82
	33011	9+9	4.44		73016	25+25	6.00
	33012	12+12	3.33		73017	30+30	5.00
33013	15+15	2.66	73018		35+35	4.28	
33014	18+18	2.22	73026		40+40	3.75	
120VA £14.35	33015	22+22	1.81	73025	45+45	3.33	
	33016	25+25	1.60	73033	50+50	3.00	
	33017	30+30	1.33	73028	110	2.72	
	33028	110	0.72	73029	220	1.36	
	33029	220	0.36	73030	240	1.25	
	33030	240	0.33	500VA £26.55	83016	25+25	10.0
	43010	6+6	10.0		83017	30+30	8.33
43011	9+9	6.66	83018		35+35	7.14	
43012	12+12	5.00	83026		40+40	6.25	
43013	15+15	4.00	83025		45+45	5.55	
43014	18+18	3.33	83033		50+50	5.00	
43015	22+22	2.72	83042		55+55	4.54	
625VA £29.30	43016	25+25	2.40	83028	110	4.54	
	43017	30+30	2.00	83029	220	2.27	
	43018	35+35	1.71	83030	240	2.08	
	43028	110	1.09	93017	30+30	10.41	
	43029	220	0.54	93018	35+35	8.92	
	43030	240	0.50	93026	40+40	7.81	
				93025	45+45	6.94	
			93033	50+50	6.25		
			93042	55+55	5.68		
			93028	110	5.68		
			93029	220	2.84		
			93030	240	2.60		

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Z4137 As above, but "return", so probably not fully functional, but complete. **£3.95**

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Z4139 As above, but skeleton version—no plastic case. **£1.50**

**SEMICONDUCTORS**  
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78M05 (5V 1/2A reg.) **10 for £1.00**  
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Lots more in Bargain List.

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Z1522 40 position CB switch. Alps SRS. 7 bits per step. **£1.00**

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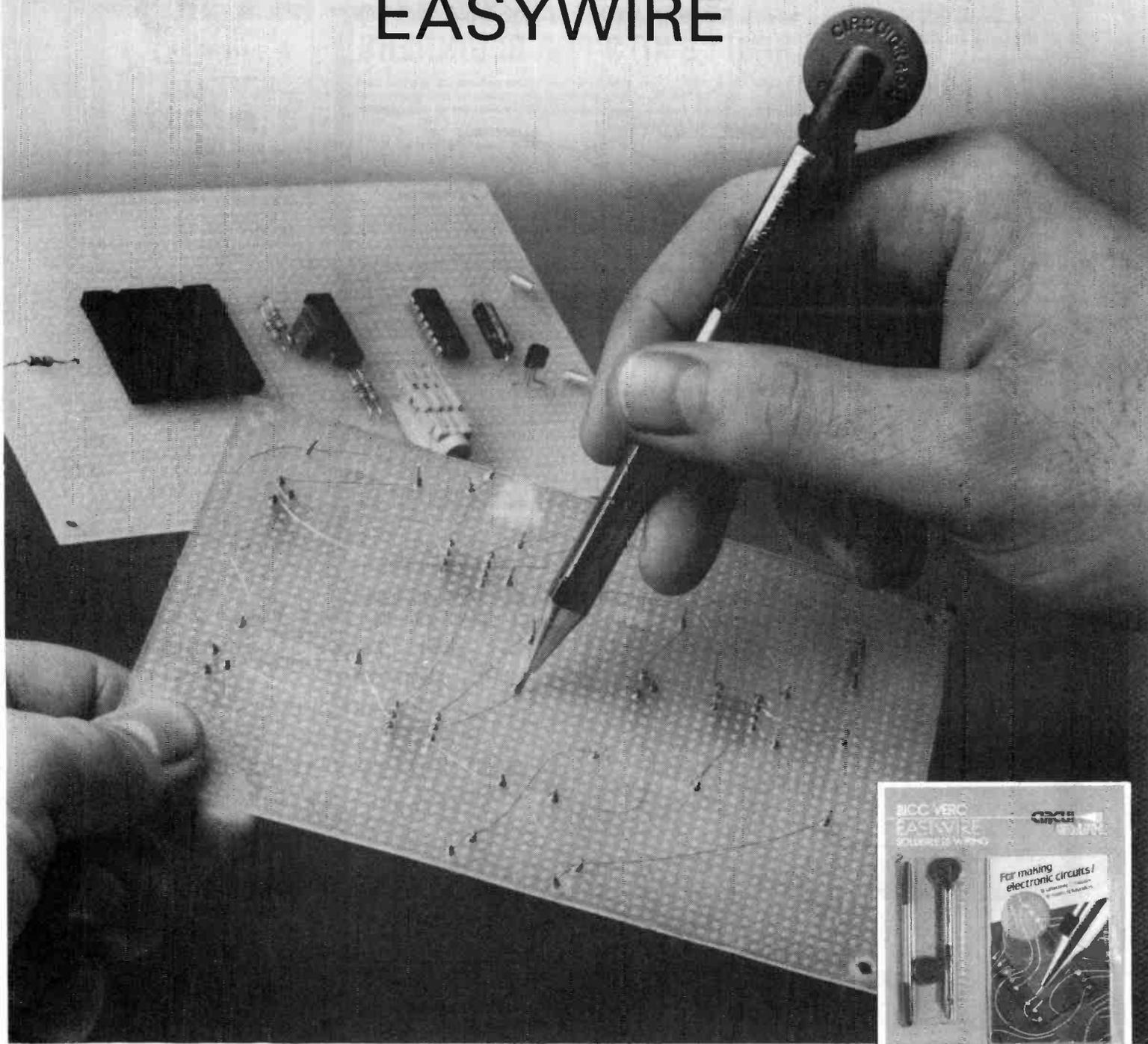
All prices include VAT; just add £1.00 P&P; Min Credit Card £5. No CWO min. Official orders from schools welcome—Min invoice charge £10.00. Our shop has enormous stocks of components and is open 9-5 Mon.-Sat. Come and see us!

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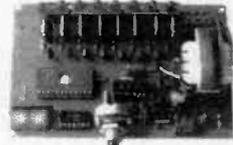
# KITS & COMPONENTS

## ELECTRONIC GUARD DOG



One of the best burglar deterrents is a guard dog and this kit provides the barking. Can be connected to a doorbell, pressure mat or any other intruder detector and produces random threatening barks. All you need is a mains supply, intruder detector and a little time.  
XK125 ..... £24.00

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DL1000K 4-way chaser features bi-directional sequence and dimming 1kW per channel. £19.25  
DLZ1000K Uni-directional version of the above. Zero switching to reduce interference. £10.80  
DLA/1 (for DL & DLZ1000K) Optional opto input allowing audio 'beat'/light response. 77p  
DL3000K 3-channel sound to light kit, zero voltage switching, automatic level control and built-in mic. 1kW per channel. £15.60

## POWER STROBE KIT

Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80x50x45.  
XK124 STROBOSCOPE KIT ..... £13.75

## PROPORTIONAL TEMPERATURE CONTROL KIT



Uses 'burst fire' technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine-making, etc. Max. load 3kW (240V ac) Temp range up to 90°C. Size: 7x4x2.5cms.  
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## SIMPLE KITS FOR BEGINNERS

Especially aimed at the beginner. Have fun with your project even after you have built it and also learn a little from building it. These kits include high quality solder resist printed circuit boards, all electronic components (including speaker where used) and full construction instructions with circuit description.



### SPECIAL OFFERS ON SK KITS FOR SCHOOLS AND TRAINING CENTRES

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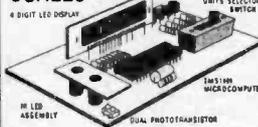
SK1 DOOR CHIME plays a tune when activated by a pushbutton. £3.90  
SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command. £3.90  
SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire-engine siren and machine gun. £3.90  
XK113 MW RADIO KIT based on ZN414 IC. kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5x2.7x2 cms. Requires PP3 9V battery. £6.60  
XK118 TEN EXCITING PROJECTS FOR BEGINNERS this kit contains a solderless breadboard, components, and a booklet with instructions to enable the absolute novice to build ten fascinating projects including a light operated switch, intercom, burglar alarm, and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section on component identification and function is included, enabling the beginner to build the circuits with confidence. £15.00

## SOLID STATE RELAY BARGAIN



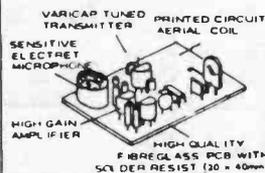
Zero voltage switching - no radio interference. 2.5KV input to output isolation. 4 KV terminals to heatsink isolation. 3V to 32V input voltage easily interlaced to TTL or CMOS logic. 24V to 240V rms load voltage. Inductive load switching. Built-in snubber network. 10A max. 4A with no heatsink at 40°C.  
CD240/10 ..... £2.25

## ELECTRONIC WEIGHING SCALES



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ES1 ..... £6.50

## SUPER-SENSITIVE MICROBUG



Only 45x25x15mm, including built-in mic. 88-100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. £5.50

## VERSATILE REMOTE CONTROL KIT



Includes all components (+transformer) for a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc - details supplied) can switch up to 16 items of equipment on or off remotely. Outputs may be latched to the last received code or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits. Supply: 240V AC or 15-24V DC at 10mA. Size (exc. transformer) 9x4x2 cms. Companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available - MK9 (4-way) and MK10 (16-way).  
MK12 IR Receiver ..... £16.30  
MK18 Transmitter ..... £7.50  
MK9 4-way Keyboard ..... £2.20  
MK10 16-way Keyboard ..... £6.55  
601133 Box for Transmitter ..... £2.60

## ★ ★ ★ BARGAIN COMPONENT PACKS ★ ★ ★

Refill those empty component drawers at a fraction of the normal price and don't be caught out. All components supplied are to full spec, and are not seconds or surplus stock. Prices exclude VAT (15%).  
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Pack C: 30x Polyester capacitors a or 0.01uf-1uf ..... £4.50  
Pack D: 35x horizontal presets 1k-1M ..... £3.00  
Pack E: 30x IC sockets 8, 14, 16 pin ..... £2.00  
Pack F: 25x Red 5mm LEDs ..... £1.75  
Pack G: 25x Green LEDs ..... £2.00  
Pack H: 30x 5mm LEDs 10 Red, 10 Green, 10 Yellow ..... £2.50  
Pack J: 50x 1N4148 silicon diodes ..... £1.00  
Pack K: 40x npn/pnp transistors BC/548/558 General Purpose ..... £2.25  
FREE Solderless Breadboard (verobloc type) when you buy all ten packs.

## MICROPROCESSOR TIMER

Kit controls 4 outputs independently switching on/off at 18 preset times over a 7-day cycle. LED display of time/day easily programmed. Includes box.  
CT6000K ..... £47.20  
XK114 Relay kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts ..... £4.30  
701115 Additional relays ..... £1.80

**TK ELECTRONICS**  
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**ORDERING INFORMATION** All prices exclude VAT. Free p&p on orders over £50 (UK only), otherwise add £1+VAT. Overseas p&p: Europe £3.50, elsewhere £10. Send cheque/PO/Barclaycard/Access No. with order. Giro No. 529314002. Local authority and export orders welcome. Goods by return subject to availability.



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# TK ELECTRONICS

# EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects  
VOL. 18 No. 2 February '89

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FAX: (0202) 841692

See notes on **Readers' Enquiries** below—we regret that lengthy technical enquiries cannot be answered over the telephone

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## AVAILABILITY

As is witnessed by our lack of many 1988 back issues, readers all over the UK are having occasional difficulties in obtaining copies. There have been rationalisations in the newspaper and magazine wholesale trade during the year and changes will continue to be implemented for some time to come. This has meant many newsagents being forced to change to new wholesalers and has led to a number of associated problems.

With so many magazines available to the consumer (around 3,000 different titles in the UK) we cannot expect every newsagent to keep every title, or even to have knowledge of one particular specialist publication. Of course EE is fairly widely known and available but if you live away from a large newsagent, it is likely that you will not always find copies available off the shelf. However EE is available from any newsagent in the UK, they only have to order a copy from their wholesaler and our distributor—Seymour—will do the rest. The key to making sure of a copy is to *place an order*. Even if you do not have a newspaper delivered by the newsagent they will order a copy and save it in the shop for your collection.

## STORIES

Over the past year we have heard many stories that readers have been told:

EE has merged with ..... and it's the same magazine now.

EE has not published this month/has stopped publishing.

EE is always late coming out.

Let me say clearly that none of these are true. We have published every month on time for at least the last five years—not one issue has been missed and not one issue has been published late. But please don't blame your newsagent, very often the problems are not of his making—he is the last man in a long supply chain.

I know that occasionally readers have failed to get a copy that they have ordered, in such cases we try to investigate and solve any problems, but a regular order will normally guarantee delivery of EE on time. A newsagent order form is on page 127.

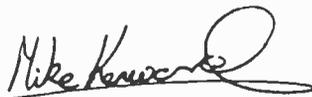
## DON'T MISS OUT

In short, *don't rely on copies just being there*, they usually will be in large newsagents situated in main towns, but elsewhere you may be out of luck. While we have tried to make sure we can supply back numbers by increasing our stock, many 1988 issues have now sold out. EE is the best selling magazine in this market and sometimes this means copies sell out quickly—don't miss out!

You can of course take out a subscription. Your copy will then be delivered by the publishing date, by post—Post Office willing! An order form for subscriptions appears on page 127.

## PRICE

I'm sorry to say that from next month EE will go up by 10p. However, EE will still be cheaper than its nearest rival and will, I believe, still represent the best value for money in this market.



## SUBSCRIPTIONS (SEE ABOVE)

Annual subscriptions for delivery direct to any address in the UK: £15.70. Overseas: £19.00 (£36 airmail). Cheques or bank drafts (in £ sterling only) payable to Everyday Electronics and sent to EE Subscriptions Dept., 6 Church Street, Wimborne, Dorset BH21 1JH.

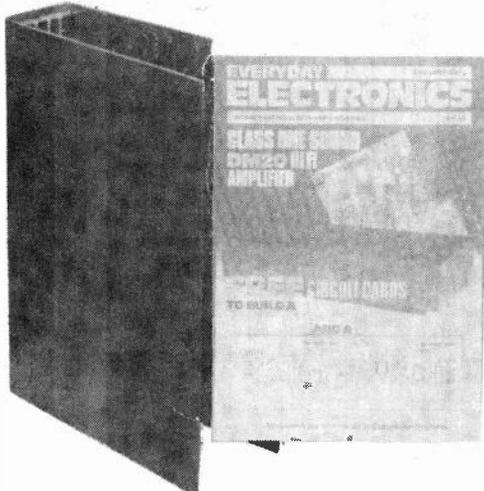
Subscriptions can only start with the next available issue. For back numbers see below.

## BACK ISSUES

Certain back issues of EVERYDAY ELECTRONICS are available price £1.50 (£2.00 overseas surface mail—£ sterling only please) inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability remittance will be returned. *Please allow 28 days for delivery. We have sold out of Sept., Oct. & Nov. 85, April, May & Dec. 86, Jan., Feb., April, May & Nov. 87, Jan., March, April, May, June & Oct. 88.*

## BINDERS

Binders to hold one volume (12 issues) are available from the above address for £4.95 (£6.95 to European countries and £9.00 to other countries, surface mail) inclusive of postage and packing. *Please allow 28 days for delivery. Payment in £ sterling only please.*



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## READERS' ENQUIRIES

We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply **must** be accompanied by a **stamped self-addressed envelope** or a **self-addressed envelope and international reply coupons**.

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.

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We regret that **we cannot provide data or answer queries on projects that are more than five years old**.

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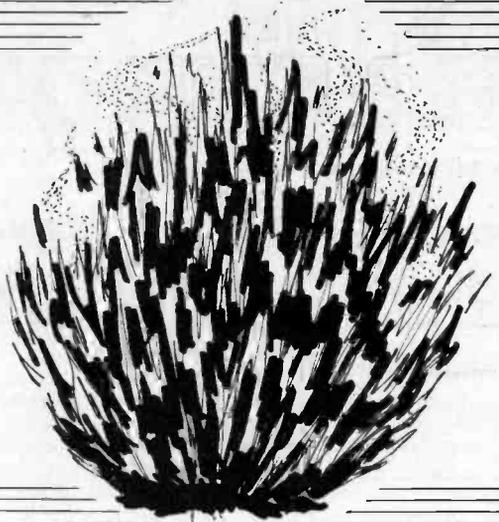
## TRANSMITTERS/BUGS

We would like to advise readers that certain items of radio transmitting equipment which may be advertised in our pages cannot be legally used in the U.K. Readers should check the law before using any transmitting equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use.

The law relating to this subject varies from country to country; overseas readers should check local laws.

# FIRE ALARM

GARY CALLAND



*Add invaluable protection to your home. An inexpensive system that will detect a fire in any room, garage etc.*

IT SEEMS as if it were every week that we hear of the tragic news of house fires. Usually at night when the occupants are asleep, the fortunate ones awaken to find their house full of smoke, and have to come to terms with the prospect of a gutted carcass where their home once stood. For the less fortunate ones. . . .

Lives and property could be saved by fitting an effective fire alarm system. However, commercially available fire alarm systems are expensive and very few people think the risk of fire in their house warrants such a large expenditure.

There have been quite a few fire alarm projects in electronics magazines over the years, but nearly all depend on using expensive and hard to obtain gas sensors. The fire alarm described here however,

uses a simple, cheap, reliable and novel method of fire detection, is extremely versatile in that as many detectors as required can be added and will give enough warning to perhaps avoid another tragic disaster.

## FIRE ALARM

The fire alarm consists of two units. The master unit which sounds an alarm and displays where the fire is, and the detector units, one of which is mounted in each room.

The master unit is intended to be mounted by the bedside in the main bedroom and to be switched on before a night's sleep. The unit has provision for six detector units, but this can be extended to any number if required. The unit supplies the

power to the detectors, and when triggered sounds quite a loud warning device and illuminates an appropriate l.e.d. to show which detector has been triggered.

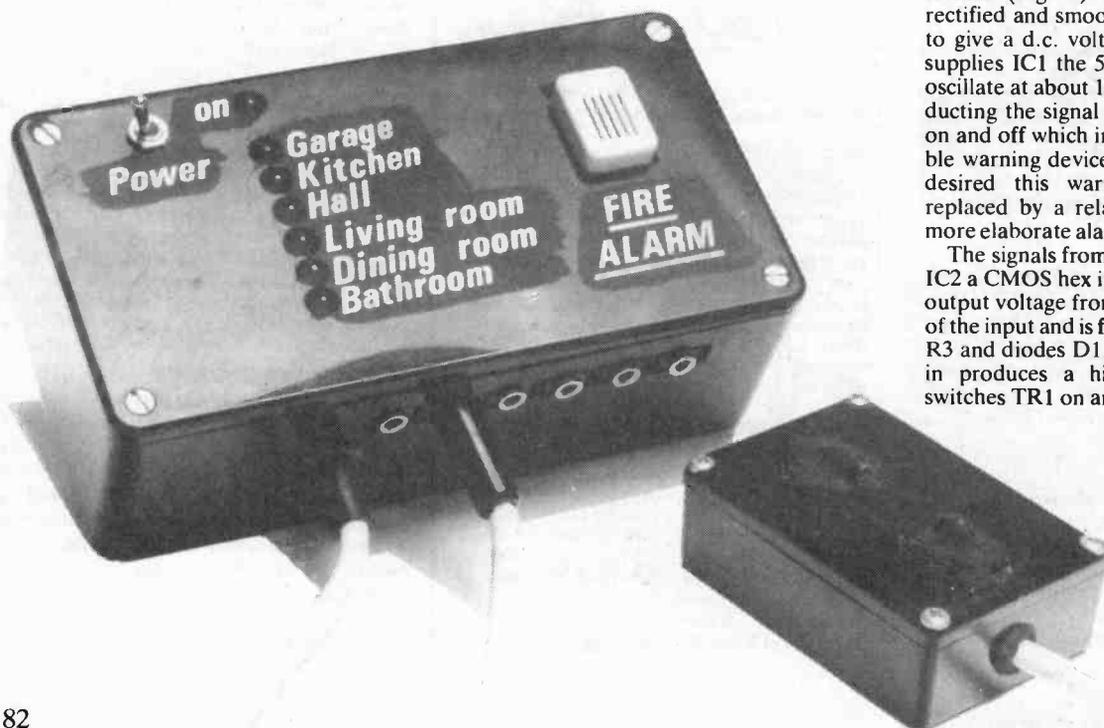
The detectors use a beam of infra-red light supplied by an infra-red l.e.d. to detect the presence of smoke particles. As the room fills with smoke, the intensity of the infra-red (IR) beam reaching the IR detector transistor decreases, as the smoke particles scatter and absorb the IR light. This drop in intensity is detected and used to trigger the master unit.

When smoke is detected, a low signal is sent to the master unit, otherwise the signal is high. As the master unit expects to see a high voltage signal when in normal operation, any faults with the detectors and any breaks in the detector cables, which might be caused by fire burning through the cables, will be detected as the signal will go low and will trigger the alarm. This is an added safety feature which detects faults, as it is useless having a broken detector unit when you think it works perfectly.

## CIRCUIT DESCRIPTION —MASTER UNIT

Power is obtained from the mains transformer (Fig. 1) through a fuse and is rectified and smoothed by D1, D2 and C1 to give a d.c. voltage of about 12V. This supplies IC1 the 555 timer which is set to oscillate at about 1.5Hz. When TR1 is conducting the signal from IC1 switches TR2 on and off which in turn switches the audible warning device (WD1) on and off. (If desired this warning device could be replaced by a relay which could drive a more elaborate alarm system — see Fig. 2.)

The signals from the detectors are fed to IC2 a CMOS hex inverter/buffer chip. The output voltage from this chip is the inverse of the input and is fed to the base of TR1 via R3 and diodes D11 to D16. A low voltage produces a high voltage out which switches TR1 on and the alarm sounds.



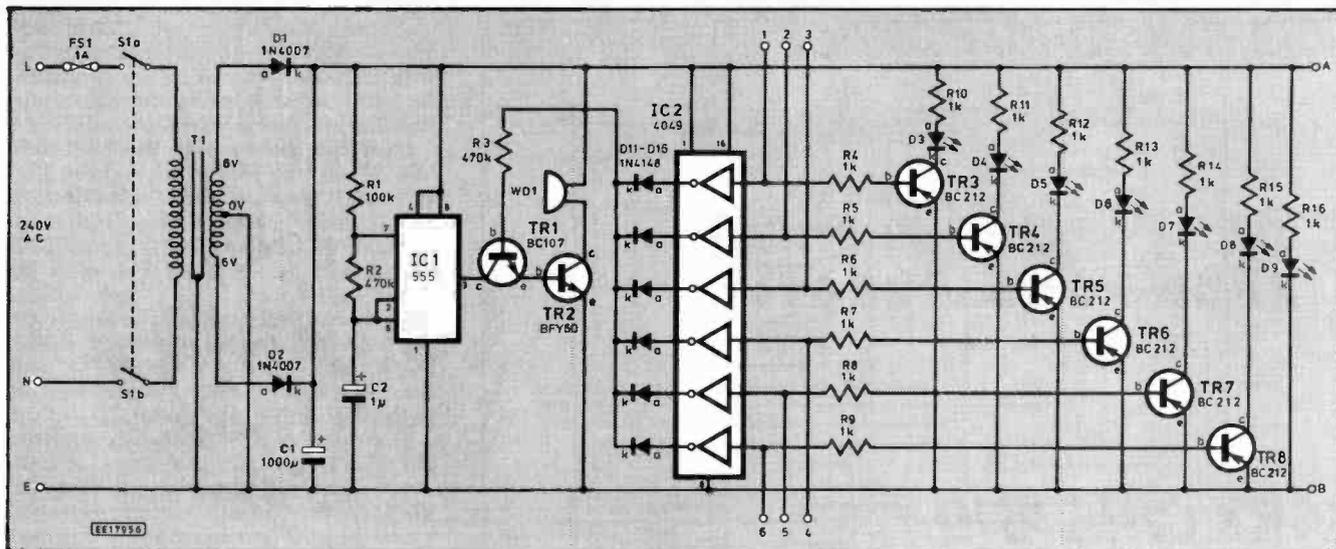


Fig. 1. Circuit of the Fire Alarm master unit.

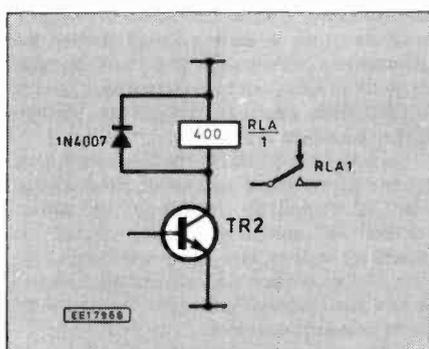


Fig. 2. Addition of a relay to drive other alarm output devices.

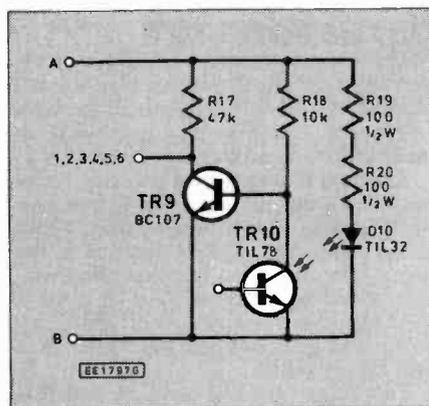


Fig. 3. Circuit of the alarm detector.

The detector signals are also sent via R4 to R9 to a set of transistors (TR3 to TR8) which switch on l.e.d.s D3 to D8 when the voltage to their bases goes low, hence showing which detector has been triggered. Resistor R16 and l.e.d. D9 are present to indicate when the unit is turned on.

## DETECTOR

The detector circuit is shown in Fig. 3, about 50mA flows through the infra-red l.e.d. D10 via R19 and R20 so that a high output of IR light is obtained. In the absence of smoke, this high intensity beam switches the IR transistor TR10 fully on so that the full supply voltage is dropped

across R18 and so the base of TR9 is at zero potential. Hence TR9 is not switched on, no current flows through R17 and there is no potential drop across it. The signal to the master unit is high.

When the intensity of the beam is reduced by the slightest amount, due to smoke particles, TR10 conducts less and so the base of TR9 sees a voltage. As the two transistors are directly coupled, this voltage switches TR9 fully on, the full supply voltage is dropped across R17 and the output signal is low.

## CONSTRUCTION

The circuit board was made out of Veroboard as this is the most available form of circuit board and this allows the project to be made by less experienced builders who may not wish to purchase a ready-made p.c.b. and who may be unfamiliar with p.c.b. construction. As a result, however, there are quite a number of breaks in the tracks, and a large number of links are present so the layout shown in Fig. 4 will have to be carefully followed.

## COMPONENTS

£30 incl. 6 detectors

### Master Unit

#### Resistors

R1	100k
R2	470k
R3	470k
R4 to R16	1k (13 off)

All ¼ watt ±5%

**Shop  
Talk**

see page 91

#### Capacitors

C1	1000µ elect. 16V
C2	1µ elect. 16V

#### Semiconductors

D1, D2	1N4007
D3 to D9	red l.e.d.'s (7 off—see text)
D11 to D16	1N4148 (6 off)
TR1	BC107
TR2	BFY50
TR3 to TR8	BC212 (6 off)
IC1	555 timer
IC2	4049 CMOS hex inverter

#### Miscellaneous

FS1	1A 20mm fuse and holder
-----	----------------------------

S1	d.p.d.t. 240V toggle switch
T1	6-0-6V 400mA mains transformer
WD1	audible warning device L7009

Mains grommet; 16 pin d.i.l. i.c. holder; Veroboard 3.75 inch by 5 inch; case—Bimbox range 152 × 82 × 50mm; p.c.b. mounting 3.5mm stereo jack sockets (6 off); cable clamp; fixings; wire etc.

### Detector Unit

(Items for one unit)

#### Resistors

R17	47k ¼W carbon
R18	10k ¼W carbon
R19	100 ½W carbon
R20	100 ½W carbon

#### Semiconductors

D10	TIL 32 I.R.l.e.d.
TR9	BC107
TR10	TIL 78

#### Miscellaneous

Verocase 72×47×25mm; Veroboard (see text); three core mains cable; 3.5mm stereo jack plug; grommet.

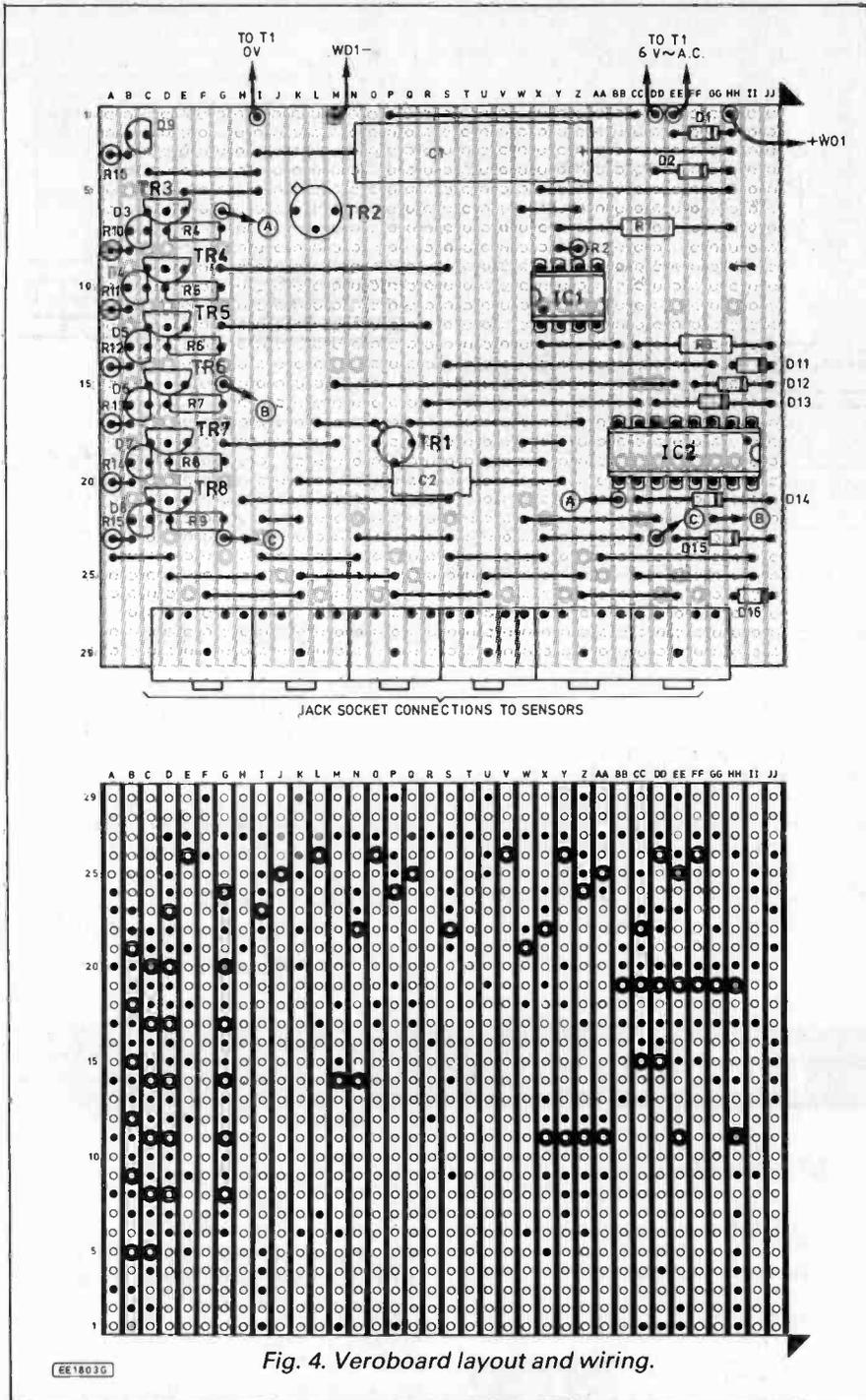


Fig. 4. Veroboard layout and wiring.

A standard 3.75 inch x 5 inch Veroboard is cut to 29 holes and the off cut kept for the detector circuit board. Very carefully mark the breaks in the tracks and cut them with a spot face cutter or twist drill.

Start construction with the links, followed by the six stereo jack sockets. The resistors, capacitors and semiconductors can then be soldered into place. Care must be taken with the orientation of polarized components (see Fig. 4). IC2 must be placed into a socket rather than directly soldered into the board (damage may occur due to the heat from the soldering iron, but IC2 is a CMOS device and none of the pins must be touched as this may cause damage to the chip due to static electricity).

Once the circuit board is complete, attention is now turned to the case construction and mains connections. The case is a 152 x 82 x 50 mm Bimbox range case which is quite attractive and accommodates the components snugly.

The mains transformer is mounted in the left hand corner using 6BA bolts and the fuse holder mounted at the back. The mains cable enters the case through a grommet and a cable clamp should be included to prevent the mains cable accidentally pulling out and weakening solder joints which could be dangerous. Mains wiring is shown in Fig. 5.

Six holes are drilled in the side of the case for the jack sockets and seven holes in the case lid should be drilled for the seven l.e.d.s. The mains switch S1 should be mounted in line with the power on l.e.d. (see Fig. 6). A hole will also have to be cut in the case lid for WD1 which should be fixed using epoxy resin.

After wiring up the circuit board, WD1, mains transformer, switch etc. (see Figs. 5 and 6) the circuit board can be mounted using bolts or the plastic spacers supplied with the case. All that remains is for the lid to be labelled with rub down letters.

### DETECTOR UNIT

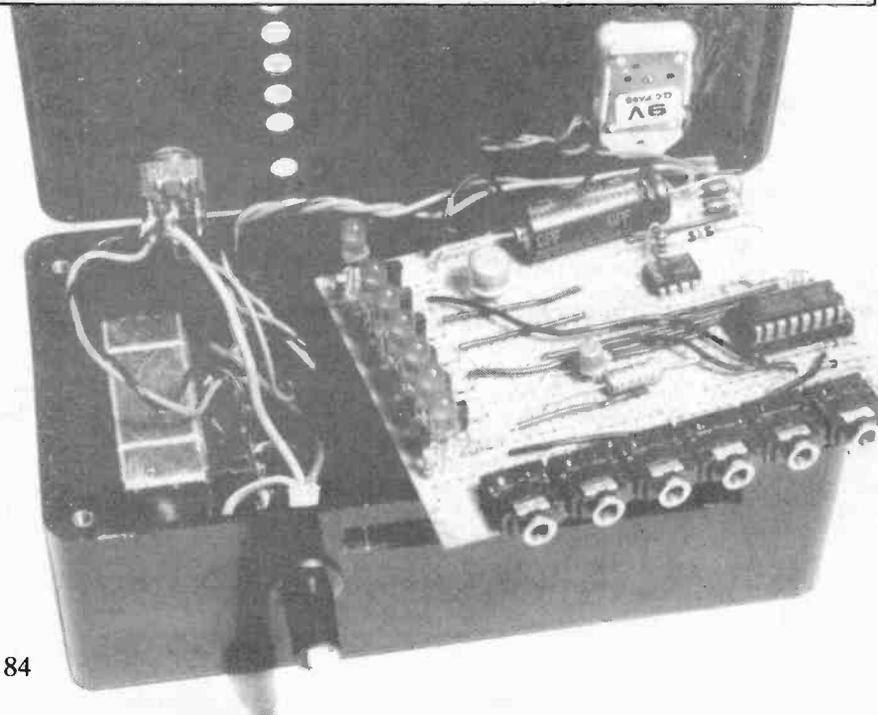
The few components which make up the detector unit are all mounted on a small piece of Veroboard left over from the main Veroboard. There is only one break to make and no links this time.

After construction of the circuit board has been completed (see Fig. 7) it is connected to the master unit via thin, 3-core mains cable. The cable is attached to the circuit board as shown, fed through a grommet in the side of the case, and attached to a 3.5 mm stereo jack plug, carefully noting which wire goes to which part of the plug (see Figs. 8 and 9).

Two holes should be carefully drilled in the case lid so that the IR l.e.d. and transistor can poke through when the lid is placed on the case. The l.e.d. and transistor are then bent through 90 degrees so that they are facing each other, and are shielded from daylight, either by using a piece of pen case or rubber tubing. Particular attention should be made to shielding the transistor as external IR sources may interfere with the detector.

Plug the detector into the main unit and if the alarm is triggered, it means the l.e.d. and transistor are not correctly lined up with each other. If this happens, small movements of either the transistor or l.e.d. should be made until the alarm is silent.

Once alignment has been completed, the transistor and l.e.d. can be glued into place using epoxy resin. This also holds the circuit board in place. The detector is now complete.



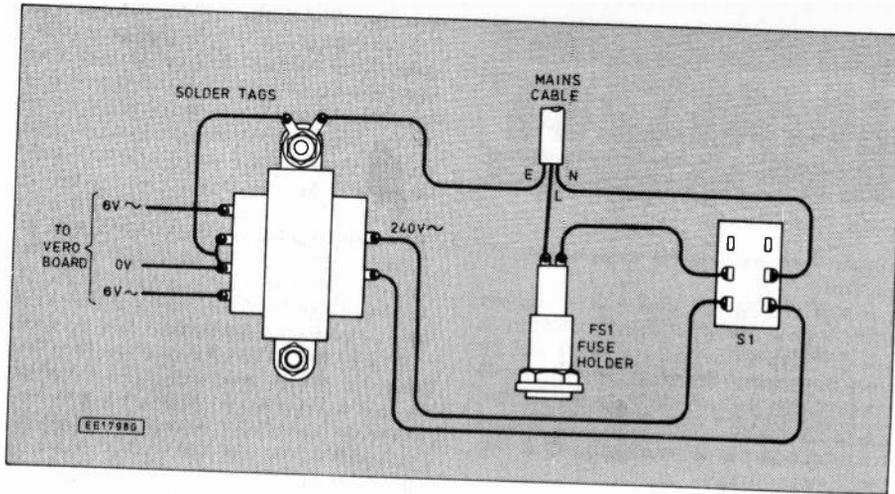


Fig. 5. Mains supply wiring.

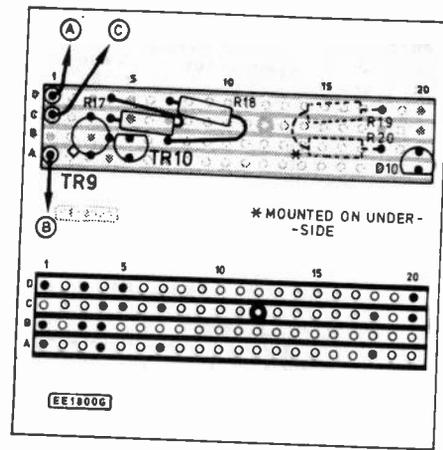


Fig. 7. Veroboard construction of the detector units. Note that point C goes to the jack plug tip (1, 2, 3, 4, 5, 6), see Fig. 9.

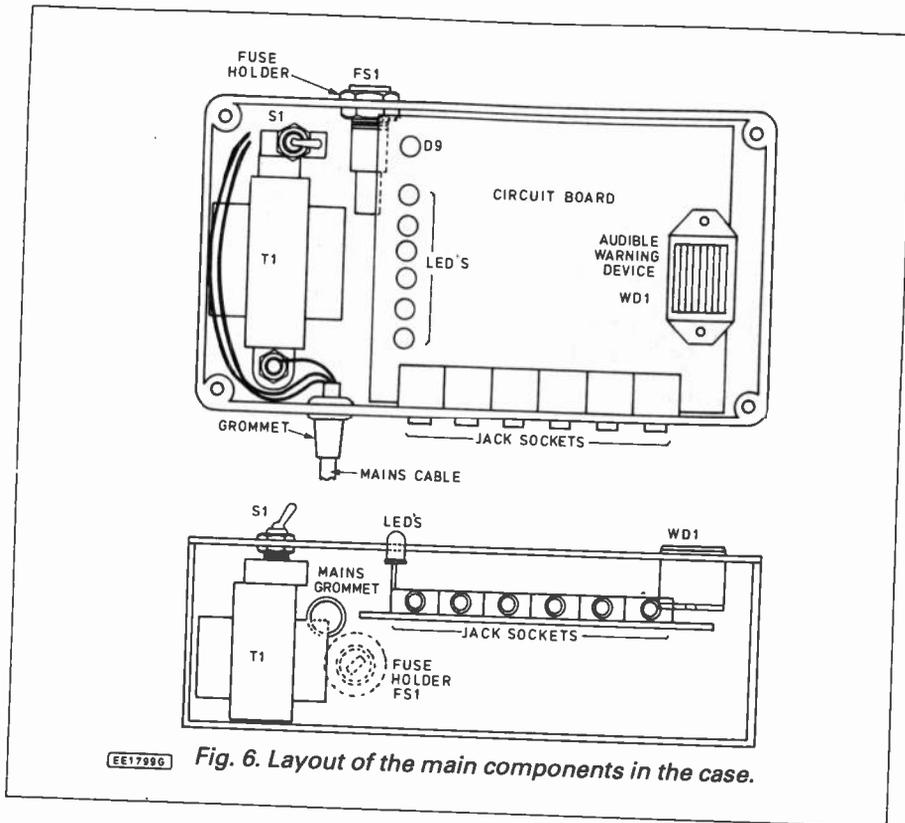


Fig. 6. Layout of the main components in the case.

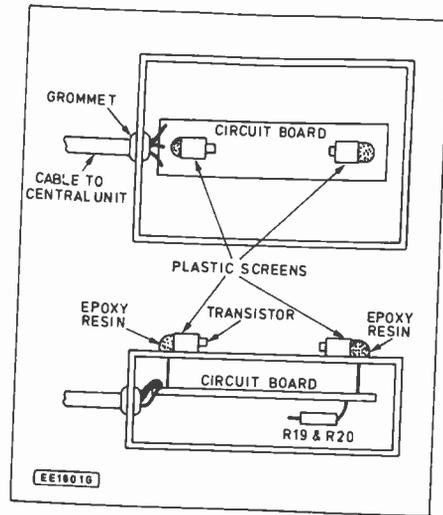
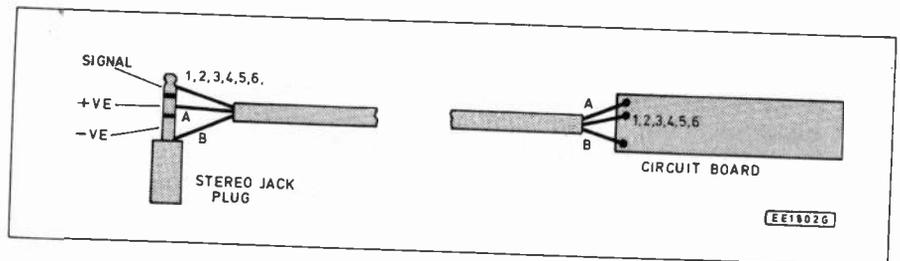
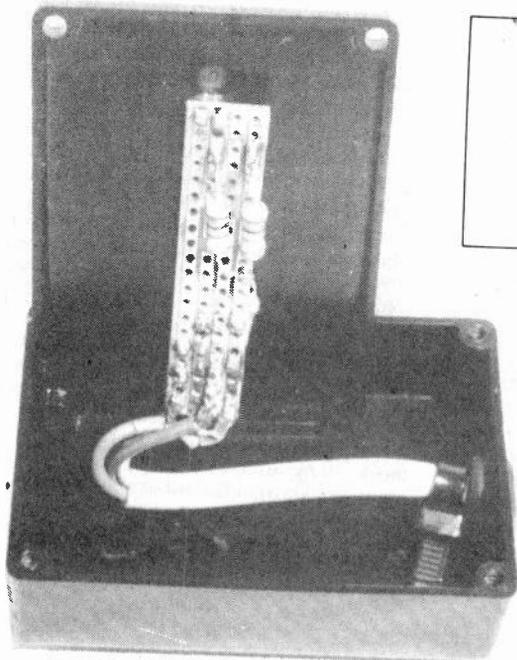


Fig. 8. Layout of the detectors.

Fig. 9. (below) Wiring of the detectors to the stereo jack plugs for connection to the master unit.



## MOUNTING AND TESTING

The detector units should be mounted high up on a room wall or on the ceiling as smoke tends to accumulate at the top of a room. Best positions are near potential fire hazards e.g. near ash trays, electric fires, above sofas, near electrical equipment etc. and detectors should be located as near to these as possible.

Testing is simply a case of cutting off the IR beam of each detector by placing a finger in the path of the beam, and checking to see if the corresponding l.e.d. lights. (You can also allow a little smoke from a cigarette to pass through the beam to check sensitivity.) If all is well, the project is now ready to protect your home from the dangers of fire. □

# FOR YOUR ENTERTAINMENT

BY BARRY FOX

## To Fit . . .

Around 300,000 homes in Britain are connected to a cable station, and around two million flat-dwellers are receiving signals from a shared dish aerial on the roof, according to estimates by Astra, the satellite broadcasting consortium. That leaves around 20 million homes theoretically in the market for a dish system to receive programmes direct from satellite.

So far around 80 companies in Europe are offering dish systems capable of receiving Astra, at prices ranging from £149 for a Sinclair system, £199 for Amstrad and Alba and £300 or £400 from electronic majors like Grundig and the Japanese. These 80 companies promise to deliver two million dish systems in the first year, 1989.

Dixons, the high street chain, talk of selling half a million. The Astra publicity video, which dealers will be asked to show in their shops describes receiving satellite programmes as "easy as ABC—all you need is a dish on a wall or roof, a set-top tuner and a TV set."

This may well turn out to be an oversimplification and understatement. A dish aerial needs to have a direct line of sight on a satellite without any obstruction from buildings or trees. It must be aligned on the invisible satellite to an accuracy of around one degree!

Because satellite signals are f.m. (whereas terrestrial TV signals are a.m.) slight misalignment of the dish may pass unnoticed on a sunny day when the incoming microwave signal is strong. As long as the signal is over the tuner's reception threshold, slight adjustments of the dish will not make any noticeable difference on the screen.

But on wet days, when the incoming signal is attenuated by water in the air, the signal from a misaligned dish system may drop below the threshold for clear pictures. So viewers will find their pictures change with the weather. This is in addition to the problem which can occur if water gets into the coaxial cable, e.g. through poorly made connections, and reduces the signal—as can already happen with u.h.f. aerials.

There will also be a problem if snow collects in a dish and blocks the signal. Flat aerials score here, either genuine flat plate aerials (like BSB's promised Squarial) or the dish-disguised-as-a-plate system developed by Sir Clive Sinclair.

Snow is unlikely to be a significant problem—the UK doesn't get much and it will soon slide from most dishes—but misalignment will show every time it rains.

The only way to be sure that a dish system works as well in wet weather as fine weather, is to align it using a signal strength meter. This technique is already used by reputable firms fitting conventional u.h.f. aerials. The exact position for the aerial is found by looking for the peak reading on a meter,

rather than the clearest picture on a TV screen.

Astra knows full well that if people start finding that their signals disappear on wet days, the bad publicity will be very damaging. Development Manager Robin Crossley announced recently that Astra is sponsoring City and Guilds training courses for aerial fitters at five technical colleges.

## . . . or Not to Fit

But the programmers are impatient. After the training schemes were announced at a press briefing, someone in the audience pointedly asked Marcus Bicknell, Commercial Director of Astra, whether people could fit their own aerials. The man who asked the question, Nick Austin, admitted afterwards that he knew full well that Marcus Bicknell had already tried fitting an aerial, and had pictures to prove it.

Many of the press have already seen these pictures. They thus know that Bicknell had fitted a dish to the wall of a house deep in the country, with unobstructed view of the satellite orbit from low level. Would-be viewers who live in towns and cities will need to fit their dishes much higher.

Nick Austin wants to publicise the

message that dish-fitting is easy. Why?

Nick Austin started the *Beggars' Banquet* small record label and is now running the *Landscape* video programme which goes out for a few hours a night on the Sky satellite channel. Landscape Video is a music programme, with background pictures.

Austin fears that there will be a shortage of professional aerial fitters, and he does not want the public put off satellite by the need to wait. "Putting up a dish is as easy as putting up a shelf", Nick told ERT "Just four Rawplugs".

But Robin Crossley prefers to play safe. He wants people who buy dishes to pay a fitter to fit them. He worries about people in urban areas climbing high ladders or clambering on the roof. At best they risk poor pictures. At worst they risk death. The tabloids will have a field day—and justifiably so.

In practice it will be dealers and manufacturers, not Astra or programme providers like Landscape, who call the shots. Few people fit their own u.h.f. aerials on a roof because when you buy a TV set or a video recorder it does not come packaged with an aerial and chimney mount. But it looks as if satellite systems will be sold in just this way, with a set-top tuner and roof top dish packaged together.

Someone who buys the package on a Saturday morning hoping to watch films and sports programmes that night may well be tempted to have a go at fitting it on Saturday afternoon, instead of waiting perhaps weeks for an engineer to come and charge to do the job.

The buck on this one stops with the satellite trade.

## Wonder of Electronics

Here's some ammunition for anyone who wants to argue that music is becoming too heavily dependent on electronics.

Stevie Wonder flew over from Los Angeles to take part in the Nelson Mandela concert at Wembley Stadium. At the last moment his appearance was delayed. At first the announcers on TV said it was because he had technical problems with his computer; then they said it was because his music computer had been stolen; and then that the computer software had been stolen.

This is what happened.

Stevie uses a Synclavier system to store sound patterns of "samples" on hard Winchester magnetic disk. The patterns are triggered by a keyboard.

The samples which come packaged with the machine are pretty basic and sound only vaguely like the instruments they are intended to mimic. The real skill of the user is in doctoring existing samples or producing new ones. Musicians spend years building up their own library of samples. Often they are derived from brief snatches of real sound, recorded digitally and then processed to taste.

At the Wembley concert, five artists, including Sting, were using Synclavier systems. Michael Jackson used four for his concerts. There is no need for musicians to carry their own Synclavier hardware round the world, they just take a library of samples, and software, to program hired hardware.

Stevie Wonder brought over an optical disc, with two gigabyte capacity, and tape back-up streamers, for use with one of the Synclaviers installed at Wembley. These units have optical disc drive, as well as a tape streamer drive and a 5.25in floppy disc drive for booting up the system with its operating system.

Just before he went on stage, someone who had conned their way backstage stole a DAT recorder being used to tape the event. With mindless stupidity, the thief also grabbed the 5.25in magnetic drive sitting on top of the Synclavier. It was no use to him whatsoever, but he just took it anyway.

This meant that the Synclavier could not be booted up with the operating system needed to load his samples from the optical discs. Apparently it was a musician from pop group UB40 who finally found the thief, made a citizen's arrest and brought back the drive so that Stevie Wonder could go on stage.

Incidentally, although more and more musicians are using Synclavier equipment, the real money is in the use of this equipment for post production work. Film and TV programme producers are able to add and edit music, sound effects and dialogue much more easily using magnetic disk storage than tape, because there is no time lost on re-winding the recording. The magnetic disk can be switched to replay "from the top" in a fraction of a second.

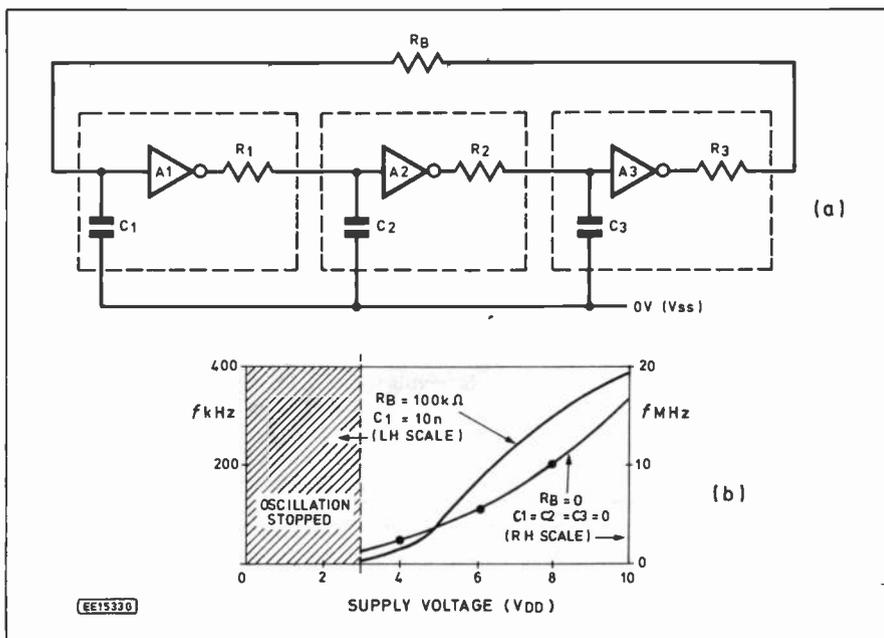


Fig. 3a. In a three-stage (buffered) inverter the input capacitances  $C1-C3$  and output resistances  $R1-R3$  plus bias resistance  $R_b$  act as phase-shift networks. (b) Supply-voltage-control of frequency for three inverters of a 4069UB.

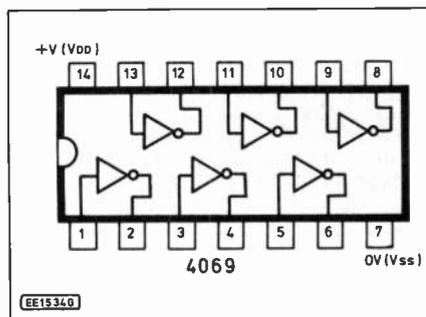


Fig. 4. Arrangement of CMOS 4069 in d.i.l. package.

set the centre frequency by trial and error to almost anything you like, below the upper limit. You can also add to the  $R_s$  but this restricts the tuning range.

The current drawn increases with frequency in CMOS circuits and a check should be made on dissipation. This is  $Supply\ Voltage \times Supply\ Current$  and must not exceed 400mW for the 4069. As always with CMOS any unused inputs should be connected to the 0V or positive supply line to avoid spurious switching by stray voltages, which increases dissipation.

### PROTECTION DIODES

The individual inverters in a 4069 have their inputs protected from excess voltages, usually by a built-in resistor and two diodes as shown in Fig. 5. In normal use the diodes are reverse-biased by the supply and play no part. Their intended function is to conduct when an abnormally large input is applied. The resistance then absorbs the unwanted energy and protects the f.e.t.s. ... up to a point.

Very large inputs can destroy the diodes and wreck the chip. To reduce the risk, before touching a CMOS circuit you should first discharge any static on your person by "earthing" yourself to the common side of the supply; i.e. to negative battery. A finger touch is enough.

Similarly, the bits of soldering irons should be connected to battery negative throughout use on the circuit, to provide a safe path for

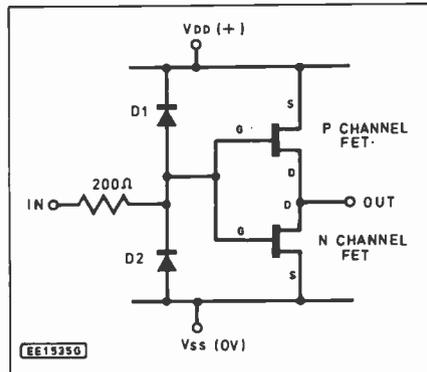


Fig. 5. One inverter of a 4069UB showing the usual type of diode protection.

mains leakage. (In practice, if your iron has a low leakage this may not be necessary. Measure the leakage from bit to mains earth; it should not be more than a few tens of microamps).

We said that the diodes don't normally conduct. This is not completely true. When two inverters are connected as a simple RC relaxation oscillator (Fig. 6a) momentary conduction takes place each time the circuit changes state. This affects the charging and discharging rates of capacitor  $C1$  and reduces the period (increases the frequency). This may not matter but it does make the frequency change rather a lot as the supply voltage changes.

In applications where frequency stability is important the effect can be reduced by connecting a swamping resistance  $R2$  (Fig. 6b) to restrict the diode current of the first inverter. Received wisdom says that if resistor  $R2$  is at least ten times resistor  $R1$  the effect of diode conduction is negligible for most purposes. Don't expect perfect stability: supply variations have other effects which  $R2$  cannot compensate.

These simple and reliable oscillators give 50/50 (approximately) square waves at the output of  $A2$ . The frequency is approximately  $0.45/(R1.C1)$ . If  $R1$  is in megohms and  $C1$  in microfarads the frequency is in hertz. The

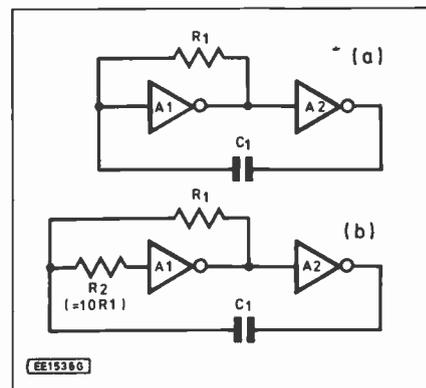


Fig. 6. Two-inverter RC relaxation oscillators. Adding  $R2$  reduces the effect of supply voltage on frequency.

corresponding period (duration of one full cycle) is  $2.2 R1.C1$  seconds.

In many applications the output of  $A2$  during one half-period (e.g. the positive half cycle) is used to control some other circuit. In this case the relevant time is  $1.1 R1.C1$  seconds. For example if you want the positive outputs of  $A2$  to turn on a further circuit for periods of one second and  $C1=1\mu F$ , then  $R1=C1/1.1=0.9M$ . In practice, use a trimming resistance of somewhat higher value for  $R1$  (or part of  $R1$ ) and set to the correct time if precision is needed.

The frequency can be predicted with fair accuracy only up to a few tens of kHz. Higher up, stray capacitance and the variability of amplifier output resistance introduce uncertainty. At low frequencies, very large values of  $R1$  can be used.

### AUDIO AMPLIFIERS

At first sight CMOS inverters seem to offer the prospect of cheap, simple audio voltage amplification. In practice they can be disappointing.

One limitation is noise, which is much higher than with proper audio transistors and i.c.s. Another is that, although the input resistance of a f.e.t. is virtually infinite, the input impedance of an inverter amplifier is drastically reduced by connecting the bias resistance  $R_b$ .

If the voltage gain is  $A$ , then with  $R_b$  in place the input resistance becomes  $R_b/(A+1)$ . So if  $R_b=10M$  and  $A=9$  the input resistance is  $1M$ .

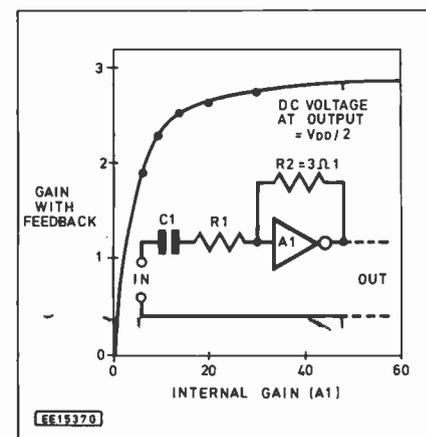


Fig. 7. Voltage amplifier showing the gain stabilization obtained from negative feedback. Target gain = 3.

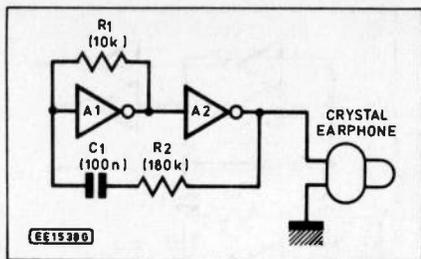


Fig. 8. Test for gain. The circuit oscillates if A2 exceeds 20.

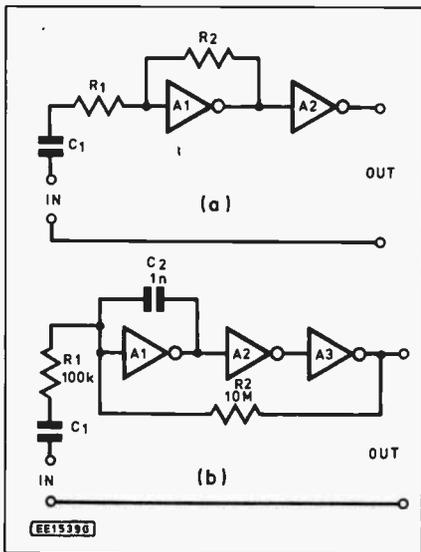


Fig. 9. Higher voltage gain is obtained by cascading (a) two stages or (b) three. Capacitor C2 helps to prevent oscillation.

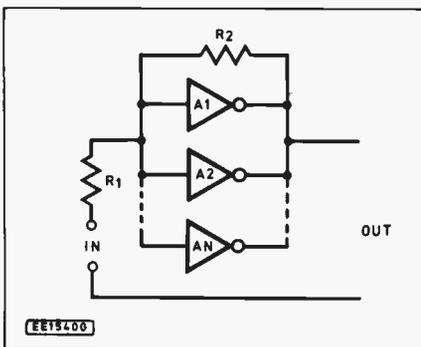


Fig. 10. Paralleled inverters for increased output current.

But what is A? Here again, you run into a problem. Chips are very variable. The gain can be under 10 or it can be very much greater.

To get reasonably repeatable results you have to use negative feedback to limit the effect of chip variability. The voltage gain tries to set itself to  $R2/R1$ . It never quite gets there but if  $R2/R1$  is fairly small (say 3) and the internal gain of A1 is fairly large (say 30) it gets close.

You may want to select chips to make sure that the internal gain is reasonably high. The circuit of Fig. 8 oscillates (at about 300Hz) if the gain of A2 exceeds about 20. (The gain of A1 has little effect.) It's usually sufficient to test one pair of inverters per chip; the rest are likely to be similar.

To get more gain you need more stages. A

simple two-stage circuit (Fig. 9a) has no feedback to A2 so the gain is A2 times  $R2/R1$ . Three-stage feedback amplifiers (Fig. 9b) can oscillate as explained earlier, but may be stable if the gain ( $=R2/R1$ ) is set high and capacitor C2 is connected to discourage h.f. oscillation (it has little effect at audio frequencies).

However, gains of much more than 100 may be impracticable because of noise. The noise output with a gain of 100 can easily be 100mV peak-to-peak, which is quite awful by hi-fi standards. But in other applications it may not matter. The lesson is: don't use CMOS inverters for anything approaching hi-fi uses.

### MORE OUTPUT CURRENT

A single inverter in a 4069 may deliver a very modest output current (less than 1mA at low supply voltage). To get more, connect inverters in parallel (Fig. 10).

### MANUAL GAIN CONTROL

By making resistor R2 (Fig. 11) variable, the gain can be adjusted. If VR is a "log. law"

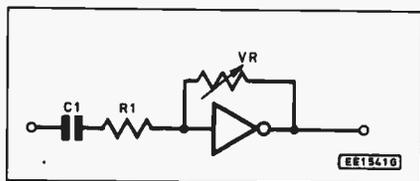


Fig. 11. Manual gain control. Maximum gain tends to  $R2/R1$ .

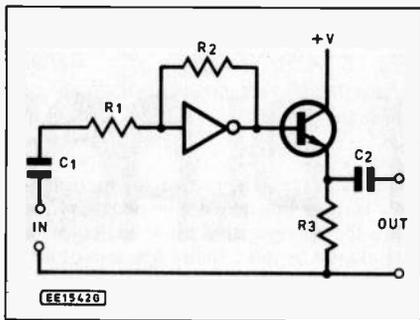


Fig. 12. Reducing output resistance by adding an emitter follower.

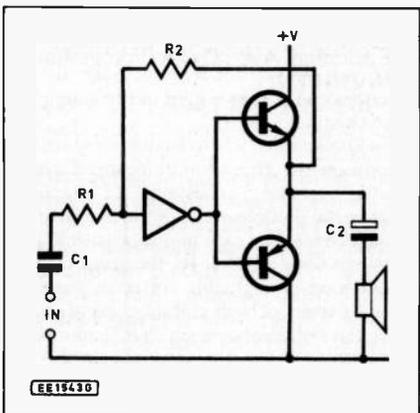


Fig. 13. Arrangement for greater output current.

potentiometer gain increases in the usual way when the pot is connected so that resistance increases with clockwise rotation. There is no d.c. through VR.

### LOW OUTPUT IMPEDANCE

The output impedance (or resistance) of an inverter falls as  $R2/R1$  falls and as the supply voltage is increased. It may be too high for some types of load.

Where only modest load currents are required, add a simple emitter-follower (Fig. 12). The d.c. through the transistor is a bit less than  $V_{DD}/2R3$  and the peak undistorted output current cannot exceed the d.c.

If distortion is unimportant, much larger output currents can be provided by adding a complementary pair of bipolar transistors (Fig. 13). Uses include driving a loudspeaker with an alarm signal such as a bleep tone.

The distortion can be reduced by using germanium transistors instead of the usual silicon ones.

### LIMITERS

Most CMOS inverters have nice symmetrical characteristics (Fig. 2). If overdriven by a sine wave both peaks are flattened.

Heavy overdrive or cascading several inverters gives an output which is an approximation to a 50-50 square wave.

### SINE WAVE OSCILLATORS

Inverters make excellent oscillators and regenerative amplifiers at audio and low radio frequencies. Their characteristic makes for stable operation with little risk of "squegging."

Oscillation calls for positive feedback. A single inverter cannot oscillate unless the associated circuitry provides a further inversion. A traditional way of obtaining this in an LC oscillator is to put a second winding on L to make a phase inverting transformer.

This can be done with inverter oscillators but a neater way is to use the Colpitts form of tuned circuit (a  $\pi$  network with shunt Cs and series L, Fig. 14a). This fits in nicely with the inverter because the L provides a bias path.

The only drawback is that the waveform may not be very good. Adding a variable

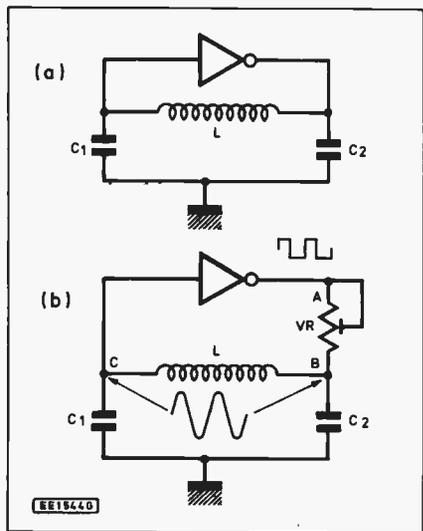


Fig. 14a. Simple Colpitts oscillator. (b) This gives improved waveform.

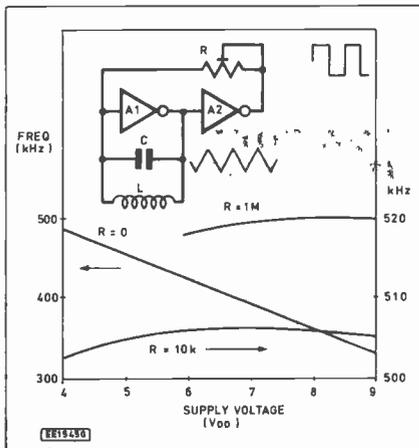


Fig. 15. Two stage LC oscillator: effect of supply voltage.

resistance (VR) to control the amount of feedback yields a good sine wave at either end of the tuning network (B or C) and a flat-topped output at A (Fig. 14b).

## TWO STAGE OSCILLATORS

The alternative way of getting the two inversions needed for positive feedback is to cascade two inverters. The job of the tuning network is then to ensure that oscillation takes place at the right frequency.

A simple form of LC oscillator (Fig. 15) has a parallel-tuned LC circuit as a negative feedback path over the first stage. Because the impedance of the LC is highest at its resonant frequency negative feedback is minimum at this frequency, and increases as the frequency moves away from resonance. The result is that gain is highest at the resonant frequency. If some positive feedback is applied overall,

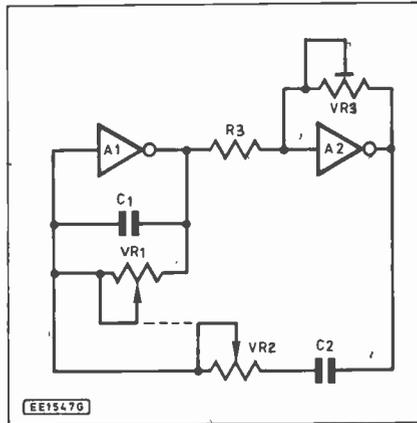


Fig. 16. RC tuned i.f. oscillator.

oscillation occurs at the tuned frequency.

The gain required from A2 is roughly  $R$  divided by the LC impedance at resonance. Thus if the LC looks like  $100k$  and  $R$  is  $200k$  the gain (A2) needed is 2. (The gain of A1 has little effect.) If desired the gain of A2 may be stabilized by local negative feedback.

Some practical results with an oscillator in which LC was the tuned winding of a  $455kHz$  (nominal) i.f. transformer is shown in Fig. 15. For good frequency stability  $R$  must clearly be high. On the other hand, making  $R$  low or zero enable the frequency to be adjusted by changing the supply voltage.

## RC SINE WAVE OSCILLATOR

At low frequencies LC oscillators are impractical because of the large values of inductance and capacitance and the difficulty of making these variable. RC tuning networks are used instead. These have very poor frequency selectivity and to get good sine waves

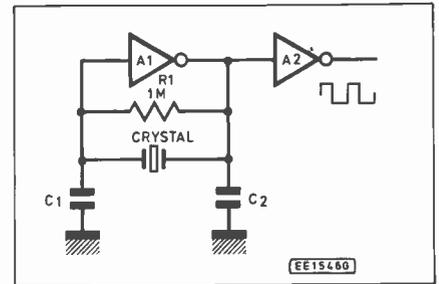


Fig. 17. Crystal oscillator.

calls for adjusting the gain so that the circuit just oscillates.

In the oscillator of Fig. 16, the tuning is done by the series RC and parallel RC networks familiar in the Wien bridge, but connected in a different way. In the usual case when the two Rs (VR1, VR2) are equal and the two Cs are equal, the gain required of A2 is about 2. (A1 has little effect.)

In theory, the circuit could be automatically set up for good waveform by making preset VR3 a thermistor whose working resistance is  $2R3$ . But most thermistors require fairly large operating currents, so it might be necessary to parallel a number of inverters to provide them.

By setting the feedback just short of the oscillating point the circuit becomes a highly selective amplifier. Input signals can be injected into A1 input via a high impedance.

## CRYSTAL OSCILLATOR

Inverters are often used for the crystal oscillators used as clocks in computers. The usual circuit (Fig. 17) is a form of Colpitts oscillator in which the crystal behaves as the inductance. Stray capacitances may provide sufficient C1 and C2 to sustain oscillation, but if precise frequency setting is needed at least one of these must be a real trimmer capacitor. □

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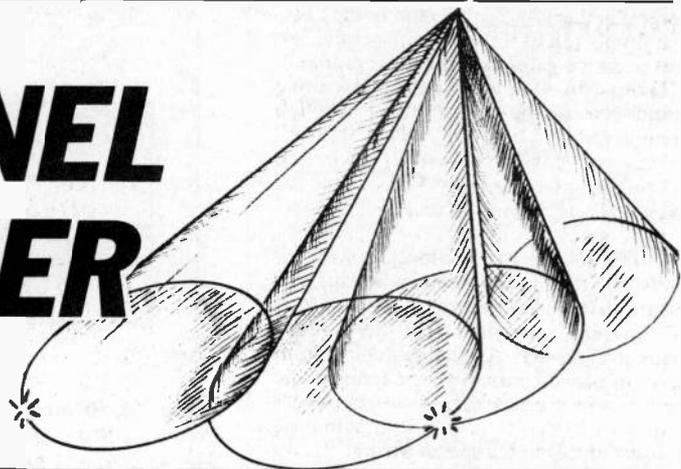
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# FOUR-CHANNEL LIGHT DIMMER



ANDY FLIND

*A safe and versatile, voltage controlled, lamp dimmer that enables up to four 0-1V d.c. inputs to control 240V a.c. mains lamps from zero to full brilliance, at up to 100W per channel.*

**T**HE voltage-controlled dimmer to be described here is an ideal project for constructors who like to experiment, which should include all readers of E.E.! It enables up to four 0-1V d.c. inputs to control 240V a.c. mains lamps from zero to full brilliance, up to 100 watts per channel.

Over the next couple of months we shall be adding a *4-Channel Sound-to-Light Interface*, to enable constructors to create their own "light shows". This will be followed by a *4-Channel Auto-Fader Interface* to allow slow, continuous changes in brilliance of lamps to be driven through the dimmer.

As the 4-Channel Voltage-Controlled Dimmer may be used with all kinds of driving circuitry, safety is a prime consideration and the inputs are totally isolated from the "live" sections through "opto-isolator" chips. The areas of the circuit intended to be accessible may in fact be earthed, or they can be left "floating", for operation at some common potential other than earth.

An auxiliary supply is available from the board for powering other circuitry, and this too is isolated and may be earthed for safety.

## CIRCUIT DESCRIPTION

The full circuit diagram for the 4-Channel Voltage-Controlled Dimmer appears in Fig. 1, and operates as follows. Phase-control is used to determine the brilliance of the lamps driven by the outputs. In a phase-control circuit, the output switches off at each mains zero-crossing (100 times per second), and the point in each half-cycle where it is turned on again determines the average power delivered to the lamp.

Most dimmer switches operate on this principle, though their circuitry is simpler since they are not voltage-controlled. To achieve voltage control, this circuit generates a linear ramp waveform that is set to one volt at the start of each half-cycle and falls to zero during the half-cycle period of 10mS.

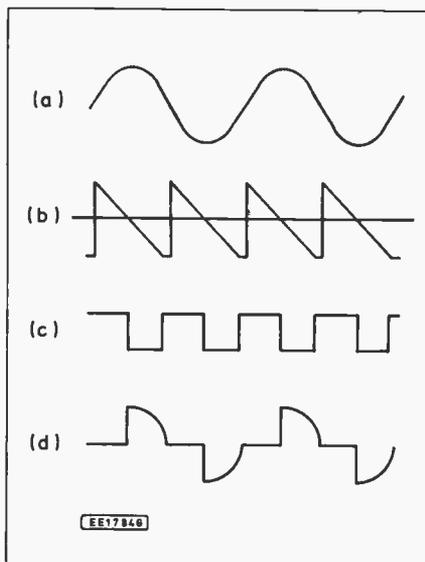


Fig. 2. Typical waveforms to be expected at various stages of the circuit.

The ramp voltage is compared with the input signal, and as soon as it drops below it the associated output is turned on. It follows that the higher the input, the sooner this will happen and the brighter will be the lamp.

The waveforms shown in Fig. 2 illustrate this more clearly: The a.c. mains waveform is shown at (a) and the ramp, synchronised to it, at (b). Superimposed on the ramp is a straight line representing the current input voltage. The comparator output (negative for "on" in this circuit) is shown at (c) and, finally, the resulting output waveform delivered to the load is shown at (d).

## ZERO-CROSSING

The first objective of the circuit is to detect the mains zero-crossing points and use them to reset the ramp generator. In

fact, resetting should occur slightly before each crossing to allow time for the triac gate currents to stop and the devices themselves to turn off.

What is needed are brief pulses straddling the zero crossings, and this is achieved with an "exclusive-OR" gate in IC1 connected to the resistor network R1 to R5. Without going too deeply into the maths of this network, it can be stated that whilst the mains voltage is less than about 20V, positive or negative, one of the inputs to IC1 will be above and one below half the supply voltage.

The EX-OR gate's output is high only for this condition, so the output is a positive pulse, about 400 $\mu$ S long, centred on each zero-crossing. Diodes D1 to D4 clamp the inputs to prevent large excursions above and below the supply rail potentials. Since there are also internal clamping diodes in IC1, resistors R6 and R7 are included to limit current flow into these should they turn on first.

The remaining three gates in IC1 are simply used as a buffer to drive transistor TR1, which pulses the l.e.d. in the single opto-isolator IC2. IC2's transistor resets the ramp, by pulling capacitor C8 up to a regulated 5V supply rail. Capacitor C8 then begins discharging through resistor R17, dropping about 1V in the 10mS before the next reset pulse arrives.

The ramp isn't perfectly linear of course, being part of an exponential discharge curve, but over this small initial portion of the curve it's good enough for the intended purpose. The ramp signal is made symmetrical, about 0.5V with coupling capacitor C9 and reference resistors R18 to R19, and then buffered by IC4 before being passed to the four comparators contained in IC5. The input signals are applied directly to the other inputs of these.

## COMPARATOR OUTPUTS

Unlike op-amps, the outputs of the comparators are single npn transistors, or their collectors, to be precise. The inputs in this design are arranged so that these transistors are normally "off", and turn "on" when an output is required.

Each collector drives an l.e.d. in the quad opto-isolator IC6, and the corresponding transistor in each isolator supplies gate current to the appropriate triac. The triacs employed are C206D's, which the author

has found to be more reliable when operated with negative gate drive. The mains Neutral is therefore connected to the positive supply rail of this part of the circuit, so that negative gate current can be supplied.

Triacs turn off automatically if gate drive is removed and the current passing through them is reduced below a small, "holding" value. As the ramp is reset slightly before each mains zero-crossing, there is time for the gate drive to turn off and triac turn-off to take place.

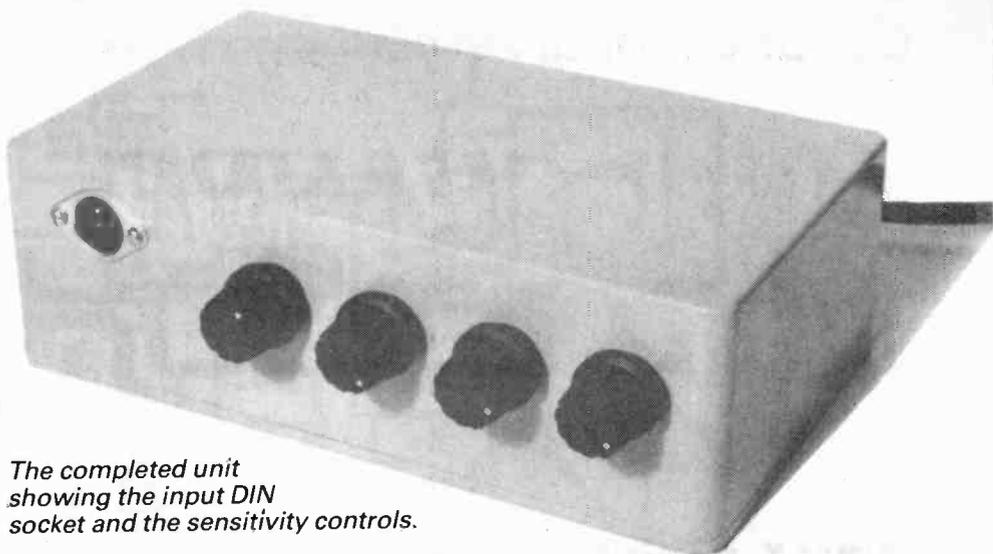
Continuous drive is supplied however whilst the triac is supposed to be "on", to ensure that it doesn't turn off through lack of "holding" current if very low wattage loads are driven. As the switching transients of phase-control cause r.f. noise, the load circuits are suppressed with choke L1 and capacitors C2 and C3 to minimise transfer of this to the mains wiring.

## POWER SUPPLY

Low voltage supplies for the circuit are obtained from a transformer (T1) with two completely separate secondaries. One of these supplies the circuit containing the triacs and zero-crossing detection, which has a direct connection to one side of the mains and so offers a safety hazard.

The other secondary winding feeds the ramp generation and comparator circuits, which are connected to the inputs which will be handled by the user or connected to other equipment. The auxiliary power for driving interface boards, input signal generators etc. is also taken from this supply.

Signals between the two sections of the circuit are transferred entirely through opto-isolators, so it should be safe under all normal circumstances. A regulated 5V supply for the ramp generator is derived from IC3, a 78L05 5V 100mA positive regulator i.c.



The completed unit showing the input DIN socket and the sensitivity controls.

A note regarding the type of transformer used may be of interest. The type used in the prototype was supplied by "Maplin" and is intended for direct mounting on a printed circuit board (p.c.b.). Originally a 9V version was fitted to the prototype, the intention being that after rectification and smoothing a supply of about 11V to 12V (peak value less a bit for the rectifier) would be available.

In fact, the voltage obtained was over 15V; a check on the transformer revealed the output as being around 12V r.m.s. Accordingly it was replaced with the 6V version of the same transformer, which was found to produce 8V r.m.s. and about 10V of rectified and smoothed d.c.

## CONSTRUCTION

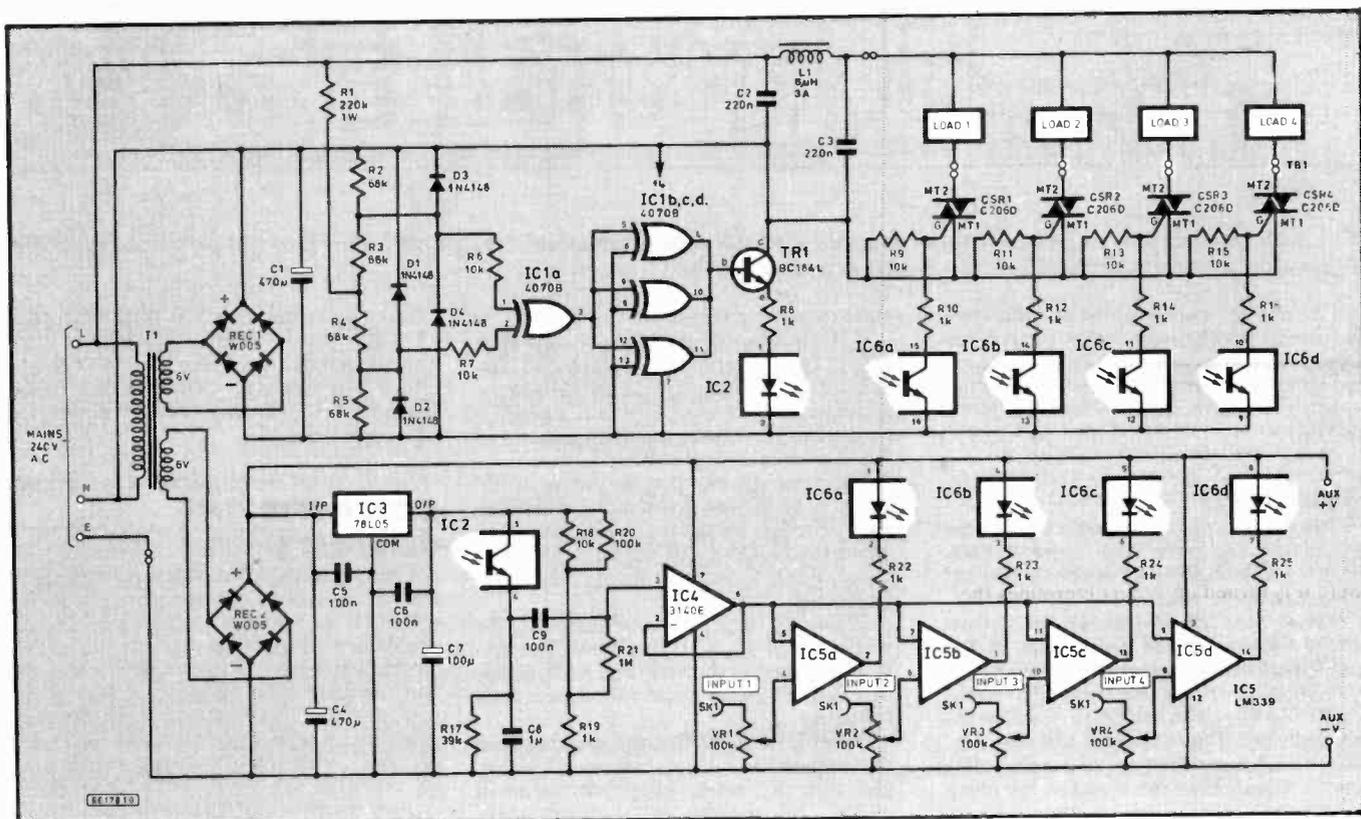
For simplicity of construction, all the components for this project are contained on a single printed circuit board. This

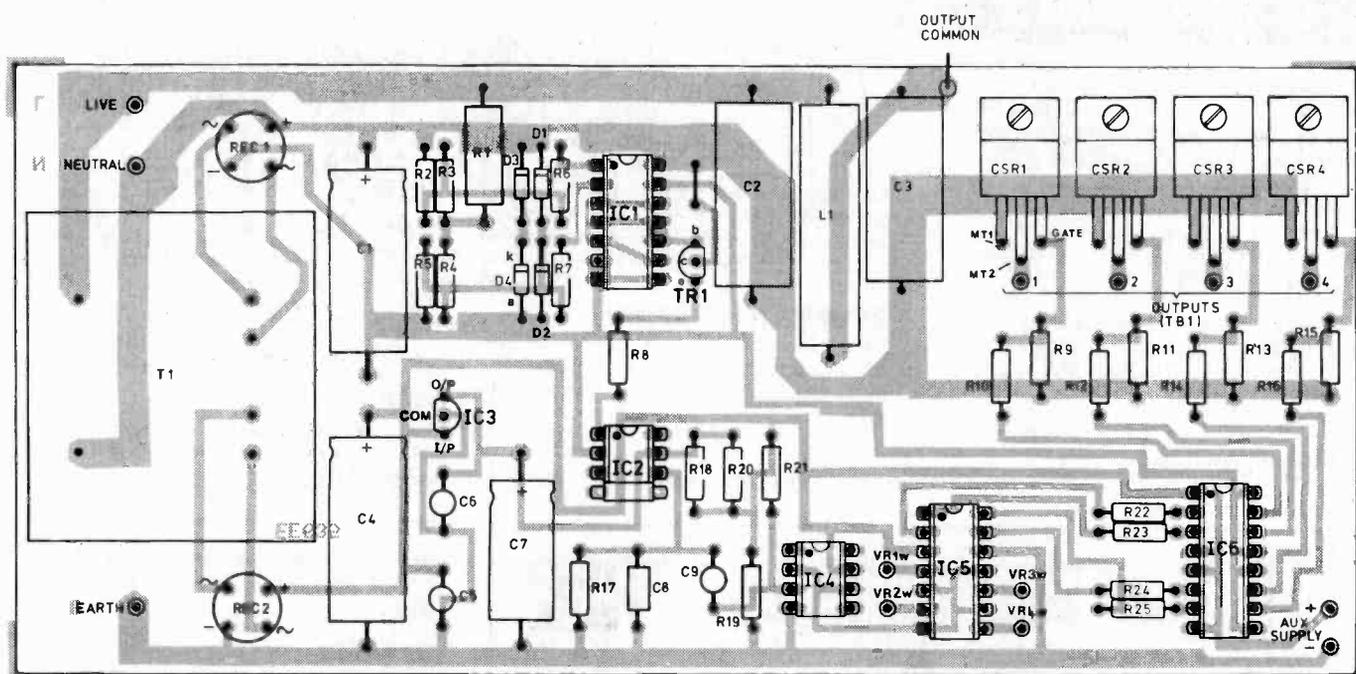
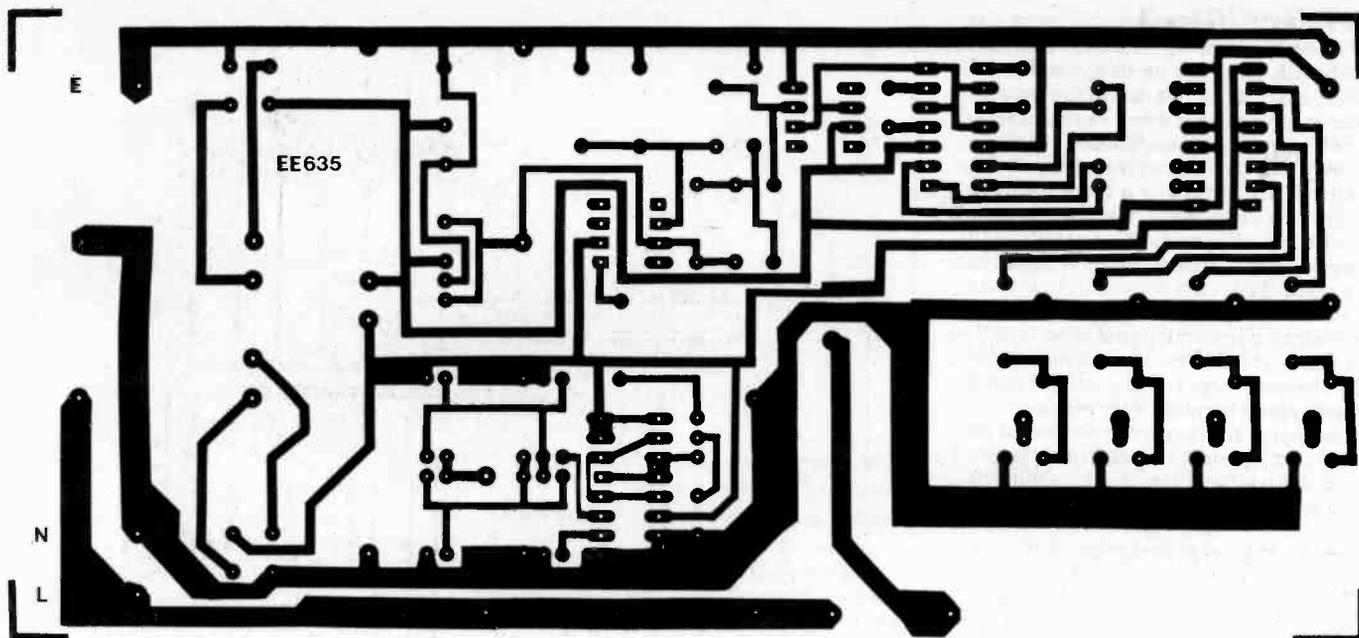
board is available through the *EE PCB Service*, code EE635. The component layout, Fig. 3, is not particularly compact, so building and testing should present no special problems.

The use of sockets for all i.c.s is recommended as, should a problem arise at any time, it does make testing much easier. Even the opto-isolators should have sockets; IC2, which is a six-pin device, is fitted in an 8-pin socket leaving the bottom two holes empty.

Under full load, the areas of p.c.b. track connecting mains Neutral to the triacs and mains Live through the filter to the load "common" may carry quite heavy current, so these should preferably be reinforced in some way. One way of thickening up these areas, which proved quite sufficient, was by heavy solder tinning, though it would be possible to solder tinned copper wire along their surfaces.

Fig. 1. Complete circuit diagram for the 4-Channel Voltage Controlled Dimmer.





EE17820

Fig. 3. Printed circuit board component layout and full size copper foil master pattern. Note the positioning of the 6-pin single opto-isolator IC2 in the 8-pin i.c. socket.

To make life easier, all the external connection points on the prototype p.c.b. were fitted with 1mm Veropins. This is strongly recommended, if only because it avoids the need to access the copper side of the board during testing.

### TESTING

Although it is not possible to test the board fully due to the "live" nature of parts of it, some useful checks can be carried out before full power-up.

**Please take all reasonable precautions whilst working on the board itself, as live 240V mains is present on some areas of it.**

To begin with, the board can be powered up before any chips are fitted, save for the regchips are fitted, save for the regulator IC3. The two supplies, across capacitors C1 and C4, can then be checked as being around 10V, whilst the regulated supply

across capacitor C7 should be 5V.

If IC4 is now plugged in the voltage at its output (pin 6) should be about 0.5V. The voltage across capacitor C8 should be zero at this point of course, but with IC1 and IC2 plugged in (IC2 at the top of its socket, see Fig. 3) it should rise to about 4.3V.

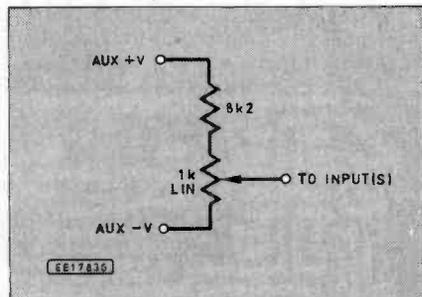
The ramp waveform at the output of IC4 can now be viewed if you have an oscilloscope. Finally, for safety the resistance between the two sides of the circuit may be checked with a meter. It should, of course, be infinity.

Following this, it's a matter of setting the whole circuit up and trying it out. The simple arrangement shown in Fig. 4 allows any or all of the inputs to be varied over their full range.

Suitable loads can be connected between the outputs and their "common" point, and with the mains supply connected it should be possible to control them

smoothly from zero to full brilliance. Unlike most dimmer switches, there should not be any sudden "on-off" effect at very low settings. Any unused inputs should be grounded, either directly or through a resistor.

Fig. 4. Input arrangement for circuit board testing.



EE17830

## INTERWIRING

The final connection and use of the circuit board is entirely up to the individual constructor. It can be incorporated into other equipment, used as part of a design, or boxed up as a project in its own right.

The prototype was intended mainly for use in the workshop so it was fitted into an inexpensive ABS plastic box, size 190mm x 110mm x 60mm. The inputs and auxiliary power supply were brought out through a 6-pin DIN socket SK1, and the outputs taken to a terminal block TB1 at the rear for quick, safe connection to various loads. The Earth connections are also taken to this block, where a link is fitted if internal mains earthing is desired.

The inputs are coupled to the board via 100k linear attenuator potentiometers, giving sensitivity adjustment and automatic grounding when not in use but still presenting reasonably high impedance to driving circuitry. The general layout can be seen from the photograph, whilst the interconnections and wiring are detailed in Fig. 5.

## COMPONENTS

### Resistors

R1	220k 1W
R2, R3, R4, R5	68k (4 off)
R6, R7, R9, R11, R13, R15, R18	10k (7 off)
R8, R10, R12, R14, R16, R19, R22, R23, R24, R25	1k (10 off)
R17	39k
R20	100k
R21	1M

All 0.6W 1% metal film, except R1

### Potentiometers

VR1-VR4	100k rotary carbon, lin. (4 off)
---------	----------------------------------

### Capacitors

C1, C4	470 $\mu$ axial elec. 25V (2 off)
C2, C3	0.22 $\mu$ mains suppression type (2 off)
C5, C6, C9	100n min. polyester layer (3 off)
C7	100 $\mu$ single-ended elec. 10V
C8	1 $\mu$ min. polyester layer.

### Semiconductors

Rec 1, Rec 2	W005 bridge rectifier 50V 1.5A, case style B2 (2 off)
D1, D2, D3, D4	1N4148 silicon diode (4 off)
TR1	BC184L npn silicon.
CSR1, CSR2, CSR3, CSR4	C206D 400V 3A triac (4 off)
IC1	4070BE CMOS quad Exclusive-OR
IC2	Single opto-transistor isolator.
IC3	78L05 5V 100mA positive regulator
IC4	CA3140E MOSFET input op-amp
IC5	LM339 quad comparator.
IC6	Quad opto-transistor isolator.

### Miscellaneous

T1	Min. mains transformer, p.c.b. mounting, 240V primary; 0-6V, 0-6V 0.5A separate secondaries.
L1	6 $\mu$ H 3A r.f. suppressor choke (Maplin, code black)
	Printed circuit board, available from <i>EE PCB Service</i> , code EE635; case, ABS plastic, 190mm x 110mm x 60mm; 6-pin DIN socket and plug; 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket (2 off); 16-pin d.i.l. socket; plastic knobs (4 off); 5-way screw-terminal block; Vero solder pins; connecting wire; solder etc.

Approx. cost  
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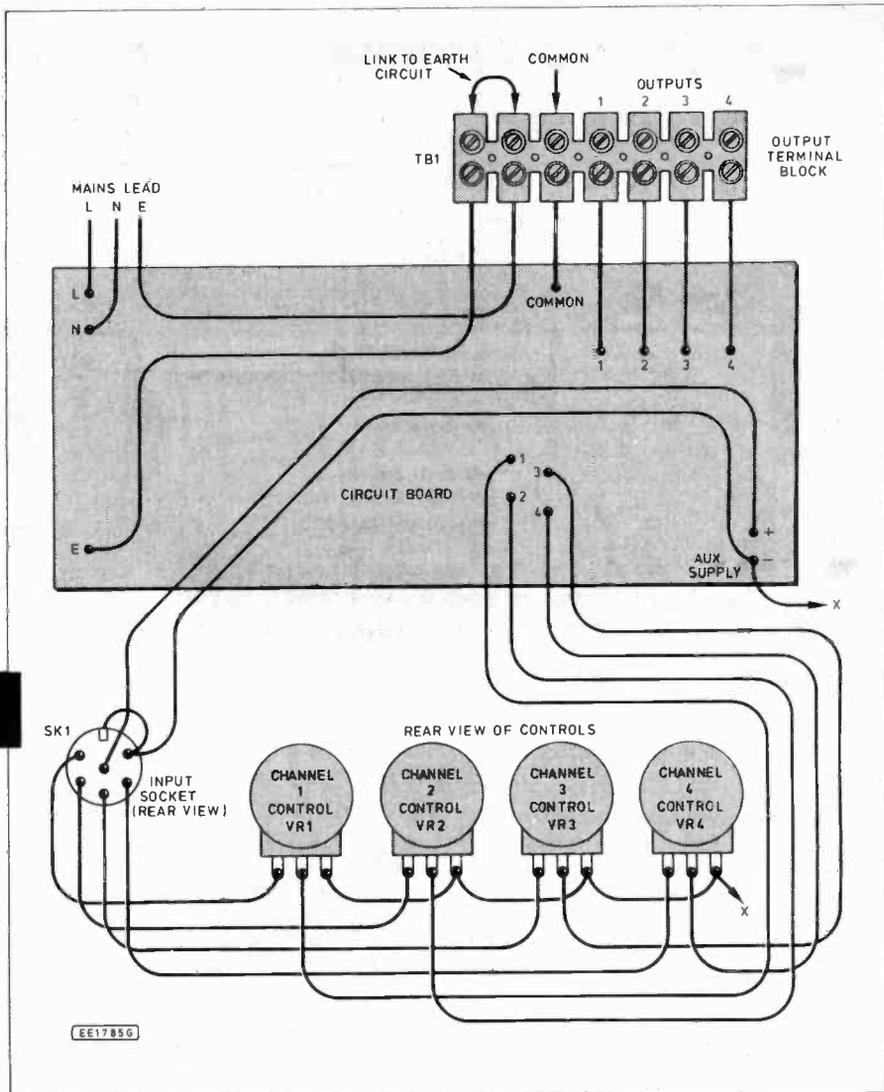


Fig. 5. Interwiring details from the p.c.b. to the input DIN socket, sensitivity controls and the "load" terminal block.

The board itself is attached to the base of the box with strips of double-sided sticky foam.

## IN USE

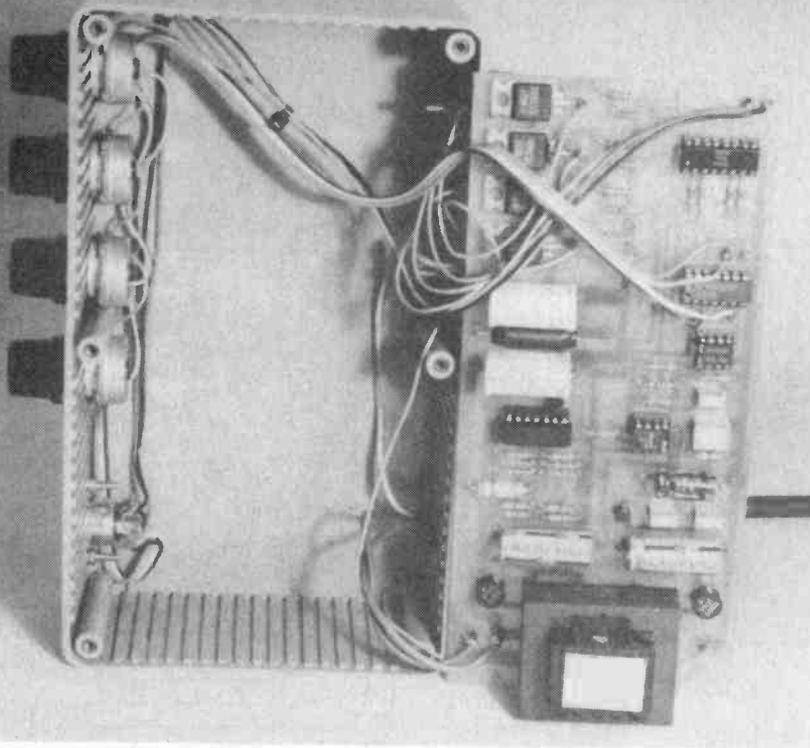
Loads used with this project should be resistive, such as incandescent light bulbs, and should not exceed 100W. These limits are set by the current carrying ability of the printed circuit board track and the choke L1, which is rated at 3A.

It should be noted that lamps take a heavy current at switch-on as the resistance of the filament is much less when it is cold. Also, though the triacs are rated at more than 100W, if used above this they will need heatsinks.

The dimmer has four channels primarily because the comparator and opto-isolator chips are available in quad versions. The ramp signal and d.c. supplies are quite capable of supplying another four channels for anyone capable of constructing these separately.

Suppression of the h.f. noise generated is quite good, better than most dimmer switches in fact, but it should be noted that some noise may still escape and affect sensitive radio or audio equipment. In particular the leads to the loads can radiate like aerials; it may be advisable in some applications to keep them short or screen them.

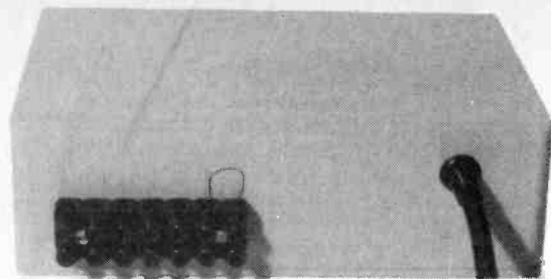
**£31**



The finished Dimmer showing the wiring loom to the sensitivity controls and the mains transformer mounted directly on the circuit board.

Uses for this project are obviously limited only by imagination. Almost any signal may be converted into a 0 to 1-volt output. Sound is the obvious, and a wide variety of "disco" effects can be easily produced to liven up parties. Colourful advertising displays could also be built with it.

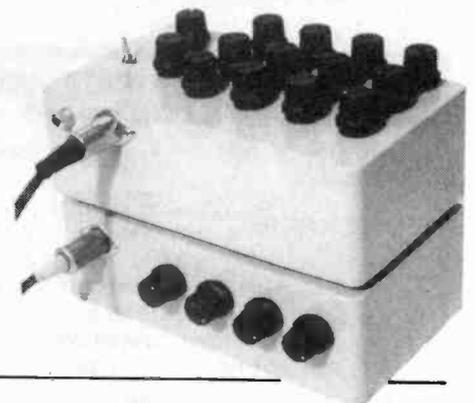
Various signal patterns can be produced by generator circuits, even a lamp that just fades slowly up and down can be astonishingly effective. With four channels, the fading could apply to four colours, making a "lamp" that gradually changes colour and intensity.



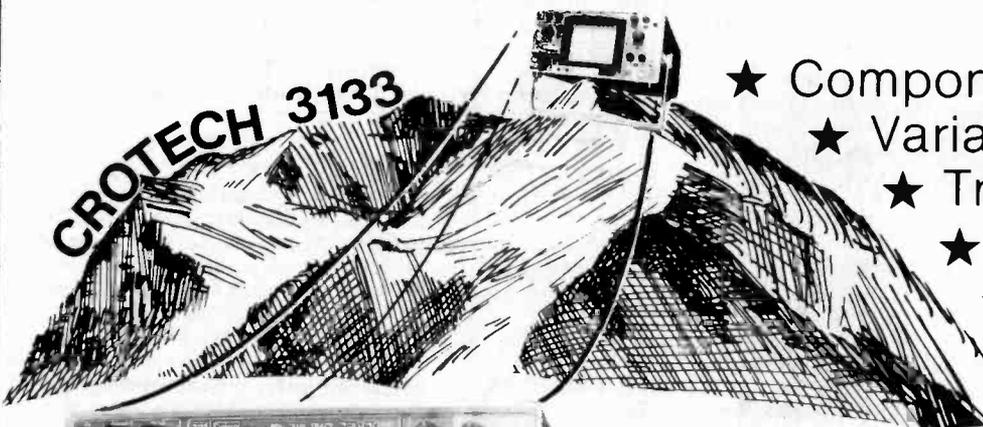
Rear of the unit showing the screw terminal block and the Earth link.

The control signals could be generated by a computer, allowing the effects to be easily changed or altered from software. For the really adventurous of course, there is a bio-feedback for which an excellent display could be made, though battery power and an extra safety isolator link is to be recommended for this.

Next month details will be given of a Four-Channel Sound-to-Light Interface and a Simple Auto-Fader, capable of a variety of interesting and attractive effects.



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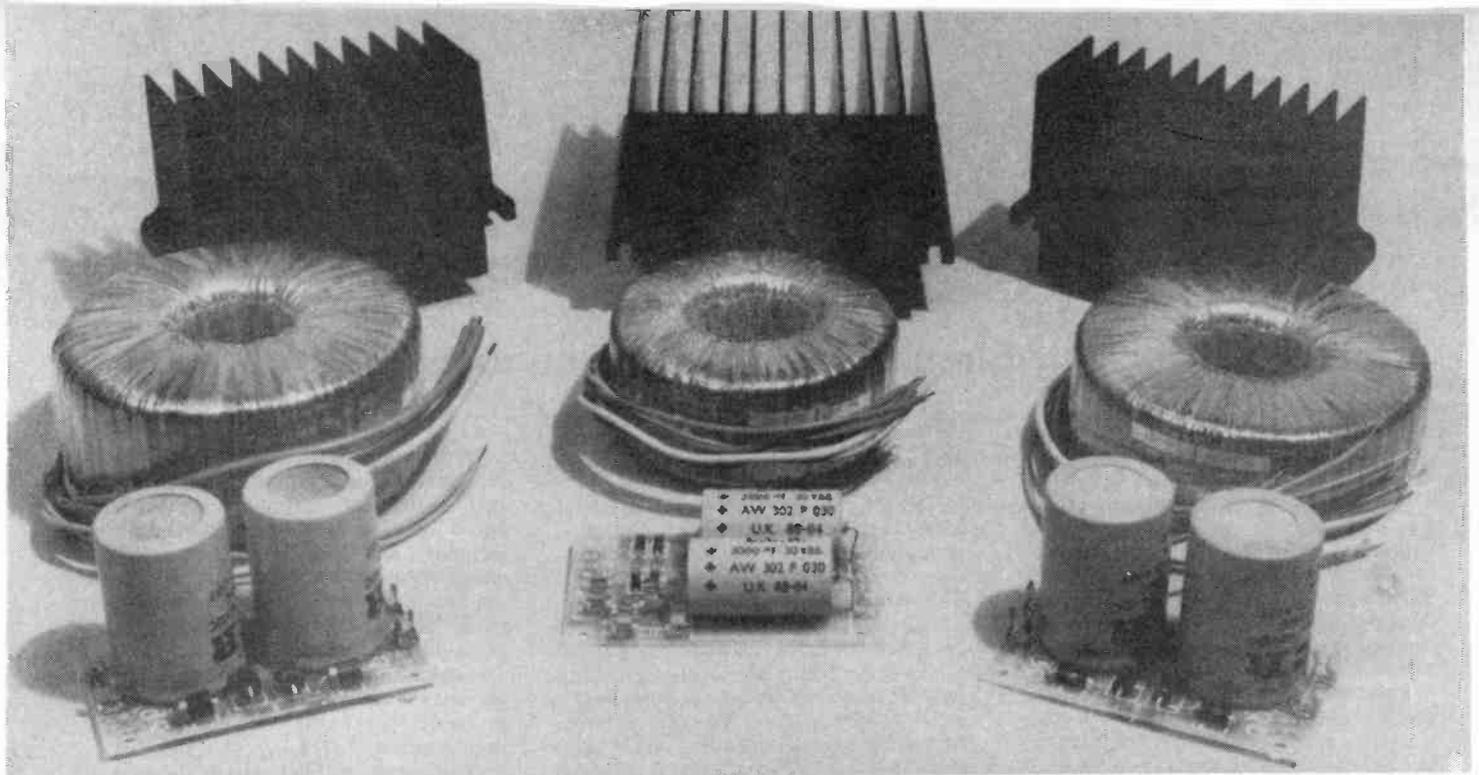


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Everyday Electronics, February 1989

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# b...Beeb...Beeb...Beeb...Beeb

## ... Harmonic Locking Circuit ... Phase locked loop i.c. 74HC4046 ...

IN LAST month's *Beeb Micro* article we considered the subject of using the BBC micro as an audio frequency signal generator. We also looked at the subject of harmonic locking, in the context of using it to boost the output frequency range of the VIA timer/counters by a factor of ten. The theory of harmonic locking was discussed last month, but no practical circuit was provided.

This situation is remedied this month by Fig. 1, which is a simple harmonic locking circuit based on the CMOS 4046BE "micro power" phase locked loop. In fact the circuit uses the 74HC4046, which is the high speed CMOS version of the device. This seems better able to handle the higher output frequencies which the standard 4046BE did not seem to be able to reach reliably.

### Circuit Operation

Resistor R1 and capacitor C2 are the timing components for the v.c.o. section of IC2. The specified values permit operation to beyond 1MHz, but might not permit the full 2.5MHz theoretical maximum output frequency to be achieved.

This does not necessarily matter, as the circuit is primarily intended as a clock generator for the MF10CN switched capacitor filter (see last month). This is only guaranteed to operate at clock frequencies of up to 1MHz (but it will typically operate at frequencies of up to 1.5MHz). It is advisable to have C2 no higher in value than is really necessary as this might compromise low frequency performance.

The 74HC4046 has two phase comparators, and in this case it is phase comparator two that is utilized. The difference between the two phase comparators is basically that comparator one is of the usual type, where under standby conditions the v.c.o. is taken to its centre frequency. Phase comparator two has a more unusual method of operation, whereby under standby conditions the v.c.o. sweeps down to a very low frequency and eventually cuts off altogether.

Coupled with the very wide operating frequency range of the v.c.o., this second mode of operation allows a very wide lock-in range to be provided. A frequency span of 100 to 1 is easily accommodated, and pushing the device to its limits it seems to be possible to exceed a 1000 to 1 range.

However, when using any 4046 series device over a very wide frequency range it has to be borne in mind that the charge/discharge current of the v.c.o. at very low frequencies is minuscule. The practical consequence of this is that the device is very vulnerable to any stray pick up of electrical noise, and it should be kept away from any obvious source of such noise. In the present context this means keeping the device away from the immediate vicinity of the BBC computer, and the circuit should prefer-

ably be contained in an earthed metal case to provide screening.

The lowpass filter is comprised of R2, R3, and C3. The very high input impedance of IC2's v.c.o. simplifies the lowpass filter design, and a basic single pole RC filter will normally suffice.

This is essentially what is used in this case, but R3 has been added in order to minimise problems with over-shoot. Without this resistor there is a tendency for the v.c.o. to waver either side of the correct frequency rather than locking onto it properly. This resistor is not normally required, but seems to be essential when the 4046 is used over a wide frequency range.

At the lower end of the output frequency range there is a reduction in the coverage. In theory a minimum clock frequency of about 76Hz can be achieved, but the v.c.o. might not actually operate this low in frequency in practice. This is not particularly important as it would provide an audio output frequency well below the lower limit of the audio frequency range (which is 20Hz). The circuit should operate properly at frequencies down to about 20Hz, and it will probably be capable of achieving output frequencies substantially lower than this.

Apart from enabling output frequencies to be set with good accuracy without the need for any calibration, another advan-

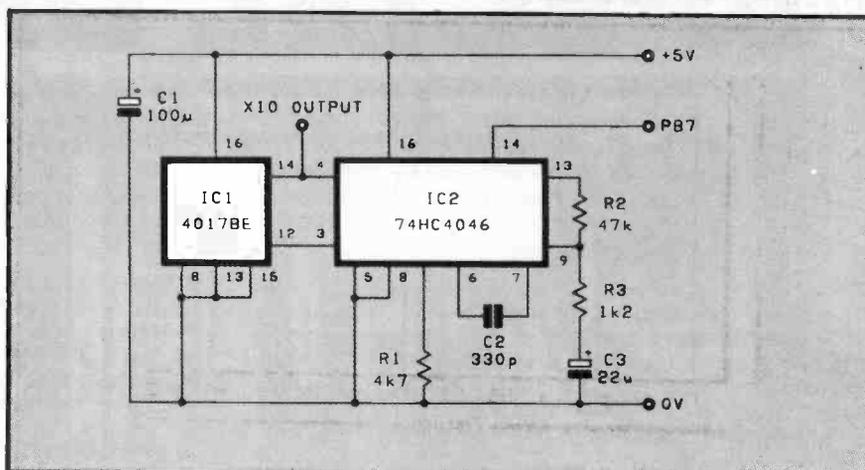


Fig. 1. Simple Harmonic Locking circuit

IC1 is a CMOS 4017BE one of ten decoder. In this case it is only the "carry out" output (pin 12) that is used, and it operates as a straightforward divide by ten counter. It connects between the output of the v.c.o. and the input of the phase comparators, so that the required harmonic locking is obtained, with the v.c.o. providing an output at ten times the input frequency.

### A.F. Generator

When used in conjunction with the Digital Sinewave Oscillator described in last month's article this unit provides a more useful range of output frequencies. As pointed out earlier, the MF10CN is only guaranteed to operate at clock frequencies of up to 1MHz. An output at this frequency can be achieved using a timer 1 value of 0 for high byte and 3 for the low byte (giving a 100kHz output on PB7).

This provides an output frequency from the sinewave generator of 20kHz in the 1:50 mode, or 10kHz in the 1:100 mode. This permits the upper limit of the audio frequency range to be reached, which is something that is impossible without the aid of the harmonic locking circuit. It also gives more output frequencies at the upper end of the audio range.

One of the advantages of this approach to audio signal generation is that it provides opportunities for producing automatic test equipment. You can do such things as outputting a series of frequencies, using the analogue port to monitor the output level from the circuit under test, and then have the computer draw up a frequency response graph from the results.

There are also possibilities for using the MF10CN as a sweep filter to give a simple spectrum analyser action. However, for the moment we will not consider these ideas in any more detail, but will first go on to a second method of generating sinewaves from timer 1's squarewave output.

### Filtered Waves

Probably many readers will already be familiar with "Fourier Analysis". For those who are new to the concept, it should perhaps be explained that all signals, however complex, are effectively a number of sinewave signals. The exception is the sinewave itself.

As explained in last month's article, a sinewave has the all important feature of containing just a single frequency, and can clearly not be broken down into more than one constituent sinewave. By analysing the

frequency content of a signal, and then recreating it using a number of sinewave signals having the correct phase and amplitude relationships, any signal can be synthesised.

With non-repetitive signals their spectra tend to be quite complex in that they change significantly from one instant to the next. Repetitive waveforms are relatively simple, and their spectra are constant. In the case of a squarewave signal it has the fundamental plus odd order harmonics (Fig. 2). In other words, the fundamental signal plus components at three times, five times, seven times, etc. the fundamental frequency.

Each successive harmonic is a little weaker than the one beneath it, but in theory the harmonics stretch to infinity. In reality it is the switching speed of the device generating the signal that determines just how far into the spectrum the harmonics extend.

### Synthesis

The conventional method of sound synthesis (known as "subtractive" synthesis) is to start with a signal having the required harmonics in abundance, and to then use filtering to trim them back to the

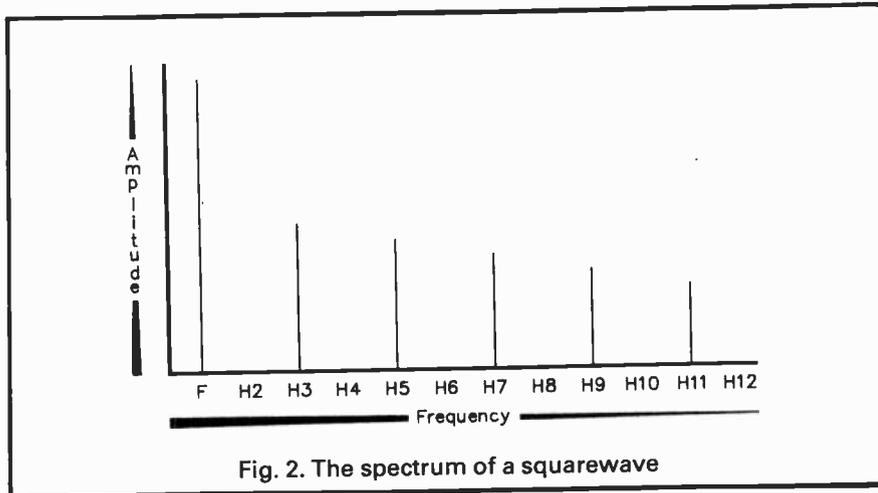


Fig. 2. The spectrum of a squarewave

required levels so that the desired wave shape is obtained. We can use what is essentially the same method in order to turn a squarewave into a reasonably pure sinewave.

It is just a matter of using lowpass filtering to attenuate the harmonics with respect to the fundamental signal. Attenuating the higher frequency harmonics is not too difficult, as they are many octaves above the fundamental frequency, and are relatively weak anyway.

The main problem is the lowest of the harmonics, which is just three times the fundamental frequency and quite strong. With it one and a half octaves above the fundamental frequency, a 24dB per octave filter would give some 36dB of attenuation. Bearing in mind that the third harmonic is somewhat lower in level than the fundamental anyway, this gives a distortion level of about one per cent.

We have ignored the other harmonics which will obviously contribute some distortion to the output signal. Also, the filter circuit might add significantly to the distortion level. However, even with one to two per cent distortion, this still gives an adequate level of performance for most frequency response testing and other audio checks.

### Keeping Track

Although filtering seems like a very simple method of converting a squarewave into a reasonable sinewave signal, there is a very big problem to overcome. Matters are easy enough when a single frequency is involved, but things are much more difficult if a wide range of frequencies has to be accommodated.

A filter having a fixed frequency is then inadequate, as the degree of filtering would depend on the input frequency. Setting a filter frequency that would suit the lowest input frequency would ensure that a sinewave output was produced at other frequencies, but the output level would be far from constant.

Assuming the use of a 24dB per octave filter, stepping up the input frequency by a factor of ten would result in the output level reducing by a factor of more than ten!

In order to give usable results it is necessary to use some form of tracking filter. In other words, a filter where the cutoff frequency varies in sympathy with the input frequency. Provided the amplitude of the input signal remains constant, and the filter tracks accurately, the output level will remain constant.

There are several types of tracking filter, and a common approach to the problem is

shows the general make up of such a system. This is a rather unconventional approach to the problem, but one which I prefer for the current application.

### V.C.F.s

There is a series of four v.c.f.s (voltage controlled filters), and with each one giving a 6dB per octave roll-off this gives the required overall attenuation rate of 24dB per octave. A buffer amplifier at the output of the circuit ensures that there is a low output impedance, and that there are no problems with loading on the final filter stage. The control voltage for the filters is obtained by rectifying and smoothing the output of the circuit, and then feeding this signal to a d.c. amplifier.

If, for the moment, we consider the v.c.f.s as a v.c.a. (voltage controlled amplifier) instead, this gives what is really just a standard audio a.g.c. system. The gain of the amplifier is normally quite high, but in the presence of a strong output signal a large d.c. control voltage is generated.

The trick here is to have the d.c. amplifier provide an inverting action. A strong output signal then generates a large positive output signal at the smoothing circuit, which is converted to a strong negative change in voltage by the d.c. amplifier. This reduces the gain of the v.c.a., and reduces the output level. A standard negative feedback action tends to stabilise the output at a certain level.

This circuit operates in much the same way, since the v.c.f.s provide an action which is not, in certain respects, dissimilar to a v.c.a. With a high control voltage there is a high cutoff frequency, and no attenuation of the input signal. With a low control voltage there is a very low cutoff frequency, and unless the input signal is at a very low frequency it will be substantially attenuated. Therefore, provided the circuit is designed to provide a suitably low output level and the input frequency is not made too low, a negative feedback action will stabilise the output level.

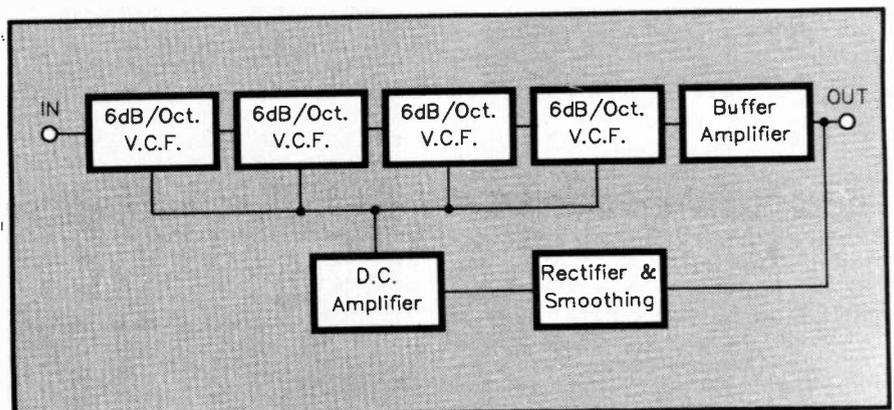
The point to note here is that the circuit is keeping the output signal at this low level by heavily filtering it. As the input frequency is raised and lowered, the feedback increases and decreases the filter's cutoff frequency in order to maintain an almost constant output level. This gives just the action we require, with the filtering giving the square to sinewave conversion, and the feedback maintaining an almost constant output level.

In next month's article a suitable filter circuit based on operational transconductance amplifiers will be described.

to use a phase locked loop and a switched capacitor filter. There would seem to be little point in adopting this approach in the current context, since it would seem to be easier to use the filter as a digital oscillator, as in the design described previously.

A simple but effective method is to use a voltage controlled filter in a what is essentially a form of a.g.c. (automatic gain control) circuit. The block diagram of Fig. 3

Fig. 3. Block diagram for a tracking filter





*a regular feature for the Spectrum Owner...*

by Mike Tooley BA

**W**ITH Christmas 1988 now just a happy memory and with New Year's resolutions firmly in mind, we shall take this opportunity to catch up with the backlog of queries received from readers. We also have a review of the versatile *Interspec* interface system which is available from DCP Microdevelopments.

We begin, however, with details of a simple device which could well be instrumental in eliminating many hours of frustration for cassette tape users.

### SAVE/LOAD Accessory

**Kenneth Murray-Taylor** writes from Redruth, Cornwall, with details of a workstation which he has developed for the Spectrum. Part of this set-up involves an improved cassette tape interface.

Kenneth writes:

*"For the last couple of years I have been using a cassette interface which obviates the need to mess with the plugs between LOAD and SAVE. This interface plugs into the DIN socket on the recorder (instead of the jack sockets) and works because there is a switch in the recorder that turns off the output at the DIN socket during record. The reason it does this is to stop feedback when recording from another recorder.*

*Unfortunately it is not quite as simple as that; the output level from the DIN socket is too low for the Spectrum so an amplifier is required to boost the signal to an acceptable level (a gain of about five is required)."*

Kenneth's LOAD/SAVE amplifier is housed in a plastic box (measuring 75mm x 50mm x 25mm) and includes a reset switch which is fitted in-line with the positive supply. The circuit (Fig. 1) should not be too critical of minor variations in components and almost any npn small signal transistor would be used in place of the BC108 specified.

The gain of the unit can be easily modified by adjusting the value of resistor R4. Readers may wish to substitute a 220 ohm skeleton pre-set resistor in place of R4, in which case the stage gain will be variable from about two (maximum resistance setting) to about 100 (depending upon the current gain of the transistor used).

Three connections are made to the rear of the Spectrum (two miniature jacks for MIC and EAR plus the power connector) whilst a single connection is made to the cassette recorder (via a lead fitted with a three-pin 180 degree DIN plug). Circuit construction is very straightforward and a matrix board layout is available in the current *On Spec Update*.

### Agony Column

**A. Combes** from Burgess Hill writes to ask if there is any way of getting round the infamous Lenslok software production which several software houses seem so fond of. This topic has been discussed at some length in the popular computer press and it would appear that many people find it far from satisfactory.

My own way round the problem is simply that of making "snapshot" files of my software using an MGT plus-D interface. However, several other interfaces with "magic buttons" or "snapshot" facilities will work just as well.

Simply load the offending software, enter the Lenslok code and wait until the opening screen is displayed before taking the snapshot. Thereafter, the program can be reloaded from tape or disk and it will restart from the point at which it was left (i.e. after the Lenslok procedure). I have used this technique successfully with all of the lens protected software in my possession and I can thoroughly recommend the purchase of an interface with backup or snapshot facilities for this purpose alone!

**D. Hudley** has asked me to recommend an I/O port for the Spectrum 128. There are several to choose from but the most versatile system is that available from DCP Microelectronics (reviewed in this issue).

The Interspec (a dedicated Spectrum I/O port also from DCP) provides eight digital (TTL compatible) inputs, eight analogue inputs, and eight TTL outputs. In addition, the Interspec has four relay switched outputs (for high currents) and four switch inputs and thus should provide nearly all of the facilities one should require of an I/O port with the exception of analogue output!

**Harold Lunson** of East Sussex has written to ask whether we have ever published details of a home constructed disk interface in a past instalment of *On Spec*. This is a regular query raised by readers and, apart from several reviews of proprietary Spectrum disk interfaces, I must confess that we have not tackled this subject.

The hardware aspects of a disk interface would not prove to be too problematic however the task of developing an effective operating system would be daunting for all but a few of our readers. The only solution would be that of supplying the required disk operating system software in EPROM (it would not be feasible to publish it in EE and then expect readers to key it in!)

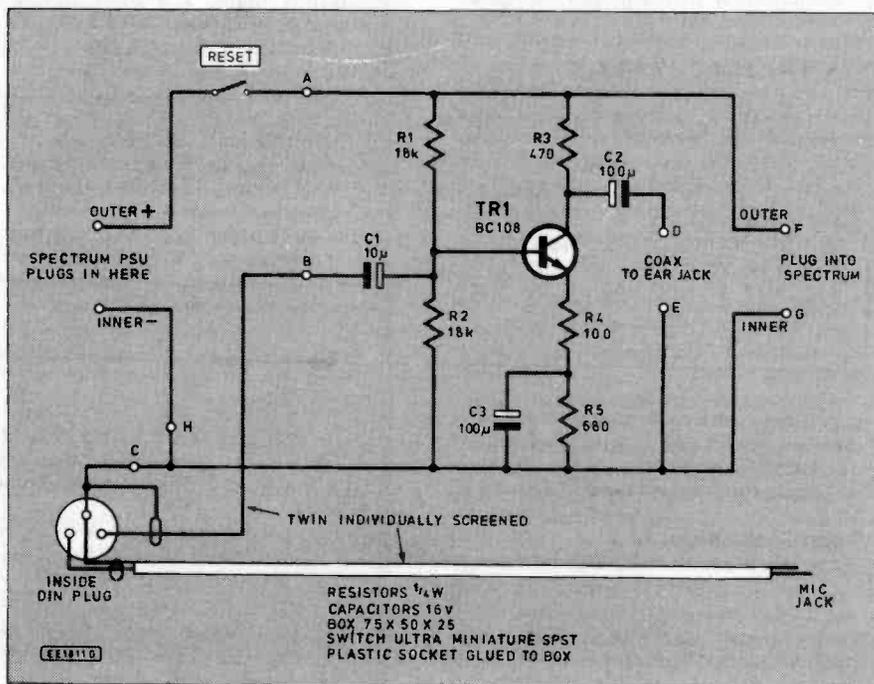
Having said all that, April's *On Spec* will contain information for readers who wish to add a budget-priced disk drive to the Spectrum. This project will be based on a proprietary disk interface (complete with disk operating system software) but will include details of interface and power supply wiring as well as recommending a source of inexpensive disk drives. The total cost of adding a disk system (including the ready-built disk interface) will be less than £100.

**Mr S. Davies** writes from Oswestry with two queries, the first of which concerns the *Rotronics* Wafadrive. Mr Davies wishes to perform a screen dump, via the parallel interface on the Wafadrive unit, but the Spectrum's resident COPY command does not appear to work.

The second problem is that of upgrading the Spectrum's keyboard. Readers will doubtless recall that there were at least half a dozen suppliers of keyboard upgrade kits in existence several years ago but advertisements for this type of accessory seem to have completely disappeared from the popular computing press! If anyone can suggest either a source for Wafadrive screen dump software or provide details of a source of keyboard upgrades, please let me know so that I can pass on the information to Mr Davies.

Finally, a reader in Ardrossan wishes to interface his Spectrum to a TV receiver with Teletext. The aim is that of printing

Fig. 1. Suggested cassette tape interface circuit from Kenneth Murray-Taylor.



# INTERPACK 1

**T**HE *Interpack 1* from DCP Microdevelopments follows on from two well established products from the same company; the *Interspec* and *Interbeeb*. *Interpack*, however, is something of a new concept—a versatile interface card which accepts a range of customised “personality modules”. It thus provides the same range of facilities as its popular predecessors but has the added advantage that it can easily be configured to work with other systems.

In the case of the Spectrum, the required personality module is known as the *ZX Inter-card*. This card is fitted with a 23-way double-sided open-ended edge connector (which mates with the expansion bus connector at the rear of the Spectrum) and a 20-way 0.1in pitch connector which mates with the *Interpack 1*. The *Inter-card* fits neatly into a notch in the *Interpack* p.c.b. and the entire assembly is housed in a black plastic enclosure.

The *Interpack* printed circuit board (including *Inter-card* personality module) measures approximately 130mm×84mm. The board contains ten integrated circuits together with a handful of transistors and other components.

The largest i.c. (a 28-pin d.i.l. device) is fitted into a low-profile d.i.l. socket whilst the remaining devices are soldered into the double-sided p.c.b. Inputs and outputs are terminated using either 10-way 0.1in pitch Molex connectors (TTL I/O) or 0.2in. colour-coded plugs and sockets (relays, switches, and analogue inputs).

The board is very neatly arranged and the connectors are sensibly laid out and clearly labelled. This, together with a clear and understandable manual, is an important consideration with a unit which has educational use and the *Interpack* scores very highly on this account!

## SPECIFICATIONS

The *Interpack* provides a range of I/O capability including eight digital (TTL compatible) I/O lines; eight analogue inputs (2.5V full-scale input); four relay outputs (suitable for loads rated at 24V 1A maximum), and four switch inputs (pulled low so that a switch closure will generate a logical 1 on the appropriate data line).

The eight-channel analogue to digital converter (ADC) is based on the National Semiconductor ADC0809 and this device offers a conversion time of less than 10ms. A precision voltage reference (ZN404) is used to provide the analogue reference voltage and thus accuracy and temperature stability are both of a very high order.

*Interpack 1* uses five of the Spectrum's I/O port addresses and these are allocated on the following basis:

Port designation	Port address (decimal)	Port function	Number of lines
A	31	Analogue inputs	8
B	63	Relay outputs	4
C	95	TTL I/O	8
D	127	(available for expansion)	
E	159	(available for expansion)	

## EXPANSION

Where further I/O capability is required, the *Interpack* may be expanded with the aid of one or more additional modules. These modules are connected to the *Interpack* by means of the *DCB Bus* and include a digital to analogue converter, a fast (1 $\mu$ s) digital analogue converter, a fast (10 $\mu$ s) analogue to digital converter, and a board which allows up to two ADC and two DAC packs to be simultaneously present on the DCP bus.

Software control of these additional modules relies on the same techniques as those used in conjunction with the basic *Interpack* and address decoding details are fully described in the handbook supplied. Users may also wish to add their own external hardware (for control via the *Interpack*). This is a relatively simple process but will require users to have some digital design experience in order to ensure that circuits will operate correctly.

Since add-on modules derive their power from the DCP Bus (which, in turn, takes its power from the host computer) there is a limit to the number of interface packs that can be present. The basic system will supply a maximum of one *Inter-card* and *Interpack* plus two additional accessories.

Where this limit will be exceeded, a *Powerbus* pack will be required. All data and control lines are extended through the *Powerbus* but the +5V and +9V supply rails are isolated and the *Powerbus* supply (rated at 500mA maximum) is fed to any further packs present on the bus.

## ON TEST

I put the *Interpack* on test with my faithful Spectrum Plus and MGT Plus-D disk interface. With the aid of a few lines of BASIC, each port was checked and then a short program was devised in order to make the system function as a low-frequency (analogue input) oscilloscope with the sweep controlled by switches connected to two of the digital input lines. The whole system performed admirably and the program was

later modified and extended so that captured data for each sweep was stored in a disk file (thus allowing later analysis).

The 26-page *Interpack* handbook describes the operation of the system as a whole before providing details of each port in turn (including outlining basic techniques for interfacing common transducers such as photo-sensitive resistors, light emitting diodes, lamps, switches and motors). The handbook also makes reference to a stepper motor interface but does not supply complete circuit information. In any event, users will almost certainly find that they need to make reference to one, or more, texts on transducers and interfacing in order to cope with anything other than the most elementary of applications.

In conclusion, I can thoroughly recommend the *Interpack* system from DCP; it is well thought out, performs extremely well, and is very reasonably priced. The interface is easily expandable and, what's more, can be readily configured for operation with other popular home computers.

DCP Microdevelopments are at Dept EE, 2 Station Close, Lingwood, Norwich, Norfolk, NR13 4AX ☎ Norwich (0603) 712482.

(Important Note: DCP still have a limited stock of the original *Interspec* and these may be available at a special price to EE readers—call or write to DCP for details!)

pages using an Epson printer and storing them on floppy disk via an MGT plus-D interface. If anyone can provide any information on this topic please get in touch!

## Four Years On . . .

*On Spec* celebrates its fourth anniversary with this issue of *Everyday Electronics*. Those of you who have been with us since 1984 will recall that the original aim of this column was that of providing a forum for those wishing to interface the Spectrum to

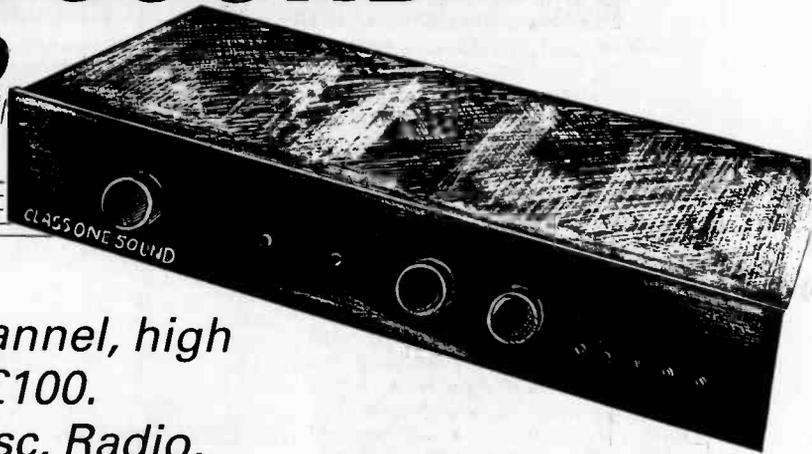
“real world” applications. More than 25 practical projects and interface circuits have appeared in *On Spec* since then and we hope that most of you have found time to try at least some of them.

Over the years, it has been heartening to receive so many letters from regular readers. To all of you, I extend my thanks and good wishes for your help and support; here's hoping that you will find something of interest in future instalments of *On Spec* just as you have in the past!

*Next Month:* We shall show how a budget-priced composite monochrome monitor can be easily connected to a Spectrum (of any vintage!). In the meantime, if you would like a copy of our “*On Spec Update*”, please drop me a line enclosing a large (250mm×300mm) adequately (i.e. 42p for UK postage) stamped addressed envelope. Mike Tooley, Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

# CLASS ONE SOUND AMPLIFIER

**GRAHAM NALTY**



A single board, 20W per channel, high quality amplifier for under £100. Inputs for Disc, Compact Disc, Radio, Video and Tape.

**L**AST month we discussed the problems associated with amplifier design and looked at the circuit stages in detail. This month we conclude by setting out the construction procedure and final testing.

## EARTHING

In audio amplifiers the earthing circuits are a very important part of the design. Ideally, every single earth return should be taken separately to a central "star" earth. In practice, some grouping is permissible, but poor earthing techniques in an amplifier will result in hum, instability and degradation of the sound. In this amplifier, all the earth returns have been looked at in far more detail than I can write about here, and the result can be seen in the way in which they have been connected in the printed circuit board (p.c.b.) layout.

If the amplifier is built in modular form,

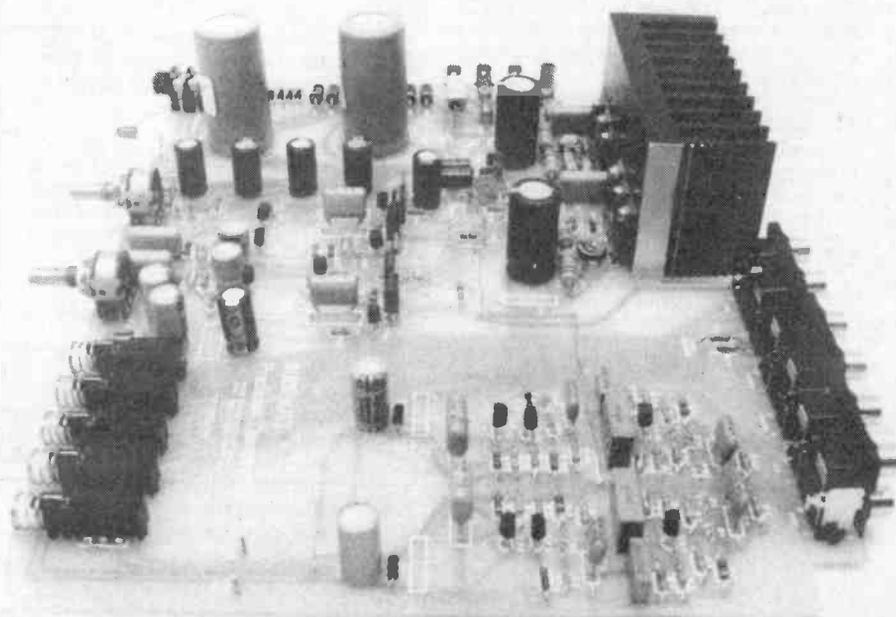
special earthing techniques will need to be applied. These can be covered separately if the demand exists for separate boards to build the amplifier in a modular form.

## BUILDING THE AMPLIFIER

The printed circuit board component layout for the *DM20 Class One Sound Amplifier* is shown in Fig. 10. Being of single board construction and as you can see from the tinted areas the copper tracking is quite complex, we would not recommend constructors attempt making their own boards.

Due to the extra closeness of some of the copper tracking and the physical size of the board, we have not attempted to reproduce the usual full size master pattern. Instead, we would recommend that any would be constructors purchase a ready-made p.c.b. from Audiokits.

*The completed circuit board ready for installation in its metal case.*



A great deal of thought has gone into making the amplifier easy to build and test. But there are easier ways to build it and you will find things easier if you follow this construction order:

1. Insert and solder all p.c.b. pins.
2. All diodes except D16 (l.e.d.).
3. All 1/4 watt metal film resistors.
4. Insert all wire links using resistor lead offcuts, except for L1 and L10 which should be made from tinned copper wire.
5. All polystyrene capacitors.
6. Attach heat sink to p.c.b. using 6BA by 3/8 inch bolts and insulating washers.
7. Slot TR10-TR12, TR110-TR112 into the board and line up the holes in the tabs with the threaded holes in the heatsink.
8. Attach the transistors to the heat-sink using a 6BA by 3/8 inch bolt, 6BA washer and nylon bush, after placing a thermally conducting electrically insulating washer between transistor and heatsink.
9. Attach VR1, VR101, C22, C116, C122 to p.c.b.
10. Attach R27, R28, R127, R128 to p.c.b.
11. Attach all remaining semiconductors including D16.
12. Attach all polyester capacitors (NB, C7, C18, C20, C23, C107, C118, C120, C123 are optional).
13. Attach all 1/4 inch blade connectors, fuse and remaining resistors.
14. Attach all electrolytic capacitors.
15. Make certain that each and every electrolytic is connected in the right polarity. Check a second time because a wrongly connected capacitor can be damaged when the power is connected.
16. Attach phono sockets, switches, potentiometers and headphone socket.

Now the board is complete, set VR1 and VR101 fully clockwise and remove fuses FS1 and FS101.

## CASE

Next assemble the case, leaving the rear panel off, and attach the mains transformer and all the parts shown in Fig. 11. The

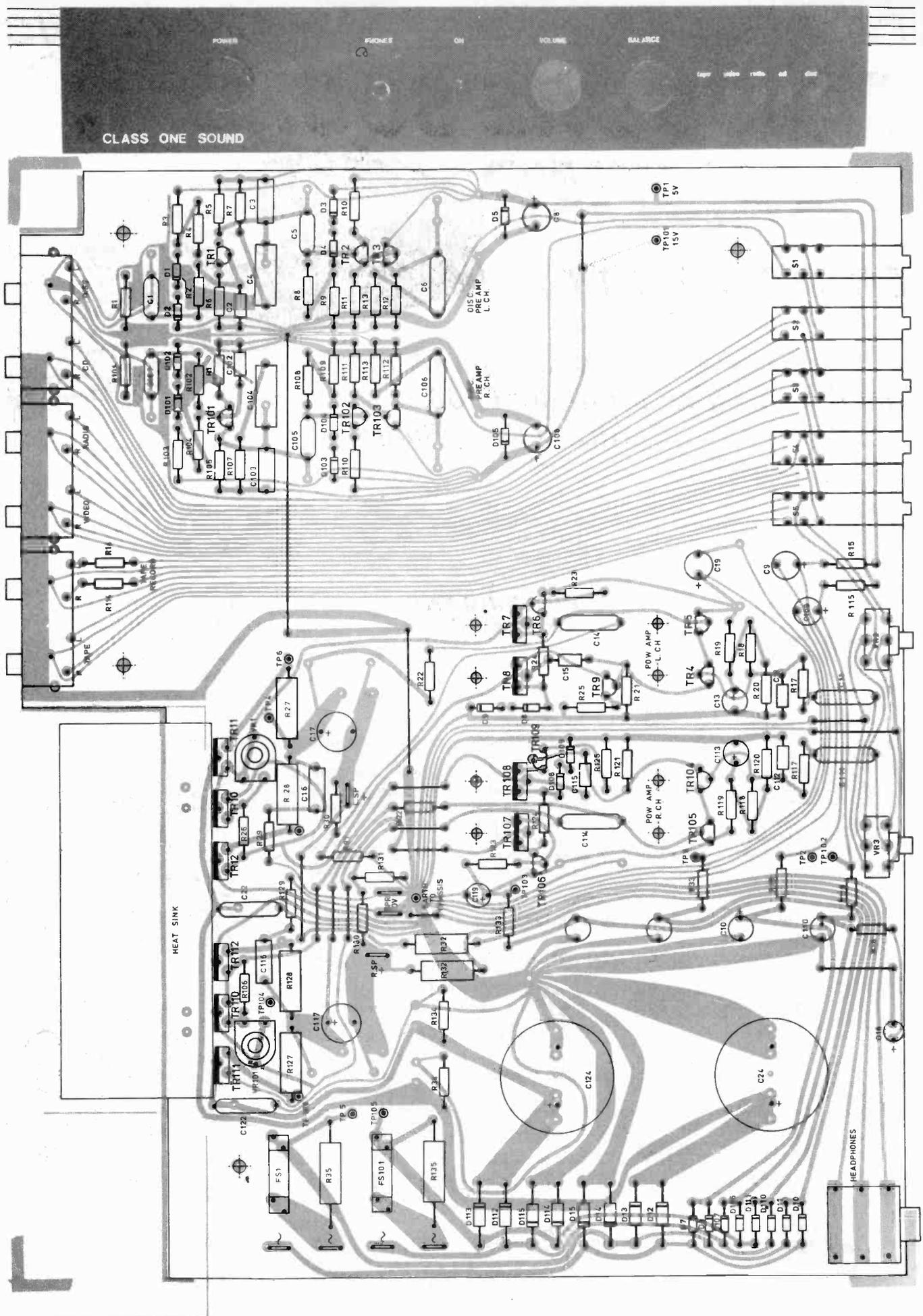


Fig. 10. Printed circuit board component layout for the Class One Amplifier. This board measures approximately 270mm×215mm and is NOT shown full size. The front panel layout and lettering is shown in the photograph above.

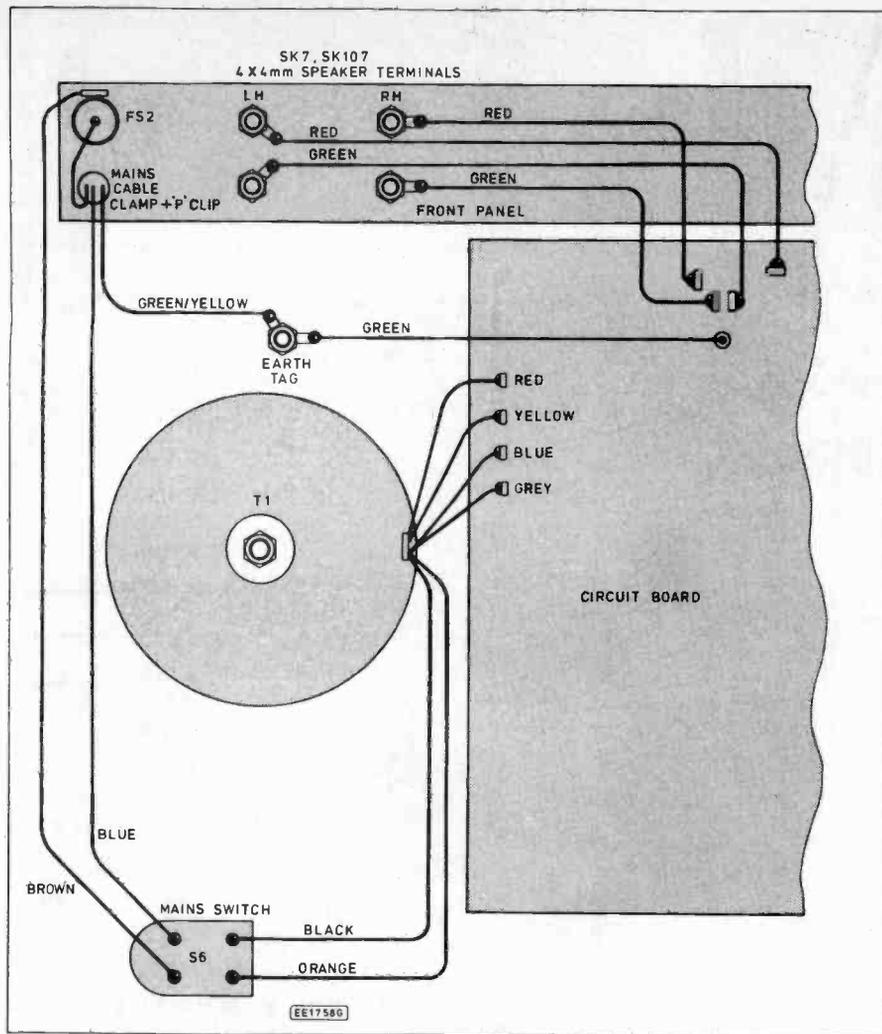


Fig. 11. Interwiring from case mounted components to the p.c.b.

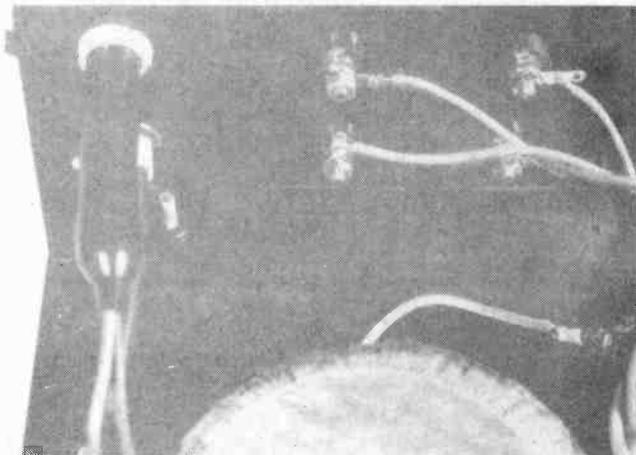
p.c.b. can now be attached to the floor of the case using 3/4 inch threaded pillars with 6BA by 1/4 inch bolts at each end. Attach the rear panel to the case and make all the necessary connections to the p.c.b. (Four 1/4 inch blade connections from the transformer, four 1/4 inch blade connections from the speaker terminals and the chassis earth connection, which is soldered to the 1mm dia. pin.

### TESTING THE AMPLIFIER

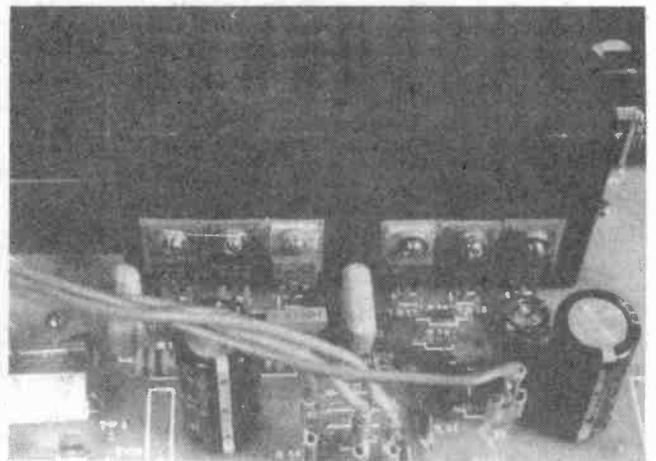
Check that fuses FS1 and FS101 have been removed from the board and that VR1 and VR2 are turned fully clockwise.

Switch on and measure the voltages at test points TP1 to TP4 and TP101 to TP104. The slightly lower readings on the right channel (TP101 to TP104) are due to the effect of the l.e.d. drawing current from the right channel supply only.

The most difficult part of building the amplifier is setting the output stage quiescent current. This is achieved on the left channel by turning VR1 anticlockwise, and on the right channel by turning VR101 anticlockwise. If you have digital meter or oscilloscope you can set the current by turning VR1 (VR101) until about 40mV is observed across R27/R28 and R127/R128. Alternatively, you can set the output stage quiescent current using only a moving coil meter on its a.c. voltage range. Connect the meter across R35 (left channel) and R135 (right channel) and adjust VR1(L) and VR101(R) until the reading across each resistor increases by one volt a.c. This will give a quiescent current of 20mA through the output stages. If all the readings appear correct, switch off, replace fuses FS1 and FS101, switch on again and start listening.



Wiring to the speaker terminals and mains fuse FS2. The fuse and mains switch should be covered with insulating "boots".

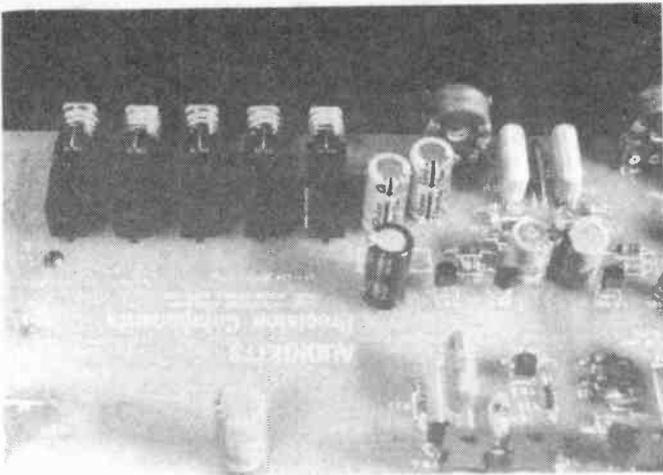


The speaker leads attached to the board "spade" terminals. Also note the insulating washers behind the transistors.

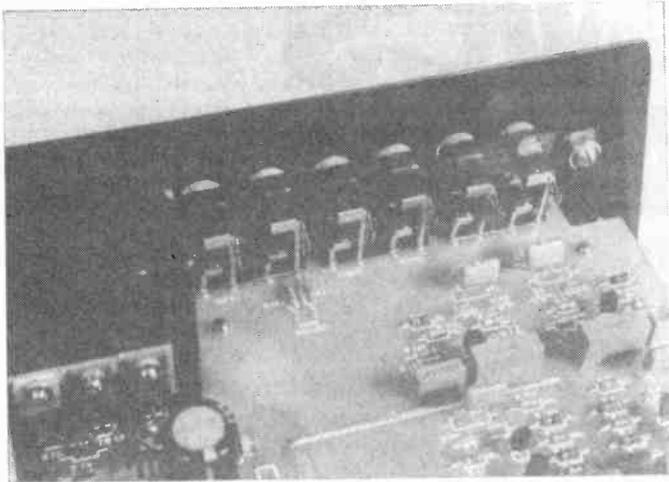
### TEST VOLTAGES

	TP1	TP101	TP2	T201	TP3	TP103	TP4	TP104	Across R35	Across R135
	L	R	L	R	L	R	L	R	L	R
A With fuses removed and VR1, VR101 set fully clockwise	14.5	14.7	31.5	31.3	45.7	45.2	23.2	28.8	1.4	1.55
B With fuses removed and VR1, VR101 set to 20mA output stage current	14.6	14.7	30.2	30.1	42.9	42.8	22.0	22.0	2.4	2.5
C With fuses inserted and 20mA output stage current	14.6	14.7	33.5	33.5	49.5	49.5	24.9	24.7		

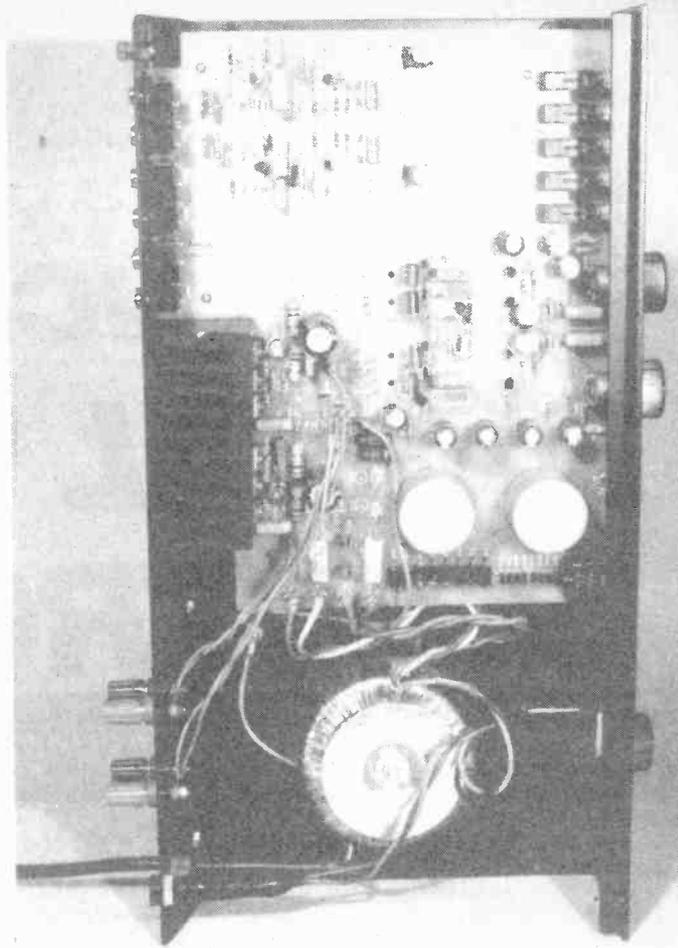
\* All measurements from TP1 to TP4, TP01 to TP104 are made using a digital meter. Measurements across R35, R135 with a moving coil meter on a.c. volts range.



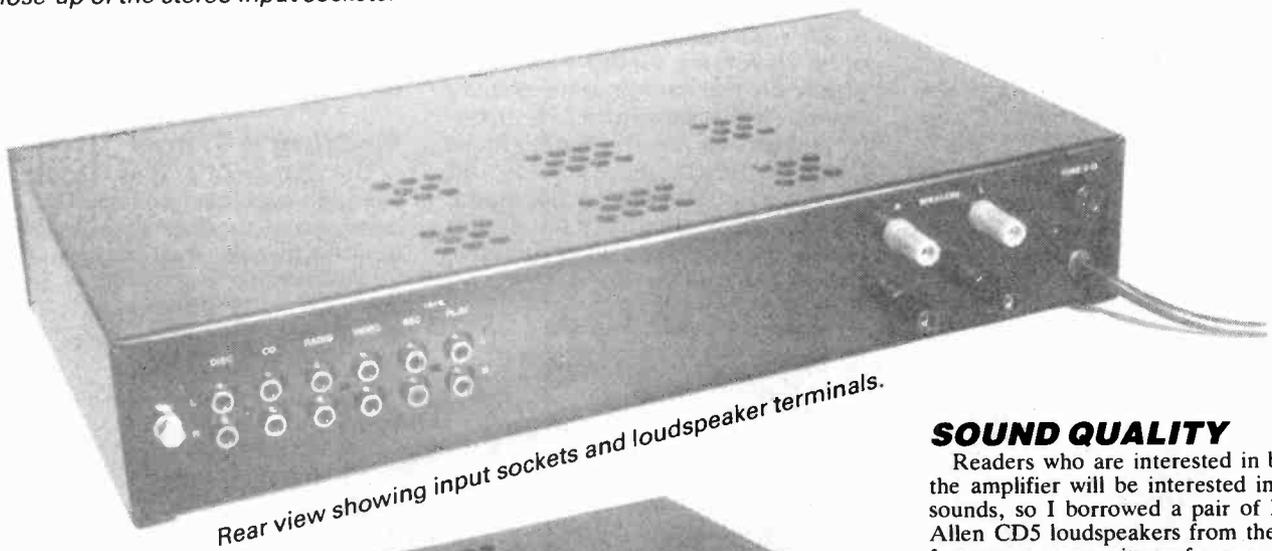
Close-up view of the p.c.b. push-button input mode selection switches.



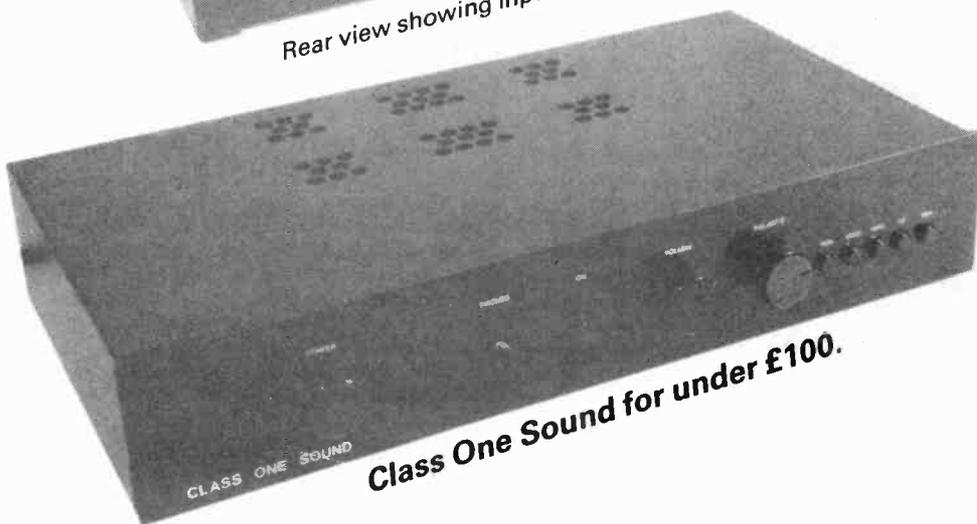
Close-up of the stereo input sockets.



The completed amplifier showing layout of components and interwiring.



Rear view showing input sockets and loudspeaker terminals.



Class One Sound for under £100.

### SOUND QUALITY

Readers who are interested in building the amplifier will be interested in how it sounds, so I borrowed a pair of Richard Allen CD5 loudspeakers from the manufacturers to assess its performance with a high quality speaker of recent design. The results were very rewarding. Stereo imagery was really good compared with one of my earlier designs, which shared the same power supplies for each channel.

In short I was really impressed by the ability of the amplifier to make all kinds of music sound interesting and involving, at both high and low sound levels with far better portrayal of dynamics between loud and quiet sounds than my experience would expect from low power amplifiers. This is very much an amplifier which you can use and enjoy, even if you also own an amplifier costing ten times the price. I am certainly pleased with the results and hope readers will also be equally happy. □

# Introducing DIGITAL ELECTRONICS

## Part 5: Measurement, Testing, Prototyping and Circuit Assembly

By **Michael J. Cockcroft**  
Training Manager, Peterborough ITeC

**B**EFORE getting into Prototyping and Circuit Assembly we will finish up Part 4 (The Oscilloscope and Logic Probes) and go through some questions and Exercises relating to it.

### The Oscilloscope

Meters, as useful as they are, are limited in their application. Often we are interested in very fast moving signals, like the waveforms discussed earlier, the dimensions of which could not possibly be registered by meters. For serious elec-

tronic testing we need an instrument which can measure and display signals which vary very rapidly with time or with respect to other signals; such an instrument is called an **oscilloscope**.

The oscilloscope draws a picture of a waveform in the form of a graph on the instruments display screen. A **graticule** (grid of horizontal and vertical lines) is always fitted to the display to allow voltage and time measurements to be made. Fig. 5.1 shows the front panel of a typical oscilloscope; although your

own oscilloscope (or the one you will be using) will be different, it will contain most, if not all, of the labelled parts in this diagram. The following discussion makes reference to all of these parts and you will need to study the operators manual of your 'scope to compare the differences.

### Getting a Trace

The beginner's first hurdle in using an oscilloscope is getting the instrument to display something (anything) on the screen. The

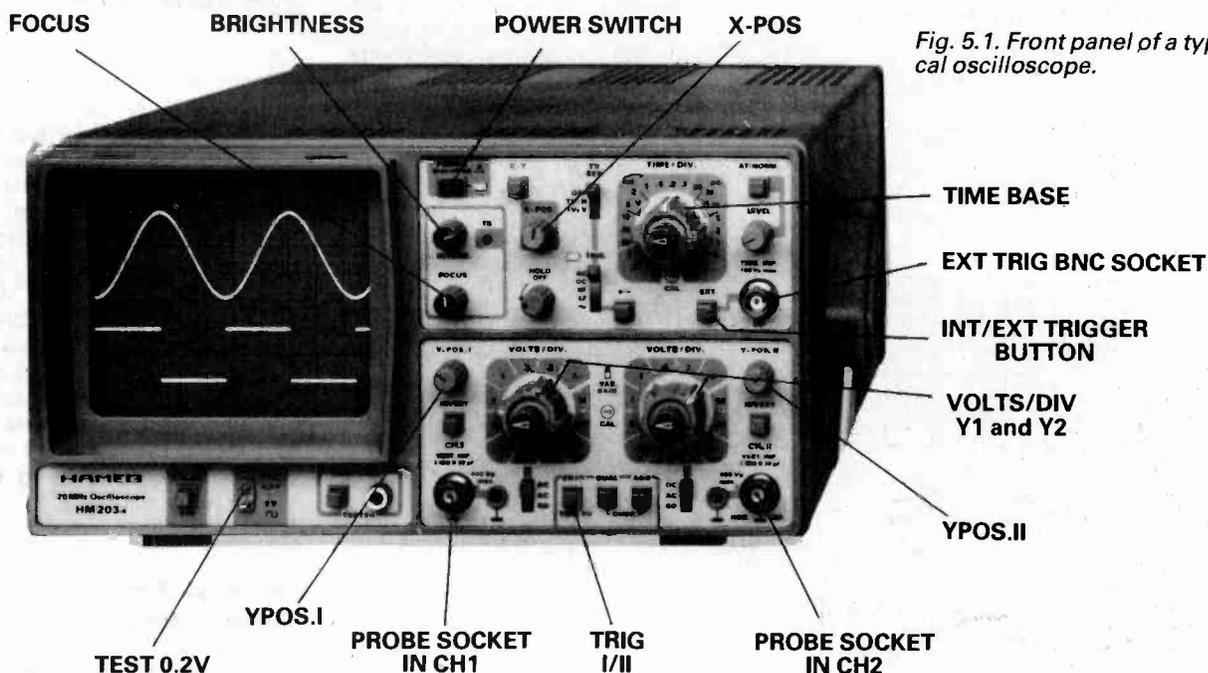


Fig. 5.1. Front panel of a typical oscilloscope.

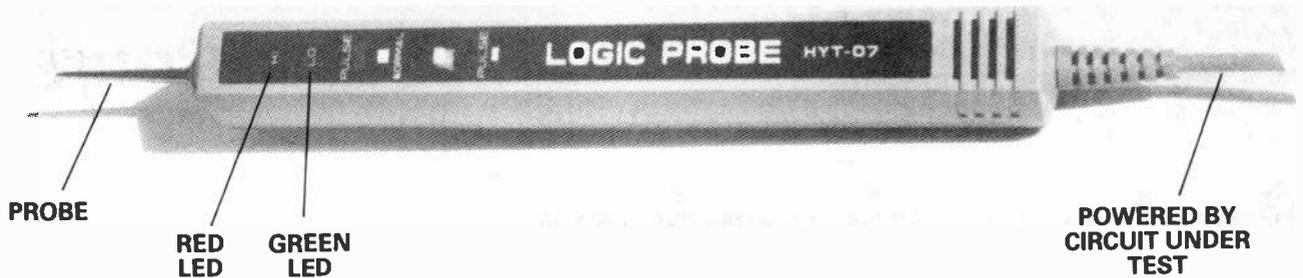


Fig. 5.4. A logic probe.

operators manual almost always explains how to do this. In general, setting the POWER switch on, all the rest of the switches off, and all control knobs to their mid or off position usually puts one or two lines on the screen, or sends one or two spots, from left to right, across the screen.

Once you have some type of trace on the display, adjust the brightness (INTENS) and (FOCUS) controls until the image is comfortable to your eyes. Avoid having too bright an image as this can burn the

inside of the screen. Plug a 'scope probe into the socket marked IN-CH1. You are now ready to take a reading through channel 1 of the 'scope (the 'scope of Fig. 5.1 has two channels—this allows two signals to be displayed at the same time.)

### Measuring a waveform

Set the timebase and channel 1 sensitivity controls as follows:

TIMEBASE to 0.5 (milliseconds)  
VOLTS/DIV-Y1 to 0.2 (volts)

Touch the 'scope probe to the calibration point, positioned below the screen in the figure, marked TEST. A square wave should appear on the screen. Adjust the XPOS and YPOS controls and observe what happens: these controls allow the waveform to be positioned anywhere on the graticule. Use these "SHIFT" controls to position the square wave as shown in Fig. 5.2.

The graticule is usually laid out, as shown in Fig. 5.3, in an eight by ten grid. The TIME-BASE and the two VOLTS/DIV controls refer to major divisions on the graticule; the present settings, for example, display the dimensions of the input waveform as 0.5 milliseconds for every centimetre on the X axis and 0.2 volts for every centimetre on the Y axis of the graticule.

The square wave signal on the TEST pin, therefore, has a pulse duration of 0.5ms and an amplitude of 0.2 volts; it has a 50 per cent duty cycle (which is a mark/space ratio of 1) and a frequency of 1000Hz:

Pulse = 0.5ms  
Period = 1ms  
Frequency = 1/1ms = 1kHz

### Triggering the Timebase

The graph displayed on the oscilloscope is not a single stationary picture, but many traces drawn one after the other at a rate determined by the timebase setting. It is important, therefore, that the oscilloscope draws the graph from the same point of the signal each time—otherwise the display would show a muddled confusion of patterns on the screen. Timing the point at which the oscilloscope starts to draw the graph each time is called "triggering" and can be set

by the user or triggered automatically.

Depending on the INT/EXT button setting, trigger signals can be provided either internal or external to the oscilloscope. Internal triggering means that the trigger signal is derived from the signal itself at the channel input. The push button TRIG I/I determines which channel is the trigger source if both channels are in use. External triggering requires a signal, at the BNC socket marked EXT. TRIG, from an external circuit.

### Logic Probes

For many digital circuit testing applications, the oscilloscope can be very much an overkill. Digital circuits recognise only two voltage levels (high and low) and, often, all that is needed is a simple device which can indicate as to whether a point in the circuit is high or low. Such a device is depicted in Fig. 5.4 and is called a logic probe.

The logic probe is used for analysing or fault finding in digital circuits; the tip of the probe is touched to the point of interest and one of two l.e.d.s illuminates to indicate either a high or a low logic level (exactly what constitutes a high or a low level depends on the logic family in use; we deal with logic families in Part 11).

Most logic probes facilitate the detection of fast going pulses. Pulses that would normally go undetected by the naked eye are electronically stretched to about 1/10th of a second. Many good logic probes also use a variety of techniques, combining the two l.e.d.s, to provide additional functions; Table 5.1 shows some examples.

Considering logic probes are easy to use, portable, and particularly useful for a number of projects and experiments in this course, you will be pleased to know that your first (optional) practical circuit construction exercise is to build one (albeit a humble one!).

### Exercises and Questions

If you intend to take 301 examinations, it is important that

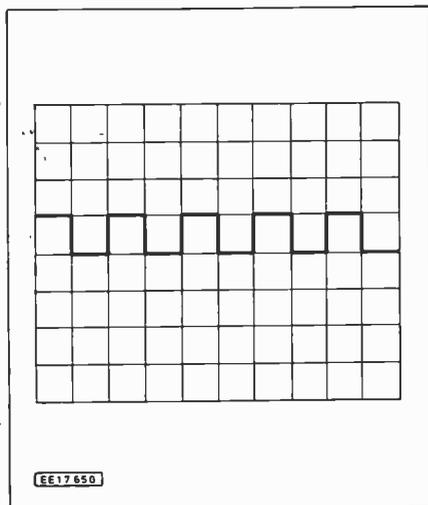


Fig. 5.2. Squarewave positioning.

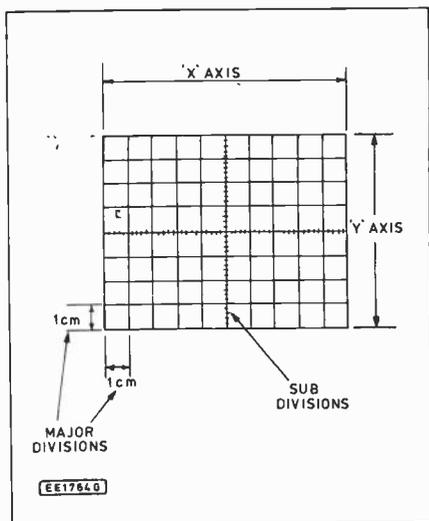


Fig. 5.3. Normal graticule marking.

**TABLE 5.1**  
**Additional Functions of Logic Probes**

I.e.d.s	Input
Both off	Open circuit or between "low" and "high" threshold
"low" on bright	Below logic "low" threshold
"high" on bright	Above logic "high" threshold
Both Flash	Square wave or repetitive wide pulses (>100ms) frequency <100Hz I.e.d.s follow input waveform
Both on Dim	Square wave or repetitive wide pulses frequency >100Hz. Relative brightness gives indication of mark space ratio
"low" Flashes	Repetitive, narrow, positive going pulse at repetition rate <100Hz. Single pulses to below 30ns cause "low" I.e.d. to flash off for approximately 100ms
"high" Flashes	Repetitive, narrow, negative going pulse at repetition <100Hz. Single pulses to below 30ns cause "high" I.e.d. to flash off for approximately 100ms
"low" on Dim	Repetitive, narrow, positive going pulses at repetition rate >100Hz
"high" on Dim	Repetitive, narrow, negative going pulses at repetition rate >100Hz

you do all the exercises here and attempt to answer all of the following questions.

**Exercises**

Because the practical work for these sections of the course is quite time consuming and many students are studying on top of full-time work, some of the exercises are carried over to next month. This month we concentrate on investigations involving the oscilloscope, function generator, and pulse generator;

The exercises are laid out in tables (labelled Exercise 5.1 to 5.4) for easy reference; if you don't have access to the equipment, contact your local Assessment Centre and ask how they can help.

**Questions**

1. Which range setting (of the meter in Fig. 5.5) would be most appropriate for measuring the current flow through the resistor in the circuit of Fig. 5.6.
2. State the polarity of the meter leads for the above operation:  
Red lead to point .....  
Black lead to point .....

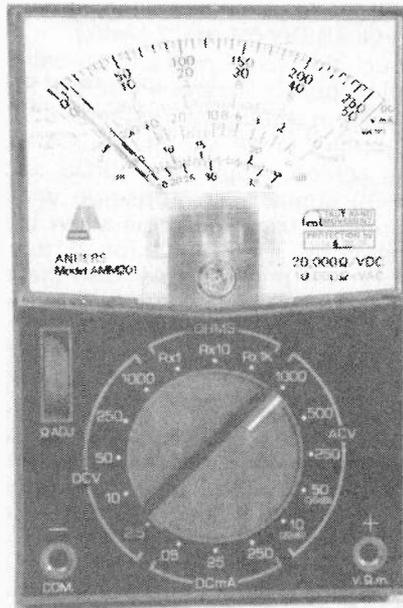


Fig. 5.5. Typical multimeter.

3. Which range setting (of the meter in Fig. 5.5) would be most appropriate for measuring the voltage across the resistor in the circuit of Fig.5.6

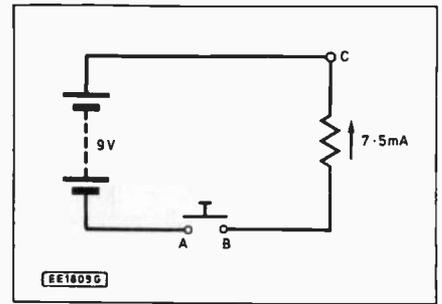


Fig. 5.6. Test circuit.

4. State the polarity of the meter leads for the above question:  
Red lead to point .....  
Black lead to point .....
5. Interpret the voltage readings displayed on the five analogue multimeters of Fig. 5.7.
6. Interpret the current readings displayed on the five analogue multimeters of fig. 5.8.
7. In what sequence would you use the following oscilloscope controls in order to obtain a trace on the screen:  
X SHIFT  
Y SHIFT  
INTENS  
FOCUS  
TIMEBASE
8. To which settings would the pulse generator controls of Fig. 4.7 (last month) be adjusted in order to produce the output waveform in Fig. 5.9.
9. What would happen to the oscilloscope displayed waveform of Fig. 5.10 if you were to adjust the trigger level?
10. State the periodic time of the oscilloscope output sine wave shown in Fig. 5.11. The oscilloscope is set to 50ms/cm.
11. State the duty cycle and mark/space ratio of the waveform of Fig. 5.12.
12. The periodic time of an alternating voltage is 10µs, what is its frequency?
13. Draw, on graph paper, a triangle wave with a periodic time of 2ms.
14. What is the frequency of a 50µs alternating voltage?
15. State the essential requirements of a d.c. supply for use with digital electronic circuits.
16. Referring to the diagram of Fig. 5.13 which label (A, B, C, D or E) represents the mark/space ratio of the waveform?
17. What is the duty cycle of a waveform having a pulse width of 1ms and a periodic time of 3ms?
18. Your oscilloscope is set to 20ms/cm, how long would it take for the beam (spot) to move across three major divisions of the graticule?
19. To what timebase setting would you adjust your oscilloscope in order for the beam to take 100µs to move across five major graticule divisions?

**A note to College and ITeC tutors**

It is impossible to generalise on measuring instruments such as oscilloscopes and signal generators when they differ so much between manufacturers; the exercises are somewhat impaired because of this. If your students are following the course and you would like to tailor the exercises to your particular equipment, you may like to contact the author at Peterborough ITeC for a copy of the text in the form of an ASCII file on computer disk (please supply a blank IBM PC/MSDOS 5.25in formatted disk).

## Exercise 5.1

### INITIALISING THE OSCILLOSCOPE

The oscilloscope represents a piece of very large electronic graph paper, the graticule of which is just a small viewfinder rather like a window through which only a portion of the entire sheet can be seen. The instruments drawing implement may be thought of as a light beam: this moves from left to right across the graticule at a speed, determined by the TIMEBASE switch settings, and moves up and down relative to the size of voltage at the input terminals (IN-CH1 and IN-CH2 are the two input channels of the 'scope in Fig. 5.1).

Before we can use the 'scope we need to position the beam appropriately on the graticule; initially, depending on the control panel switch settings, the beam may not be visible *anywhere* on the screen. This exercise is designed to help you locate the beam, position it on the graticule, and set its speed.

#### Instructions

Unplug any probes from IN-CH1 or IN-CH2 and switch the 'scope on.

Turn the TIMEBASE switch fully anti-clockwise.

If you are using a dual trace oscilloscope, set CH1/DUAL/CH2 switch to CH1.

Turn the INTENS control fully clockwise.

Switch the input coupling switch (AC/DC/GND) to GND.

Adjust the channel 1 XPOS and YPOS controls until you can see a spot of coloured light moving across the graticule. If the beam still isn't visible, consult your manual and find out how to switch to the automatic trigger mode. Adjust the FOCUS and INTENS controls to obtain a sharp image that is comfortable to the eyes.

Align the beam to run along the centre graticule line (XPOS) starting from the leftmost vertical graticule line (YPOS). You should now have a spot running across the centre of the screen. If you have a stopwatch on your wrist, time how long it takes for the spot to travel from extreme left of the screen to extreme right.

Turn the TIMEBASE clockwise until the spot transforms into a line.

Leave the oscilloscope settings for the next exercise.

#### Comments

Most oscilloscopes need a minute or so to warm up after switching on. While you are waiting, set all knobs, switches, and buttons to their mid, off, or out positions.

This reduces the speed of the beam to its slowest rate which is usually 0.2 or 0.5 sec/cm, depending on the oscilloscope. Do not worry if you can't see the beam yet.

This is to ensure that, for the moment, we only get one beam.

If a bright line or spot appears on the screen immediately, reduce the brightness (INTENS) a little.

Because we are not measuring anything, this sets the voltage level (amplitude) to zero volts ground.

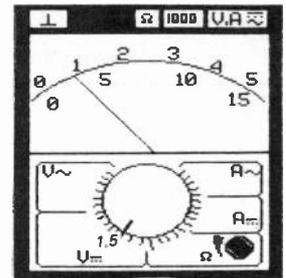
XPOS and YPOS are called the 'shift' controls; they determine where the beam starts its cycle from the left of the graticule, and where it starts in the up or down direction.

Do not have a very bright image on the screen for too long as this may burn the inside surface of the screen.

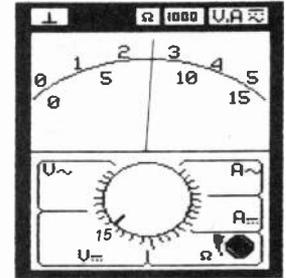
If the beam is not steady, adjust the control labelled 'sync' or 'level'.

What is the channel 1 TIMEBASE switch setting labelled for its present (fully anti-clockwise) position? If it is labelled 200ms (0.2 sec), the spot should have taken two seconds to travel the distance (0.2 secs per centimetre for ten major divisions =  $0.2 \times 10 = 2$ ).

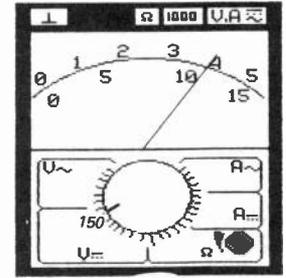
The spot is moving so fast it looks like a stationary line. How long does the spot now take to travel *halfway* across the graticule? (Look at the timebase setting and multiply it by five).



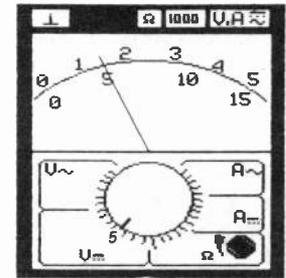
(a)



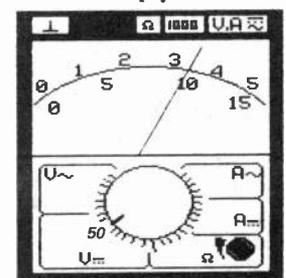
(c)



(e)



(b)



(d)

Fig. 5.7. Multimeter displays of voltage.

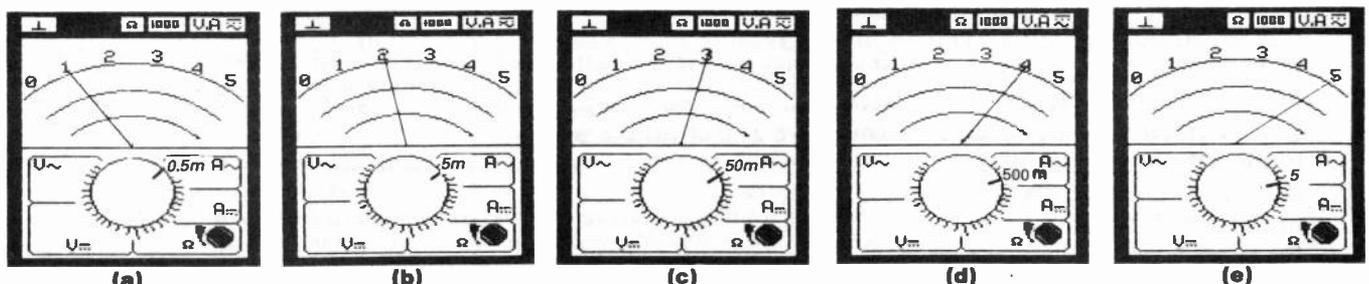


Fig. 5.8. Multimeter displays of current.

## Exercise 5.2

### MEASURING AC AND DC ON THE OSCILLOSCOPE

The oscilloscope's beam moves up and down a distance on the graticule relative to the voltage being measured. If the voltage is positive the beam will move upwards, and if the voltage is negative the beam will move downwards. The point in the circuit being measured is connected to the input connector (or connectors: a dual trace scope has two input channels making it possible to look at two signals at the same time) of the oscilloscope by special probes, as explained in the text.

This exercise examines the measurement of a.c. and d.c. voltage on the oscilloscope; but first, we investigate an important property of probes.

#### Instructions

Connect a length of insulated copper wire (1/0.6) to the channel 1 input terminal (IN-CH1) of the scope.

#### Comments

It is not necessary to put a BNC plug on the wire, just strip about 10mm of insulation from the end of the wire and push the conductor into the centre hole of the socket. This is a makeshift scope probe.

All other settings should be preserved from the previous exercise.

There should be a sine wave on the screen. The wire is acting as an aerial and picking up electromagnetic waves\* from the air.

The closer the wire gets to the cable, the larger (vertically) the signal becomes. What is the peak to peak amplitude of this wave at its greatest?: if it covers 3 or 4 major vertical divisions at 0.2V/cm it is between 0.6 and 0.8 volts.

This is the frequency of the mains. Refer to last month's text if you need to.

Now try and pick up air waves. The probe is screened to prevent this from happening or, at least, minimise it!). It also has other properties but these are beyond the scope of the course.

Some 'scopes call this test point 'probe adjust' or 'cal'.

It is usual to display at least one or two full cycles of the waveform.

The adjuster screw is usually in the body of the probe or in a box at the base of it.

This is called "compensating" or "calibrating" the probe.

The reading should match the TEST pin label (e.g. 1kHz 0.2Vpp).

Switch the TIMEBASE to 50ms/cm, channel 1 sensitivity to 0.2V/cm, and the input coupling to DC.

Hold the other end of the wire on (or close to) the insulation of the nearest active mains cable (e.g. the mains lead of the scope).

Vary the distance between the wire and the mains lead, and watch the screen as you do so.

Work out the frequency of this signal.

Remove this home-made probe and plug an oscilloscope probe into the socket.

Touch the probe tip to the test point (TEST).

Adjust the timebase and sensitivity until you get a reasonable picture of the square wave.

With a screwdriver, turn the calibration screw in the probe back and forth a few times observing the displayed waveform at the same time.

Adjust the probe until the top and bottom horizontal lines of the square wave are parallel.

Read the frequency and amplitude of the square wave signal.

Adjust the sensitivity to 5V/cm and screw an earth lead into the probe. Set the beam to the centre of the graticule.

Measure the voltage of your PP3 battery.

Spend some time adjusting the oscilloscope controls and reading the user manual until you fully understand the operation of all that we have used so far.

Clip the earth lead to the negative terminal and touch the probe to the positive terminal.

The next exercise assumes this knowledge.

\*An electromagnetic wave is energy radiating from a source: radio transmitters produce such waves. Alternating current in a wire transmit electromagnetic waves (of the same frequency as the signal in the wire) into the air. After you have completed this exercise, if you have a nearby window and a little imagination, you may be able to display a signal on your scope from a local radio station.

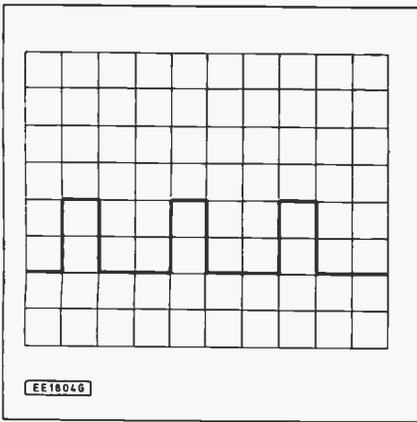


Fig. 5.9. Waveform of the pulse generator output. Timebase setting 10ms/cm.

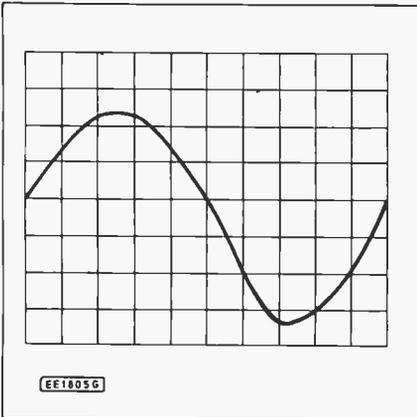


Fig. 5.10. Sinewave display.

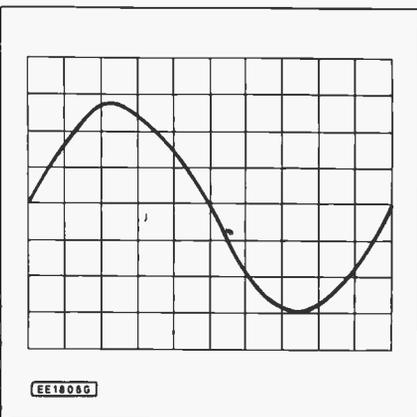


Fig. 5.11. Display for periodic time calculation.

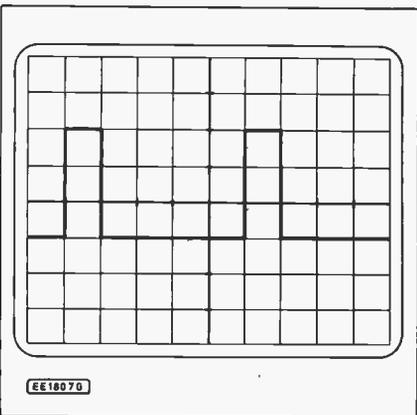


Fig. 5.12. Display for duty cycle and mark/space calculation.

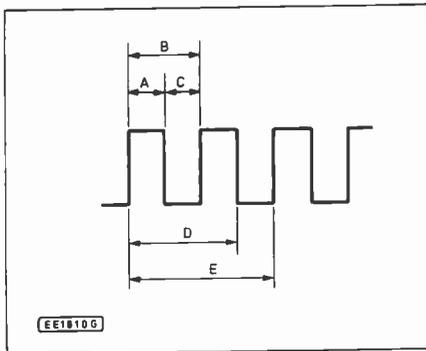


Fig. 5.13. Labelled squarewave.

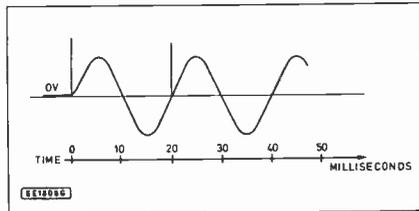


Fig. 5.14. Time dimensions of the a.c. mains supply.

20. Fig. 5.14 gives the time dimensions of the a.c. mains signal in Great Britain, what is the frequency of the waveform?

We now proceed with the lesson that embarks on the following City and Guilds objectives:

### 3.1 Circuits and block diagrams

3.1.1 State the purpose of, and distinguish between, circuit diagrams, block diagrams, and layout physical diagrams.

3.1.2 Use standard conventions to draw very simple circuit, block, and layout diagrams.

3.1.3 Compile a components list from a given simple circuit diagram.

3.1.4 Devise a component layout for the breadboard construction of at least one of the circuits given in Appendix D.

### 3.2 Breadboarding

3.2.1 Identify a breadboard system.

3.2.2 Identify common interconnections provided internally within a breadboard system.

3.2.3 State the advantages and disadvantages of using a breadboard system for the development of digital circuits.

### 3.3 Logic Tutors

3.3.1 Identify a logic tutor.

3.3.2 Identify the various interconnections provided internally within a logic tutor.

3.3.3 Construct and test a simple logic arrangement using not more than TWO logic gates assembled on a logic tutor. Sketch the circuit and write a brief report on the test carried out.

## Exercise 5.3

### LOOKING AT WAVEFORMS ON THE OSCILLOSCOPE

Function generators are used to produce square, triangle, and sine waves of a range of amplitudes and frequencies. Connect a function generator to the oscilloscope, power up both instruments, and proceed with the following exercise.

#### Instructions

Set the amplitude control of the function generator to produce a 10 volt signal. Adjust the 'scope' appropriately to receive it.

Turn the function selector switch of the function generator to 'sine' and select a frequency range that will produce a 1kHz sine wave.

Adjust the 'd.c. offset' control of the function generator and watch the 'scope screen.

Change the 'scope's' input coupling switch to AC and adjust the 'd.c. offset' control again.

Change the function selector of the function generator to 'triangle'.

Change the function selector of the function generator to 'square'.

Use a pulse generator to produce a 1kHz signal with a 10% duty cycle.

#### Comments

Set the 'd.c. offset' control of the function generator to its mid position and the 'scopes' into coupling to DC.

What timebase settings will display two full cycles of a 1kHz signal on the graticule? Set the timebase so that you can see two cycles.

The signal moves vertically.

What happens? The 'd.c. offset' no longer moves the signal because the AC setting of the input coupling switch blocks the d.c. component of the signal (more about d.c. blocking — in Part 8).

Observe the time and amplitude relationship between this signal and the previous sine wave. Could you draw a 1kHz triangle wave on graph paper?

Is there any means of changing the duty cycle of this signal? No, the square wave is also time related to the sine wave.

Remove the BNC to BNC lead at the function generator end and plug it into the pulse generator. The controls of the pulse generator are labelled and you should now be able to produce the signal on your own.

## Exercise 5.4

### TRIGGERING THE TIMEBASE OF THE OSCILLOSCOPE

If you had difficulty in getting *exactly* two cycles of a waveform on the graticule when you were doing the previous exercise, the reason was that you had not made the correct trigger system adjustments on the oscilloscope. Trigger settings tell the 'scope the exact point of the waveform at which to start tracing the image: what is displayed on the screen is all the cycles of the waveform overlaid into what looks like one picture. This exercise investigates triggering.

#### Instructions

Turn on the oscilloscope and get a signal from the test point TEST.

Move the trace away from the left hand side of the graticule so that you can see where the signal starts (XPOS). Watch the display while you operate the +/- switch.

Remove the probe from TEST and put a 1kHz sine wave into channel 1 using a signal or function generator. Depress the INT/EXT push button.

Adjust the amplitude of the signal so that the signal height is at least 2 or 3cm.

Now, with a sensitive touch, adjust the level control back and forth.

#### Comments

The waveform display starts at the positive or negative leading edge of the signal depending on the +/- switch setting.

If you can't see the trace adjust the "level" control until you can. At this point it may also be necessary to re-adjust YPOS.

You can do this from either the function generator amplitude control or the oscilloscope YINP-1 control.

You will see the leading edge of the signal move along relative to the control setting.

## Diagrams

In addition to written documentation in the form of descriptions and specifications, electronic systems are expressed graphically as diagrams. There are a number of technical drawings used in electronics and it is important to be able to use some of them; in particular, we need to be able to read and draw:

- Circuit Diagrams
- Physical Layout Diagrams
- Block Diagrams

### Circuit Diagrams

Circuit diagrams show electronic system interconnections using component symbols and ruled lines. Although there is no one correct way to draw a particular circuit, there are conventions with respect to format; for example, consider the following points about the three circuit diagrams of Fig. 5.15 (taken from the City and Guilds Resource Document). **Note:** These diagrams are reproduced exactly as shown by City and Guilds, they are not drawn to the normal EE style and do include some symbols and mark-

ings that we would not normally use.

- The power supply lines are always positive to the top and negative to the bottom of the diagrams.
- British Standard symbols are used.
- Component part numbers or values are clearly labelled.
- Input electronics (temperature sensing in circuit (a), light sensing in (b), and touch sensing in (c)) is drawn to the left and output electronics (bell (a), bulb (b), and relay (c)) is drawn to the right of the diagrams.

These are the conventions adopted by most electronic establishments in the UK and, in particular, by City and Guilds as their marking criteria for some of the tests and assignments in this course. It is important to note that point (d) above is not a prescript but rather a general rule that is governed by readability and sensible use of area on the diagram as a whole; for example, if drawing

input to the left, processing to the middle, and output to the right produces a circuit diagram like that of Fig. 5.16a then the format would be rearranged to sensibly fill the available space on the paper, as shown in Fig. 5.16b.

### Physical Layout Diagrams

The circuit diagram tells nothing of how a system is physically constructed; it expresses exactly how the circuit works with respect to how the electronic components are connected together, but how it is assembled on printed circuit board, stripboard, or **breadboard** (explained later) is drawn as physical layout diagrams.

Physical layout diagrams must show the precise positioning of components on the circuit boards with component parts clearly labelled, as shown in the p.c.b., stripboard, and breadboard layouts of Fig. 5.17. (NOTE: these do not all show the same unit).

### Block Diagrams

Block diagrams, sometimes called "system diagrams", illustrate

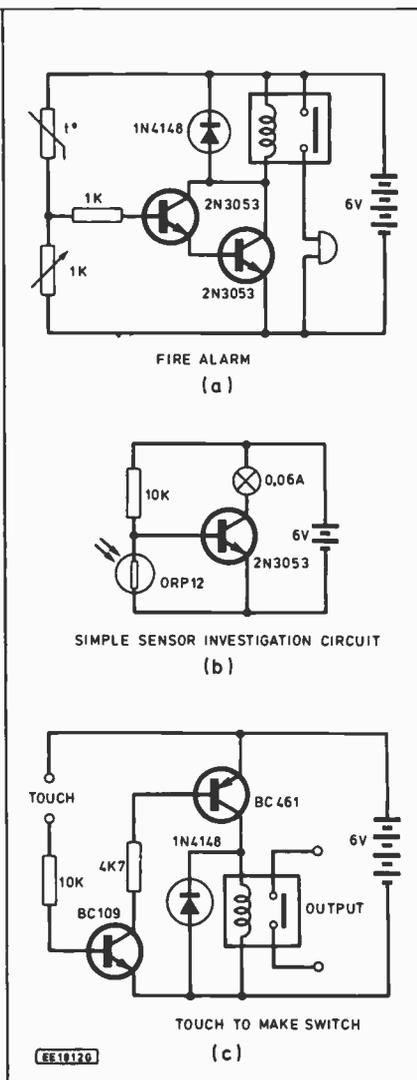


Fig. 5.15. Three "City and Guilds" circuit diagrams.

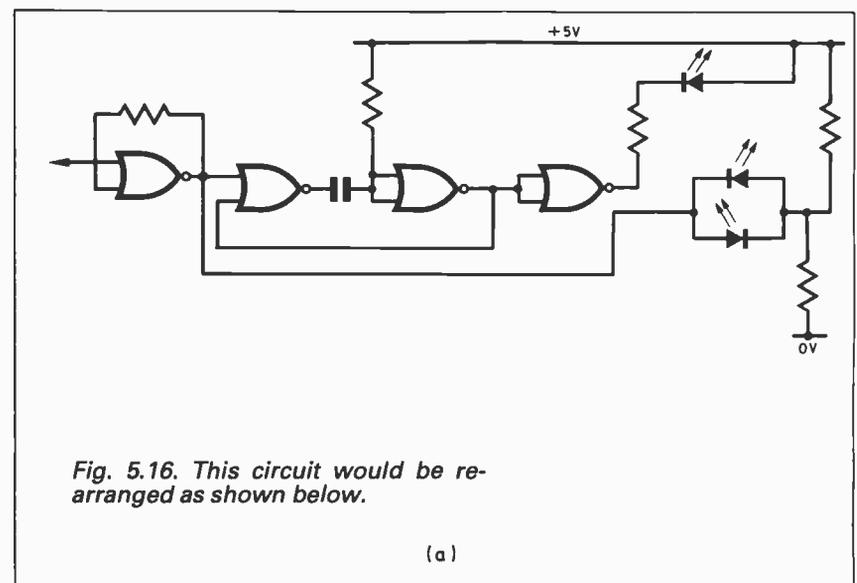
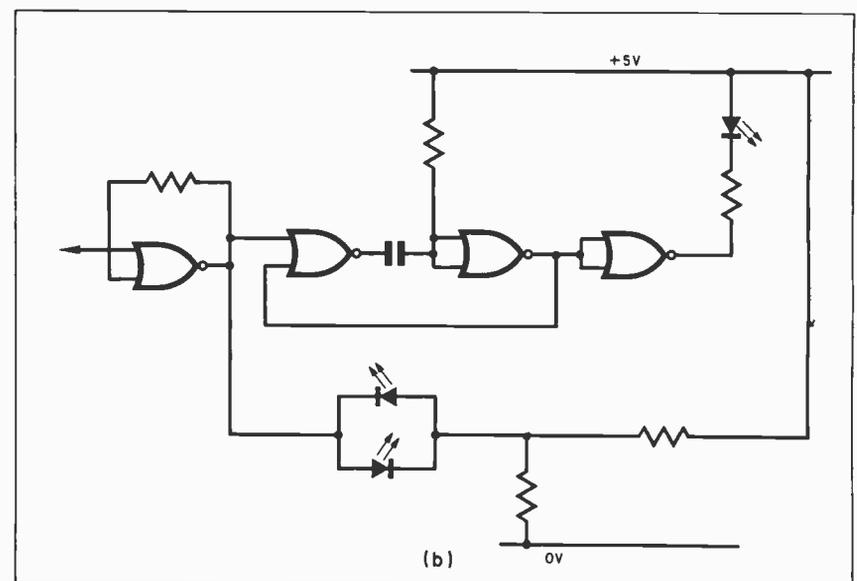


Fig. 5.16. This circuit would be rearranged as shown below.



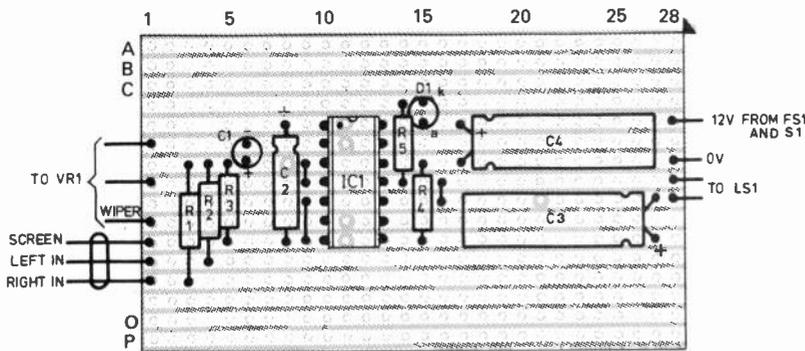
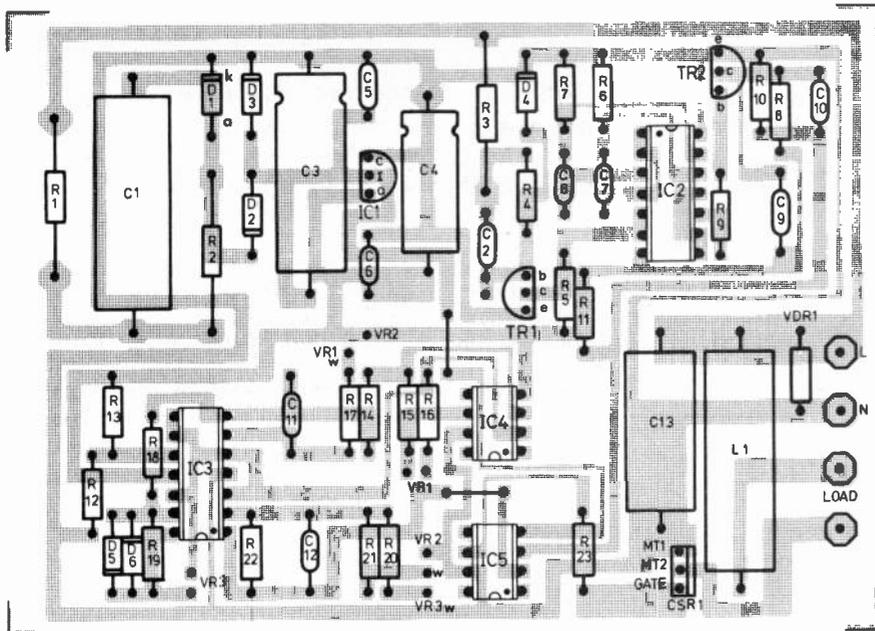
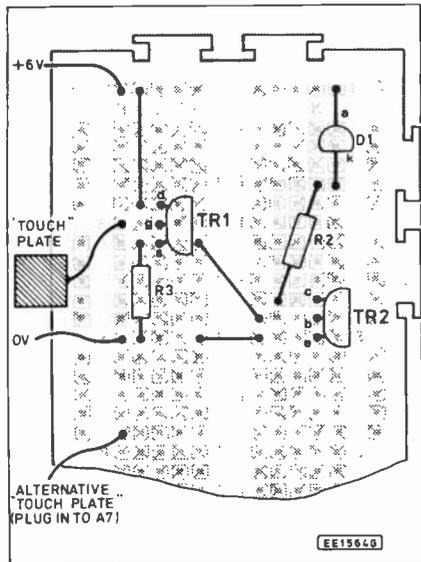


Fig. 5.17. Examples of p.c.b. (top), stripboard (above) and breadboard (below) construction.

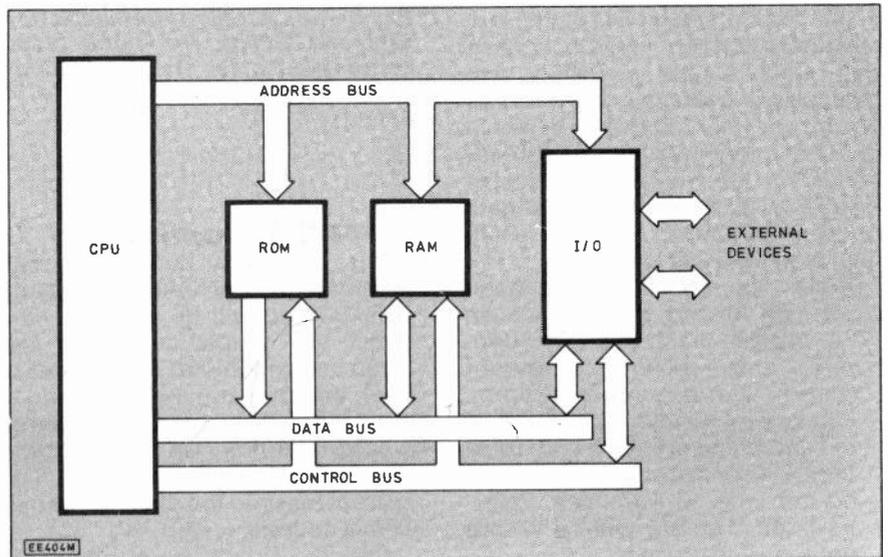


how a system works in a very general way: they show how the sub-systems are put together to form the whole system. Such diagrams show the system details using a minimum of technical information, making them useful for conveying an overview or an initial idea of how a system works very quickly. An example block diagram of a microprocessor based system is given in Fig. 5.18

### Prototype Wiring

A prototype circuit is the original model on which the final version of the circuit is based. Prototypes are usually built as a first stage in testing the theory of a design: only by putting theory into practice can the circuit be tested under real world conditions.

Fig. 5.18. A block diagram of a microprocessor system.



In industry, prototype wiremen/wirewomen are employed in the research, design, and development departments within electronics companies to construct (and sometimes test) trial models. Once the design is validated, if the system is to be mass produced, printed circuit board artwork (copper foil masters—see page 89 for an example of a p.c.b. master) are developed.

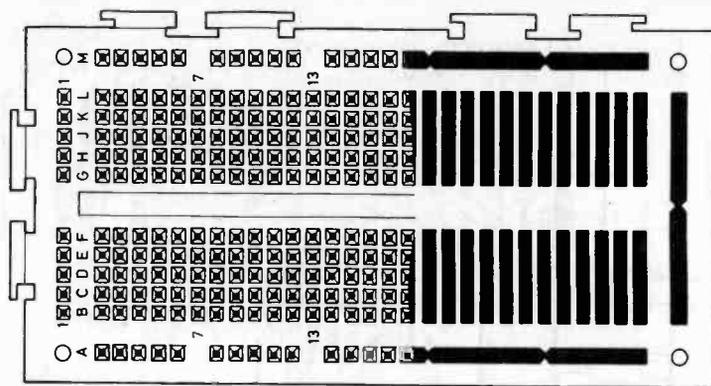
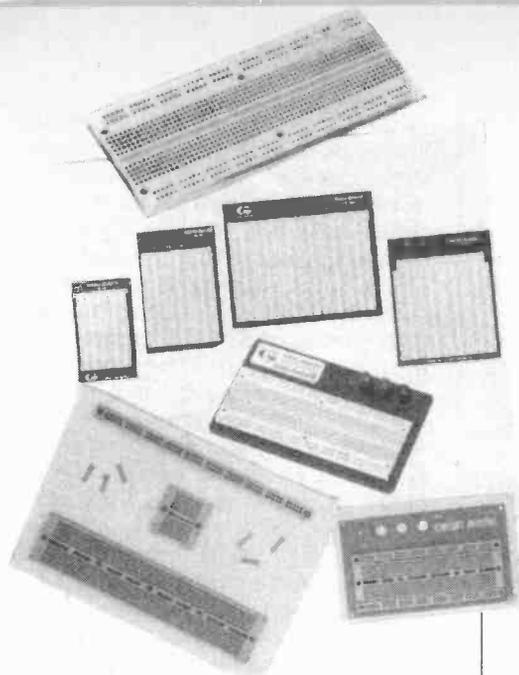
It would not be wise to go to the trouble of developing p.c.b. artworks at the development stage, however, since the design is very likely to be changed. What is needed is a fast and cost effective method of construction which does not involve the manufacture of a printed circuit board. Stripboard is one solution if the prototype circuit is going to be developed into a full-blown prototype model. If, on the other hand, the prototype circuit is only intended to try out the design, there are distinct disadvantages of stripboard over other prototyping systems: the breadboard system, for example.

### Breadboarding

Breadboard, as an alternative to stripboard, has the following advantages:

- (a) Components are not soldered
- (b) Changes can quickly and easily be made to the circuit
- (c) Components can be re-used over and over again
- (c) Fewer wire links are required between components
- (d) Much faster method of assembly

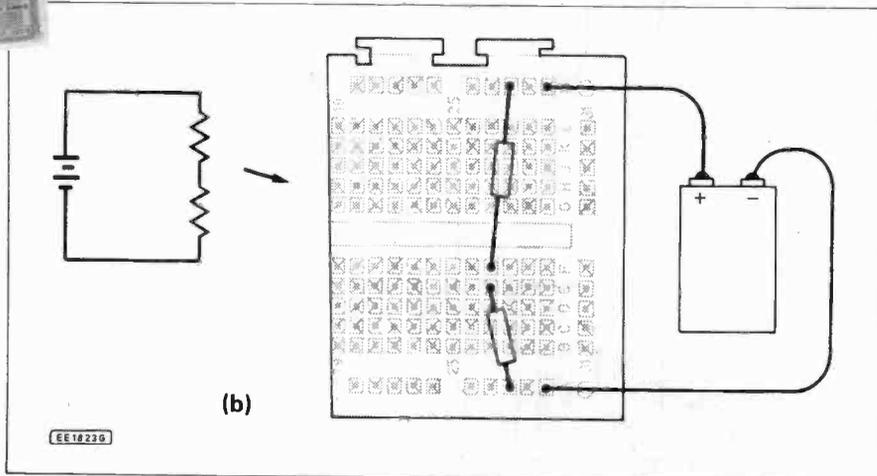
A number of breadboarding systems are shown in Fig. 5.19. Circuit assembly on breadboard is quick and simple: wires or component leads are connected together by inserting them into adjacent holes (they are held in place by spring contacts) as shown in Fig. 5.20—the internal connections of a bread-



(a)

Fig. 5.19 (above). Examples of various breadboards.

Fig. 5.20 (right). Construction of a breadboard (top right) and the method of connecting a simple circuit.



(b)

board system are shown (in black) in (a) and the method of connecting two resistors together in (b).

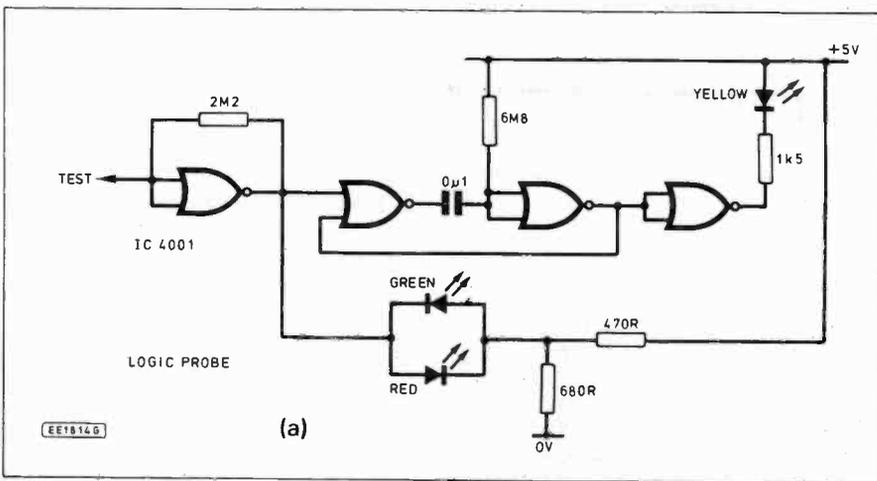
A breadboard physical layout diagram for the logic probe circuit of Fig. 5.21a (reproduced from Appendix D of the City and Guilds Resource Document) is shown in Fig. 5.21b. Fig. 5.21c relates some of the physical connections of the 4001 integrated circuit to the layout diagram.

### Logic Tutors

A natural extension to the breadboard for prototype work is a system with built-in functions such as logic switches and indicators which may be simply "wired in" as part of prototype circuits. These systems are called Logic Designers or, because they are useful for teaching digital electronics, Logic Tutors.

We will be using the Pencilbox Logic Tutor (Fig. 5.22a), a block diagram of which is given in Fig. 5.22b. The Pencilbox has eight l.e.d. indicators (which can be latched on), eight toggle switches, two push button switches, and a square wave generator (clock); all of which can be connected to the breadboard via the interconnect socket (see Fig. 5.22b). We will investigate the various functions of the Pencilbox in an exercise later.

**Note:** The pencilbox has been selected for this course because the product is relatively inexpensive and most assessment centres own a number of them. Purchasing details are given at the end of the article. If your local Centre does not own one and you do not wish to purchase, Peterborough ITec are willing to hire out a couple by post.



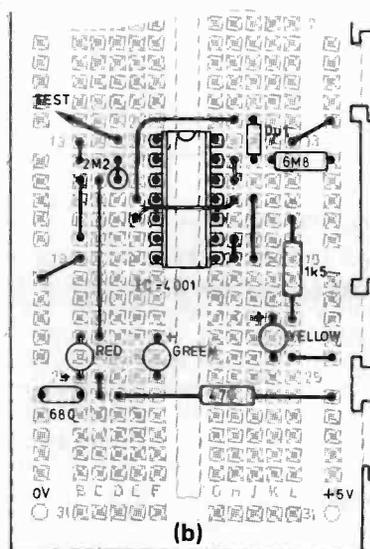
(a)

Fig. 5.21(a). A logic probe circuit from City and Guilds. (b) (right) breadboard layout of (a). The power supply connections to the i.c. (pin 7 and 14) are not shown.

### Circuit Assembly

The only way to learn circuit assembly is by actually assembling circuits. You will be asked to construct the simple sensor of Fig. 5.15b on breadboard as an exercise later; whether you then continue to build it on stripboard and put it into a case is entirely up to you but, if you are taking the certificate, you must at least do the exercise as part of this course.

Building circuits on stripboard is



(b)

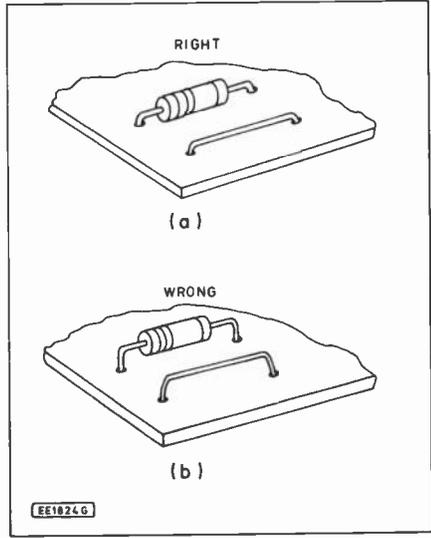
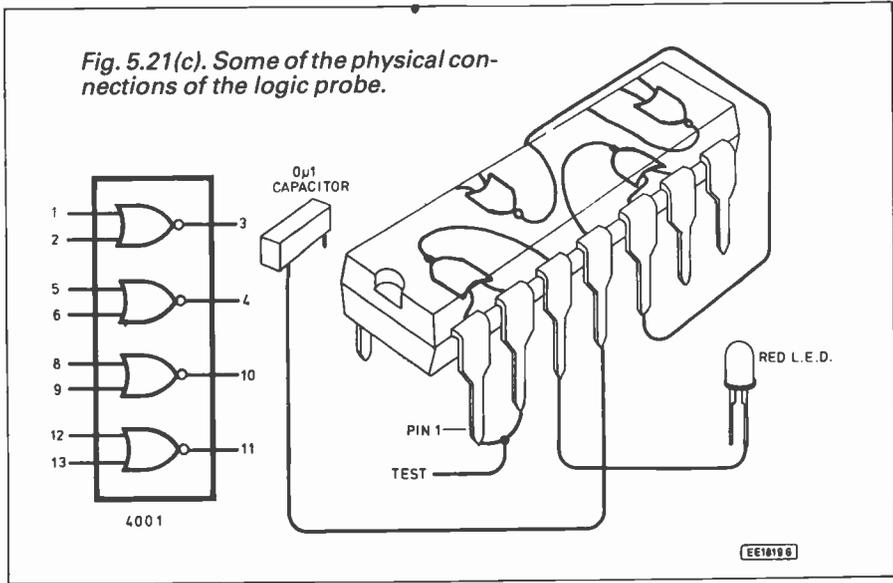
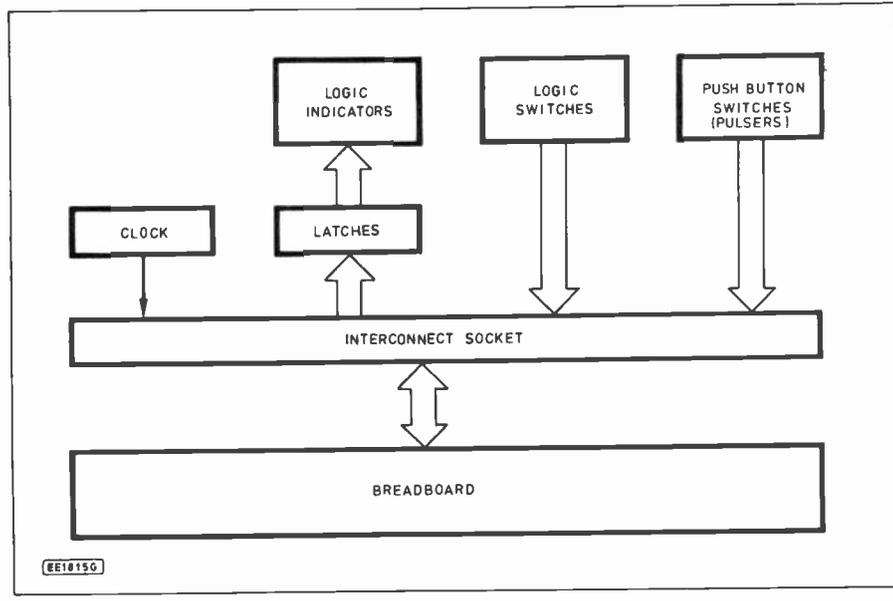


Fig. 5.23. Component and link mounting.



(b)

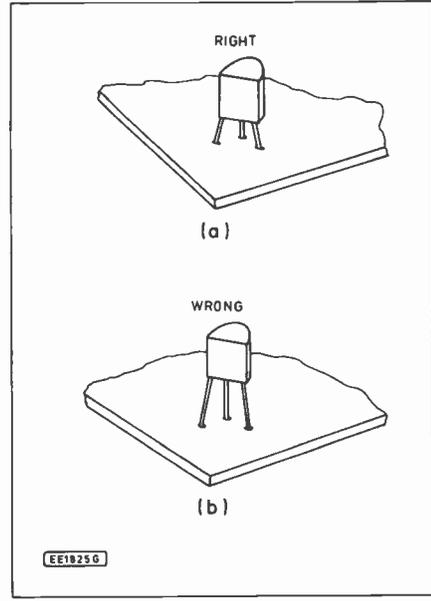


Fig. 5.24. Transistor mounting.

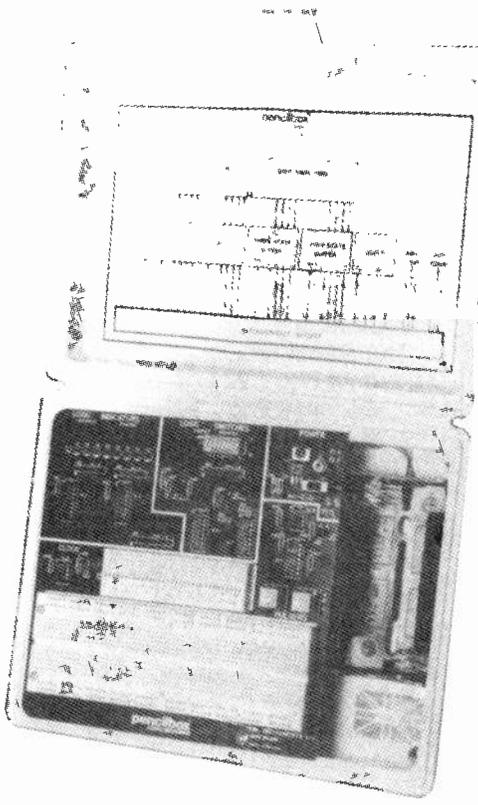


Fig. 5.22. The Pencilbox Logic Tutor (left) and a block diagram of it (above).

(a)

a little more difficult: the components need to be mounted properly and soldered in place neatly. The soldered joints must make a good electrical connection without causing shorts.

**Mounting Components**

Components and linking wires should (where possible) sit completely down on the circuit board, as shown in Fig. 5.23a. Where this is not possible the component should be mounted as low as possible without putting a strain on the connecting leads; for example, the transistor in Fig. 5.24a is fine but in Fig. 5.24b it is mounted too high.

The wires and component leads are bent at about 45 degrees on the copper strip side (Fig. 5.25) to hold

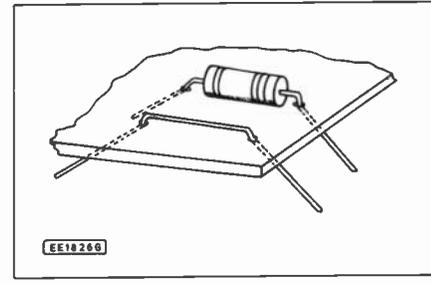


Fig. 5.25. Bend the leads to hold the component in place.

them in place when the board is turned upside-down for soldering.

**Soldering**

To make good soldered joints the iron must be clean and well tinned, and the component leads should be free from rust or other foreign matter. Component leads can be cleaned with a cleaning tool or an ink eraser if necessary.

### Safety Notes

1. A proper earth connection must be made to all mains powered soldering irons.
2. Keep the iron in its holder or on a purpose built metal stand when not in use.
3. Switch off the iron when not in use.
4. Keep the hot part of the iron well away from its own mains lead.
5. Inspect the iron and its lead regularly for damage.

Position yourself and your work as shown in Fig. 5.26: hold the iron like a pencil and rest one or both elbows on the table (if it is comfortable to do so) while soldering. In the beginning stages you may find it difficult to keep the soldering iron steady; this will not be a problem after a time as you learn to relax.

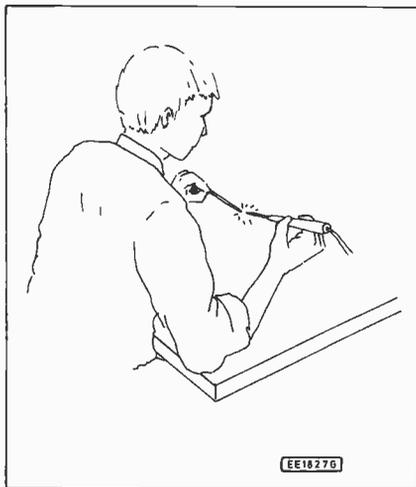


Fig. 5.26. Comfortable position for soldering.

Follow these steps to make soldered joints to stripboard:

1. Clean the hot "bit" of the iron on a damp sponge.
2. Tin the iron (apply a little solder to the hot bit).
3. Touch the iron tip to the joint until the whole area to be soldered (both the component lead and the copper strip of the stripboard) is hot enough to melt solder.
4. Apply rosin cored solder to the joint (not to the iron). The molten solder should readily flow over the joint. Apply just enough solder to cover the joint (see Fig. 5.27).
5. Remove the solder wire keeping the iron in place until the solder forms a neat joint then remove the iron (the whole soldering process should only take a few seconds), then snip off the component lead as close to the solder as possible with side cutters.
6. Examine the joint. The solder should be smooth and bright without rough patches or spikes. Fig. 5.28 shows the

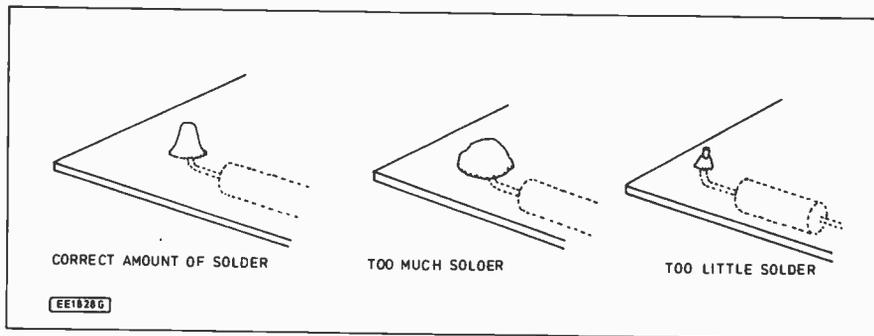


Fig. 5.27. The soldered joint.

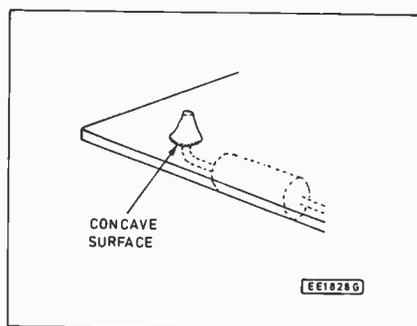


Fig. 5.28. Correct soldering.

concave surface of a perfect soldered joint. If the joint is dull, pitted, or spikey it should be soldered again.

### Short Circuits

After soldering, all the joints should be thoroughly inspected for short circuits. Some common causes of shorts are shown in Fig. 5.29: loose strands of wire (a), excessive solder bringing two or more joints into contact (b), spikes (c), and splashes of solder (d). These shorts can be easily removed: shorting strands of wire can be cut, excessive solder can be removed using a desoldering tool, a "spike" can be reheated with an iron to remove it, and solder splashes can be scraped away with a small screwdriver.

For practice try making some joints on stripboard,

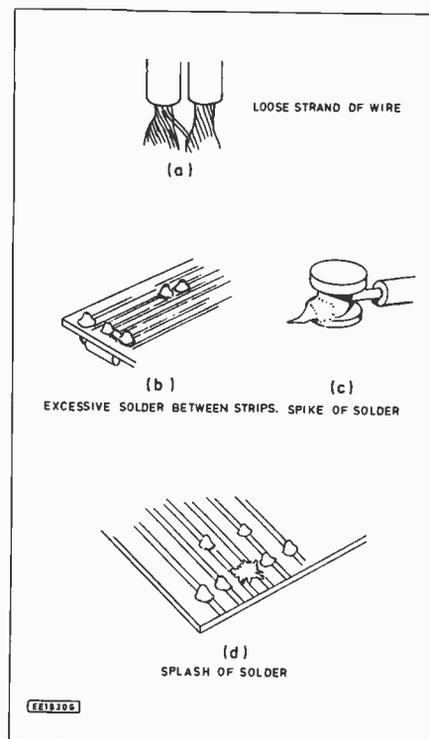
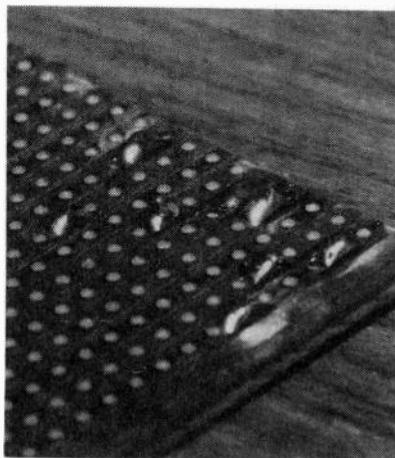


Fig. 5.29. Soldering faults.

**Next month:** We go on to build and test a light sensor on stripboard and include various exercises relating to component layout and logic testing on the Pencilbox (or a similar logic tutor) before getting into Switches and Relays.

### PENCILBOX

The Pencilbox Logic Tutor shown in Fig. 5.22 is available to all teaching establishments, companies or private individuals direct from E & L Instruments, Dept. EE, Whitegate Industrial Estate, Whitegate Road, Wrexham, Clwyd, LL13 8UG. Tel. 0978 291030. The unit costs £79.80 plus £1.50 p&p plus VAT. It is available to overseas customers; please write for a quote.

E & L issue a free catalogue showing their range of products.



City and Guilds

# ASSESSMENT CENTERS

**The following letters have been received from Assessment Centres for City and Guilds courses:**

**DIGITAL ELECTRONICS for readers of EVERYDAY ELECTRONICS**  
City and Guilds 726 Information Technology Scheme Module 301—Introductory Digital Electronics

We are able to offer external candidate registration for the above scheme as well as conduct the required assessment and assignment supervision necessary for completion of the module and attainment of the Certificate.

See below for a list of costs and facilities offered, but please note that these costs are based on a minimum of 5 (FIVE) candidates so, if you're interested, persuade a couple of friends to join the scheme too!

**Candidate Registration: £12.50**  
Covers registration with City and Guilds and with BCTC and all scheme administration costs

**Written Assessment Fee £3.00**  
This is payable for each assessment taken or re-taken. Each candidate must take THREE

**Practical Assignment Fee £12.50**  
This is payable for each assignment taken or re-take. Each candidate must take FOUR.

**Components Set (FOUR assignments) £15.00**

**Components Set (per assignment) £4.00**

This is payable if the candidate requires BCTC to supply components for the practical assignments. You can save by paying for the FOUR assignments at registration, if required.

Written and Practical fees are payable at the time of taking the test. It is not necessary to pay in advance.

ALL PRICES ARE EXCLUSIVE OF V.A.T., therefore ADD 15% to everything!

To register and sit all the above assessments and assignments (but no re-takes!) and use BCTC components would cost £99.50 (including VAT).  
Bournemouth Computer and Technology Centre  
63 Cavendish Road,  
Bournemouth, Dorset, BH1 1RA  
Tel. (0202) 290943

Mainport Training is engaged in both Y.T.S. and R.T. programmes; offering in-House Training for Clerical, Motor Vehicle and Engineering candidates. We are an MSC approved Training Centre and have approval from RSA and City and Guilds to run a full range of Information Technology subjects and to act as an external Examination Centre.

Mainport Training Ltd  
Ferry Lane,  
Pembroke, Dyfed SA71 4RE  
Tel. (0646) 681431/681381  
Telex: 48494

We refer to the Introductory Notes and Assessment Centres supplement included with the October 1988 edition of *Everyday Electronics*.

Upon examination it was noted that the entry against our organisation is incorrect; please note that for the past two years our telephone has been changed to 07842 42885.

We shall be obliged if you will please arrange to update the information and publish the current telephone number in a future issue of the magazine.

Acorn  
ITeC  
Short Lane,  
Stanwell,  
Staines. TW19 7BJ.  
Tel. 07842 42885

I would like to confirm that this College should be included on your list of approved centres for the City and Guilds 726 Information Technology scheme.

Dewsbury College  
Halifax Road,  
Dewsbury,  
West Yorkshire WF13 2AS  
Tel. 0924 465916

Please note that this College is **not** a centre for external examination candidates. Only registered students of the College can be accepted for entry.

Reading College of Technology  
Crescent Road,  
Reading RG1 5SR  
Tel. (0734) 583501

*The only negative letter we have received?—Ed.*

Since this ITeC has been omitted from the list of approved centres given in the booklet, it is doubtful if we will have many approaches from your readers on this subject.

GEC Glenrothes Information Technology Centre  
Flemington Road,  
Queensway Industrial Estate,  
Glenrothes, Fife KY7 5QF  
Tel. Glenrothes (0592)751512

*The updated list was delayed by the postage strike—we apologise for any omissions—all assessment centres on the latest list were sent a letter about the series (after the strike)—Ed.*

We would like to be included in your list, under Staffordshire, as a Centre which is approved for City and Guilds 726.

Cannock Chase Technical College  
The Green,  
Cannock, Staffordshire WS11 1UE  
Tel. Cannock (0543) 462200

With reference to your publication on approved centres for City and Guilds 726 courses, I find that our college is not listed. As we are an approved centre could you please include our name in your list. If any of your readers, or yourself, wish to contact me they can do so at the address below.

Mr. J. J. Stanton,  
W. R. Tuson College,  
Trinity Annex,  
Great Shaw Street,  
Preston. PR1 2HH  
Tel. (0772) 53558 Extn 202

Further to your letter concerning City and Guilds 726/301 Introductory Digital Electronics, Ipswich ITeC Ltd. would be pleased to accept registration for candidates and would be grateful if you would include our details in your next issue as they were omitted from the booklet. If possible could you include the contact names Sue Butcher/Ted Shawki and "prices on application".

Ipswich ITeC Limited  
Argyle Street,  
Ipswich. IP4 2NA  
Tel. (0473) 21645

With reference to your letter dated 26th September, I am pleased to confirm that we are prepared to register candidates for the C & G 726/301 Assessments.

We also see opportunities to attract a different group of clients into the Department by offering tutorials providing we can attract sufficient numbers. Perhaps you would be able to publicise this if we gave you dates starting in January. We envisage perhaps one mainly practical tutorial per month, running as a drop-in facility between 6.00 pm and 9.00 p.m. Naturally, we would have a lecturer knowledgeable in Digital Electronics and a Technician on hand in

a well equipped Laboratory/Workshop. We would have to charge a fee, but this would not be excessive.

We wish you well with this initiative and hope that it will make worthwhile the treatment of other C and G 726 modules in the same way.

De Havilland College  
The Campus,  
Welwyn Garden City,  
Hertfordshire. AL8 6AH  
Tel. (0707) 326318

We note with pleasure the course that is to be offered in your magazine *Everyday Electronics*. East Birmingham College is willing to offer a complete package to support any readers of your magazine who wish to follow the series:-

This package would consist of:-

- \* Registration fee
- \* Access to electronic workshops, tools and equipment
- \* Written and practical assignments
- \* Support time in our electronics learning development centre.

The cost of the package would be between £30 to £60 depending upon the amount of support time required.

East Birmingham College  
Garrets Green Lane,  
Birmingham. B33 0TS  
Tel. (021) 743 4471

I am pleased to be able to tell you that we can offer the following facilities for the 726/301 certificate.

I would estimate the services and costs to be:

- 1) Registration of candidate, course booklets and logbook provided, £10.00.
- 2) Testing of candidate for three written and four practical tests assuming 1 hour/written, 2 hour/practical duration, at a cost of £12.50.
- 3) Retakes for either written or practical tests £2.00 per test.
- 4) "Drop in" facility to cover elements of the course with ITeC equipment and on ITeC premises with skilled tutor assistance, at £1.50 per hour.

Doncaster ITeC provides quality training at all levels for both computing and electronic vocational qualifications. We also provide consultancy and business services in computing to the local community.

Doncaster ITeC  
St. Wilfrid's Road,  
Cantley,  
Doncaster. DN4 6AH  
Tel. (0302) 537341/2

We are not listed in your booklet and I would ask you to amend this situation as soon as possible. A similar situation occurred with "Introducing Microprocessors Course" published by your magazine last year.

As a college we are most eager to par-

ticipate in the scheme and fully support your innovative stand, but if people do not know where we are, they cannot come to us.

Watford College  
Hempstead Road,  
Watford,  
Hertfordshire WD1 3EZ  
Tel. Watford 57500

*We are pleased to concur—Ed.*

This is to confirm that Reading ITeC are pleased to be able to offer a comprehensive service to all applicants to the C and G 726/301 course in Digital Electronics and we welcome your initiative in encouraging beginners to the subject.

We have already had a number of enquiries and are soon to commence a specially timed course.

At least one company have indicated their interest to support employees in this scheme financially and we hope to extend this involvement to include more advanced units at a later time. Would you be considering doing the same?

The details in the October issue regarding Reading ITeC are correct.

Reading Information Technology Centre  
Liverpool-Victoria House,  
3rd Floor, 7 Cheapside,  
Reading. RG1 7AQ  
Tel. (0734) 598515  
Fax: (0734) 508315

*We are considering going on to more advanced levels in future publications. Of course our Introductory Microprocessors book is now available—see the Direct Book Service pages for full details.—Ed.*

Please note the 'phone number for Gateshead ITeC is incorrect in your booklet. It should be: 091 4785096.

May I inform you of the actual address of the centre, in your magazine you quoted the telephone number of the Civic Centre.

Alex Fenyvesi  
Middlesex Training Centre,  
Futures House,  
Clayton Road,  
Hayes, Middlesex.  
Tel. (01) 756 1516

The booklet enclosed with your circular letter (and issued with EE) does not list this College as approved centre. I therefore confirm the telephone request, and would be grateful if you could add this college to your list of centres and also publish the fact as soon as it is convenient.

W. Crompton  
Lecturer  
Bridgend College of Technology,  
Cowbridge Road,  
Bridgend,  
Mid Glamorgan, CF31 3DF  
Tel. Bridgend 766588

The Gloucestershire ITeC is the only centre in the county offering the facilities for 726/301 Introductory Digital Electronics or 726/303 Introductory Microprocessors.

Open Learning Students to contact Mr. D. Griffin or Mr. E. Johnson on Gloucester 0452 613141. (Our telephone number is 0452 613141. Not as stated by City and Guilds).

Gloucestershire Information Technology Centre  
Larkhay Road,  
Hucklecoat,  
Gloucester  
GL3 3NT.  
Tel. (0452) 613141

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Peterborough Information Technology Centre,  
Vicarage Farm Road,  
Peterborough,  
PE1 5TP  
Tel. (0733) 312120

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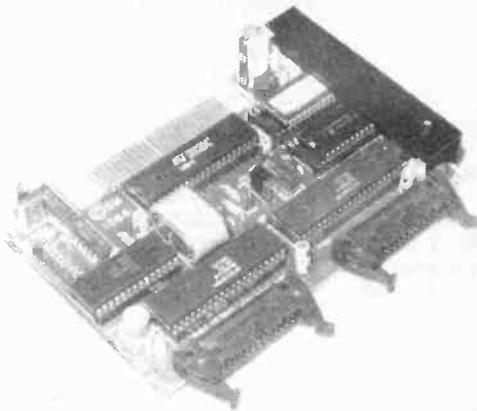
This is by no means a complete list of centres that will assess readers. It is simply those centres that have written to us.

Response to the course has been exceptional and we believe that most readers have been able to find a relatively local assessment centre that will take them.

We would like to thank the many readers, instructors and centres who have offered their assistance and encouragement with this series. By the way our previous series for City and Guilds (726/303) *Introducing Microprocessors* is now available in book form price £2.45. See *Direct Book Service* pages for ordering this and "Electronics"—the book recommended for background reading for *Introducing Digital Electronics*.

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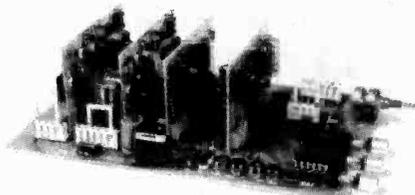


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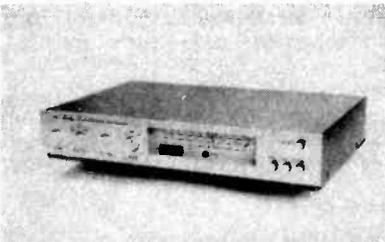
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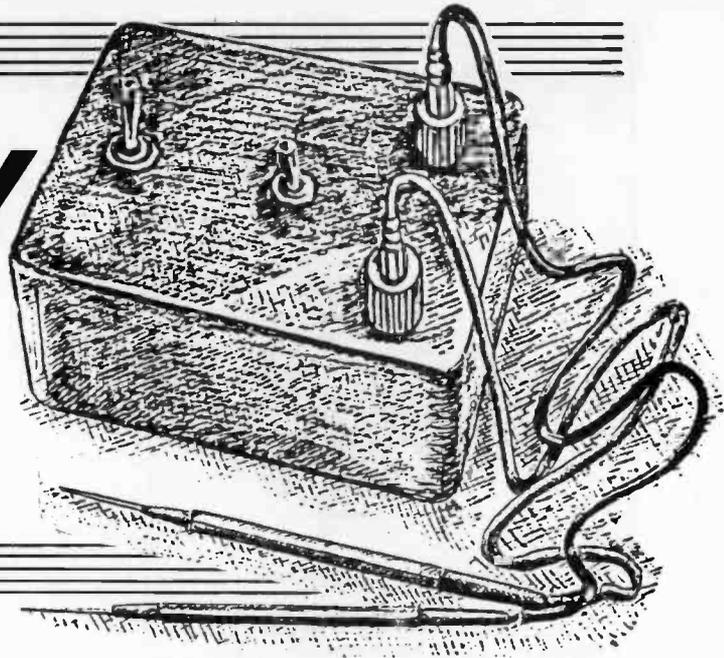
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# CONTINUITY TESTER

JOHN RUGG



*A simple but invaluable testing device that is a vast improvement on simple buzzer type continuity testers.*

**M**OST of us have at one time or another had cause to use a continuity tester. Perhaps the most common domestic example is that of testing whether or not a fuse has blown in the plug of some household appliance. In this sort of situation, where the resistance of the component under test can be one of two widely separated values (i.e. zero ohms for a good fuse, infinity ohms for a dud one), all circuit testers will perform satisfactorily.

For the home electronics enthusiast, things are never so simple. In any circuit, normal resistances are scattered over a very large range, so tracking down a fault is more tricky. For example, a continuity tester which operates a l.e.d. for resistances of less than 100 ohms, will be useless if you are trying to confirm that a 47 ohm resistor is correctly connected.

Can continuity testers be this bad, I hear you ask? The answer is most definitely YES! Continuity buzzers fitted to Digital Multimeters (DMM's) typically show continuity for resistances up to a couple of hundred ohms, and one tester I used showed continuity for resistances of several kilohms!

This really begs the question of what we expect a continuity tester to do. What might the characteristics of the ideal device be?

(a)—The most important is that the device should be able to detect a short circuit. By my definition this means resistances of less than about one ohm (not 200 ohms!). With this sort of performance we will for example be able to find bad connections that have resistances greater than one ohm, and check that very low value resistors are correctly connected in any circuit.

(b)—As well as short circuits, the device must be able to detect open

circuits (say greater than about one megohm). This is ideal for checking isolation between tracks on a board (e.g. Verostrip cut with a spot face cutter).

(c)—Diodes and transistors should not cause the device to give false readings (a diode is not a short circuit!),

(d)—The device should consume no power and occupy no space. This means you don't have to buy batteries very often and it fits in your pocket.

## BASIC PRINCIPLE

The fact that we have to decide whether the resistance between the test probes is greater than or less than a certain value (i.e. one ohm or one megohm), means that we are performing a comparison. This immediately suggests that we might be able to use a comparator. A standard bridge network is ideal for this sort of application and the circuit diagram Fig. 1 shows the basic scheme.

When resistors  $R1/R2=Rx/R3$ , the input voltages to the comparator are equal. If we make  $R1=R2=R3=$ one ohm, then if  $Rx$  is less than one ohm the comparator's positive input is highest, and the output is high. Conversely, if  $Rx$  is greater than one ohm, then the output will be low. If we now change  $R3$  to one megohm by using a switch, then we have a device that will detect open circuits too.

The "sense voltage" is the voltage that appears between the test probes for an open circuit. If the sense voltage was 2V, diodes would appear as a short circuit, since with a forward voltage drop of 0.7V, the positive input of the comparator would be highest.

This is clearly no good (unless we wish to use the device to check diode polarity). Another reason for reducing the sense voltage is that we do not want to damage the circuit under test by applying large voltage biases between two parts of an unpowered circuit. Therefore, a sense voltage of 0.2V has been chosen for this design.

Moving on to consider power consumption, since we are using a linear i.c. (the comparator) we will probably need a supply voltage of at least 6V. A PP3 9V battery is appropriate since they are small and easily available.

With the circuit so far described, a short circuit between the probes will cause a current of  $I=V/R=0.2V/1\text{ ohm}=200\text{mA}$  to flow. This is far too large if we want the battery to last very long.

The other thing we must consider is how to generate the sense voltage in the first place. Fig. 2 shows how these problems can be overcome.

In order to reduce the current, resistor  $R5$  has been added. Both  $R3$  and  $R5$  are 220 ohms. We have now complicated the issue by trying to resolve the difference between 220 ohms and 221 ohms. In this situation the input offset voltage of the comparator has a direct impact on the resistance resolution. Varying  $Rx$  from 0 to 1 ohm will change the voltage on the comparator positive input by

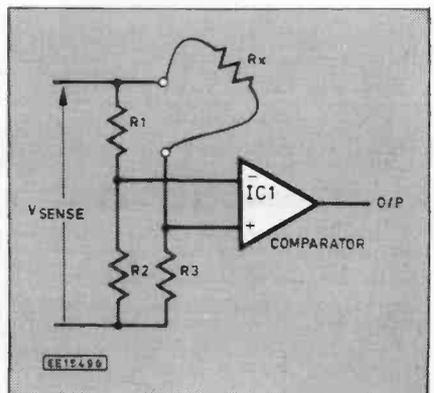


Fig. 1. Basic comparator principle.

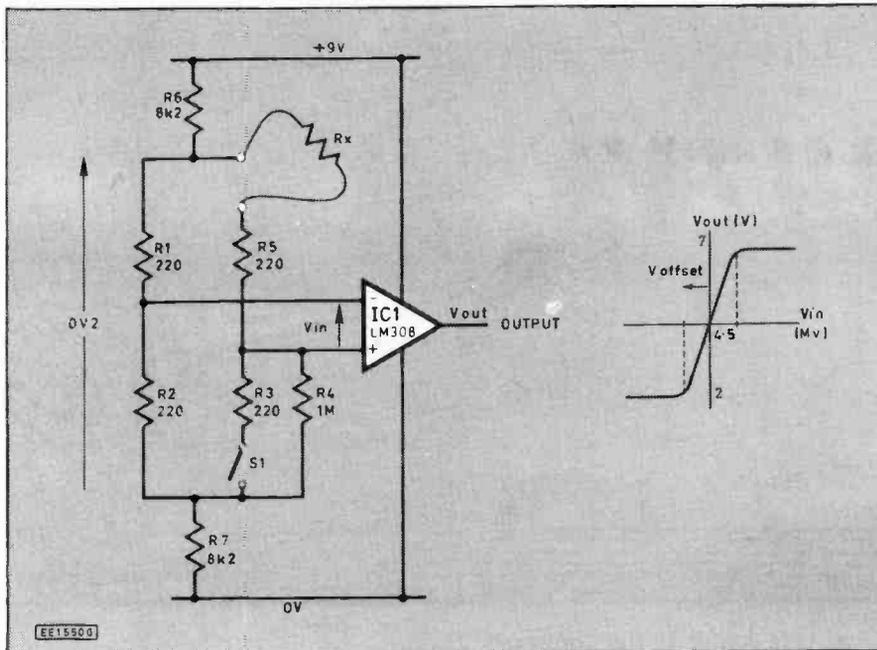


Fig. 2. Improved sense network.

one ohm  $\times 0.2V / (R3 + R5) = 0.5mV$ . This has to be sufficient difference for the comparator to change state.

Comparators are normally optimised for fast switching applications. Since we do not need fast switching performance in this application, we can use an op-amp instead. An ideal power economic op-amp i.c. is the LM308. It has a current consumption of just 0.3mA and an input offset voltage of 2mV. The offset looks too large for our needs but in fact this does not turn out to be a difficulty.

### OUTPUT

An important consideration is the type of output we require from the tester. LED outputs are simple to implement, but take a lot of current (10mA–15mA). Also, and perhaps more importantly, it is often difficult to look at the test probes (to keep them in the right place) and an l.e.d. indicator some distance away, at the same time. An audio output, however, is just what the doctor ordered to reduce this sort of eye strain.

Using a conventional eight ohm speaker will be wasteful of power, and a preferable method is to use a piezo-electric transducer. A suitable audio interface circuit diagram is shown in Fig 3.

Since the output of the op-amp will be neither high (9V) or low (0V) for marginal values of resistance but somewhere in

between, a Schmitt trigger buffer is needed to turn it into a clean on/off signal. See Fig. 4.

By effectively introducing this threshold on the op-amp output, the resolution of the device is increased over what one might expect given the input offset of the op-amp. The CMOS CD40106 (IC2) is a good choice here since it consumes virtually no power and will run happily from a 9V rail.

There are six Schmitt inverters on the chip and we can use one of the others to make a square wave oscillator. The values of  $R$  and  $C$  are chosen to give an audio output of about 1kHz but the exact frequency can vary depending on the thresholds provided by the Schmitt inverter. By varying  $R$  or  $C$  slightly you will be able to produce a tone you are happy with.

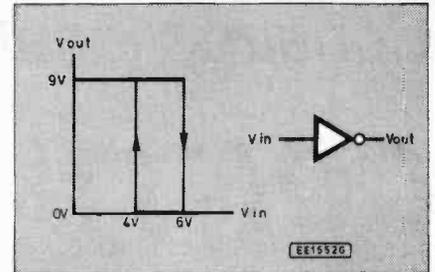


Fig. 4. Schmitt trigger characteristics.

The piezo-electric transducer WD1 is driven directly by the oscillator output. The oscillator output is disabled when the first inverter output is high.

This leaves four other inverters that are spare. If you wish these can be used to drive an l.e.d. indicator (all connected in a parallel configuration), or to produce two tones (one for one megohm, one for one ohm).

### IDIOT PROOFING

The design given so far will perform well in tests on unpowered circuitry. However, it is inevitable that eventually it will be used on powered circuitry by mistake. We have to make sure that the tester is not destroyed. One might expect the worst case to be connection across a plus and minus 15V supply, i.e. 30V between the test probes!

From Fig. 2 there are several ways in which damage could occur:

- (a)–Resistors R1, R2, R3, R5 get hot. 30V across  $4 \times 220$  ohms gives  $\frac{1}{4}W$  of power dissipation in each resistor.
- (b)–Current will try to get pumped into the battery.
- (c)–Op-amp input pins may be biased at voltages outside the voltage appearing at the supply pins.
- (d)–If the supply rail exceeds 20V, the CMOS chip will fail.

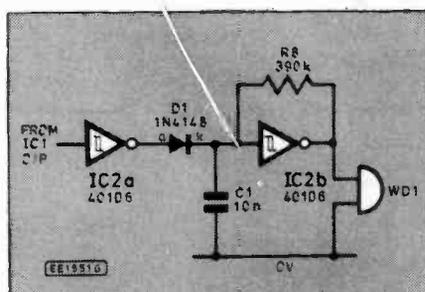


Fig. 3. Audio output stage.





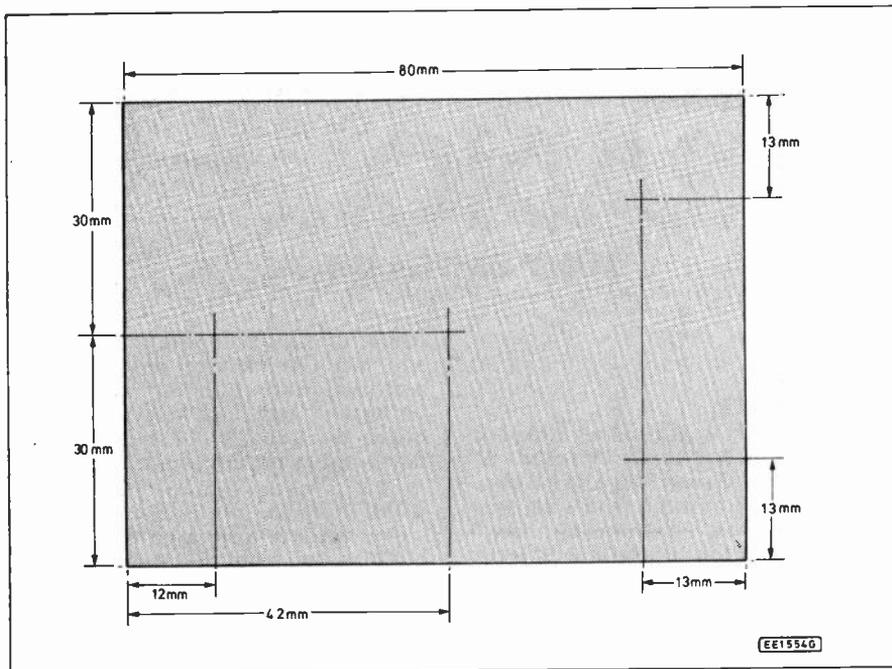
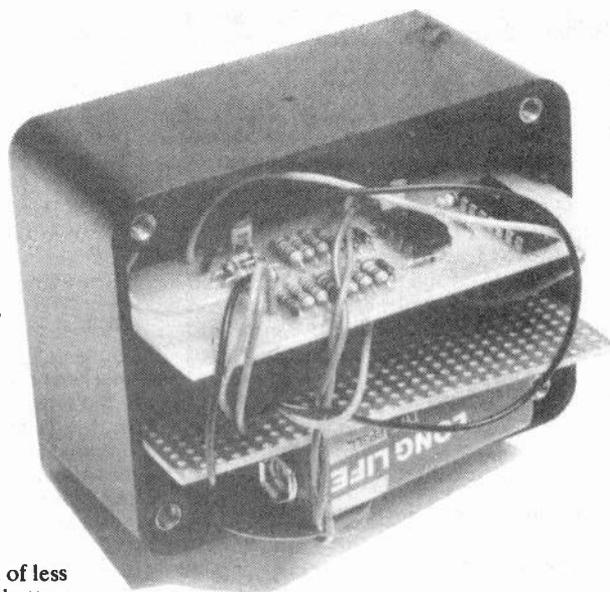
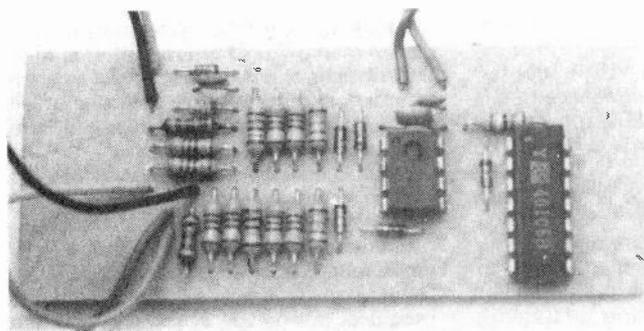


Fig. 7. Case drilling details.

Apart from testing for open and short circuits, the design also allows us to make measurements of capacitance. With the device set to detect resistances of less than one megohm a discharged capacitor connected between the test probes will cause it to buzz. This will continue until the capacitor has charged above 50 per cent of the sense voltage, when the buzzing will stop.

This behaviour can be well described mathematically, and it turns out that for the circuit values we have used the duration of the buzz (seconds) =  $0.7 \times C$ , where  $C$  is in microfarads. With the aid of a watch then, capacitors in excess of  $1 \mu F$  can be measured. However, larger electrolytic capacitors can be leaky and if the leakage current exceeds  $100 \mu A$  then the Continuity Tester will not stop buzzing.

The tester is ideal for testing domestic fuses, but be careful when it comes to testing very low current fuses (typically 20mm types), since these often have a normal impedance of more than 1 ohm. If you think this is likely to be a problem it may be worth increasing the resistance threshold to a larger value (say 10 ohms). □



size and place it across the box in the slots provided. This leaves a space just large enough for the PP3 battery.

The piezo-transducer can be jammed between the battery and the side of the box (make a few small holes in the case here to let the sound out!). The transducer is supplied without leads and extreme care must be taken when making connections to it; use the minimum of heat and solder.

### IN USE

The current consumption of the entire circuit comprises about 0.5mA through the main resistor network, and 0.3mA for the LM308. With a total current of less than 1mA it is clear that the battery will last for a very long time.

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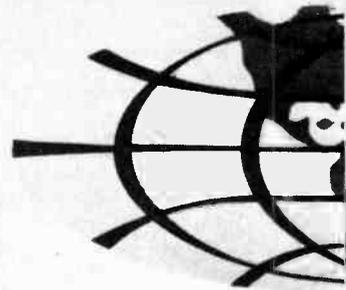
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# ...REPORTING AMATEUR RADIO... TONY SMITH G4FAI



## STUDENT LICENCE?

The Radio Society of Great Britain has published a consultation document containing its proposals for a Student licence as part of Project YEAR, "Youth into Electronics via Amateur Radio". The Society proposes to provide basic training in electronics by means of a simple study course leading to the acquisition of a "Student Licence". This, it is hoped, will permit holders to operate low power amateur radio equipment using Morse code and, in some cases, speech, computer-based or other modes, on designated frequencies. This, says the Society, will provide world-wide communication and a freedom to develop skills "in a manner that is prohibited to holders of the Citizens Band Licence."

It is envisaged that the course will involve no more than 30 hours of classroom and home study, plus the time necessary to learn to use Morse code at 5 words per minute. The examination would be of the multiple-choice type, relying heavily on visual presentation such as block and pictorial diagrams.

A draft syllabus has been published and this covers eight areas of study on practical subjects — Components and units of measurement; Concepts of communication practice; Measurements; Interference, and how to avoid it; Electrical safety; Propagation theory; Antennas/feed lines/test equipment; Operating an amateur station.

## IN SCHOOL CURRICULUM?

It is visualised that apart from providing the necessary qualification to obtain a "Student" amateur radio licence, the passing of this examination would be of significance to the education activities of youth movements and to young people seeking employment in the electronics field. Encouraged by news that the State of New York is about to introduce amateur radio as a subject in its schools, the RSGB even dreams of the eventual inclusion of basic amateur radio in the UK school curriculum!

Of course, everything is still at the discussion stage and no proposals have yet been put to the licensing authority, the DTI. There is much discussion to take place amongst the membership of the RSGB before final proposals can be put forward and already there is disagreement in the ranks.

The main objection is that a student licence would admit unskilled operators to already overcrowded bands but the RSGB argues that successful completion of the proposed syllabus, with its emphasis on practical procedures, would ensure a satisfactory standard of operating among those qualifying for the new licence. They would not, in any case, be allowed to operate in the popular sections of the bands but would be

allocated small sections of the less-used bands.

## LOW-COST KITS

The objective is to provide an inexpensive entry into the hobby by means of low cost easy-to-assemble kits for simple receivers, transmitters, aerials and appropriate test instruments, constructed under the supervision of local instructors. Much work will need to be done to bring the various proposals to fruition, to set up the necessary training and examination procedures both nationally and locally, and to get the student licence formally recognised.

The RSGB hopes for support from government bodies, the electronics and communications industries, and broadcasting organisations. They are proposing to call an "Industry YEAR" conference to discuss their proposals and it is presumably a mark of DTI approval to the basic idea that this will be held at the DTI conference centre.

The Society seeks involvement from educationalists, youth movements, publishers, and organisations for the retired and the disabled. It also looks to its own members who will play an important role in assisting or training those wishing to enter amateur radio by this new route.

So when will it all happen? the RSGB is optimistic that if all goes well DTI approval will be given in time for student licensing to begin "sometime during 1989". I will report on progress in due course.

## CONSTRUCTION RESTRICTIONS

One of the attractive features of holding an amateur licence is that a radio amateur is legally permitted to construct transmitting equipment for use on the bands covered by his licence. It seems paradoxical, therefore, at a time when there are active proposals to permit "student" entrants to amateur radio to build such transmitters, that the new amateur licence effective from 1st January 1989 (see this column, November 1988) should contain a footnote which apparently forbids home construction of transmitters for the amateur 10 metre band.

Members are taking the RSGB to task for negotiating a new licence on their behalf which contains such a restriction and many are unhappy about the explanation they have received. The ban arises from the Wireless Telegraphy (Citizens Band and Amateur Apparatus) (Various Provisions) Order 1988, which restricts the importation, manufacture or assembly of apparatus covering 26.1 to 28MHz to type-approved equipment.

The RSGB says that it objects strongly to the inclusion of the amateur band in this Order, the purpose of which was to prevent the import or manufacture of

illegal CB equipment. However, they say, the DTI insisted on linking the amateur with the CB frequencies because of the possibility of amateur 10 metre (ie, 28.00-29.7MHz) equipment being converted for illegal CB use.

## COMPROMISE

The Society also says that a compromise has been negotiated with the DTI whereby *bona-fide* amateurs may make individual applications to the Radio Investigation Service for a "readily available" authority to be exempt from the provisions of the Order.

It is this "compromise" which has caused the upset. Licensed amateurs, who are permitted by the terms of their licence to construct or modify equipment to use on all other amateur bands, cannot see the point of having to apply for an exemption which will automatically be given because they are already licensed.

If possession of an amateur licence automatically ensures exemption, they ask, why cannot the Order simply say so instead of creating the possibility of thousands of unnecessary applications having to be processed? Some cynics suggest that all this is just an excuse to increase the price of the amateur licence since the cost of the licence reflects the amount of work necessary to administer it!

## SINISTER PLOT?

A more alarming suggestion is that it is the thin end of the wedge, the beginning of a sinister plot to erode traditional hard-earned amateur privileges, a hardening of official attitude to amateur radio leading, even, to a loss of allocated frequencies as part of the coming process of privatising the radio spectrum. When I heard this suggestion I felt that I should put the matter to the test. I duly wrote to the DTI as advised by the RSGB, seeking authority, as a licensed radio amateur, to construct a single-band transmitter for use on the amateur 28.0 to 29.7MHz band. I gave no further information.

In theory, I should receive an automatic, no-questions-asked, authority by return. If everything was above board, the fact that I possess an amateur licence would provide all the information required. I can already construct any transmitter I like on the other bands, provided the finished product is in accordance with the terms and conditions of my licence.

I sent my application at the beginning of November and I received a prompt acknowledgement stating that the Department would be contacting me again as soon as possible. At the time of writing, mid-November, I have heard nothing further. Why is this, I wonder? Have I called their bluff?

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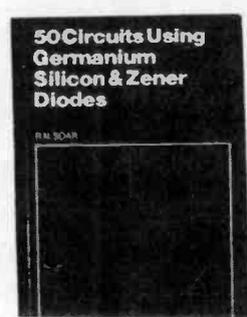
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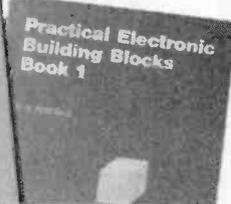
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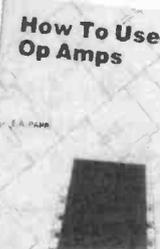


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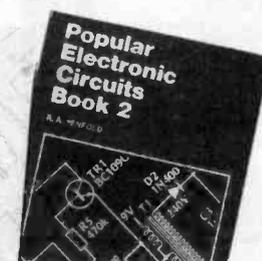


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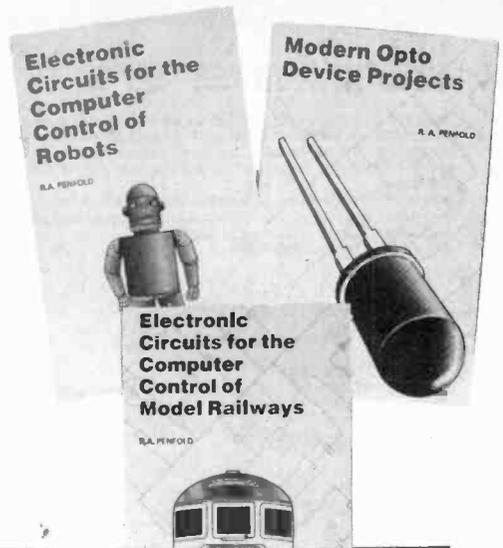
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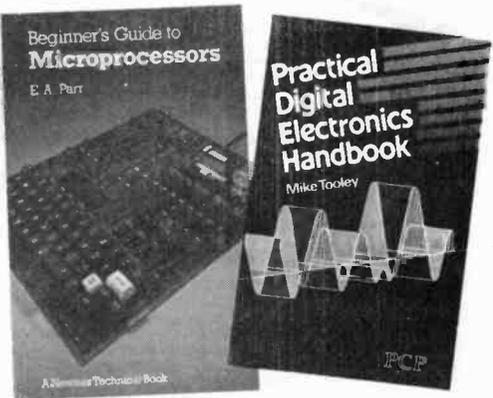
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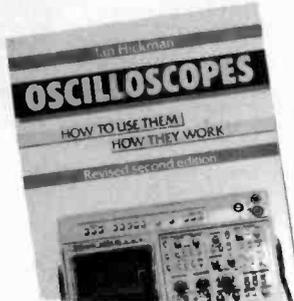
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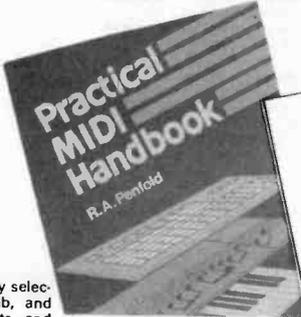
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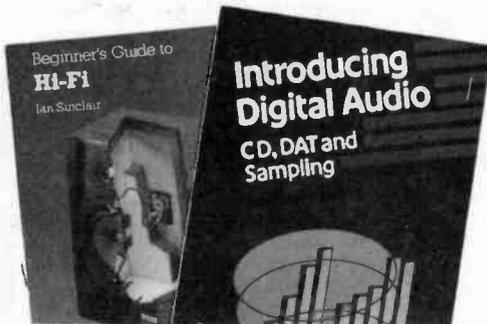
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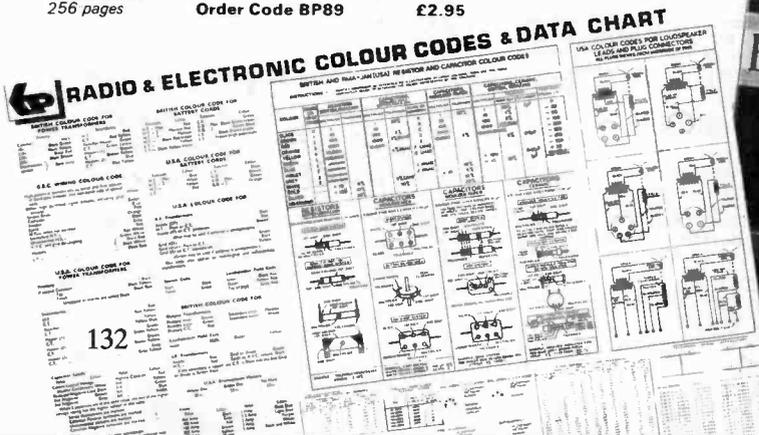
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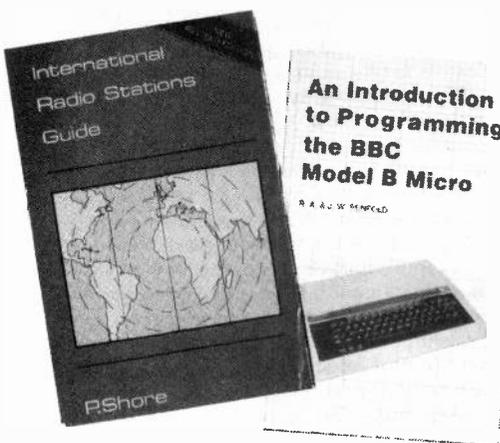
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# ACTUALLY DOING IT!

by Robert Penfold

**T**HIS month's *Actually Doing It* article is about taking care of your delicate parts (electronic ones of course). In the days when valves reigned supreme most components were pretty tough, both electrically and mechanically. Even the glass encased valves were physically a lot tougher than you might think. The miniaturisation of modern components, plus the trend towards ever more complex integrated circuits, has tended to make components rather vulnerable both physically and electrically.

About the only way in which modern components are tougher than those of twenty or so years ago is that they are much more tolerant to having the supply connected around the wrong way. Usually a reversal of the supply will result in a few heated components, but provided the supply is disconnected and corrected reasonably quickly, it is quite likely that everything will work properly. This contrasts with the early semiconductors (which were germanium rather than silicon devices). Getting the supply wrong with one of these often resulted in the destruction of every semiconductor in the circuit.

There is a characteristic smell to hot electronic components. A useful tip is to be on the alert for this when first switching on a newly constructed project. Unless the circuit has some power devices that are meant to run hot, at the first sign of this smell switch off at once and recheck the wiring, etc. A common cause of problems is an integrated circuit plugged in round the wrong way. A quick dab of a finger tip on the integrated circuits will usually reveal the over-heating component or components.

## HOLDERS

I am occasionally asked why I, and others, recommend the use of holders for all d.i.l. integrated circuits, even those that are not particularly expensive or vulnerable to static. There are two main advantages to the use of holders. One is simply that if a mistake is made, and the device is fitted round the wrong way, it is easily removed and refitted around the right way. Desoldering integrated circuits from a printed circuit board can be very awkward even if you do have the right tools. It is virtually impossible if you do not have any proper desoldering equipment. The second advantage is that when fault finding it can often be very useful to be able to unplug some of the semiconductors.

When you do have occasion to remove an integrated circuit from a holder, I would strongly advise against trying to pull it out using your fingers. This usually results in

one end of the component coming free and the other end remaining in the socket. Apart from severely buckling some of the pins, you can also end up with the pins at the free end of the device embedded in a finger! It is much better to slide the blade of a small screwdriver under the integrated circuit and to then prise it free (Fig. 1), or use an i.c. removal tool.

With small projects it can be difficult to find sufficient space to accommodate even the smallest of screwdrivers. The tweezer type extractor tools that were once readily available seem to be more difficult to find these days. However, it is not too difficult to improvise a small 'L' shaped lever which can be fabricated from a piece of thin metal. With one of these it should be possible to lever integrated circuits out of their holders even if they are in very awkward positions.

Even with careful handling, sooner or later you are still likely to be faced with an integrated circuit having some severely bent pins. In most cases they can be bent straight without too much difficulty. I find an easy way of doing this is to place the blade of a screwdriver along-side the bent pin, and to then press the pin firmly back in place up against the blade. If you simply try pushing the pin back into place without anything to support it, as the bottom end is straightened the top part will probably twist out of shape.

If a pin is very badly deformed it may well snap when straightened out. Usually this will leave the top part of the pin intact, and a piece of 24 s.w.g. tinned copper wire can then be carefully soldered to it. After this has been trimmed to length and aligned with the other pins the device should plug into a holder without any difficulty.

## HEAT STROKE

Most modern electronic components are not easily damaged by heat when soldering them into place. I suspect that modern automated production methods have resulted in components having to be made reasonably heat-proof, and this has made life that much easier for the home constructor. There are still some components which are vulnerable to heat damage, and these are mainly the germanium semiconductors. These have largely been replaced by silicon devices which are much more hardy, but if you build an old project it might include one of these components. Germanium transistors mostly have AC\*\*, AD\*\*, and OC\*\* type numbers.

What you are more likely to encounter are germanium diodes. These have lower forward voltage drops than silicon types, and because of this germanium diodes are

still preferable to silicon types in some applications. Germanium diodes usually have AA\*\* or OA\*\* type numbers (OA90 and OA91 diodes are still quite common in designs for the home constructor).

The standard solution to the overheating problem is to use a simple tool called a heatshunt. This should not be confused with a heatsink, which is a piece of metal which acts as a cooling fin for semiconductor devices that have to dissipate power of about one watt or more. A heatshunt is a small tool which clips onto the leadout wire of a component between its body and the end of the leadout wire. The idea is for the heatshunt to conduct away much of the heat from a soldered joint so that it never reaches the semiconductor chip.

Heatshunts can be very effective, but in practice can be a little fiddly to use. If you can complete soldered joints quite quickly a heatshunt is probably not worthwhile, since there will be little risk of damage anyway. In the past I have occasionally seen the suggestion that a crocodile clip can be used as quite a good heatshunt. Modern crocodile clips are mainly of very light construction, and even with a heat-fin added they do not always work very well in this role. There is a real risk that this method will lull you into a false sense of security and result in more damaged components rather than less. If you can obtain one of the older types of crocodile clip, particularly those of copper construction, they will almost certainly work very well as heatshunts.

## SEEING THE LIGHT

The other main category of heat sensitive components are l.e.d.s. Some of the early l.e.d.s seem to be even more heat-sensitive than germanium semiconductors. The problem seems at least in part to be due to the use of thick leadout wires on many l.e.d.s, which provide an excellent thermal contact between the soldering iron and the chip.

Modern l.e.d.s seem to be much improved, but reasonable care still needs to be taken when using l.e.d.s with their leadout wires cut short. Where possible it is best to leave the leadout wires fairly long so that there is a relatively poor thermal contact between the bit of the iron and the semiconductor chip.

With seven segment and bargraph l.e.d.s the pins are quite short and it is not feasible to use a heatshunt. If they are soldered into circuit with each joint being completed fairly swiftly it is unlikely that any problems will occur. Wherever possible I always use sockets for these components though. The small (0.3 inch) seven segment displays and most of the bargraph types will fit into standard d.i.l. integrated circuit holders without too much difficulty.

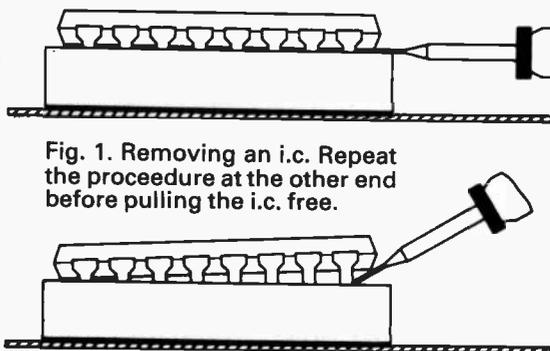


Fig. 1. Removing an i.c. Repeat the procedure at the other end before pulling the i.c. free.

The larger seven segment displays such as the 0.5 and 0.56 inch types have the rows of pins too far apart to permit them to fit into the smaller d.i.l. holders, but their 0.6 inch row spacing is correct for d.i.l. holders having 24 pins or more. A little trimming down to size using a junior hacksaw is likely to be needed in order to produce holders having the right number of ways, but it is not too difficult to improvise something. An alternative is to cut sockets having 0.3 inch row spacing into two s.i.l. strips of pins. These can then be placed 0.6 inches apart, or given virtually any other spacing that is required. Soldercon pins can be used in much the same way and offer another alternative.

It is as well to bear in mind that virtually any component can be damaged by excessive heat from a soldering iron. Apart from damage to the materials from which the component is constructed, there is a risk of desoldering joints within a component. Crystals need to be soldered into place reasonably quickly, as do many types of non-electrolytic printed circuit mounting capacitors. In fact many printed circuit mounting capacitors are something less than tough, and need to be treated with reasonable care.

### STATIC PROBLEMS

The dire warnings about static electricity and its consequences that are to be found in some catalogues, manufacturers data, etc., can be a little off-putting to say the least. You may occasionally obtain an exotic integrated circuit in a lot of anti-static packing which is covered in warnings not to remove the device from the packing except in an anti-static chamber, or with the protection of some other elaborate piece of equipment. This type of thing can tend to give the newcomer to electronics the

impression that static sensitive devices are simply too delicate to be used in a normal environment.

In truth it is probable that careless handling of static sensitive components brings a greater risk of physical damage than damage due to static electricity. A lot of constructors treat static sensitive devices no differently to other components and have no reason to regret it. On the other hand, there is no point in taking unnecessary risks, especially with the more expensive components that are vulnerable to this problem.

For the beginner it can be difficult to know which components are prone to this problem. It is mainly MOS semiconductors, which include MOSFETs, CMOS logic integrated circuits, and a lot of other integrated circuits including some operational amplifiers and a substantial proportion of the larger and expensive types. Some liquid crystal displays also seem vulnerable to static charges. Most modern MOS devices have built-in static protection circuits that render them much less easily damaged than many of the early devices. Some even have protection circuits that make them no more vulnerable to static damage than non-MOS components.

### HANDLING PRECAUTIONS

Normally the article or book in which a project is described will give details of any components that need handling precautions. The fact that a component is supplied in some form of anti-static packaging does not necessarily mean that any handling precautions are needed. A lot of suppliers seem to have standardised on this type of packing which is used for all integrated circuits. However, if there is any doubt as to whether or not a component requires any special handling precautions, common sense would dictate that the appropriate

precautions should be taken just in case they are required.

So what are the standard anti-static handling precautions? Rule number one is to use sockets wherever possible. Rule number two is to leave any static sensitive components in their anti-static packaging until they are the only items needed to complete the project. They should then be plugged into place using a minimum of handling. Avoid having any obvious sources of static charges in the vicinity when fitting these components in place.

The main sources of static electricity in homes are plastics, which can include such things as clothing, storage boxes, and carpets. Choose a work area that is free from anything that is known to generate the familiar "clicks" and sparks of static discharges.

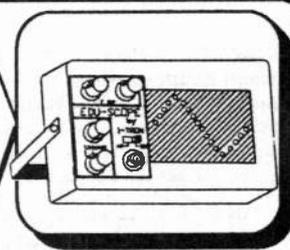
There are numerous items of anti-static equipment on sale. These range from cleaning sprays through to such things as anti-static mats and furniture. The expense of much of this equipment is not really justified for home use, and most of these items are aimed at professional users. If you follow the simple rules outlined above you should not encounter any difficulties with semiconductors getting "zapped" by static charges.

Note that some dual gate MOSFETs are supplied with a metal clip that short circuits their leadouts together. These devices do not need any special handling precautions, but obviously the clip must be removed *after* soldering the device into circuit and before switching on the completed project. If, for some reason, you have to solder a non-protected MOS device into circuit, you should use a low leakage iron having an earthed bit. Any iron which includes an earth lead in its mains cable almost certainly has an earthed bit, but check that the earth lead is connected.

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## LITTLE NODDY



**MICHAEL PERROW**

*There is no chance of nodding off when Noddy's about.*

*A fun project that can have serious applications.*

**C**HOOSING a title to accurately describe this article proved rather difficult so perhaps a more detailed explanation is called for.

If you've ever driven long distances on motorways I'm sure you must have experienced the very dangerous effect of driver fatigue especially at night or when travelling alone. Advanced warning of the effect usually comes in the form of the head gradually drooping and then a quick reflex brings you back, hopefully to full awareness.

This is where Little Noddy comes to the rescue. With this device fitted to either ordinary glasses or an old frame (or even, on extra bright days, sunglasses) when the head tilts a musical tune is automatically played until the head is lifted again.

This project uses very few components and makes use of one of those annoying novelty musical birthday cards — you know — the ones that play tunes when they are opened. Even if you are lucky enough not to receive one of these cards and you fancy having a stab at this project then you can buy one at any market for about 75p and that price includes the battery!

It would cost at least three times as much to buy and build the equivalent circuit using discrete components. The other main item is a mercury tilt switch, everything else is out of the spares box.

### HOW IT WORKS

There is very little to be said about the circuit diagram Fig. 1. The mercury switch S1 acts as an on/off switch,

which is on when the liquid mercury covers the contacts; by "tilting" the switch. This switch replaces the original contacts on the small printed circuit board and turns on IC1, the melody chip.

The output from IC1 drives the small transducer LS1. On some boards the choice of melody is selected by connecting the leads from the transducer across different pins (via solder pads on the circuit board) of IC1.

### CONSTRUCTION

The first part of the construction is actually dismantling the musical card. Carefully remove the printed circuit board and "loudspeaker" after separating the two pieces of card.

By referring to Fig. 2, Fig. 3 and photograph a good idea of the construction method will be appreciated. Only the basic format is given as the constructor can adapt this to his/her requirements.

The original on/off switch is a pair of contacts which are closed when the card is opened. In our application these contacts must be bent to be permanently open and the mercury tilt switch connected directly across the contacts.

The tilt switch is best adjusted by a second person whilst you are wearing the device with your head in the normal driving position. When you dip your head forward the contacts of the switch should close and initiate the alarm.

The prototype used double-sided sticky tape to secure most items but other methods may be used if the constructor wishes. To keep the total weight down no power switch has been incorporated and the unit is stored upright when not in use.

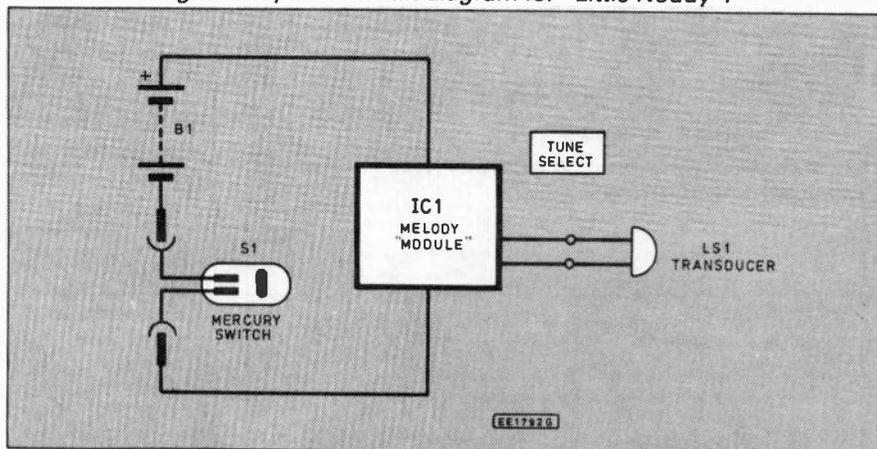
### WARNING

**Mercury is a toxic substance and on no account must the tilt switch S1 be opened up.**

### OTHER IDEAS

This project shows how easy it is to adapt a cheap ready made circuit to give another function. We are sure most readers will have ideas of their own and will find many other uses for this or similar devices.

Fig. 1. Simplified circuit diagram for "Little Noddy".



In addition to the musical greetings card, there is a whistle responsive key ring and a minute mini organ on the market both of which use similar, small ready made printed circuit boards.

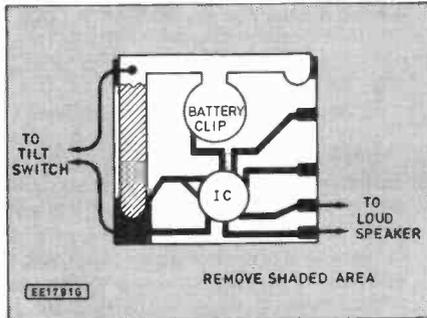


Fig. 2. Circuit board removed from musical greetings card.

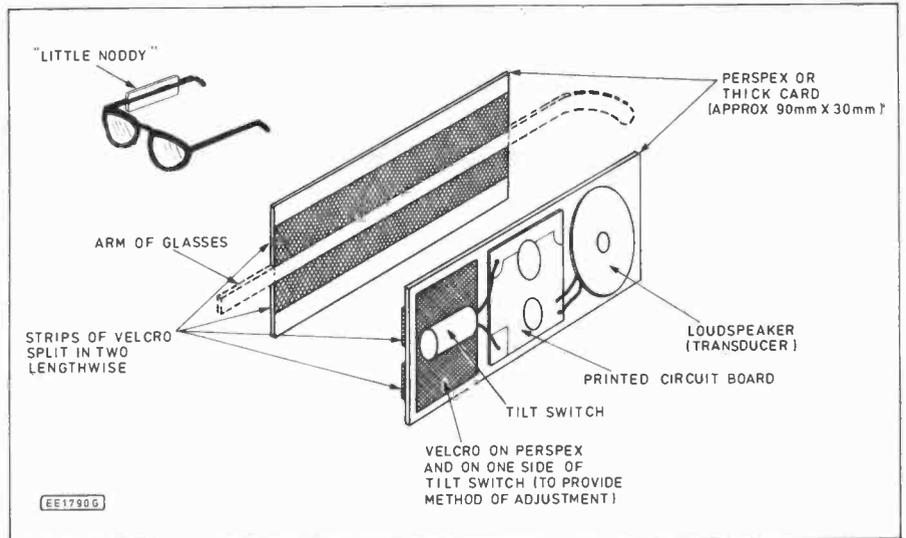
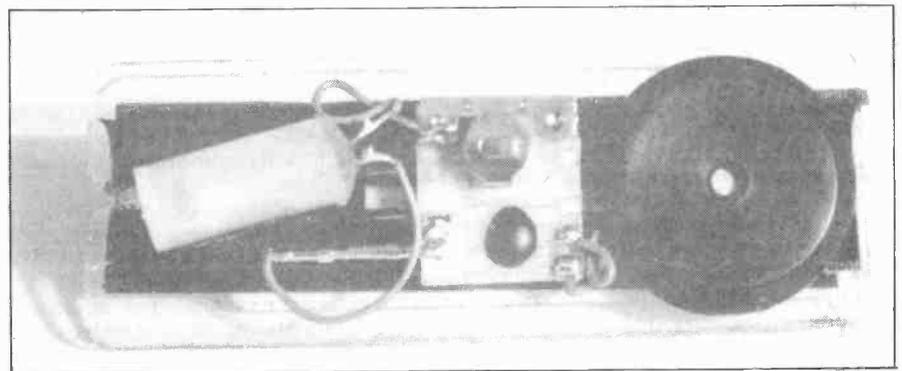


Fig. 3. Basic method of construction using Perspex and Velcro strips. The completed project is shown below.



## Materials ...

Musical birthday card.  
Mercury Tilt Switch.  
Spectacles or Spectacle Frames.  
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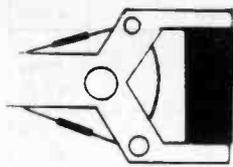
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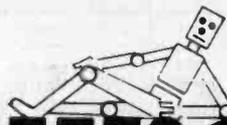
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# Robot Roundup



NIGEL CLARK

**F**ISCHERTECHNIK was one of the first kit companies to realise there was a market for kits which could demonstrate the properties of robotics and control technology. However after its initial moves it seemed to stand still, letting other suppliers, particularly Lego, develop similar ideas and then take a lead in the variety of items provided.

Lego was the first to produce a buggy and then develop a step-by-step approach, leading people into the investigation of robotics, introducing them to simple gearing and motors, which were then used in more complex devices, and then into keyboard and computer-control. The company also produces kits aimed at specific parts of schools' curricula.

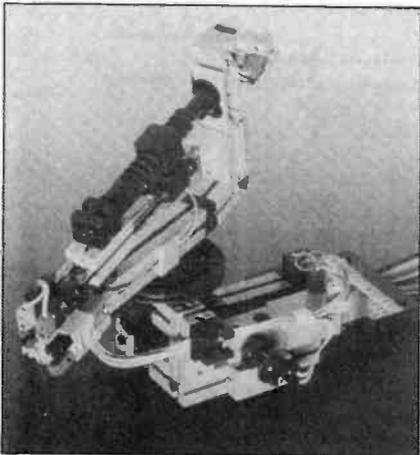
Fischertechnik, however is aiming to redress the balance with a new kit known as Computing Experimental. It contains parts to build a number of devices, an interface and user literature. The models which can be built include a buggy, winch, radar scanner and an ingenious "welding" robot.

The importer and main distributor of Fischertechnik in Britain is Economatics Educational based in Sheffield. The company has added its own software for the BBC series of computers and is selling the whole package to educational establishments for a price of about £190 (retail prices are higher).

## "WELDING"

The "welding" robot has two degrees of freedom, being able to rotate until it points in the desired direction and then the "welding" unit moves to the required point on an arm which extends and contracts. At the end is a device which flashes when the "weld" signal is given.

As with the software for most of the other models a moving display of the "welders" movements are shown on screen. One of the examples given by



Welding Robot

Economatics involves the replication of welding on a car production line.

The models can be instructed to make "welds" at particular points on the body. If an outline of the car has been built up on the screen the display will show where the "welds" have been made. There are three different programs for use with the "welder".

## BUGGY

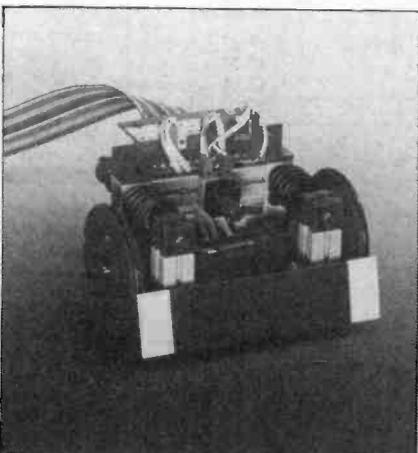
The other main model is the buggy which has eleven programs written for it. It also has a moving simulation on screen. The two-wheeled mobile has bump sensors and light detectors and looks like a stripped-down version of the BBC Buggy, which Economatics used to sell until problems with the supply of the electronic components resulted in its withdrawal around 18 months ago.

Economatics say that the new buggy can detect and follow a light beam, read bar code instructions and solve mazes. The Fischertechnik interface has eight digital and two analogue inputs and four pairs of outputs thus allowing it to be used to control models more complex than those for which building instructions are given. It also has a three-colour i.e.d. display of the input and output lines which are in use.

Economatics say that a feature of the new kit is a colour-coded connector, built into each model. The wiring plugs are also colour-coded to make checking and fault-finding easier.

The *Computing Experimental* kit joins Fischertechnik's older products in this area, the *Computing Kit* the 4-motor robot arm and the plotter/scanner.

The computing kit was the first of its type in this country with instructions on the building of ten models, including a simple two-axis arm with magnetic gripper, a plotter and an arm which can solve the Towers of Hanoi problem. However for computer control an interface and software is required.



Buggy

## SOFTWARE

Economatics supplies separately the Fischertechnik interface and a control program, which can be used on the BBC series, and which can control up to four motors or magnets. It allows the computer to read the switches and the potentiometers providing feedback for control.

Software is supplied with both the four motor arm and the plotter/scanner but again the Fischertechnik interface is needed. The arm has three axes powered by d.c. motors with digital encoders for feedback, and a gripper which can be altered by adding more parts to it depending on what it is required to pick up.

The plotter/scanner uses two stepper motors with either a pen in an up/down mechanism for plotting or a sensor for scanning.

## TECHNOLOGY SHOW

The new kit was on show at the Design and Technology Education Exhibition at the NEC, Birmingham in November. From the robotics point of view it was one of the few notable displays at the show, being held in Birmingham for the second time.

As usual the most impressive display was that of Cybernetic Applications which had its full range on view including the recently-launched Kestrel gantry robot—making its public working debut. Support was available from the other arms in the range working together under the control of Cybernetics' Walli system.

Tribotics was also at the NEC, displaying its re-engineered drainpipes and getting attention by running its buggy around the floor near the stand.

The only other robot was on the Proops Distributors stand, not to be confused with that of Proops Brothers, where the Department of Cybernetics of Reading University were putting on a display.

The arm looked just like any other seen at many other exhibition displays except that it was not operating under computer control. The arm is not electronic but a sequential machine controlled by limit switches and relays; the purpose being to show that simple technology could be used to achieve what appeared to be complex results.

On the display stand the arm picked up a ball bearing with a magnetic gripper, dropped it in a chute, down which it travelled into a box from where it was picked up by the arm again.

There were other exhibitors who had robots to show but most appeared to be keeping them in the background, particularly Shestotech with its Armtech 2000, based on the Colne Armadroid. Richard Shestopal said he preferred to promote his other products for the time being.

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## POWER CONDITIONER

FEATURED IN ETI  
JANUARY 1988

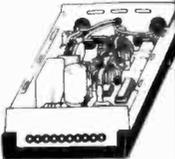
The ultimate mains purifier. Intended mainly for lowering the noise floor and improving the analytical qualities of top-flight audio equipment.

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

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

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## KNIGHT RAIDER

FEATURED IN ETI JULY 1987

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

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

The parts set consists of box, PCB and components for control, PCB and components for sequence board, and full instructions. Lamps not included.

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FEATURED  
IN ETI  
AUGUST 1988

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

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

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

PARTS SET £33.80 + VAT

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



## THE DREAM MACHINE

FEATURED IN ETI  
DECEMBER 1987

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

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

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

PARTS SET £16.50 + VAT

Ben Swainston's best seller GROW RICH WHILE YOU SLEEP is now in stock. £2.95 (NO VAT)



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The best ioniser design yet — this one has variable ion drive, built-in ion counter and enough power to drive five multi-point emitters. For the technically minded, it has nine main drive stages, five secondary drives, and a four section booster to give an output capability of almost fifteen billion (1.47 x 10<sup>10</sup>) ions every minute, or 2.45 x 10<sup>11</sup> ions per second. With extra emitters this can be increased still further!

PARTS SET £24.80 + VAT

The parts set includes case, printed circuit boards, 126 top grade components, all controls, lamps, hardware, a multi-point phosphor-bronze emitter and full instructions.

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



## READY-BUILT MISTRAL

The Mistral Ioniser (and most of our other projects) can now be supplied built, tested and ready to go. For details, please contact Peter Leah at P.L. Electronics, 8 Woburn Road, Eastville, Bristol BS5 6TT. Tel: 0272 522703. Evenings Only

INTERNAL EMITTER £2.69 + VAT

Can be used in place of the P-B external emitter, or both can be used together for the highest ion output. Parts set includes PCB, ion emitters, components and instructions.

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Essential for removing grease and flux residues from the Mistral PCB to achieve peak performance. Applicator brush supplied.

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## ION FAN

An almost silent piezo-electric fan, mains operated, to pump ions away from the emitter and into the room. Increases the effectiveness of any ioniser by five times!

£9.80 + VAT

## TV BOOSTER

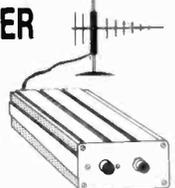
Good TV pictures from poor aerials is what this project is all about. Keith Brimbleby's Aerial Booster gives a massive 20dB gain to ensure good viewing for campers and caravaners, from indoor aerials, or wherever a properly positioned high-gain antenna is not practical.

Based on the OM335 hybrid amplifier, the booster has specifications to meet the best widespread operation from 10MHz to 1.4GHz, mid-band gain of up to 20dB and a wide supply range of 9V to 20V (it will run from car batteries for campers, dry batteries for campers, or a mains 'battery eliminator' in the home). No special UHF construction skills are needed — the project could be made by a careful beginner.

There are two parts sets for the project. AA1 contains the printed circuit board, OM335 hybrid amplifier, components and instructions. AA2 is the optional case set, rugged screened box, front and rear panels, waterproofing gaskets, feet, sockets and hardware.

AA1 PARTS SET £12.80 + VAT

AA2 PARTS SET £4.80 + VAT



## POWERFUL AIR IONISER

FEATURED IN ETI  
JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build, ... and fun! Apart from the serious applications, some of the suggested experiments were outrageous! We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller lined printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs about a third of the price of the individual components. What more can we say?

PARTS SET WITH BLACK CASE £11.50 + VAT  
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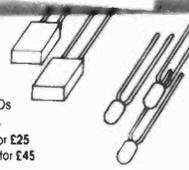
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## BRAINWAVE MONITOR



FEATURED IN ETI  
AUGUST 1987

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

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

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

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

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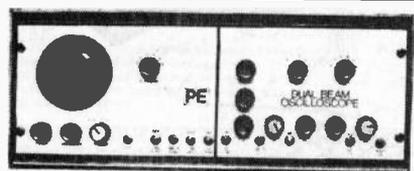
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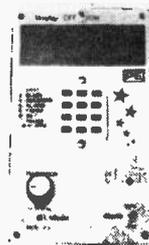
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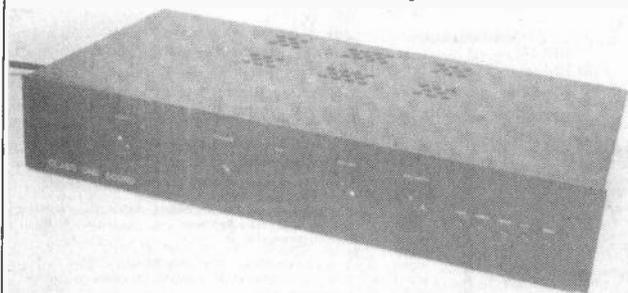
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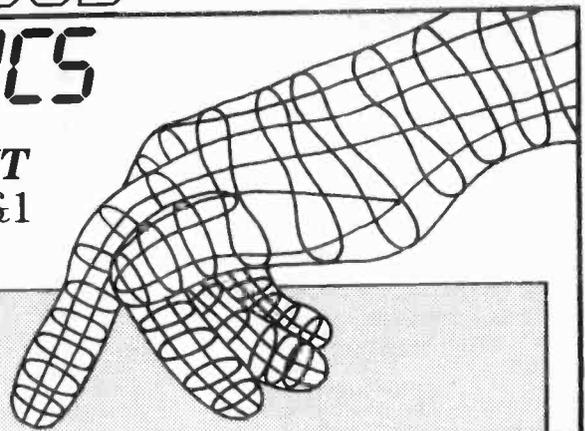
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VP26	100	50, Ins total Copper Clad Fibre Glass Board	£1.50
VP42	10	Black Heatsinks, fit T03 and T0220, drilled	£1.00
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VP44	15	Assorted Heatsinks, T01/3/5/18/200	£1.00
VP45	20	Assorted I.C. DIL Sockets, 8-40 pin	£2.50
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VP83	1	Electronic Buzzer 5V 25MA	£0.95
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VP114	1	Coax Antenna Switch, 3 way	£4.75
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VP177	1	Pack assorted Hardware, nuts, bolts, etc	£1.00
VP178	5	Assorted Battery Holders and Clips, PP3/9, AA/D, etc	£1.00
VP223A	6	Tag Board, 10 way parallel	£1.00
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VP232	1	Cassette Head Cleaner/Demagnetizer, in case	£2.00
VP233	1	Revolving Cassette Rack, holds 32, smoky periscope	£2.50
VP235	1	VHS Video Head Cleaner Cassette, wet type	£2.50
VP236	1	Beta Video Head Cleaner Cassette, wet type	£2.50
VP237	1	Universal Ni-Cad Battery Charger, AA-HP1-HP2-PP3	£6.00
VP238	4	AA Ni-Cad Batteries, 1.25V 500mAh CR HA	£4.00
VP239	2	C-HP11 Ni-Cad Batteries, rechargeable	£3.50
VP240	2	D-HP2 Ni-Cad Batteries, rechargeable	£4.00
VP244	1	High power Piezo Electric Siren, emits ear piercing wailing sound. Ideal alarms. White plastic body with mounting bracket. Power: 12V dc 150mA. Output 100db (A) at 1m dup. freq. 2.5KHz. Size: 57x42x37mm	£6.00

VP245	1	Automatic Lighting Switch, photo electric, weatherproof, switched lights or equipment "ON" at dusk and "OFF" at dawn. Loads up to 2amp 240V ac. Size: 50x45mm	£5.50
VP260	1	9in x 6in Elliptical 8 ohms 10W RMS Speaker. Freq. res. 60-10000Hz. Gauss 10000. Centre HF cone	£4.50
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VP273	10	10K Lin Rotary Potentiometers, slim spindle	£1.00
VP281	4	Plug-In Relays, mixed volts, etc	£1.00
VP286	2	Etch Resist PCB Transfer sheets, asst symbols/lines, etc	£1.00
VP254	1	250 grams Etchant Granules (Ferric Chloride) makes 1/2 pint	£1.00
VP255	1	Etching Pen, etch resistant, spare tip, blue	£1.00
VP258	1	Multicore Solder, 5m total, 10 and 22SWG	£1.00

### MISCELLANEOUS

Pak No	Qty	Description	Price
VP470	8	Dual Pots, linear, all different values	£1.00
VP471	8	Dual Pots, Log, all different values	£1.00
VP472	8	Switched Pots, Linear, all different values	£1.00
VP473	8	Switched Pots, Log, all different values	£1.00
VP474	12	Slider Pots, Insulob, Black/Chrome, push fit	£1.00
VP475	1	100 Sq. Ins. Double-sided Copper Clad Board	£1.50
VP475A	2	Sheets 20 x 15cm, extra thin 1/2mm, double-sided Copper Clad	£1.50
VP484	1	pair Line Socket and Chassis Plug Euro style GA 250V ac	£1.00
VP485	1	Scart Plug, 21 way Euro Video Plug	£1.00
VP486	1	2 x 23 way Edge Connector and matching PCB Board, plated at pin 3 as for ZX81, etc	£1.00
VP519	1	4in Round Dome Tweeter, 8ohms 50w RMS 2000-20000Hz. Dia. 98mm, depth 32mm, black metal and plastic front, mesh centre	£5.50
VP520	1	Uni-directional Dynamic Microphone, high imp 50K ohms	£6.50
VP521	1	Uni-directional Dynamic Microphone, low imp 500 ohms, response 80-12000Hz: sens. -77db at 1kHz. All plastic body black metal mesh, head dia. 53mm. On/Off switch holder inc.	£6.50

### DIODES & SCRS

VP29	30	Assorted volt Zeners, 50W-2W	£1.00
VP30	30	Assorted volt Zeners, 10W, coded	£1.00
VP31	10	5A SCRs, T066, 50-400V, coded	£1.00
VP32	20	3A SCRs, T066, up to 400V, uncoded	£1.00
VP33	100	Silicon Diodes like IN4148	£1.00
VP34	200	Silicon Diodes like OA200/BAK13-16, 40V	£1.00
VP35	50	1A IN4000 Diodes, all good, uncoded	£1.00
VP49	30	Assorted Silicon Rectifiers, 1A-10A, mixed volts	£1.00
VP141	40	IN4002 Sil. Rectifiers, 1A 100V, performed p/tech	£1.00

VP142	4	40A Power Rectifiers, silicon, T048, 300 PV	£1.00
VP184	3	4A 400V Triacs, plastic	£1.00
VP187	10	SCR's 800mA, 200V, 2N5064, plastic T092	£1.00
VP194	50	OA91 point contact germanium Diodes, uncoded	£1.00
VP195	50	OA47 gold bonded germanium Diodes, coded	£1.00
VP196	50	OA70-79 detector germanium Diodes	£1.00
VP197	50	OA80 type germanium Diodes, uncoded	£1.00
VP198	40	BA248 Silicon Diode, 350V, 2A, fast recovery	£1.00
VP222	20	3A stud Rectifiers, 50-400V, assorted	£1.00
VP262	10	BY127 Silicon Rectifiers, 5A, 1200V	£1.00
VP263	5	Bridge Rectifiers, 2A, 50V, 2W005, plastic	£1.00
VP264	4	2amp 400V Bridge Rectifiers	£1.00
VP265	25	OA10 germanium Diodes	£1.00
VP274	12	SCR's (Thyristors) 1A, 100-400V, T039	£1.00
VP275	3	50amp 400V SCR's, T0220, T0106D	£1.00
VP276	5	SCR's standard type, 5-16A to 400V	£1.00
VP277	4	Triacs 2A 400V, T039	£1.00
VP278	4	6amp 1000V plastic silicon Rectifiers	£1.00
VP283	5	Diac BR100 Triac trigger	£1.00
VP460	1	Triac 6A 600V, isolated case T0220	£1.00
VP460A	1	Triac 10A 600V, isolated case T0220	£1.25
VP482	50	Assorted IN4001-IN4007 1A 50-1000V Diodes, coded	£2.00
VP483	50	Assorted IN5400-IN5408 3A 50-1000V Diodes, coded	£3.00

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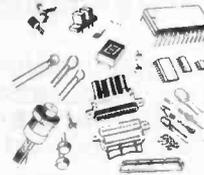
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1N4002	5p
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79L05	30p	7905	36p
79L12	30p	7912	38p
79L15	30p	7915	38p

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14 pin 9p, 10 off	85p
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24 pin 20p, 10 off	180p

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CA3240E		125p
TL071		60p
TL072		80p
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TL082		55p

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4001	25p	4075	27p
4011	25p	4077	30p
4013	38p	4081	27p
4017	55p	4093	35p
4023	30p	4510	65p
4025	25p	4511	65p
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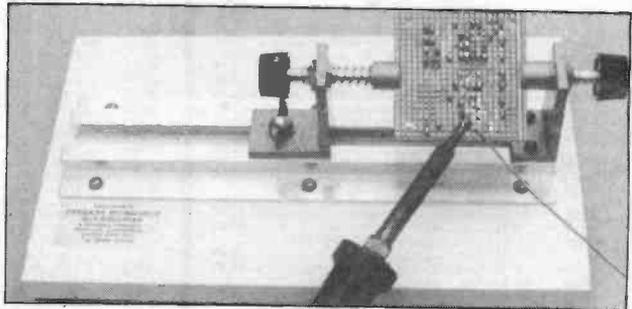
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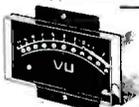
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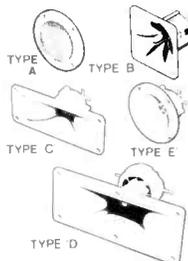
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