EVERYDAY ELECTRONICS

OCTOBER 1988

INCORPORATING ELECTRONICS MONTHLY

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Introducing DIGITAL ELECTRONICS

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QUAD CAR CONTROLLER

EPROM ERASER

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.

BD1 5 13A junction boxes for adding extra points to your ring main circuit.
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 6½in 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 48 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 2 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 coil 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.
BD246 2 Tacho generators, generate one volt per 100 revs.
BD252 1 Panostat, controls output of boiling ring from simmer up boil.
BD259 50 Leads with push-on ¼in 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.
BD275 1 Guitar mic—clip-on type suits most amps.
BD283 3 Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
BD293 50 Mixed silicon diodes.
BD296 3 Car plugs with lead, fit into lighter socket.
BD305 1 Tubular dynamic mic with optional table rest.

Most other packs still available and you can choose any as your free one.

VERY POWERFUL 12 VOLT MOTORS—⅓rd HORSEPOWER Made to drive the Sinclair C5 electric car but equally adapable to power a go-cart, a mower, a rail car, model railway, etc. Brand new. Price £15.00 plus £2.00 postage. Our ref 158.

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.

NEWLY ADVERTISED ITEMS

FET CAPACITOR MICROPHONE Eagle CI.200 Electret type microphone. An FET amplifier is built in for obtaining an output equivalent to a high class dynamic microphone while retaining the characteristics of a capacitor microphone. External influence by magnetic and electrostatic noise is minimised since no magnets or coils are used. The small size of this microphone and the low power supply needed for its operation makes this microphone a very versatile unit. Electrical specifications are as follows: Output Impedance: 500ohms±30% at 1kHz. Sensitivity: −65dB±3dB (0dB=1V/ubar at 1000Hz). Frequency response: 50-8000Hz. Price £1 each. Order Ref. BD646.

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

Ex GPO MULTI-RANGE TEST METER 12/C1 Complete in real leather case with carrying handle–this is a 20,000 OPU instrument, with 19 ranges including AC and DC volts–dc current 5mA to 1A, 4ohms ranges up to 20meg– the low ohms range is particularly useful, you will be able to read right down to one ohm and below. This meter also has provision for reading dc current 0-5 amp and 0-25 amp. Meter size 6" long × 3" wide ×2" deep. Leather case has compartment for test leads, prods, and croc clips all of which are included. Can be used in the case. Not new but are in first class condition–tested and guaranteed. Price is £7.00. Order ref 7P5.

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.

8 TRACK CASSETTE DECK Complete with cassette holder. In fact, if you have any 8 track cassettes, then with the addition of 2 speakers this unit would play them. As 8 track cassettes are no longer made the units have become surplus, however, they do contain lots of useful parts: motor, tape head and drive, pulley wheels, etc. and a stereo amplifier. Mains operated. Brand new in makers packing. Only £3.00 each plus £1.00 additional postage. Order ref 3P46.

COMPUTER BARGAIN—MEMOTECH MTX 512 64K RAM Full size QWERTY keyboard with 57 professional keys and additional 12 dual function keys arranged as a separate key pad with cursor control and editing keys. Auto repeat is standard on all keys. This is a very superior home computer and comes complete with power supply, cassette lead, TV lead and 3 cassette programmes. Brand new in manufacturer's original packing with 250 page Operator's Manual. Price £45.00 plus £4.00 postage.

STEREO SPEAKERS Each 10 watts 8 ohm and twin speakers mounted in Walnut-finish cabinets. size 16" high × 10" wide × 6" deep. Front is black Dacron and the finish is very pleasing. Price £7.00 per pair. Extra postage and packing £3.00.

UNUSUAL MAINS MOTOR Quite small, measures only 2"×2"×1" approx., but is surprisingly powerful. it revs at 3,000rpm and is reversible. It has good length ⅛" diameter spindle. Price £1.00. Our order ref BD640.

LASER TUBE
Made by Philips Electrical. New and unused. This is helium-neon and has a typical power rating of .9mW. it emits random polarised light and is completely safe provided you do not look directly into the beam when eye damage could result. Do not use in the presence of children unless a diverging lens is fitted. DON'T MISS THIS SPECIAL BARGAIN! Price £29.95 plus £3 insured delivery.

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. 4¾" square x 1⅝" 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.

FLIP-OVER DIGITAL CLOCK Quite an eyecatcher, this is mains operated. The figures flip-over per minute and per hour and give a larger than usual visual display. Supplied complete with front and perspex panels to glue together to make its case. £2.00 each. Our ref 2P205.

STABILISED 15V 2A PSU kit which mounts on SRB panel. Mains operated. Ideal to drive monitor, etc. Price only £6. Our Ref. 6P7.

SMOOTHING CAPACITOR 230uF 63V 10A at 50 deg. C. Can type with mounting bracket. Price £2. Our Ref. 2P206.

SMOOTHING CAPACITOR 2200uF 63V 5.8A at 50 deg. C. Can type with mounting bracket. Price £1. Our Ref. BD644.

10A 100V BRIDGE RECTIFIER ASSEMBLY comprising 4 diodes mounted on two 4in x 3in sinks with bottom insulators. Price £2. Our Ref. 2P207.

DO YOU WANT TO MEASURE AC AMPS? We have found a few more of the 50Hz 0-40A AC 2½in diameter panel meters, made for RAF equipment these are very reliable and robust. Price £5 each. Our Ref. 5P105.

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

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

DOUBLE MICRO CASSETTE DECK made by the Japanese ABS company. This takes two micro cassettes and is complete with motors, solenoids to select the deck to use and record and playback heads. Price £10. Our Ref. 10P49.

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

NEW ARRIVALS, FIRST TIME OFFERED

EPSON MINI PRINTER 15011 This is a till roll size printer and uses plain paper. £15 each. Order Ref. 15P14.

2764 EPROM 65K bits. BBC micro compatible. £3 each. Order Ref. 3P48.

PIEZO SOUNDER. Reference PKM11 3-30V operation, 90dB output. 2 for £1. Order Ref. BD647.

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

3½in FDD CHINON 80 track 500k. Shugart compatible interface. Standard connections, interchangeable with most other 3½in and 5¼in drives. Brand new. £28.50 plus £3 insured post.

3in FDD HITACHI HFD305SXA 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 3½in. £11.00. Ref 11P2 for the Chinon, 11P3 for the Hitachi.

9in MONITOR made for ICL, uses Phillips black and white tube. Brand new and complete but uncased. £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.

3 INCH FDD Hitachi ref. HFD 305SXA. Ideal replacement or second drive in most computers, especially Amstrad 6128, etc. Price £30 plus £3 post.

FREE POWER! Can be yours if you use our solar cells—sturdily 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—you join 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.

15A PANEL METER These have been stripped from Government surplus battery charger units made originally for army use. Unused, tested but of course rather old. diameter 2in can be surface or flush mounted. £3 each. Our Ref. 3P40.

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 4¼in x 4in high, ends are louvred for ventilation other sides are flat and undrilled. Order Ref. 2P191. Price £1.

BIG SMOOTHING CAPACITOR. Sprague powerlytic 39,000uF 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.

BULK-HEAD MOUNTING LOUDSPEAKER. Metal case with chrome grill front and with mounting lugs for screwing to ceiling, 8in. speaker. £10 each. Order ref. 10P43 add £2 post.

TWIN GANG TUNING CAPACITOR. Each section is .0005uF with trimmers and good length ¼in spindle. Old but unuse3d and in very good condition. £1 each. Our ref. BD630.

13A PLUGS Good British make complete with fuse, parcel of 5 for £2. Order ref. 2P185.

13A ADAPTERS Takes 2 13A plugs, packet of 3 for £2. Order ref. 2P187.

20V-0-20V Mains transformers 2½ 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.

24 HOUR TIME SWITCH—16A changeover contacts, up to 6 on/offs per day. Nicely cased, intebnded for wall mounting. Price £8. Ref. 8P6.

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

PIEZO ELECTRIC FAN—An unusual fan. more like the one used by Madame Butterfly than the conventional type, it does not rotate. The air movement is caused by two vibrating arms. It is American made, mains operated. very economical and causes no interference, so is ideal for computer and instrument cooling. Price is only £1 each. Ref. BD598.

SPRING LOADED TEST PRODS—Heavy duty, made by the famous Bulgin company. very good quality. Price 4 for £1. Ref. BD597.

ASTEC 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. BD582.

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.

3-30V VARIABLE VOLTAGE POWER SUPPLY UNIT—with 1 amp DC output. Intended for use on the bench for experimenters, students, inventors, service engineers etc. This is probably the most important piece of equipment you can own (after a multi range test meter). It gives a variable output from 3-30 volts and has an automatic short circuit and overload protection, which operaes at 1.1 amp approximately. Other features are very low ripple output, a typical ripple is 3mV pk-pk, 1mV rms. Mounted in a metal fronted plastic case, this has a voltmeter on the front panel in addition to the output control knob and the output terminals. Price for complete kit with full Instructions is £15. Ref. 15P7.

STEREO SPEAKERS Each 10 watts 8 ohm and twin speakers mounted in walnut finish cabinets, size 16in high x 10in wide x 6in deep. Front is black Dacron and the finish is very pleasing. Price £7 per pair. Extra postage and packing £3. Our Ref. 7P6.

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INCORPORATING ELECTRONICS MONTHLY

ABC

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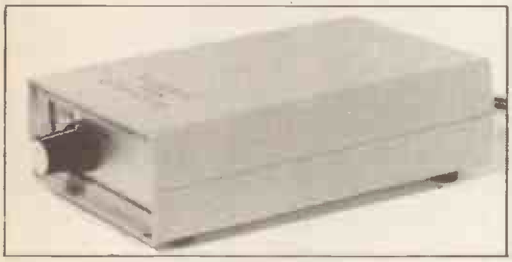
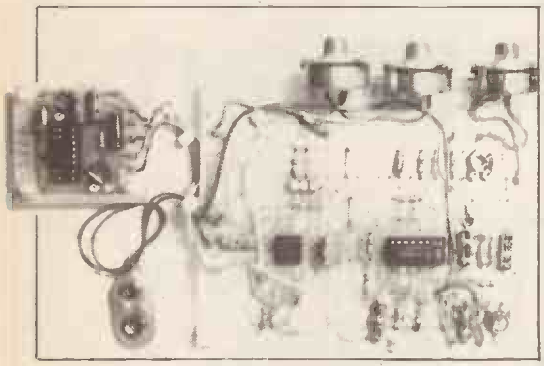
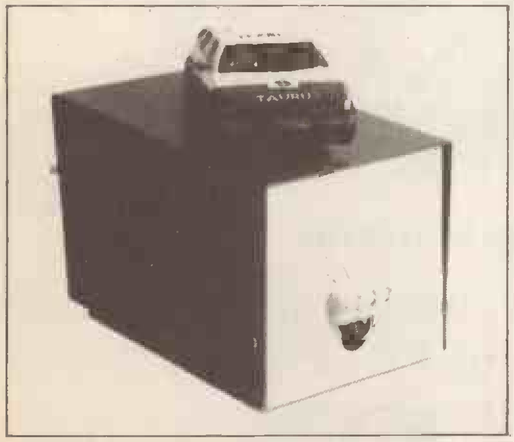
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .







Our November '88 issue will be published on Friday, 7 October 1988. See page 555 for details.

Projects

Series

Features

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INTRODUCING DIGITAL ELECTRONICS BOOKLET
C&G 726/301 Certificate Course Student Information

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1 x I.E.C. 1 amp mains filter socket	1.25
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5 x 240V panel neons	70p
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10 x 5mm x 2mm green leds	1.00

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Made by well-known Japanese manufacturer. Twin cassette mechanism, complete with stereo heads, counter, doors and leads, only £6.00, P&P £1.00
Complete working pcb from LW, MW, FM, stereo music centre. Only £5.00, P&P £1.00.

NEW SYSTEM
Merlin Systems PC Turbo 256K RAM, 8088 CPU, 1 Disk Drive, Hires Mono Monitor, 84 Keyboard, Par printer port, Radio and MSDos software and Merlin Systems backup. £450.00 plus £15.00 P&P.

2nd USER SYSTEMS
Apple II+ with diskm drive and software 150.00
Franklin with disk drive and software 150.00
Apple parts, S100 cards, IBM cards, disk drives, CPN systems, MSDos systems, IBM PC, and mono/colour monitors.

You are welcome to call at our Warehouse, but please ring first.

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10x4.7uf 25V	30p
10x22uf 10V	30p
10x22uf 25V	35p
10x47uf 25V	35p
10x47uf 35V	40p
5x47uf 250V	60p
10x100uf 10V	35p
10x220uf 10V	35p
10x220uf 16V	35p
10x220uf 25V	40p
10x220uf 40V	45p
10x220uf 50V	45p
10x470uf 25V	35p
10x470uf 50V	50p
10x1000uf 25V	35p

POWER ELECTROLYTICS

5x50ufx50uf 200V	60p
2x220uf 315V	1.75
2x220uf 400V	2.00
2x470uf 200V	1 50
2x15000uf 25V	1.75
2x22000uf 25V	2.00
5x3300uf 25V	1 30
2x3400uf 40V	75p

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1xGSX Graphics PC CPM86	1 50
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1xCPM86 user	1.50

COMPUTER OESK
Up-Market Desk, L 102cm×W 74cm×H 74cm with keyboard recess and cableing trunking. New only £50.00 plus £16.00 P&P.

POWER SUPPLIES AND TRANSFORMERS
Bench power supply In blue case, with switched 240V mains input and HT output. Outputs, 6.3V ac at lamp and 250V dc stabilised at 50mA. H 115mm, W 185mm, D 125mm. Just the job for valves! AS NEW ONLY £9.50.

2nd USER TEST EQUIPMENT
SE Labs SN111 18MHz bandwidth, twin beam, mains or battery input. Only £160.00 plus £15.00 p&p. Ring for list.

PAYMENT: Credit card, cheque, PO, cash. **Post and packaging, £0.00 to £10.00 add £1.50; £10.00 to £20.00 add £1.00.**

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. Very sensitive and low standby current through CMOS circuitry. 9V operation, range up to 1000m. Measures 30mm x 40mm £15.95
- **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 £9.95
- **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

SUMA DESIGNS (Dept. EE), THE WORKSHOPS, 95 MAIN ROAD BAXTERLEY, Nr ATHERSTINE, WARKS CV9 2LE. TEL. 0827 714476

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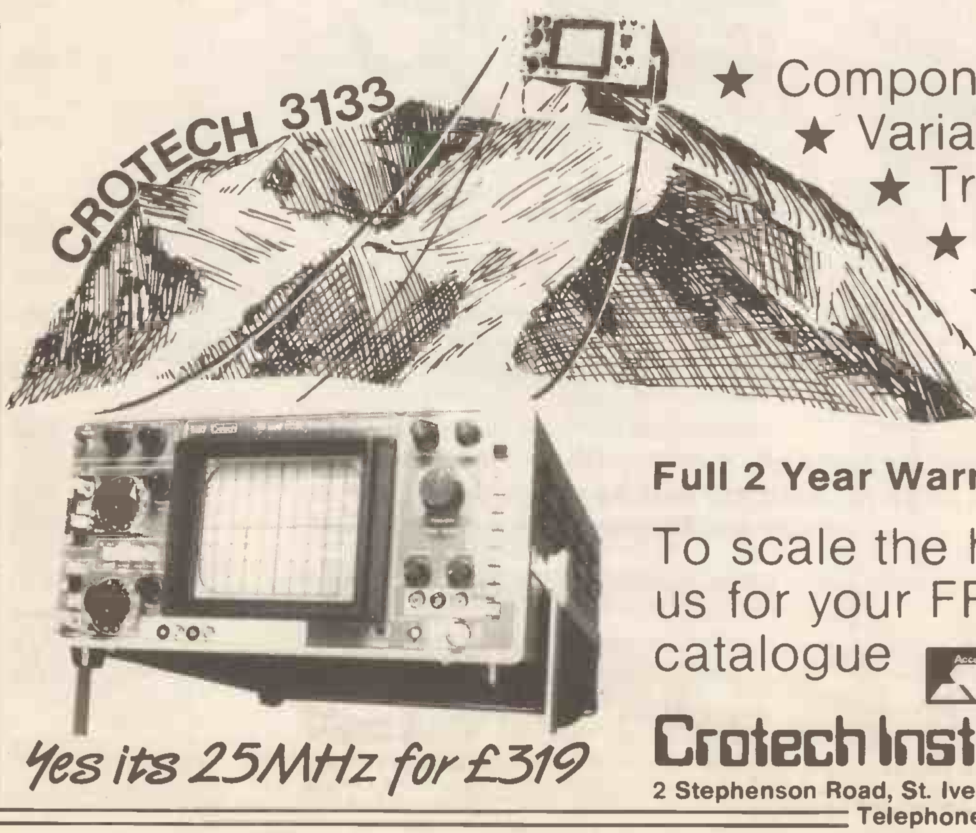

★ Component Comparator
★ Variable Hold Off
★ Triple DC Source
★ DC – 25 MHz
★ 40ns/div
★ 2mV/div
★ Low Cost

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Yes its 25MHz for £319

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NEXT MONTH

REAR-SCREEN ONE SHOT

Car rear screen heaters tend to take a lot of current. In winter months when headlamps, wipers, heater, fog lamps, etc., may all be in use this extra current can be critical to speedy battery recharging following a cold start. Our simple project ensures that the rear heater is not left on, thus avoiding unnecessary use of precious power.

MICRO ALARM

Computers are vulnerable to theft—especially when left unattended in schools, offices or other situations where there is easy access for the casual thief. This simple alarm will help to protect your valuable micro.

FREE with this issue

GREENWELD

ELECTRONICS COMPONENT CATALOGUE

100 PAGES of BARGAINS! WORTH £1

100 Page GREENWELD CATALOGUE

A new catalogue from Greenweld Electronics and you, the lucky readers of EE, will get one free as soon as it is published. The catalogue normally costs £1 but a free copy will be banded to every November issue of EE. Don't miss it, demand will be massive, place an order with your newsagent NOW!

EVERYDAY ELECTRONICS

NOVEMBER ISSUE ON SALE FRIDAY OCTOBER 7

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12" Double Tubes

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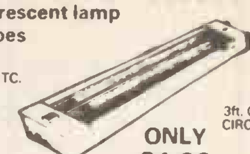

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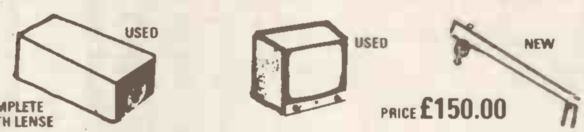


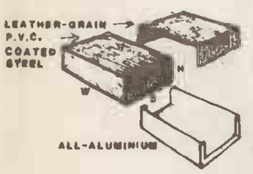
COMPLETE WITH LENSE

PRICE **£150.00**

PLEASE ADD 85p P&P +15% VAT TO ALL ORDERS

unless otherwise stated.

EQUIPMENT CASES



DIMENSIONS

Height Ins.	Depth Ins.	Width Ins	Price £
2.0	2.25	4.5	1.50
2.0	4.0	6.0	2.00
2.0	5.5	8.0	2.70
2.0	11.0	11.0	4.70
2.5	3.0	4.0	1.70
2.5	3.0	6.0	2.10
2.5	4.0	8.0	2.60
2.5	5.25	9.0	3.00
3.0	6.0	5.0	2.70
3.0	6.0	8.0	3.20
3.0	8.0	8.0	3.80
3.0	6.0	11.0	4.20
3.5	7.5	11.0	4.90
3.5	7.5	17.0	7.20
4.0	4.0	6.0	2.70
4.0	6.0	6.0	3.20
4.0	9.0	6.0	4.20
4.0	7.0	8.0	4.20
5.0	6.0	8.0	4.30
5.0	6.0	11.0	5.20
5.0	6.0	15.0	6.20
5.0	11.0	8.0	5.90
5.0	11.0	11.0	7.60
5.0	11.0	15.0	9.40
7.0	10.0	7.0	6.80
7.0	10.0	10.0	8.40
7.0	10.0	17.0	11.90

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Goldklene Degreasing Solvent	1.78
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Supa Freeze-it	1.46
Foam Cleanser	1.26
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Aero Klene	1.16
Anti Static Spray	1.28
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Aero Duster	1.55
Super 40	1.94
Rapid Fire extinguisher	3.45
Silicone Grease Tube	1.82
Silicone Grease Spray	1.48
Heat Sink Compound	1.20
Solde Mop Light gauge 0.08mm	0.80
Standard gauge 1.2mm	0.78
Industrial reel 1.2mm	2.96

RESISTOR KITS each value individually packed

¼W pack 10 each value E12-10R to 1M 610 piece	4.50
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½W pack Popular–2R2 to 10M 1000 pieces	9.50
1W pack 5 each value E12-2R2 to 1M 353 pieces	13.75
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ADDITIONAL KITS

Disc ceramic 50V	125 pieces £3.50
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Fuses Q/Blow 20mm	80 pieces £3.75
Fuses T/Delay 20mm	80 pieces £7.50
Pre-set Pots–H	120 pieces £6.75
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Soldering Station complete with 30W or 40W iron (state which)	72.50
XS25W Iron kit complete withn stand, lm lead & plug attached	8.20
CS17 Iron kit	7.99
C15 Iron kit	8.30
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CS 18W as above	10.90
Antex 15W iron	5.40
Antex 18W iron	5.60
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Antex bits	1.15
Antex stands	2.20
Soldersucker	2.99
Spare nozzles for soldersucker	0.60

13A TEST PLUG–useful for testing 13A sockets.
PRICE: 99p ea. 10 off 90p ea.
TEST PRODS–fused– 99p pair

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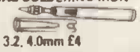
ORYX PORTASOL GAS SOLDERING IRON
1+ Price £16.00
5+ Price £15.30
SPARE TIPS: 1, 2.4, 3.2, 4.0mm £4



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LARGE RANGE OF BOXES AVAILABLE:
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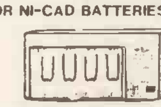
LATEST CATALOGUE £1**

SOLDER AT A RIDICULOUSLY LOW PRICE!!
A 50g reel of 22 SWG Multi-Core Solder 60% tin 40% alloy non-corrosive.
ONLY £4.99
Also 18 SWG 10+£3.75

RESISTORS–CARBON FILM 5%

¼W 1R0 to 10M (E12 Range)	2p each. 15p/10. 75p/100
½W 2R2 to 10M (E24 Range)	2p each. 15p/10. 75p/100
1W 10R to 2M2 (E12 Range)	5p each. 40p/10. 3.00/100
2W 10R to 2M2 (E6 Range)	8p each. 60p/10. 5.00/100

CHARGER FOR NI-CAD BATTERIES
Charges AAA, AA, C, D & PP3 NI-CADS
£4.50



NI-CAD RECHARGEABLE BATTERIES

AAA	– £1.25 (10+£1.20ea.)
AA	– 90p (10+ 85pea.)
C	– £2.10 10+£1.90ea.)
D	– £2.50 (10+£2.20ea.)
PP3	– £4.10 (10+£3.90ea.)

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2OZ. REEL

14swg	60p	30swg	90p
16swg	62p	32swg	92p
18swg	65p	34swg	94p
20swg	68p	36swg	£1.02
22swg	75p	38swg	£1.05
24swg	78p	40swg	£1.15
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28swg	88p	44swwg	£1.75

LOGIC PROBE

PRICE–£7.99

HELPING HANDS WITH MAGNIFIER

ONLY £3.99

LED 5mm

	1+	10+	100+
Red	9p	8p	5p
Green	11p	9p	6p
Amber	12p	10p	8p
Yellow	12p	10p	8p
Holder	4p	3p	2p

FLASHING LEDs

	1+	10+	100+
Red	45p	40p	35p
Amber	50p	45p	40p
Green	50p	45p	40p

VOLTAGE REGULATORS

78L05	0.26
78L08	0.28
78L12	0.28
78L15	0.28
7805	0.36
7808	0.36
7812	0.36
7815	0.36
7818	0.36
7824	0.36
7905	0.36
7912	0.38
7915	0.38
7918	0.38
7924	0.38
LM305H	1.45
LM317T	0.95
LM723	0.65

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High impact ABS
Colour: black
Internal Dimensions (mm)

A	B	C		1+	10+
76	58	35	Box/MB1	£1.04	98p
95	71	35	Box/MB2	£1.14	£1.05
115	95	37	Box/MB3	£1.34	£1.24
140	90	55	Box/MB5	£1.88	£1.70
207	122	77	Box/MB4	£3.60	£3.40
213	142	57	Box/MB6	£2.70	£2.60

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Master Socket (flush)	£2.90
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Secondary Socket (surface)	£1.85
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Extension lead, 5 mtr	£2.90
Wiring Tool	36p
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Viscount Phone	£26.04
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TA7205AP	1.80
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TAA611A12	3.50
TA1208	1.30
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TBA530	1.70
TBA540	1.64
TBA560C	1.50
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TCA2705Q	4.02
TDA1006A	2.45
TDA1035S	4.50
TDA1170S	1.99
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TDA2030	1.80
TDA2530	2.20
TDA2532	2.80
TDA2560	3.20
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AC128K	0.38
AC141	0.58
AC141K	0.38
AC142	0.40
AC142K	0.38
AC152	0.48
AC153K	0.46
AC176K	0.32
AC187	0.40
AC187K	0.42
AC188	0.24
AC188K	0.38
ACY22	1.50
AD142	0.88
AD149	0.95
AD161/162	1.20
AF114	0.88
AF115	2.10
AF116	2.10
AF121	0.66
AF124	0.70
AF125	0.50
AF126	0.50
AF127	0.50
AF139	0.56
AF178	1.50
AF239	0.65
AF279S	1.40
ASY80	5.20
AS217	2.00
AU110	2.90
AY102	4.32
B40C200	1.03
BA115	0.12
BA121	0.40
BA148	0.16
BA155	0.12
BA157	0.20
BB105B	0.32
BB105G	0.30
BB110B	0.42
BC108	0.10
A B or C	0.14
BC109	0.10
A B or C	0.14
BC115	0.15
BC117	0.28
BC118	0.20
BC119	0.43
BC125	0.14
BC140	0.48
BC141	0.36
BC142	0.26
BC143	0.36
BC147B	0.16
BC148	0.10
BC148B	0.12
BC149	0.12
BC149C	0.14
BC159	0.14
[illegible]	0.16
BC160	0.38
BC161	0.30
BC168B	0.25
BC170/A/B/C	0.12

Type	Price (£)
BC171/A/B	0.10
BC172/B/C	0.12
BC177/B/C	0.24
BC182/A/B/C	0.10
BC182L	0.10
LA LB LC	0.12
BC183/A/B/C	0.10
BC183L	0.10
LA LB LC	0.12
BC184	0.08
A B CL LC LB	0.10
BC212/A/B/C	0.10
BC212L	0.10
LA LB	0.10
BC213/A/B/C	0.10
BC213L	0.10
LA LB LC	0.10
BC237	0.12
BC238	0.12
BC251A/B	0.14
BC267	0.26
A B	0.29
BC301	0.36
BC302	0.38
BC303	0.36
BC307A	0.15
BC317B	0.15
BC323	0.90
BC327	0.10
BC328	0.10
BC337	0.08
BC338	0.10
BC350A	0.24
BC351	0.16
BC516	0.35
BC547	0.08
BC440	0.36
BC548	0.08
A B or C	0.10
BC549	0.08
A or B	0.10
BC550	0.10
A or B	0.10
BC557A	0.10
BC558A	0.10
BCY70	0.36
BCZ10	3.21
BCZ11	2.60
BD124P	1.20
BD129	0.90
BD130Y	0.68
BD131	0.46
BD132	0.50
BD135	0.26
BD136	0.26
BD137	0.28
BD138	0.30
BD139	0.30
BD140	0.29
BD142	1.60
BD145	1.82
BD150B	0.50
BD160	1.58
BD165	0.45
BD183	0.70
BD201	0.52
BD202	0.57

Type	Price (£)
BD222	0.80
BD225	0.40
BD232	0.52
BD234	0.30
BD235	0.30
BD236	0.36
BD237	0.38
BD410	0.76
BD438	0.64
BD439	0.85
BD441	0.85
BD507	1.06
BD520	1.20
BD587	0.88
BD707	0.80
BDX18	1.00
BDX32	1.75
BF115	0.32
BF117	0.50
BF119	0.82
BF125	0.42
BF127	0.44
BF154	0.14
BF157	0.46
BF160	0.23
BF167	0.32
BF177	0.42
BF178	0.36
BF180	0.27
BF181	0.27
BF182	0.32
BF183	0.32
BF184	0.47
BF185	0.28
BF194A	0.15
BF195	0.12
BF224J	0.20
BF240	0.15
BF241	0.18
BF257	0.22
BF258	0.26
BF259	0.30
BF262	0.34
BF263	0.38
BF270	0.30
BF271	0.28
BF273	0.22
BF274	0.34
BF294	0.46
BF336	0.40
BF337	0.38
BF338	0.28
BF355	0.42
BF371	0.27
BF450	0.30
BF451	0.36
BFR51	0.36
BFR61	0.32
BFR90	0.86
BFT41	0.68
BFT43	0.38
BFY50	0.32
BFY51	0.32
BFY52	0.32
BFY90	0.80
[illegible]	1.34
BR100	0.20
BR101	0.76

Type	Price (£)
BR103	0.60
BR303	2.75
BRY39	0.80
BRY56	0.42
BSX20	0.20
BSY52	0.35
BSY95A	0.25
BT100A/02	0.90
BT101/300	2.75
BT101/500	3.25
BT102/300	3.60
BT106	2.05
BT116	1.20
BT119	3.30
BT138/600	0.98
BT151/560R	0.90
BTY79/400R	2.80
BU104	1.80
BU105	1.40
BU108	1.90
BU126	1.60
BU133	1.90
BU204	1.60
BU205	1.40
BU208A	1.50
BU326S	1.75
BU407	1.40
BUX80	2.90
BUY20	2.75
BUY69A	2.90
BUY69B	1.98
BY100	0.80
BY103	0.50
BY122	0.60
BY126	0.10
BY127	0.08
BY133	0.10
BY135	0.35
BY164	0.45
BY179	0.60
BY182	0.80
BY184	0.38
BY187	0.65
BY189	6.75
BY198	0.64
BY199	0.72
BY206	0.14
BY207	0.16
BY210/400	0.21
BY210/800	0.22
BY227	0.28
BY228	0.50
BY238	0.65
BYX10	0.28
BYX36/150	0.40
BYX36/600	0.48
BYX48/300	0.70
BYX55/600	0.30
BYX71/600	1.50
E1222	0.30
E5024	0.30
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MF0413	0.70
MF6004	0.26
MF1121	0.62
MJ400	1.45
MJ2955	1.10

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A very good range is obtainable–we have obtained over ½ mile, but it does depend on conditions. Simply remove cover–insert battery–and you're ready to go.
reception can be obtained on any FM radio.
Frequency: 105-109 MHz FM
Power: PP3 9V battery (not included)
Dimensions: 4.25in x 2.25in x 0.75in.
Order Code SO/034 Price £8.50

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C-Tag–1.8AH
10 off 65p, 100 55p

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Robust construction–made from 1.1mm thick steel.

Available in five different sizes.

Grille pitch 11mm x 11mm

Diameter	order Code	Price
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8in.	SO/028	£1.80
10in.	SO/029	£1.95
12in.	SO/030	£2.50

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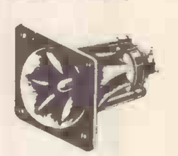
FLIUSH FLANGE EXPONENTIAL HORN

Size: 3.25in round
Impedance: 1000 ohm at 1kHz
Power Nominal: 16V
Power Max. 35V
Frequency Response: 3kHz-25kHz
Output SPL: 100dB
Weight: 62g
Dimensions: 85 x 85 x 74mm
Order Code–AUD/KSN1005A
PRICE–1+ £5.00
10+ £4.50



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10 x D size Ni-Cads (4Ah) encapsulated in a black plastic case. fuse holder. gives 12V output when fully charged. Ex-equipment–fully tested and guaranteed. 245 x 75 x 75mm.
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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

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PACE

IT IS at this time of the year when the pace of the electronics hobby picks up again. Schools and colleges go back and eveyone starts to get down to study or project building in earnest following the summer holidays. Once again we have some excellent projects in this issue, we also have Part One of *Introducing Digital Electronics* plus the introductory booklet for the course.

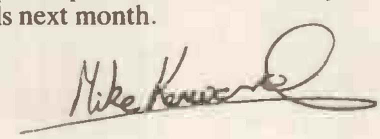
In addition to these you will find a priority order form for the *Teach-In 88/89* book "Introducing Microprocessors" which will be available in early November. Next month you will also get the free 100-page Greenweld catalogue banded to your issue of EE—that's worth £1 so don't miss it.

NEW HOBBY

Although EE has been going for seventeen years now–and we have a number of readers who have bought the magazine from the very first issue–to many, electronics is a new hobby. Any new hobby demands a learning process and perhaps one of the fascinations of electronics is that you never stop learning. The hobby is one that moves with the times–indeed technology is often the very reason for changes in our lives.

It is not now possible to think of a world without electronics or to think that electronics will ever be replaced. We, therefore, are part of one of the biggest industries in the world. Although hobbyists, and those who keep us supplied with components, are a very small section of the industry, it is an important section as many hobbyists are the engineers of the future. It is pleasing to find a number of large companies that believe in catering for the small buyer and who actively look after the interests of our hobby.

In a couple of months we will start a special promotion in EE with just such a company–watch out for full details next month.



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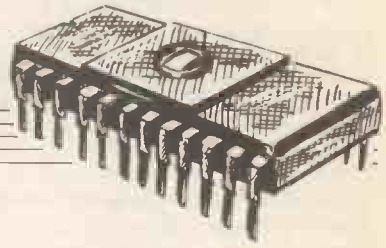
Constructional Project

EPROM ERASER



MARK STUART

Safe, low-cost unit capable of erasing up to four EPROM's simultaneously in less than twenty minutes. Could also be used to drive some fluorescent tubes from 12V supply.

MANY projects have been published in the last few years for EPROM programmers. These have been designed for use with various different computers, and each one has had particular features such as speed of programming, simple hardware, elaborate software, ability to program a wide range of i.c.'s etc. In each case, it has been assumed that a source of blank EPROMS was available, and yet, a good EPROM *ERASER* project has been elusive.

To redress the balance, this article describes an EPROM eraser which should cover most needs. It is capable of erasing up to four EPROMS at once in less than 20 minutes. It operates from 12 volts d.c. and was designed specifically for use in schools where mains voltages are not allowed—it is ultra-safe. The advantages go further than this, however, because the use of a high frequency inverter circuit results in longer lamp life and higher efficiency.

WHAT IS AN EPROM

The letters EPROM stand for Eraseable/Programmable Read Only Memory. The fact that these are Read-Only Memories means that the computer in which they are used cannot store information in them, but can only read from them. In practice EPROMS are used to hold permanent information such as the computer "operating system" that enables it to read the keyboard and print on the screen before other programs are loaded. In the case of the BBC computer, sockets are available to enable EPROMS to be fitted which contain special programs.

EPROMS are supplied "blank" by the manufacturers and are programmed by applying the information to be stored along with a pulse of 12.5, 21 or 25 volts depending upon the type. There are various ways of applying the information and the voltage pulses so that faster programming can take place. This is probably why so many people have been attracted to the design of EPROM programming hardware and, more particularly, software.

During programming, each data "bit" is set to a 0 or 1 by trapping (or not) a tiny amount of electrical charge in the gate region of a field effect transistor (f.e.t.). The trapped charge cannot escape because it is completely surrounded with insulating silicon dioxide.

ERASING

To erase the EPROM is necessary to remove the trapped charge. This cannot be done by applying voltages to the pins, or by any other direct electrical method. It is achieved instead by making the silicon dioxide act like a photo conductive cell. Applying ultra-violet radiation of the correct (short-wave) type directly to the surface of the silicon chip causes the silicon dioide to become very slightly conductive, so allowing the trapped charge to leak away. This, of course, is the reason for the familiar "window" in the middle of EPROMS which allows the ultra-violet radiation to penetrate to the surface of the silicon.

The special short-wave ultra-violet radiation which (for the technically minded) has a wavelength of 2537 Angstrom units, is produced by a special type of tube, similar to a flourescent lighting tube, but without the white flourescent coating. The tube has a combination of mercury vapour and inert gas filling, and is made from a special "glass" that allows short-wave ultra-violet to pass. Ordinary tubes, and those used to expose photo-resist in printed circuit boards have little, if any, effect. A fully erased EPROM has all its bits set to "1" and so will read FF or 225 when in circuit. This seems "upside down", but has little practical significance.

CIRCUIT

The circuit diagram is shown in Fig. 1. A single transistor is used in a self-oscillating circuit to produce 120 volts peak to peak at 25kHz. The tube is driven from this high voltage via the current limiting inductor L1. An incoming 12V d.c. supply passes via D1, which protects against reverse polarity, and on to decoupling capacitor C4.

The current consumed by the circuit is just under 400mA so only a modest power supply is required. As the circuit draws current in large pulses at 25kHz the value of C4 needs to be quite large to maintain a clean supply rail. The important part of the circuit is T1, this is a tuned transformer with a step-up ratio of just under 6 to 1. The primary winding is of 9 turns and is connected between the supply and the collector of TR1. The secondary winding of 52 turns is wound on from the primary for convenience and is tuned by C2 to 25kHz. TR1 is made to oscillate by means of positive feedback supplied from the winding on T1 via C3, R3, and R2. Resistor R1 supplies a small base current to start the oscillator at switch-on.

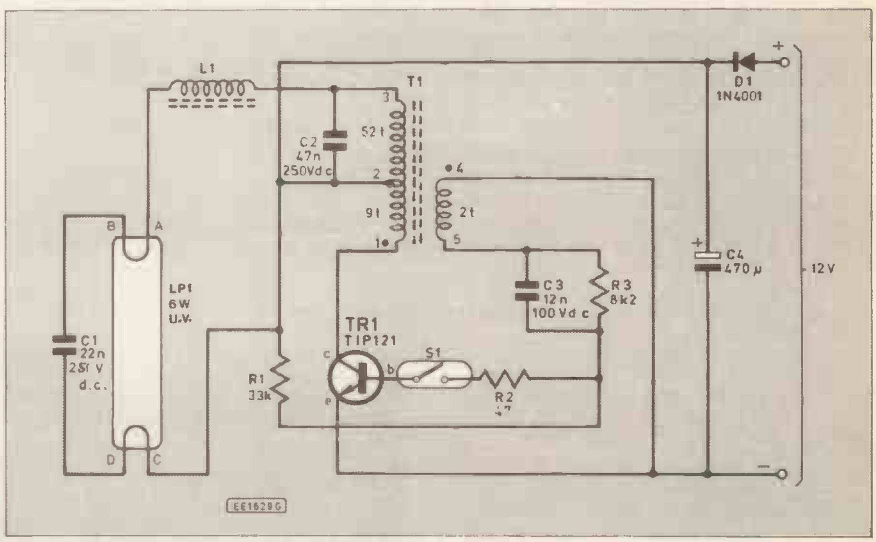


Fig. 1. Complete circuit diagram for the EPROM Eraser.

The short-wave ultra-violet radiation from the tube is harmful. To prevent possible exposure whilst changing EPROMS a simple interlock circuit is provided by a reed switch (S1) and a magnet. Only when the EPROM tray is slid into position can a magnet get close to the reed switch and close it. At first it was thought ideal to put the reed switch in the 12V supply line. The high initial surge current needed to charge C4 rules out this approach, however, because reed switches are unable to handle large currents and the switch would soon fail. By fitting the reed switch in series with the base of TR1 it is possible to switch the circuit on and off by means of a current in the region of 1mA.

This type of oscillator circuit is simple and reliable provided the correct values are used for all of the components. The values of C3 and R3 are particularly important as they determine the correct level of base drive for TR1. Over, or under driving TR1 results in reduced efficiency.

INDUCTOR

As mentioned before, the output from T1 is almost a sine wave of 120 volts peak to peak. This cannot be directly connected to the tube because of the nature of all gas discharge lamps. At low voltage the gas inside is not conductive and the tube behaves like an open circuit. At higher voltages the gas and vapour in the tube become ionised and the tube becomes a good conductor—so good that it will draw excessive current and destroy itself unless the current is limited by some external means. In this circuit the same principle is adopted as that used in domestic flourescent lights—a series connected inductor—or choke.

It is easier to use a series resistor instead of a choke, but the power loss in a resistor would be very high. At 25kHz a suitable inductor can be very small and simple to wind, so offering an easy, efficient means of current limiting.

The final component in the circuit, C1, is a very important one. In order to get the tube to "strike" it is necessary to apply a high voltage across the ends, and to heat the filaments at each end of the tube. The filaments (which are connected between the two pins at each end) are heated by a current passing from L1 via the filament AB, through C1 and then via filament CD back to T1.

At 25kHz the impendance of C1 is a few hundred ohms, and so it passes current reasonably well, however this is helped further by the fact that C1 and L1 together form a series tuned circuit that resonates close to 25kHz. The effect of this is to substantially increase the filament current and at the same time step up the peak voltage applied to the tube. As soon as the filaments are hot, the tube strikes, the voltage across it falls to around 20 volts r.m.s, and the resonant effect of L1 and C1 is damped by the effective resistance of the conducting tube. The current in C1 now becomes insignificant and all the power from L2 is delivered to the tube. This type of starting circuit is known as "semi-resonant start" and is employed on the more expensive types of domestic light fittings.

CONSTRUCTION

A lot of attention was paid to the "mechanical" aspects of the design to ensure a very high level of safety. **It is recommended that the case and type of construction used is followed closely as a substantial amount of care has been taken to get this right.**

The construction can be divided into two parts. One is the assembly of the printed circuit board and the tube into the "top" part of the case. The other is the mechanical slide arrangement which is fitted inside the "bottom" of the case. Those who recognise the type of case will appreciate that *it is being used upside down* in this application.

The details of construction of the slide arrangement which is built on the case lid are shown in Fig. 2 The material used in the prototype was 1.6mm thick printed circuit board material, but any type of insulating board is suitable, such as Paxolin, s.r.b.f. or s.r.b.p. material. Begin by cutting strips as shown in Fig. 2. These are cut slightly shorter than the case lid so that they clear the internal p.c.b. guides moulded into the case.

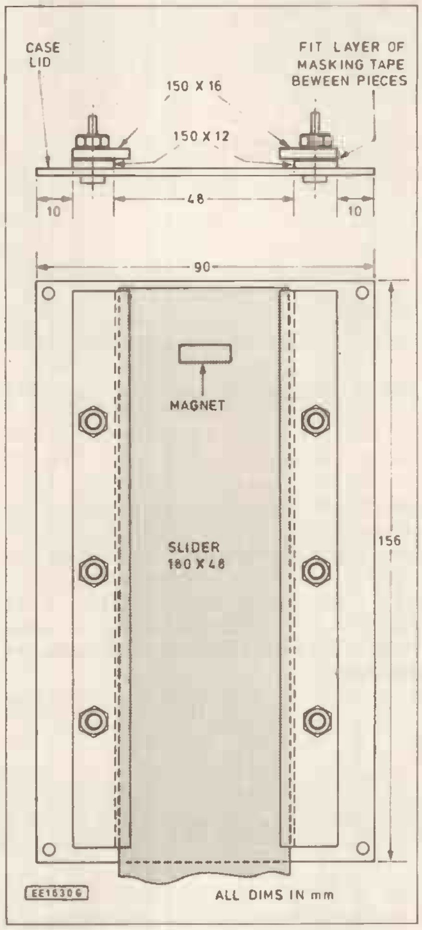


Fig. 2. Suggested method of slide construction.

Next cut a piece 180mm long×48mm wide for the slider which will carry the EPROMs and the magnet to operate the interlock reed switch S1.

The long edges of the slider and the inside edges of the two 150×12mm pieces should be smoothed with fine abrasive paper to ensure a smooth sliding action when assembly is complete. At this stage the slides should be fitted to the inside of the case lid. This is best done by fitting one side first, and then using the 180×48mm slider as a spacing guide to position the strips on the other side. A layer of masking tape or similar material between the two strips on each side will ensure ade-

COMPONENTS

Resistors

R1	33k
R2	47
R3	8k2

All ¼W carbon film

Shop Talk **See page 594**

Capacitors

C1	22n 250V d.c. polyester
C2	47n 250V d.c. polyester
C3	12n 100V d.c. polyester
C4	470μ radial elec. 16V

Semiconductors

D1	1N4001
TR1	TIP121 Darlington power transistor

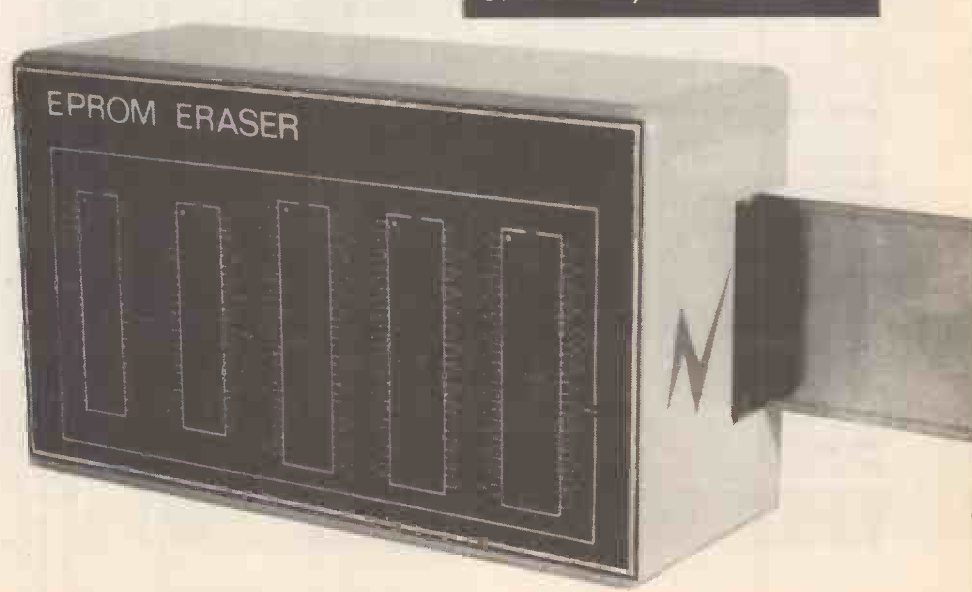
Miscellaneous

T1	Transformer core+28 s.w.g. wire
L1	Choke core+32 s.w.g. wire

(L1 and T1 are available as a pack of cores, formers, and wire from Magenta)

Printed circuit board available from the *EE PCB Service*, order code EE620; material for slides, slider, and tube mount; nuts and screws 7×M3 screws nuts and washers; 2×M3×25mm Nylon screws with nuts and washers; wire; glass reed switch; magnet; two 2-way terminal blocks to fit tube; tube, 6in. 4W short-wave U.V.; conductive foam; case; wooden block.

Approx. cost Guidance only **£25**



quate clearance for the slider to move easily.

To ease assembly it is useful to fit the whole thing together using strips of double-sided adhesive tape. The fixing holes can then be drilled whilst everything is in place, thus their correct alignment is ensured. Three sets of M3 screws, nuts and washers are sufficient to fix the slides permanently in position. Take care to position these as shown in Fig. 2 away from where the tube mounting boards are to be fitted.

TUBE MOUNTING

The next step in assembly is to make and fit the boards which hold the tube. Two boards are used as shown in Fig. 3, one at each end, fitted into the internal case slots. At one end, the board is the printed circuit (which should not have any components fitted at this stage). The board at the other end is a plain piece of Paxolin or other insulating board which is cut to the same size and has a matching hole 16mm in diameter. This piece is easier to make if the printed circuit board is used as a template. A rectangular cut-out in the plain board is also required, for the EPROMS to slide under, and a small notch must be cut in one corner to allow the two wires from the end of the tube to pass.

Check that the tube fits correctly and that the lid can be fitted (minus the slider). The tube mountings are held in place by the lid and two pieces of foam rubber stuck to the slides in the correct position will hold the tube mountings more firmly, and stop rattles.

The final cutting job is to make a rectangular cut-out in the end of the case for the slider to pass through. This should be 50mm×22mm as shown in Fig. 4. To protect the case and simplify marking-out, the case end should be covered with masking tape. The cut-out can then be made, and filed smooth before removing the masking tape.

A small hole is needed at the other end of the case to allow the power supply wires to pass through to the board. A 4mm diameter hole is adequate, positioned as shown in Fig. 4. Finally check the whole assembly with the tube and slider in position and make any adjustments necessary before moving to the next stage.

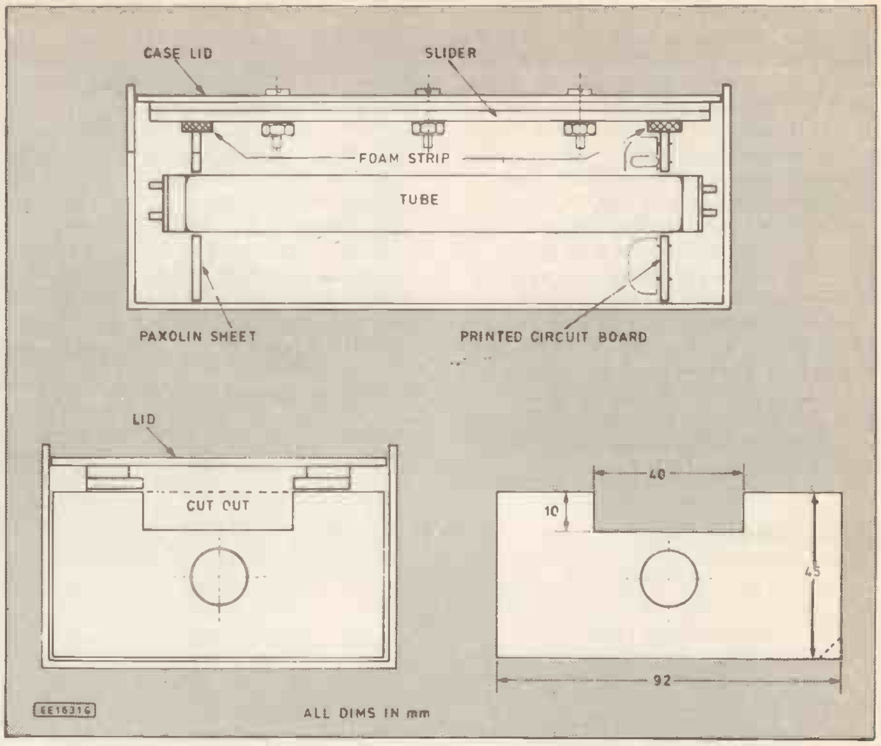


Fig. 3. Suggested arrangement for mounting the tube inside the plastic case.

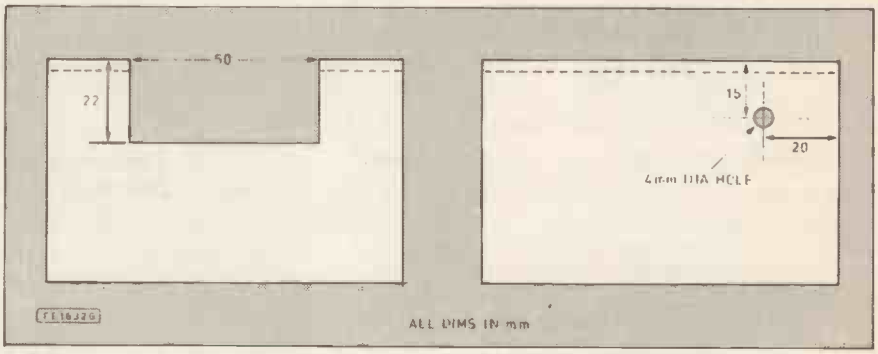
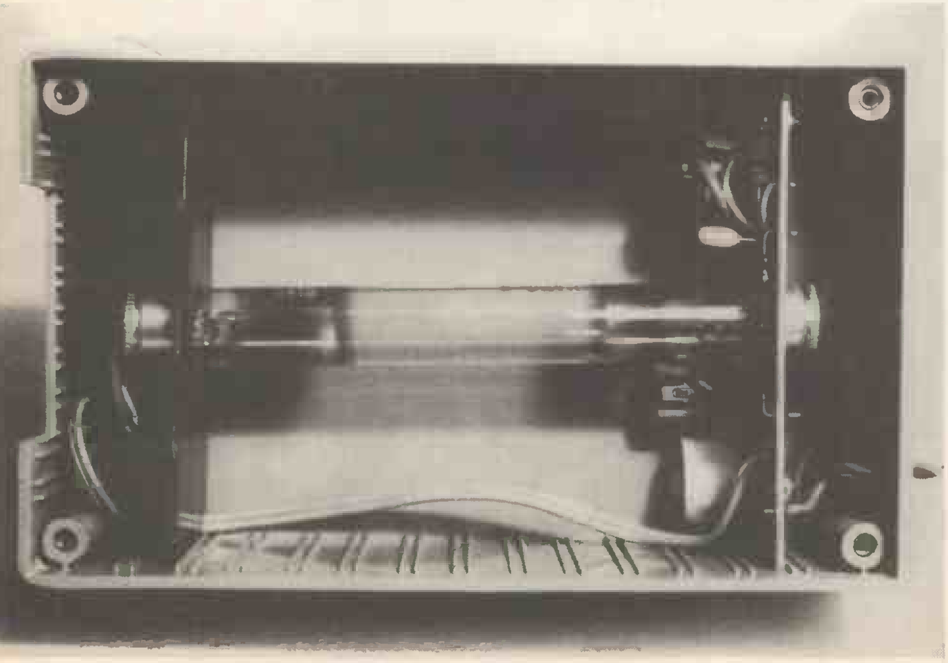


Fig. 4. Dimensions, cutting and drilling details for the ends of the case. Note that the slider cutout is the opposite end to the p.c.b.

The circuit board and tube mounted inside the case.



COIL ASSEMBLY

This type of inverter circuit is very dependent upon correct coil construction, and so every care should be taken at this stage. The choke L1 is wound from 32 s.w.g. enammelled copper wire on a single or multi-section coil former. 145 turns are required and are easily accomodated within the 18mm diameter ferrite pot cores specified.

Winding is simplified by using a "mandrel" which fits inside the coil former and allows it to be held easily. A ball-point pen case was found to be ideal when winding the prototype coils.

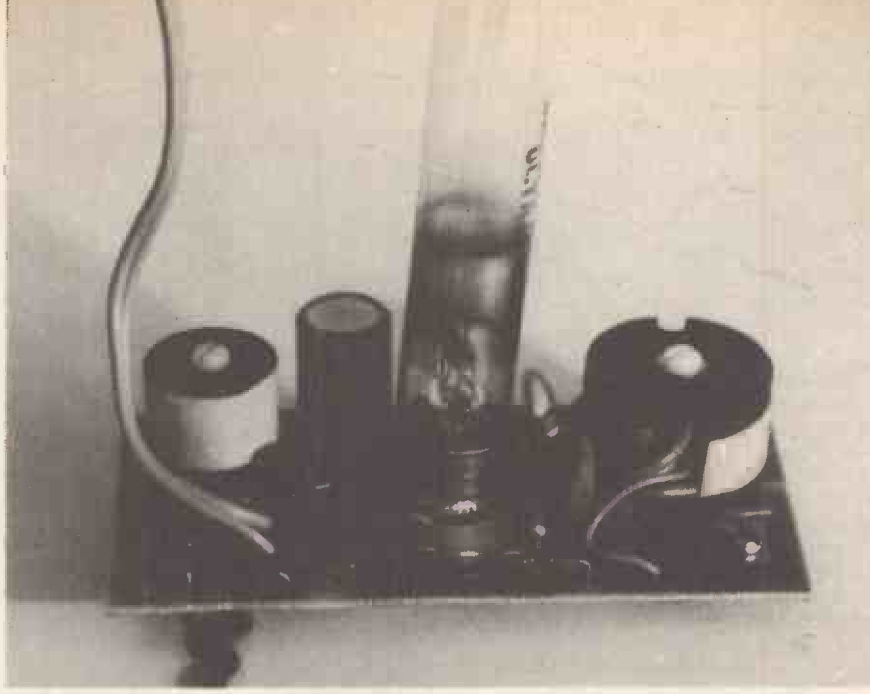
Wind the choke by building up the wire evenly across the former. There is no need to wind the coil in layers—in fact this is practically impossible by hand. All that is needed is an even spread of wire across the former. The start and finish of the winding must be brought out through the same gap in the ferrite core. A layer of insulation or masking tape over the completed coil will keep everything in place. Fit the two core halves around the coil, making sure that nothing is trapped between them and fix them together with a layer of type.

Next wind the step-up transformer T1. The main winding is made from 28 s.w.g. enamelled wire. Fig. 5 shows the winding in detail. Before begining, cut some lengths of masking tape the same width as the coil former sections and 10cm long. Start winding from the edge of the former with terminal number 1 and wind a single layer of nine turns. Cover this winding with a layer of tape and bring out a loop for about 80 cms through the same slot in the former as the start. Fit a second layer of tape, loop the wire back into the former and continue winding in the same direction until a further 52 turns have been added. If the specified two section former is used, wind 20 turns in the first section, and 32 in the second section. Tape over both sections and leave approximately 80mm of wire free at the end—this is terminal number 3.

FEEDBACK WINDING

The feedback winding is made from 1/0.6 or 7/0.2 insulated connecting wire wound as shown in Fig. 5b. The position of the winding is not important, but the vital thing is to get the direction right, and to label the ends correctly. The black dots next to wires 1 and 4 on the circuit diagram indicate the starts of each winding. Provided the windings are then made in the same direction everything else should follow automatically.

Secure the feedback winding with tape and fit the two halves of the 25mm pot core assemblies. As with the choke, ensure that the two halves are in close contact with nothing trapped between them, and that all five coil connections are brought out through the same gap in the cores. Tape the two halves together and prepare the three enamelled wire leads for assembly to the board.



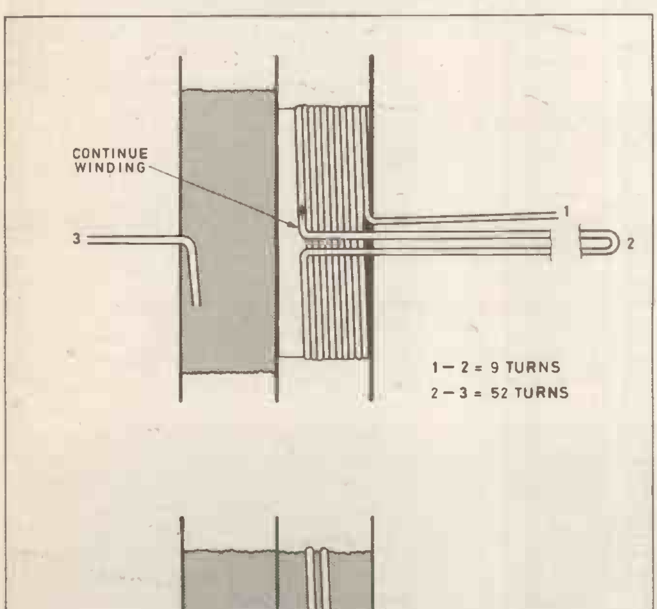
Close-up of the circuit board showing the reed switch S1 mounted on the front edge of the board. This board is available through the EE PCB Service, code EE620.

The type of enamel used on the wire is a self-fluxing solderable type, but it can still take some time to melt away and allow the wire to be tinned. In case of difficulty, drawing the wire through a small folded piece of fine abrasive paper works wonders and strips the enamel very easily. Note that connection number 2 is in the form of two wires, which should be twisted together after tinning. Fit a short length of insulating sleeving over each of the three leads, and the coil is ready for fitting to the board.

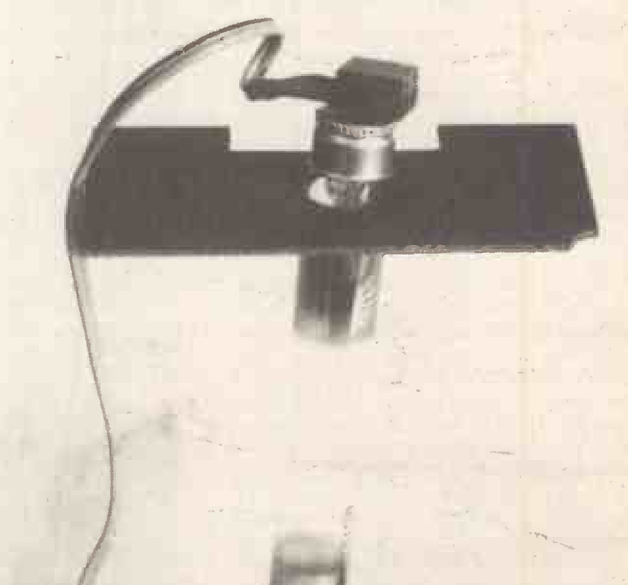
P.C.B. ASSEMBLY

There are very few components on the board, and assembly is simple. Refer to Fig. 6 for the component layout, and to Fig. 7 for the track pattern. Diode D1, and capacitor C4 are the only polarity conscious parts, so take care when fitting these. The wires to the power supply should be fitted to the rear of the board, as should the two tube wires which connect to the near end of the tube. A length of twin cable 220mm long to reach to the opposite end of the tube should be fitted

Fig. 5. Step-up transformer T1 winding details.



The completed circuit board, with the u.v. tube, prior to sliding it into the case side runners.



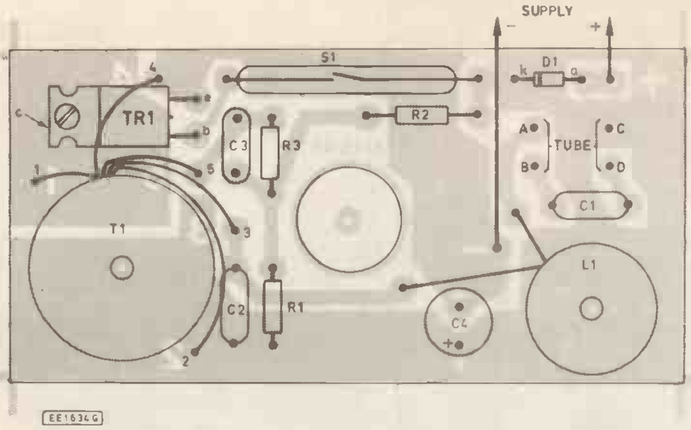


Fig. 6. Printed circuit board component layout. The centre of the board is cut out to take the u.v. tube.

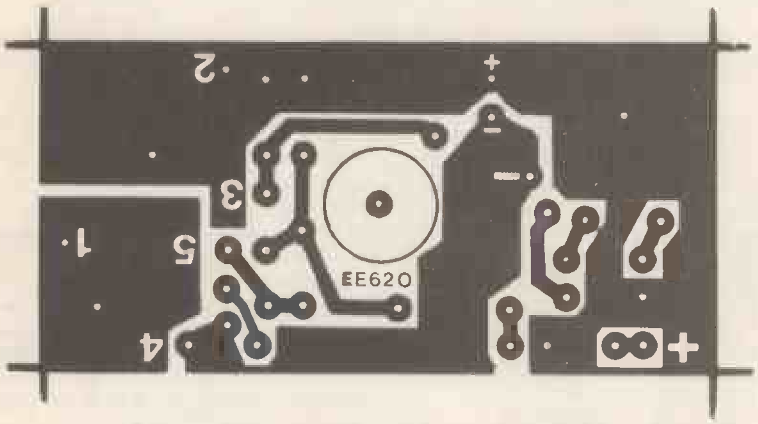


Fig. 7. Full size copper foil master pattern for the EPROM Eraser p.c.b.

on the component side. The power transistor TR1 is mounted on the board by means of an M3 fixing screw through the tab. This mounting also provides the collector connection, so do not use an insulating set. The actual collector lead—the centre one—can be removed from the transistor or bent out of the way.

The reed switch, which is mounted directly to the board, must have it's leads bent at 90° **This must be done very carefully**, as it is easy to fracture the glass envelope. The best method is to support each lead with a pair of pliers between the envelope and the point where the bend is made, then use another pair of pliers to make the actual bend.

The connections to L1 can be made either way round, but the five connections to T1 must be made exactly as shown. To make this easy the board has been marked on the track pattern with the corresponding wire numbers. The two coils are fixed to the board using M3×25mm nylon screws. **Metal screws must not be used because current will be induced into them, and there will be considerable circuit losses.** Metal nuts and washers can be used, as these are outside the cores.

The connections to the tube are made by means of two-way 90° p.c.b. terminal blocks. The wires are soldered onto these and the joints sleeved with 25mm lengths of close fitting p.v.c. sleeving. The terminals fit perfectly onto the tube pins and can be held firmly in place by gently tightening the screws. The tube can be fitted either way round.

TESTING

As there are no adjustments to make it is likely that the circuit will work first time, and all will be well. The most likely source of trouble is T1 and its connections, which can easily be mixed up. The circuit board can be tested before the tube is fitted to check the functioning of the oscillator. Tape the magnet to the reed switch and apply 12 volts. The current should be around 50mA, and a meter set to a.c. volts should read approximately 40V (which corresponds to 120V peak-to-peak) across C2.

If all is well so far, fit the tube, assemble the whole unit and attach the magnet to the slider so that it is directly under the reed switch when it is pushed fully home. Remove the slider and connect a 12V supply via a meter set to read 0 to 1 amp. Push the slider into place and the current should rise to approximately 350mA, fluctuating slightly as the tube strikes. To check correct operation, the tube can be viewed briefly through a piece of glass. **The short-wave ultra-violet radiation is harmful to skin and eyes, and so direct exposure should be avoided.**

Once correct operation has been obtained, assembly should be completed by fitting a small block of wood or other opaque insulating material to the slider so that it completely closes the case cut-out when the slider is in position. This, along with the reed switch ensures that it is impossible to view the tube, even by peering into the slot. A piece of black anti-static foam attached to the slider over its centre 100mm is ideal for holding the EPROMS whilst erasing.

OPERATION

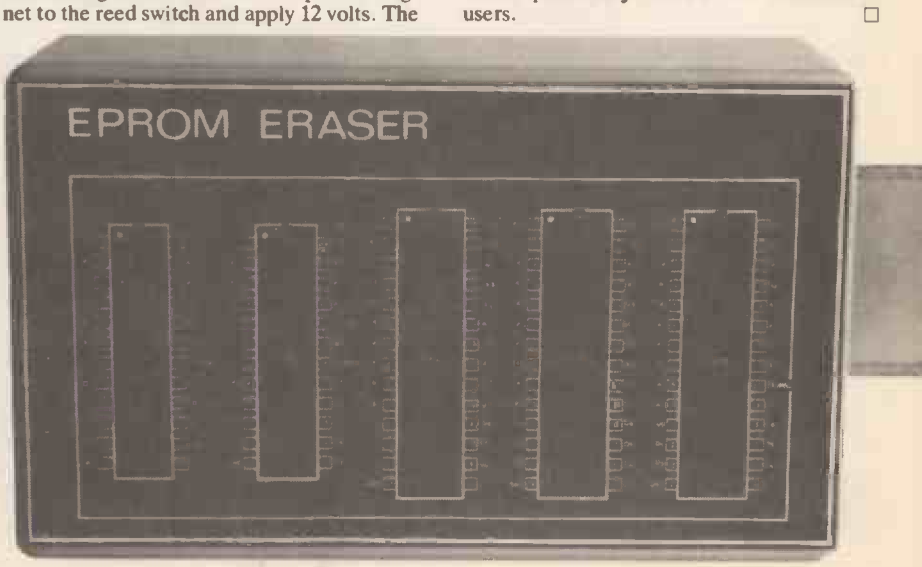
With a tube of this type running at full power it is normal to allow 20 minutes to erase EPROMS at 25mm from the tube. In this eraser the distance is slightly shorter, and the tube is slightly under-run, so the time should be about the same. With a new tube faster erase times are possible.

To test the operation, put a programmed EPROM into the eraser, and check it at two minute intervals. Once the EPROM is erased. (All locations read FF) record the time and then erase further for three times as long again. This ensures full erasure in all circumstances.

The level of radiation along the tube is not uniform and falls off towards each end. It may be possible to erase 4, 5 or 6 EPROMS in a row depending on the condition of the tube. A few tests will soon show the practical limits.

SAFETY

As already stated, safety was a major factor in this design. The highest voltage present at any time is 60V (120V peak-to-peak) and this is from a relatively high impedance source. In addition, construction is such that contact is impossible during use. The reed switch interlock makes contact with the tube radiation impossible. These factors make the eraser particulaly suitable for educational users. □



Constructional Project

SOLDERING IRON TEMPERATURE CONTROLLER

R. PENFOLD

There is no need to get overheated if you have trouble making the right connection. Master the art of good soldering, build this low-cost unit and be in full control.

THE most important skill for an electronic project constructor to master is the ability to produce reliable soldered joints. With modern solders, components and constructional methods this is certainly much easier than it used to be in the days when projects were largely hard-wired. If difficulties arise when making soldered connections these days, there are two likely causes. The first is using the wrong type of solder (a 60 per cent tin / 40 per cent lead multicored–type should be used for electronic work), and the second is over-heating of the soldering iron.

If over-heating of the iron is a problem it will probably soon become all too apparent. Keeping the bit well tinned with solder is likely to be very difficult, with the solder on the bit tending to rapidly go very dull in appearance as it oxidises. If the iron is left in its stand for a while re-tinning will almost certainly be necessary, and might prove to be difficult. Perhaps of more consequence, the quality of the soldered joints seems to be adversely affected. This is presumably due to the flux in the solder being burned away before it has a chance to take effect properly. Another unwelcome effect of over-heating is greatly reduced bit life, and possibly the premature destruction of the element as well.

PRODUCTION LINE

The reason for the excessive bit temperature that seems to afflict many soldering irons is probably that they are designed to be able to operate on production lines where soldered connections are often produced at a high rate for hours on end. This requires a powerful element to avoid having the bit "freeze" to the joints. Much electronic project construction is conducted at a much more leisurely pace, and with heat being extracted from the bit at a much lower rate it tends to overheat. A soldering iron stand designed to act as a heatsink and remove excess heat from the iron can sometimes effect a great improvement, but a more reliable alternative is to use a power controller such as the unit featured in this article.

Although the unit is quite simple, it provides sophisticated control with an output that is continuously variable from zero through to full power. The output is of the "burst-fire" variety. This is better than a basic lamp dimmer style circuit, as the latter generates radio frequency interference (r.f.i.) which is difficult to fully suppress. Even weak r.f.i. is unwelcome in an electronics workshop where it can make the testing of some pieces of equipment problematic. The "burst-fire" method of power control has an inherently low level of r.f.i. generation.

The controller could be used in other applications that do not involve output powers of more than about 200 watts, but it

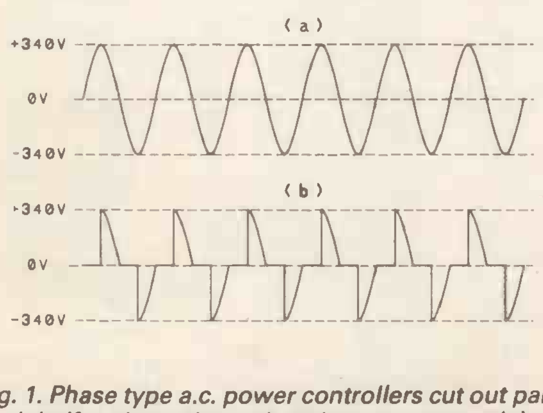


Fig. 1. Phase type a.c. power controllers cut out part of each half cycle to give reduced output power. (a) sinewave, (b) half power operation.

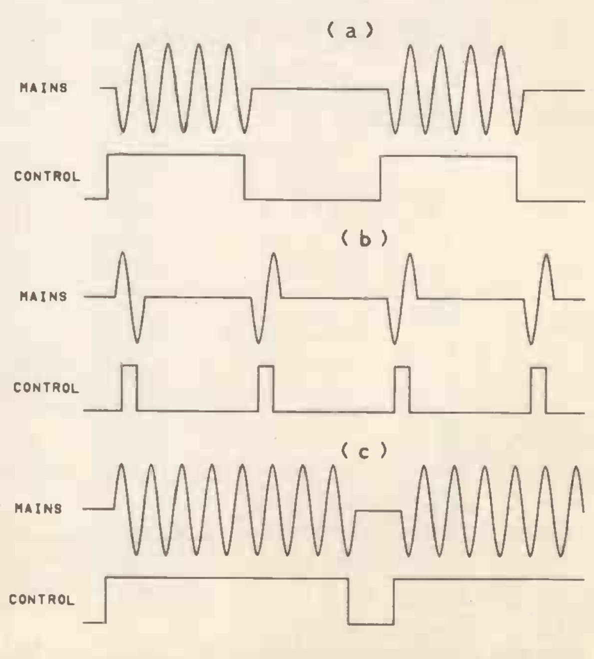


Fig. 2 (right). Example waveforms associated with "burst fire" power control.

has to be emphasised that this method of power control is not suitable for all types of equipment. It is well suited to the control of heating elements, but does not work properly with lamps. With the latter its effect is to flash the lamp on and off at a rate of a few Hertz, although I suppose the unit does have possible application as an interference-free lamp flasher.

CONTROL TECHNIQUES

Circuits that use the standard phase method of a.c. power control (which includes the vast majority of lamp dimmers) can be very simple indeed, but as explained previously, they tend to generate large amounts of r.f.i. This problem is at its worst when the unit is set at about half power. The mains supply is an a.c. type with a waveform that is a reasonably pure sinewave, as in Fig. 1a. The 50 Hertz sinewave signal contains only the 50 Hertz fundamental signal, with no harmonics or other output frequencies. In practice there will be some other frequencies on the output, but these should only be quite weak.

A phasing controller reduces the output power by cutting off the beginning of each half cycle, so that a waveform of the type shown in Fig.1b is obtained at half power. The cause of the strong r.f.i. is the almost instant rise from zero volts to 340 volts that occurs during each half cycle. This can produce strong signals at harmonics of up to 1MHz or more.

BURST FIRE

A "burst-fire" controller uses the alternative approach of supplying complete half cycles to the powered equipment, but when necessary the power is reduced by removing some of the half cycles. Fig. 2 shows the way in which this system operates. A low voltage pulse signal switches the mains signal on and off, and the output power is varied by altering the mark-space ratio of the output signal. For example, in Fig. 2a. the control signal is a squarewave having a 1:1 mark-space ratio. With the output switched off for 50 percent of the time only half maximum power is supplied to the load. In Fig. 2b and Fig. 2c the output is switched on for about 20 percent and 80 percent of the time respectively, producing corresponding output power levels. This is essentially the same method of control that is often used with small d.c. electric motors.

In its most crude form this system would not generate very much less r.f.i. than a simple phase controller. However, by using zero crossing switching, the level of r.f.i. generation can be reduced to practically nothing. If you carefully examine the waveforms of Fig. 2 you will notice that the a.c. output signal does not switch on and off exactly in sympathy with the control signal. The output does not switch on immediately, but is held off until a new half cycle is commenced. Similarly, the output does not switch off at once, but is held on until the current half cycle has finished.

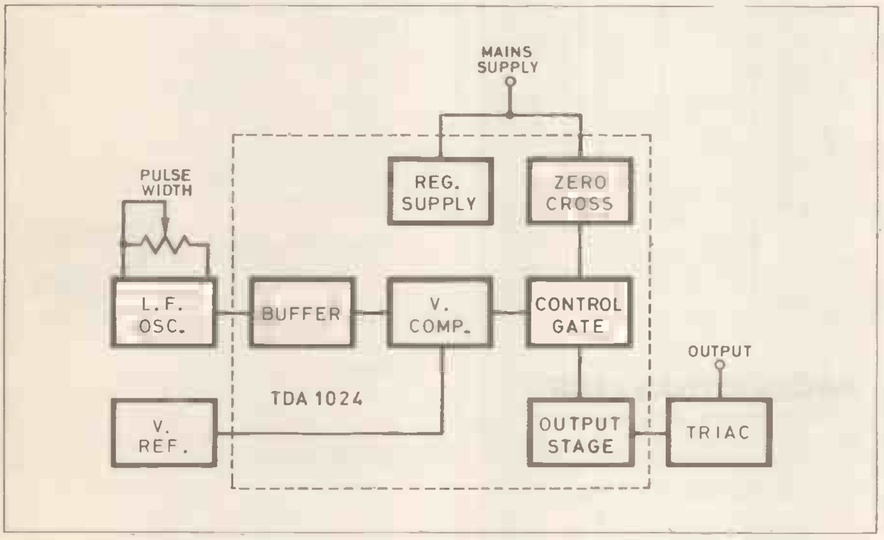


Fig. 3. Block diagram for the controller based around the TDA1024 triac i.c., incorporating zero crossing detection circuit.

With only complete half cycles fed through to the output there are no rapid jumps in voltage, and no strong radio frequency signals generated. The only real drawback of this system is that it only works well if the frequency of the control signal is much lower than the a.c. frequency. With 50 Hertz mains this means having a control frequency of about five Hertz or less. This gives an output that is unsuitable for some types of load, and the flashing effect with lamps that was mentioned earlier. It is a system that works perfectly well with heating elements though.

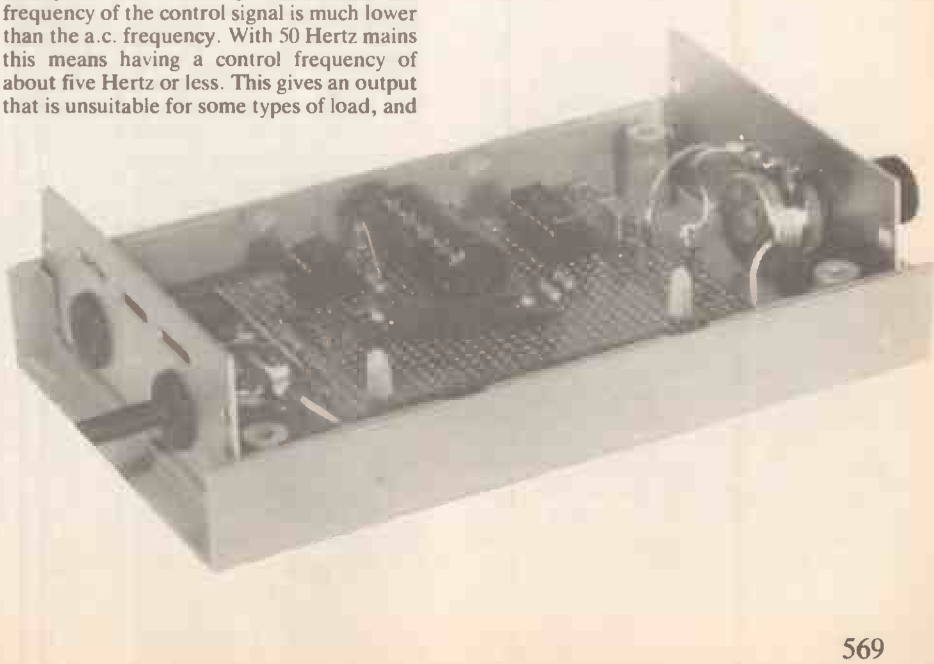
SYSTEM OPERATION

The block diagram of Fig. 3 shows the overall make-up of the unit, and helps to explain the way in which it functions. It is based on a TDA1024 integrated circuit, which is a triac controller that incorporates a zero crossing detection circuit. The blocks within the broken lines are those provided by the TDA1024.

The control signal is produced by the low frequency (l.f.) oscillator. This incorporates a timing circuit that permits the mark-space ratio to be varied over very wide limits so that the output power can be varied from virtually zero to almost full power. The output signal from this circuit is always a pulse type, and it never goes continuously high or low. This means that the output power cannot be adjusted right down to zero, or fully up to maximum, but in practice the errors are so small as to be totally unnoticeable.

A voltage comparator has one input fed from a reference voltage, and the other fed from the oscillator via a buffer amplifier. In this application these three stages are superfluous since the output from the voltage comparator will not be significantly different to the signal provided by the oscillator. However, this is the only way of coupling the oscillator signal through to the control gate stage, since the TDA1024 does not permit direct access to this stage.

The control gate is really just a form of AND gate. It only provides a high output signal level if it receives suitable input levels from both the voltage comparator and the zero crossing detector. The latter only provides a suitable signal when it detects that the mains voltage is at zero, or more precisely, at a potential of only about 1 volt or less.



Therefore, once a high ouput level has been received from the comparator, the control gate will not provide a high output level until a zero cross-over of the mains signal has been detected.

OUTPUT STAGE

An output stage provides a trigger pulse of adequate drive to activate a triac. A triac is a bidirectional semiconductor switching device that can directly control a.c. loads. In this type of application it has the useful property of remaining in a state of conduction once it is triggered, even if the gate signal should cease. The device only switches off when the current passing through it drops to a very low level. With an a.c. supply this occurs at the end of each half cycle. The triac effectively provides zero-crossing detection and automatic switch off at the end of each half cycle.

The TDA1024 contains the main components for a simple regulated power supply, and this is used to power both its internal and the external circuits.

Unlike a diode, a voltage dependent resistor is bidirectional, and a single device will suppress noise spikes of either polarity.

IC1 is a CMOS 4001BE quad 2 input NOR gate, but in this circuit one of the gates is left unused, and the other three are connected to function as simple inverters. IC1a and IC1b are connected in what is virtually the standard CMOS astable configuration. The circuit only differs from the standard set up in that the timing resistance has been replaced by VR1, R1, R2 and steering diodes D1 and D2. This effectively gives separate timing resistances on each set of output half cycles. With VR1 at a central setting the two resistances are identical and the output signal is a squarewave. Setting VR1 off-centre results in one timing resistance being increased, while the other resistance is reduced by the same amount. This permits the mark-space ratio of the output signal to be varied over wide limits, but as the total timing resistance remains constant, so does the output frequency.

trimmed down from a larger piece using a hacksaw, or a standard 24 track by 37 hole board can be used with one track being ignored. Details of the board and wiring are provided in Fig. 5. Make the 18 breaks in the copper strips before fitting any of the components to the boards. The breaks can either be made using the special tool, or a hand-held twist drill bit of about 4 millimetres in diameter is a suitable alternative.

BOARD CONSTRUCTION

Construction of the board is not particularly difficult, but in view of the fact that the circuit connects direct to the mains supply it is important to go very carefully, and thoroughly check the finished board for errors. Mistakes could result in costly damage to the unit, and could be dangerous. Try to avoid accidental short circuits between tracks due to excess solder, and thoroughly check the finished board for these. IC1 is a CMOS

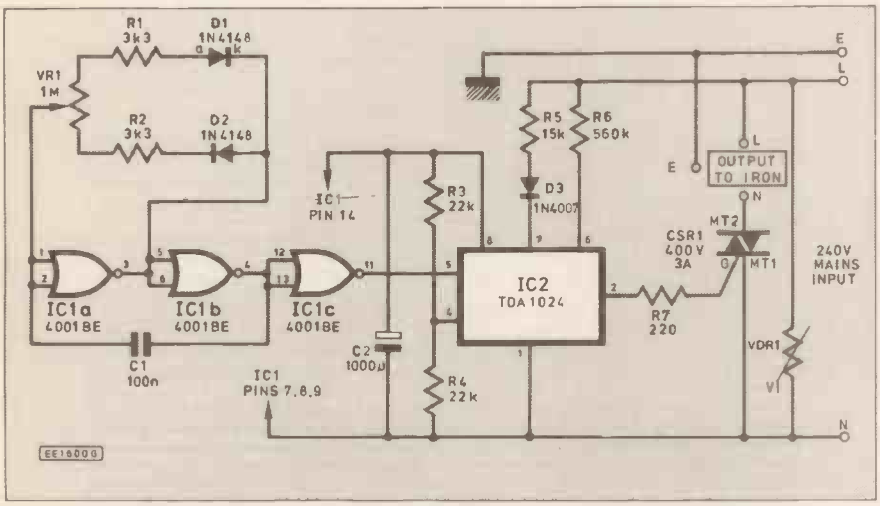


Fig. 4. Full circuit diagram for the Soldering Iron Temperature Controller.

CIRCUIT OPERATION

The full circuit diagram for the Soldering Iron Temperature Controller appears in Fig. 4.

Only two discrete components are needed in the power supply circuit. These are dropper resistor R5 and smoothing capacitor C2. D3 is an optional power supply component, and its only effect is to reduce the power dissipation in R5. Resistors R3 and R4 form a potential divider across the supply rails, and this provides the reference voltage for the voltage comparator. R6 loosely couples the mains supply to the input of the TDA1024's zero-crossing detector circuit.

The output of IC2 drives the triac (CRS1) via current limiting resistor R7. Although rated at three amps, unless it is fitted with an adequate heatsink the current through CSR1 should be limited to no more than about one amp. VDR1 is a voltage dependent resistor, and this normally has no effect. However, if the peak mains voltage should exceed more than about 350 volts due to the presence of noise spikes, the resistance of VDR1 will drop from its normally very high level to a much lower figure. This clips the noise spikes in much the same way as a diode clipper stage in audio circuits, and it prevents the noise pulses from damaging the main circuit.

CONSTRUCTION

It has to be explained at the outset that the way in which this circuit connects to the mains makes it essential to regard the entire circuit as "live". **None of the components or wiring should be touched when the unit is connected to the mains supply**, and this project **must be constructed in a way that makes it safe to use**. The main safety points to watch are that the unit is not housed in a case which has a clip-on lid or cover that could easily be removed to expose dangerous wiring, and that **VR1 is properly earthed**. VR1 is mounted on the front panel, and if this panel is metal **it must also be earthed**. VR1 should be fitted with a plastic control knob and not an aluminium or other metal type. Also, VR1 should be a type having a plastic spindle and not a metal spindled type. Fortunatley, virtually all potentiometers seem to be of the plastic spindled variety these days.

The case used for the prototype is a plastic type having an aluminium front panel. It has approximate dimensions of 90 by 41 by 145 millimetres, which seems to be about ideal. The rear panel is drilled with holes for the mains input and output leads. Both of these holes should be fitted with grommets to protect the cables, which should be clamped.

Apart from VR1 the components are all mounted on a 0.1 inch pitch stripboard which has 37 holes by 23 copper strips. This can be

COMPONENTS

Resistors

R1, R2	3k3 (2 off)
R3, R4	22k (2 off)
R5	15k 7 watt
R6	560k
R7	220

All 5% ¼ watt carbon film except where noted

Potentiometer

VR1 1M lin

See page 594

Capacitors

C1	100n polyester layer
C2	1000µ axial elect. 10V

Semiconductors

IC1	4001BE CMOS quad 2 input NOR
IC2	TDA1024 zero crossing switch
D1, D2	1N4148 (2 off) silicon diodes
D3	1N4007 1000V 1A rectifier
CSR1	C206D 400V 3A triac

Miscellaneous

VDR1 mains transient suppressor.

Case about 90×41×145mm with screw fixing lid (see text); 0.1 inch pitch stripboard 37 holes by 23 tracks; 8 pin d.i.l. i.c. holder; 14 pin d.i.l. i.c holder; plastic standoffs; plastic control knob; grommets; cable clamps; wire; solder; mains lead; pins; etc.

Approx. cost Guidance only **£12**

device and it should, therefore, be fitted in a holder. Do not fit it into the holder until the unit is in other respects finished. IC2 is not a MOS device, but it is not a very cheap type either, and I would also recommend the use of a holder for this component.

Several link wires are needed, and these can be made from the wire trimmed from resistor and capacitor leadouts. At this stage only pins are fitted to the board at the points where off-board connections will eventually be made.

Resistor R5 has to dissipate quite a lot of power, and must have a power rating of at least four watts. A seven watt component seems to be the smallest type that is readily available in the correct value and provides an adequate rating.

The completed component panel is mounted on the base panel of the case using plastic stand-offs. The hard-wiring is then added, using ordinary multi-strand insulated connecting wire. If VR1 is mounted on a metal panel, both VR1 and the panel can be earthed via a solder tag bolted to the panel. An alternative is to make a connection direct to the body of VR1, and there seems to be little difficulty in making a reliable soldered connection provided the area to which the connection will be made is scraped clean first. If VR1 is mounted on a non-metallic panel this second method is probably the only practical method of earthing VR1.

If the soldering iron fed from the output of the unit has an earth connection it is essential to connect this to the 'E' output of the unit. The output of the unit could be taken to a free-standing mains outlet, or a larger case could be used so that there would be sufficient space to accommodate a mains outlet on the top panel. If the controller will only be used with one soldering iron it is cheaper and easier simply to connect the iron direct to the controller.

TESTING

Thoroughly check all the wiring before fitting the lid in place and connecting the unit to the mains supply. **Never have the unit connected to the mains when the lid of the case is removed (even if the mains is switched off at the socket).** It is helpful to have the output set at maximum initially so that the iron warms up as quickly as possible. Once the iron has reached working temperature, backing off VR1 should prevent over-heating from occurring. In fact with VR1 set well in an anti- clockwise direction the iron should start to cool off again, but there will always be a substantial delay before the iron responds to changes in the setting of VR1. This is due to the characteristics of soldering irons rather than any fault in the controller.

You may prefer to connect the output of the unit to a table or desk lamp for initial test purposes. This should immediately respond to adjustments to VR1, but as explained previously, the lamp will flash at low and medium power settings and will not be subjected to a conventional dimming action. This method is still a good one for test purposes as it will quickly show whether or not the unit is functioning correctly.

Finding the ideal setting for VR1 is very much a matter of trial and error, and the unit may be in use for some time before a decision is reached. Having located the optimum setting, mark it clearly on the front panel so that the unit can be quickly reset when necessary. Remember that the power can be increased if a lot of connections or some larger joints are to be made, and backed off again when the iron is only going to be used intermittently. □

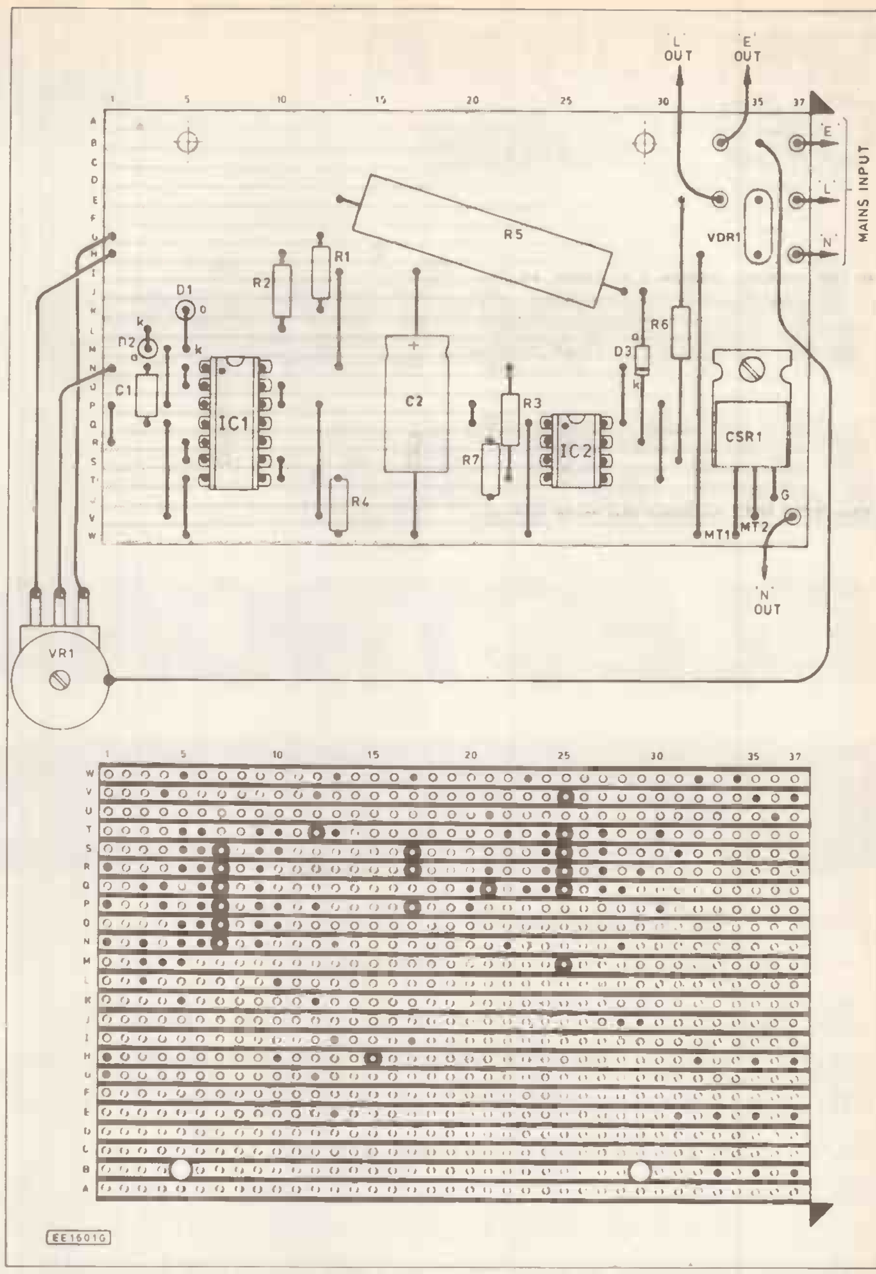
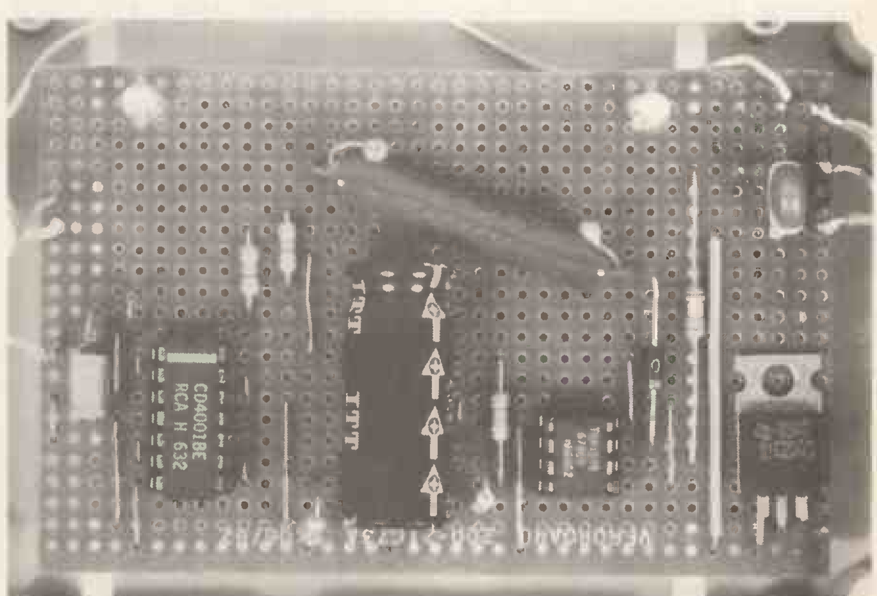


Fig. 5. Stripboard component layout, interwiring and details of breaks required in underside copper strips. (below) The completed board showing the high wattage resistor R5.



City and Guilds

C&G

Certificate Course

Introducing DIGITAL ELECTRONICS

Part 1: Important Concepts

By Michael J. Cockcroft
Training Manager, Peterborough ITeC

This series of twelve articles has been designed as a complete course for the City and Guilds Introductory Digital Electronics syllabus (726/301). Full details on registering for C&G assessment, details of assessment centres, components required and information on the course in general are give in the 16 page booklet provided free with this issue.

The City and Guilds introduction to module 726/301 reads: "A candidate who satisfactorily completes this module will have a competence to identify basic components and digital integrated circuits and connect them together to form simple working circuits and logic units". This provides an excellent introduction to our series.

THE subject of electronics is diverse; it may, however, be divided into two major areas:

(a) Digital
(b) Analogue

Computers, calculators, and digital watches are systems containing circuits built with mainly digital electronic components; and televisions, radios, and music systems (excluding CD systems) are concerned mainly with analogue signals and usually contain few, if any, digital electronic components.

Although any electronic system can be devised without digital component parts, no electronic system is made up entirely of digital components. For this reason treatment of both digital and analogue concepts are included in the course.

This first of a twelve part series aims to provide readers with an overview of some of the more important ideas contained in the City and Guilds 726/301 syllabus. In particular, we focus on some basic principles of electricity and electronics divided into the following subsections:

What is Electricity?
Current
Voltage
Voltage Sources
Circuits
Electric or Electronic?
Circuit Diagrams
The Switch
Electronic Signals

What is Electricity?

What is electricity? For our immediate purposes electricity may be regarded as the general term used to describe the "thing" which causes electrical devices like the appliances in Fig. 1.1 to operate; it may be thought of as a form of energy.

This energy, unlike other forms of energy such as heat and light, cannot be observed by our senses in the normal way; we cannot see it, feel it etc.; we can only observe the changes that occur in physical objects as a result of electricity being applied to them. When household appliances are connected to the domestic supply we can easily determine that electricity is present because of the resulting physical changes taking place—the hairdrier

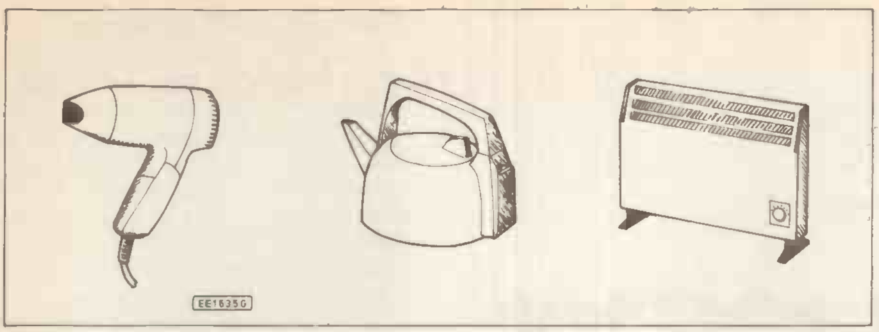


Fig. 1.1. Various electrical appliances.

blows, the kettle boils, and the heater gets hot; but we cannot in any way observe the *electricity* itself that is causing these things to happen.

To understand electricity, then, we must learn to accept certain principles at face value—we must realise that certain conditions exist and certain things happen simply because *they do*. Here is a notion to test your ability to do this:

Contrary to what our limited physical senses try to tell us, nothing in this world is solid or continuous, everything is made up of tiny particles separated by space (even water and air). These tiny particles are called atoms, they are so small they cannot be seen even under the most powerful microscope. There are millions of atoms even in the smallest piece of matter such as a grain of sand or salt.

The atom can be visualised with the help of Fig. 1.2. Every atom consists of a central nucleus surrounded by a number of orbiting electrons (the actual number of electrons depends on the matter to which the atom belongs). This can be likened to the solar system where planets (electrons) orbit the sun (nucleus).

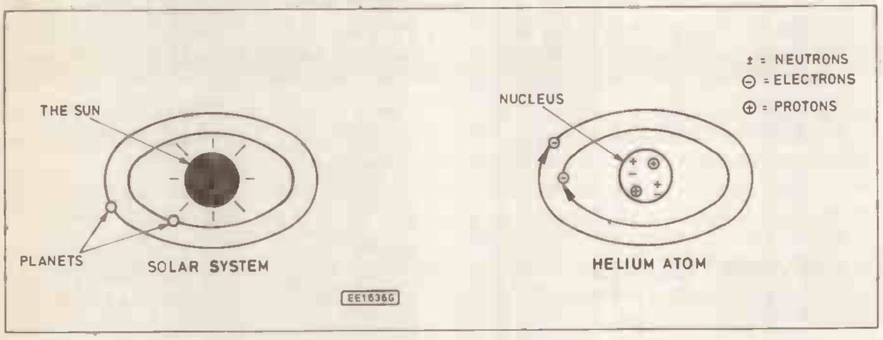


Fig. 1.2. The solar system and the atom.

Current

Electricity is the effect on certain materials when electrons flow like water within them. The science of electricity and electronics establishes methods of *controlling* the direction in which electrons flow. A steady flow of electrons in one direction is called an electric **current**.

Current is measured in terms of the electrical unit Ampere (usually abbreviated to Amp).

One way to get electrons to move in, say, a length of copper wire is to apply heat to it as depicted in Fig. 1.3. However, this kind of electron movement is not *controlled*, the heat causes electrons to scatter in many different directions as shown. So, heat cannot be used in this way to establish a steady flow of electrons.

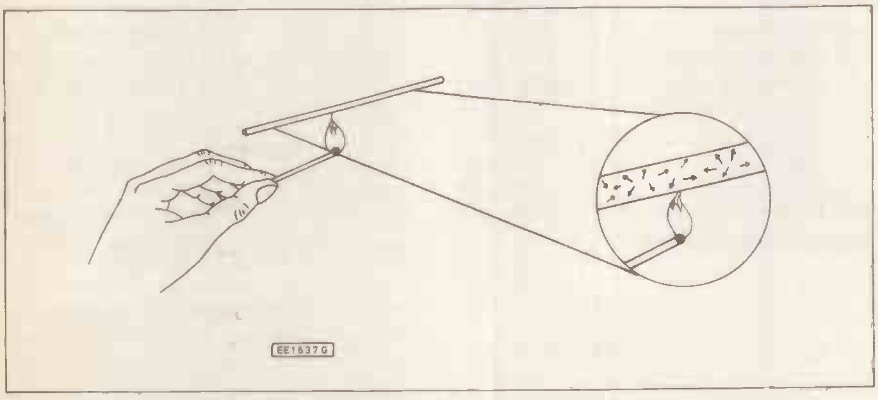


Fig. 1.3. Heat will make electrons move randomly.

Voltage

Heat can be used as an energy source for creating a current of electrons and this is shown in Fig. 1.4a. An energy source such as this develops what is termed a **voltage** which is the force that moves the electrons. Electrical energy sources are often called voltage sources.

The electrical unit for voltage is the volt.

The voltage source in the figure is made up of two plates of unlike metals. The two plates, one of antimony (x) and the other of bismuth (y), are joined together at one end and heated up. If now the same length of copper wire from Fig. 1.3 is bent and touched to the two terminals at the cool end of the device (Fig. 1.4(b)) a current of electrons will flow from the x-plate, through the copper wire to the y- plate.

Copper is a **conductor** of electricity. Conductors allow electrons to flow easily and are used for transferring them from one place to another. Materials through which electrons do not easily flow are called **insulators**. Rubber and plastic are insulators.

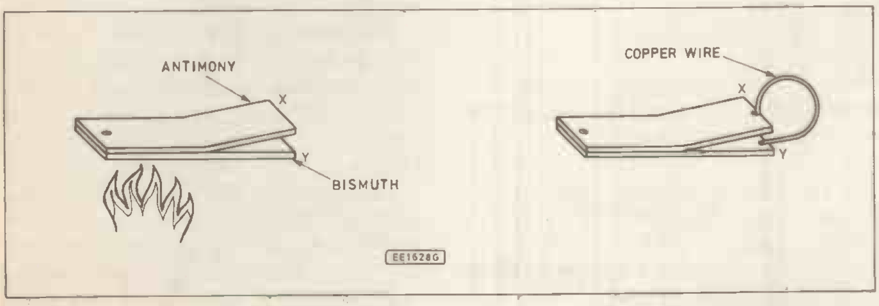


Fig. 1.4. Heat can be used to create electricity.

Of course, just an electric current in a copper wire is of no practical use, we will come to this point in a moment; but first the voltage source of Fig. 1.4 requires a little more explanation:

When the junction is heated electrons scatter from both metals across the join. Because the atoms of each metal are different (i.e. their atomic structures differ) more electrons pass from the x-plate to the y than in the other direction.

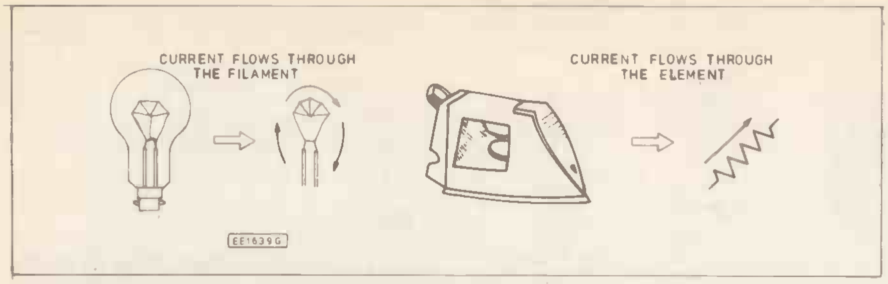


Fig. 1.5. Current must flow through the "component" in order for it to perform its function.

this results in the y having an excess of electrons with respect to the x.

Whenever there is an excess accumulation of electrons at one point with respect to another point, a voltage exists—the greater the difference between the two points the greater the voltage (this is why voltage is often referred to as **potential difference**).

Voltage Sources

The purpose of a voltage source, such as this one of Fig. 1.4, is to provide a continuous supply of electrical energy. This is achieved here by keeping the joined end of the device at a higher temperature, thus the unequal movement of electrons from each plate maintains a steady potential difference.

Batteries and the home "mains" electricity supply are the most commonly used and well known sources of voltage. The primary difference between one type of voltage source and another is the actual amount of energy they make available. The types of batteries in widest use are 1.5 volt, 9 volt, and 12 volt; and the domestic electricity supply in England is 240 volts.

Since voltage is the driving force behind the movement of electrons, the greater the voltage the greater the potential for moving electrons and creating higher currents. The heat generated voltage source in the above figure is capable only of very small voltages (just a few millionths of a volt); although it has an important application in electronics, it was included here only to simplify some of the difficult to visualise ideas.

Circuits

As promised, we now return to Fig. 1.4(b) to look a little deeper into current flow. This diagram depicts a voltage source with a length of copper wire connected in such a way that there is a complete path through which electrons flow. The part of the voltage source containing the excess accumulation of electrons is called the **Negative** terminal and the part with a lack of electrons is the **positive** terminal.

Theoretically, Fig. 1.4(b) contains all that is necessary to create an electric current. It contains a potential difference between the two terminals of the voltage source, and a complete path through which electrons can flow. This forms what is called an **electric circuit**.

In practice, however, in forming a useful electric circuit an additional part is required: a "device" or "component" which makes a conversion from electrical energy to a purposeful other kind of energy such as heat or light. One such component is a light bulb filament, and another is a clothes iron element, both shown in Fig. 1.5.

These components are "electrical" rather than "electronic" components. The difference is explained later.

Electric current must flow *through* the component in order for it to perform its function. This means that it must be connected in the circuit as *part of the circuit*. To understand what is meant by this, consider Fig. 1.4(b) yet again and imagine that the voltage source is powerful enough (which it is not) to make the Iron element of Fig. 1.5 operate (i.e. to make it get hot). If now the copper wire were replaced by the element, the element would be part of the circuit and the current would flow through it. Similarly, if the filament in Fig. 1.5 were made part of a circuit containing an appropriate voltage source, current would flow through the filament making it white hot and thus producing light.

Electric or Electronic

Because the newcomer to electronics is more likely to be familiar with domestic appliances rather than electronic systems we have, up to this point, only used "electrical" components in our examples. This is about to stop. But before we say goodbye to "electrical" in favour of "electronic", we had better explain the difference between the two.

The truth of the matter is that there really is not a lot of difference. Both electrical and electronic components need to be placed in a circuit with a voltage source in order to function—current must flow through them in order for them to operate. Having said that, however, electronics engineers are not often found working on electric drills or wiring houses; nor are electricians very often found designing computers or repairig televisions.

There is no formal difference between electrical devices and electronic components; but it is conventional to regard the parts of household and industrial equipment like washing machines, lawn mowers, etc. as electrical; and the parts of televisions, hi fi systems, computers and the like (these are resistors, capacitators, diodes etc. and are the subject of next month's lesson) as electronic.

A practical exercise is appropriate at this point. We will be using the assembly of Fig. 1.6, the parts for which are included in the list given in the booklet. If you haven't purchased these you may be able to compromise in some way with components you already have available.
available.

The parts for the assembly are supplied to you in three basic parts: (a) PP3 battery, (b) bulb holder with battery clip and crocodile clips, (c) bulb. Press the clip firmly onto the terminals of the battery (it will only engage one way) attach the crocodile clips to the bare tinned copper wire inside the leads and screw in

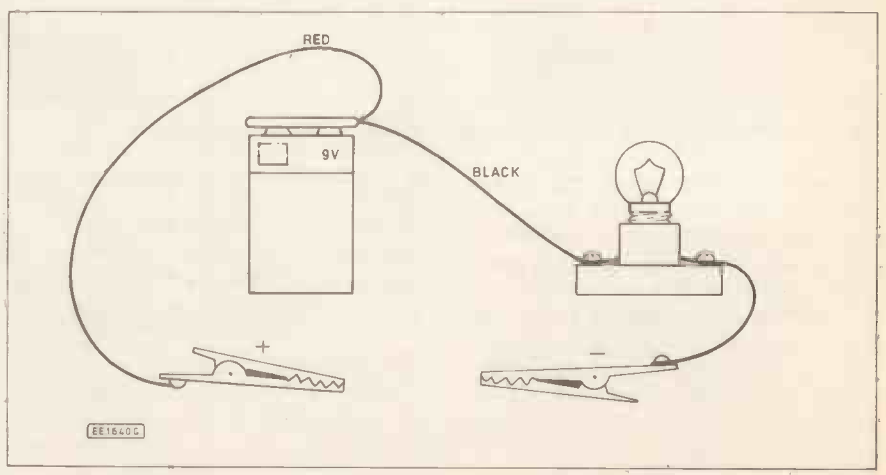


Fig. 1.6. Demonstration assembly to show current flow.

the bulb so that your assembly looks something like that of Fig. 1.6.

If the crocodile clips are not touching, the bulb will be off, we will leave it in this condition for a moment while we study the component parts and how they are connected to form an electric circuit.

The primary parts of the assembly are the voltage source (battery), the conductors (wires), and the component (bulb); one item from each of these three categories is the minimum requirement for any electric circuit (from now on we will refer to an electric circuit simply as a "circuit"). The voltage source provides a potential difference between its terminals, the conductors provide a line along which electrons can move, and the component provides a function for the circuit (in this case converts electrical energy into light). The remaining parts, the bulb holder and the crocodile clips, are included as a convenient way of connecting the components to the conductors.

Circuit Diagrams

Circuits are usually expressed and described with the aid of circuit diagrams. Circuit diagrams are a convenient way of showing the interconnection of components within a circuit using circuit symbols and ruled lines. Fig. 1.7 is the circuit diagram for this exercise as a direct replacement the drawing of Fig. 1.6. The battery symbol is marked 9V, the bulb is unmarked, and the wires (or conductors) are represented by straight lines. Note that parts which do not alter the function of a circuit (in this case, the crocodile clips and bulb holder) are not included in circuit diagrams.

Now touch the two crocodile clips together. By doing this a complete path has been made for electrons to flow and the bulb illuminates. Electrons flow from the negative terminal of the battery, through the black wire, through the bulb filament via the bulb holder, through the wire at the other end of the bulb holder and the two crocodile clips to the red wire, through this to the positive terminal of the battery to complete the circuit. Now electrons flow inside the battery from positive to negative and through the black wire again and so on, repeating the same trip again and again the whole time there is a complete circuit. A complete circuit such as this is called a **closed circuit**.

Now separate the crocodile clips so that they are no longer touching. The circuit is now broken and the bulb is off—an **open circuit** condition. If the path for electrons is broken at any point there will be an open circuit and current will not flow; removing the bulb, for example, breaks the circuit because the filament is part of the circuit. It may appear that the bulb holder alone completes the circuit but it doesn't: all but the metal parts of the holder are made of insulating material (nonmetals hardly ever conduct electricity). Examine very closely all the component parts of the circuit and convince yourself that the path for electrons is a metal path. Note, for example, that the insulating material coating the copper wire has to be stripped back at the terminals of battery, bulb holder, and crocodile clips.

The Switch

Components and British Standard circuit symbols are part of next month's lesson, but we will introduce one more component and it's symbol before we move on. Placing a switch into the circuit of Fig. 1.7 transforms it into a "torch" and changes the circuit diagram to that shown in Fig. 1.8.

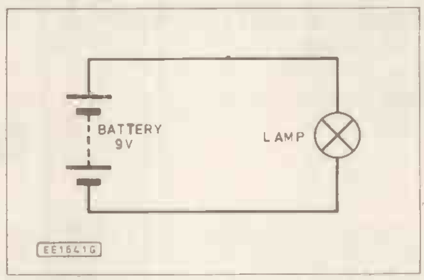


Fig. 1.7. Circuit diagram for Fig. 1.7.

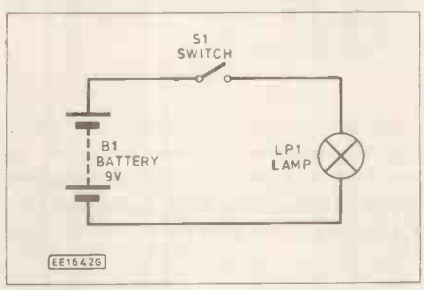


Fig. 1.8. Adding a switch in circuit.

A toggle switch is included as part of the kit, locate it and connect it to the assembly by clipping one of the crocodile clips to one of the metal switch terminals and the other clip to the other terminal (it is not important which clip goes to which terminal). Sometimes, when connecting components into a circuit it is important to observe **polarity**—this means that if the component is polarised attention must be paid to the orientation of the component in the circuit, the component terminal "+" must be connected to the part of the circuit which is most positive.

Electronic Signals

What is an electrical signal? Any kind of signal is some kind of sign indicating a message; for example, a traffic signal conveys one of three messages depending on the colour (or position, if one is colour blind) of the illuminated light source. An electrical signal is similar in that it conveys one of a number of messages depending on the size of voltages or currents at particular points around a circuit.

Many times, in electronic systems, the message is interpreted not only by the size of the signal at a physical point in the circuit but also in terms of the signal's size at a particular time.

The number of actual voltage (or current) levels that can be detected depends on whether the electronic system is analogue or digital. Digital systems are really counting systems and are able to distinguish only between two levels of voltage ("on" or "off", "true" or "false", "yes" or "no", "high voltage" or "low voltage"). Analogue systems, on the other hand, are measuring systems and can detect any number of voltage or current levels.

The difference between analogue and digital signals can be seen with the aid of Fig. 1.9. These graphs are obtained by plotting the voltage against time for two different signals, one analogue (a) and the other digital (b). The signals here are typical—analogue signals can vary to any shape waveform within a range, and digital signals always switch between two voltage levels.

The analogue signal waveform in (a) could be the electrical response of a microphone to the spoken voice. A microphone is a device which converts vibrating air particles (remember?—even air is made up of atomic particles) into equivalent electrical waves.

The digital signal waveform in the figure could be generated by our simple "torch" circuit above. If the voltage was to be measured across the bulb (this amounts to the same thing as counting how many electrons there are on one side of the bulb with respect to the other side) and the switch turned on and then off repeatedly, the graph so produced would resemble that of Fig. 1.9(b).

Next month: Component Identification and Coding.

Components

The components necessary to carry out the exercises described in the first six parts of the series are listed in the *Introducing Digital Electronics Booklet* given free with this issue.

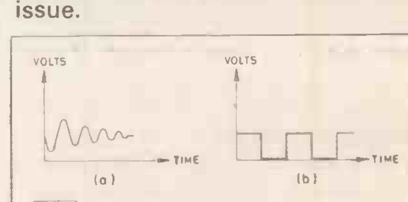


Fig. 1.9. Analogue and digital signals.

Special Feature

MILITARY COMMUNICATIONS

IAN GRAHAM

Good communications may not win a war, but poor communications can certainly lose a war. Ian Graham reports on the radio technology of electronic warfare.

RADIO is a key element in the business of moving information around. But radio signals do not discriminate betwen receivers. They can be received by allies and enemies alike. Military forces face the problem of feeding information from dispersed mobile radio transmitters at the fighting front to command centres reliably, without allowing the same information to fall into enemy hands.

A great deal of time, effort and money have been invested in developing ways of denying the enemy access to communications. This electronic cat- and-mouse game has hotted up considerably in the past ten years as the cost of computer memory and digital electronics has fallen. Because of this, each new generation of communications equipment can be both cheaper and more versatile than its predecessors.

Computers are numerical creatures. Even the most sophisticated computers at the heart of talking, seeing and hearing robots work by processing numbers. Modern weapons invariably use computers at some point in their aiming, firing, guidance or detonation. This huge increase in the use of "number-crunching" computers means that it has become very important for military forces to be able to transmit and receive numbers very rapidly and reliably. Some would say that this is now *more* important than voice communications.

DIGITISED

Whatever the source of the information–printed text, spoken words, computer data, etc.–it can be digitised before transmission. That is, it is converted into a stream of pulses. The rapid stream of pulses is converted back into its original form by the receiver.

This "digital" transmission resists interference better than the alternative–analogue transmission. As long as the digital pulses can be detected by the receiver, however degraded or distorted they may be, the voice or printed text that they represent can be recreated almost perfectly. In contrast, an analogue signal, which represents information as waves of radio energy changing in frequency or magnitude, subject to the same amount of interference would be severely degraded, perhaps unintelligible.

ENCRYPTION

One way of preventing the enemy from reading the contents of messages transmitted is to scramble the messages, a process called encryption, which is carried out by computer. But the techniques are equally well known by everyone in the electronic warfare business and so enemy computers can be used to identify the particular technique or combination of techniques used and begin to unravel the coded message.

There is a further complication. If you've ever brought an ordinary radio set or a cordless telephone within a few feet of a personal computer, you'll be aware that computers themselves transmit radio waves. The receiver picks up a mish-mash of noise from the computer. Subtle changes in the frequency of this generally unwanted radio "noise" reflect what the computer is actually doing. A suitably equipped "eavesdropper" can pick up this noise with a radio reciever and convert it back into intelligible information.

In this way, it is possible to read what a computer operator some distance away is typing into the computer. The radio signals transmitted by the computer are recieved by a radio and fed into another computer programmed to turn them back into text on the screen. "Tapping" a computerized military communications system in this way enables the interceptor to read what a soldier is typing into his terminal before it is encrypted and transmitted. To do this successfully, the interceptor has to get close enough to the terminal to pick up the low-power signals being transmitted by its keyboard. Designers make this even more difficult by shielding military computer terminals to a much higher degree than home or office personal computers, greatly reducing the amount of radio energy that they broadcast.

JAMMING

Even if a message is encrypted so that the enemy cannot understand it, all the effort is wasted if the signal is jammed–no-one can receive it! In the same way as a spoken message can be swamped by loud music playing nearby, a radio signal can be jammed by transmitting a stronger signal on the same frequency. Once a signal has been jammed in this way, the only way to resume communications is to change frequency. The jammer then homes in on the new frequency. If the communicators can change frequency more quickly than the jammer, communications can continue.

Radio equipment designed to seek out and jam radio signals does the job so quickly that the repeated re-tuning necessary to keep one step ahead of the jammer and maintain communications has to be done automatically too, under the control of computers.

There are two tyes of "frequency hopping" as this rapid frequency-changing is called–orthogonal and non-orthogonal. The first ensures that signals from different communications networks are always kept apart on different frequencies to minimise interference. The second doesn't attempt to keep the signals apart. Some interference is possible as the radios can momentarily transmit on the same frequency, effectively jamming each other. In practice, because frequency-hopping radios have between several hundred and several hundred thou-

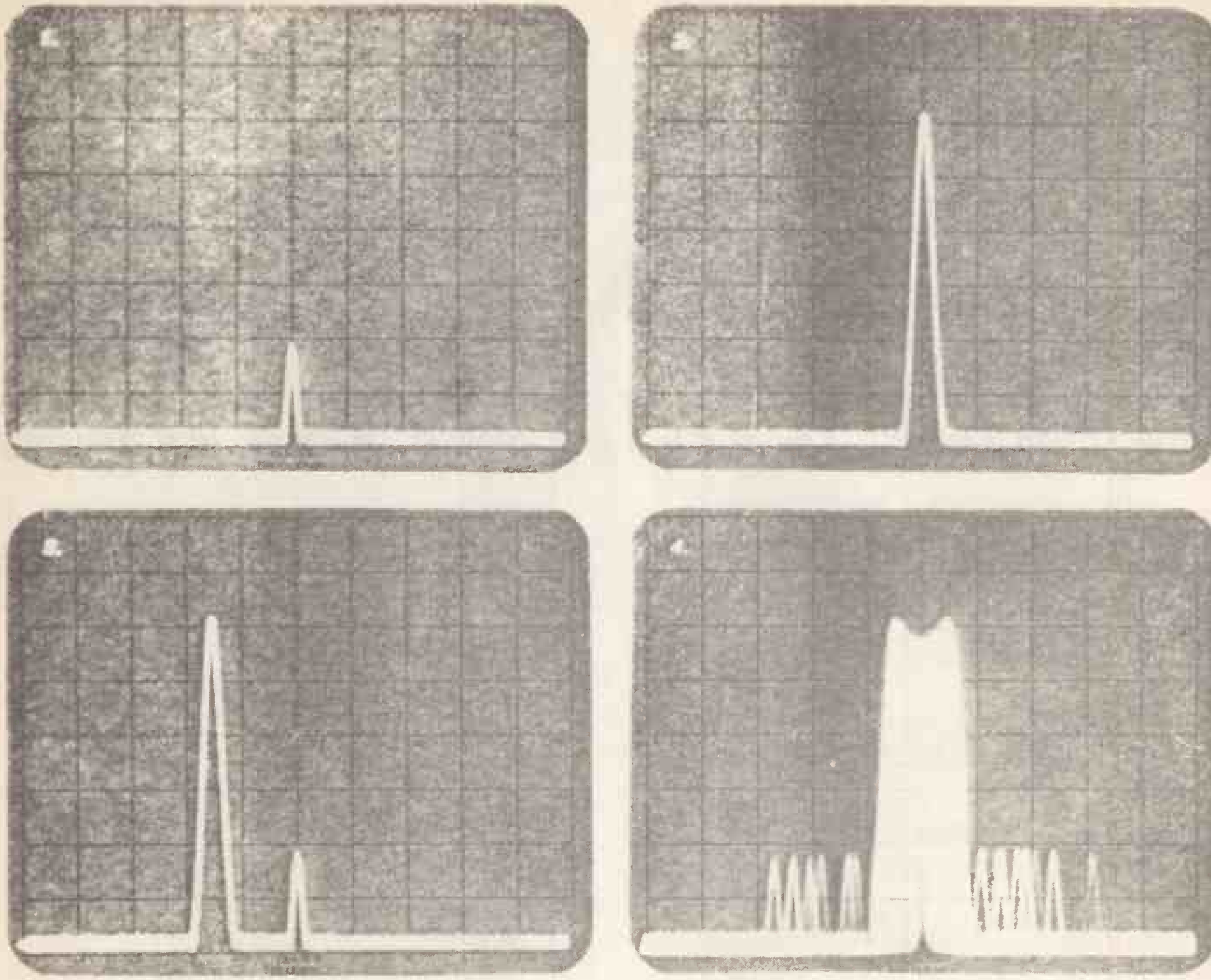


Fig. 1. Evading jamming by frequency hopping. Screen 1 shows a low-power fixed-frequency communications signal. On screen 2, a higher-power jamming signal is homing in on the communications signal and on screen 3 the jamming signal has obliberated the communications signal. Screen 4 shows the communications signal rapidly changing its frequency (frequency hopping). Wideband jamming has tried to wipe out the whole waveband, but the communications system is operating on an even wider band. Many radio systems enable the jammed band to be programmed out of the system, so that the radio doesn't hop onto any of the jammed frequencies.

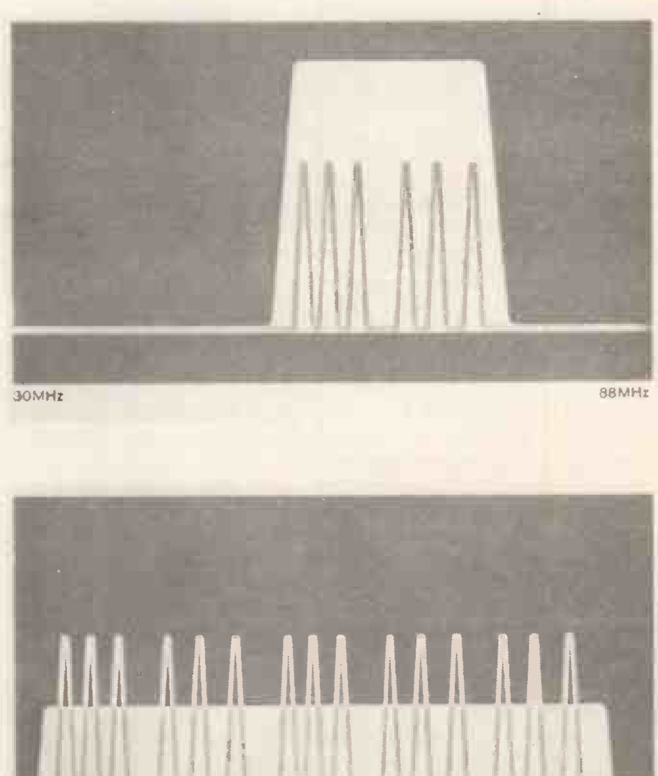


Fig.2. If a radio frequency-hops over a limited bandwidth, a jamming signal can blot out the whole band quite easily (top). A radio system such as Marconi's Scimitar hops over a much broader spectrum and makes it much more difficult for the same jammer to transmit a sufficiently powerful signal to wipe out all the frequencies used–the communications signal gets through.

sand different frequencies at their disposal, signals rarely hop onto the same frequency. Even when they do, the two signals only overlap for a fraction of a second and so interference is negligible.

If the jammer can't follow the frequency hopping radio quickly enough to disrupt communications, one answer is to jam the whole waveband. However quickly the radio hops about, the jammer swamps all the frequencies that are likely to be used. But there is a limit to the amount of energy that a jammer can transmit. So, for a given jammer power output, the greater the number of different frequencies that are jammed, the smaller is the power level of the jamming signal at each frequency. This makes it easier for the communications signal to break through, because its transmitter can devote all its power to transmitting on just one frequency at a time.

Increasing the bandwidth of the communications network as much

Racal Tacticom's BCC39 military communications systems can transmit voice and data on any of 285,000 channels.

The Scimitar communications system made by Marconi is actually a family of several radio products, from pocket size up to vehicle-mounted systems. Digital data and voice communications can be transmitted on up to 284,000 channels and the system can automatically hop between channels at great speed to evade jamming.

as possible also makes things more difficult for the jammer. If the communications channel is broad enough, the jammer simply can't cover all the available frequencies powerfully enough to obliterate everything being transmitted.

SATELLITE COMMUNICATIONS

Of course, military communications now extend out into space. On the face of it, satellites are very weak communications links in time of war. They can be knocked out quite easily. They're sitting ducks, stationary with respect to the earth's surface and very easy to locate and destroy by relatively crude missiles or lasers. Yet military communications networks frequently use satellites to collect information and relay it around the world. Satellite communications terminals can now be made small and light enough for a soldier to carry around with him in a back- pack—Ferranti's Mansat for example.

Military analysts are of the opinion that satellites will probably remain relatively untouched during a conflict. A satellite war would affect both sides and ultimately would prolong a conflict due to the reduction in intelligence gathering and so each side would be reluctant to embark on anti-satellite activities. That's the theory! Nevertheless, the vulnerability of satellites is taken into account. Communications circuits are usually duplicated by ground-based circuits in case a vital satellite link *is* knocked out.

SPECIAL FORCES

Special forces such as the Special Air Service Regiment (SAS) and the Royal Marines Special Boat Squadron (SBS) have particular requirements for radio equipment. These special forces need to be highly mobile and difficult to locate, and so they require radios that are very small, lightweight and more versatile than the standard infantryman's radio.

The Racal-Tacticom BCC39 radio system, for instance, consists of a series of modules. Troops need only carry the modules needed for a particular mission. The basic 50-watt transceiver weighs only 2.3kg. It can also be mounted in a vehicle, doubling its power output to 100 watts and it can transmit on any of 285,000 frequencies. To evade detection, it can be used with a "burst transmission device" which transmits short bursts instead of a cotinuous signal.

New developments include a radio that can transmit on a frequency so high that it makes molecules of oxygen in the atmosphere vibrate. Every object has a natural frequency at which it will vibrate very easily, called its resonant frequency. Radio energy is most easily absorbed by an object when it is at the object's resonant frequency. For this reason, radio communications systems normally avoid the resonant frequencies of the gases and vapours normally found in the atmosphere, because transmitted radio signals would be absorbed by the atmosphere and dramatically reduced in power before reaching the receiver. However, special forces requiring secure communications over relatively short distances, perhaps behind enemy lines, may not wish their communications to be broadcast further than a few kilometres. The latest direction-finding systems need to receive a radio signal for only a few milliseconds to locate its source.

The resonant frequency of oxygen in the atmosphere is 60 Gigahertz (60 thousand million cycles per second). Transmitting radio signals at this frequency therefore ensures that they are rapidly absorbed by atmospheric oxygen and so they do not travel very far.

Racal Tacticom's new TSC 501 satellite communications terminal. The two-man operating team can set it up and have it running in less than ten minutes.

HARDENED HARDWARE

Military radio networks may have to contend with more than difficult combat conditions and interception by hostile receivers. If a nuclear war ever begins, most of the radio, television and computer equipment in our houses and offices will be destroyed by the enormous burst of electromagnetic radiation that will stream out from the explosion—called Electromagnetic Pulse (EMP). Military systems have to be " hardened" against EMP.

Future battlefields will rely heavily on electronic information gathering and interpretation. Remotely piloted vehicles (unmanned aircraft) will relay television pictures of troop movements to command centres. Pictures taken by satellites and cleaned up by computer will enable commanders and politicians to monitor military activities in several parts of the world at once.

The battlefield will be peppered with electronic listening devices and radio jamming equipment delivered with pin-point accuracy by aircraft, guided missiles and artillery shells. Computerised communications networks will detect a failure occurring anywhere in the network and automatically re-route communications signals around the problem. In fact, this is no science fiction scenario—the technology exists and is already in use in many parts of the world. □

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Constructional Project

QUAD CAR CONTROLLER

C. J. WALKER

Add more thrills (and spills) to your model racing car or train layout by running two models on the same track, with full independent control. Allows four cars to be raced simultaneously on two lane track.

For some years now, budding high speed racing drivers have had their maniacal thirst for thrills quenched by a "Scalextric" set, nimble fingers and a little creative imagination. The latter ingredient can only be stretched so far though, and sooner or later many enthusiasts (myself included) resort to modifying the rules in an attempt to add an extra degree of excitement to the game.

Such activities may include "banking-up" the hairpin bends on a pile of cushions from the settee, demanding a high degree of driving skill from the operator if his vehicle is not to plunge into the depths of the hearth rug. Alternatively, two cars are raced per lane, governed by a common speed controller. This does tend to "overload" the hand controls, but requires skilful "split vision" from the operator to be able to safely race both team cars around the course.

INDEPENDENT CONTROL

It was during this latter episode when I pondered on the possibility of being able to *independently* control two cars on the same lane with two separate hand controls, thus allowing four cars to be raced simultaneously on a two lane track. The benefits of such a system may not be immediately apparent, but after successfully implementing this design the fun and excitement that is achieved (as well as the ability to keep Dad, Uncle (or mum) and the two kids occupied at any one time) has to be experienced to be appreciated.

Of course, this design is not only restricted to the "Scalextric" track, the circuit can be used to independently control any two d.c. appliances with a single pair of wires e.g. two model trains on one track.

CIRCUIT THEORY

The concept of controlling several systems using a single information-carrying cable is not new. Digital techniques have allowed "multiplexing" for several years and the telecommunication network uses the technique to send several thousand telephone calls simultaneously along one line, achieving an obvious saving in the amount of cable necessary.

However, the beauty of the *Quad Car Controller* circuit lies in its elegant simplicity—many constructors may already posses the components required. Its disadvantage is that only two cars may be controlled per lane, compared to an unlimited number which could be raced using digital techniques. In practice, when one considers the size of a track layout and the speed of the cars, more than two cars per lane would make the game a little cramped!

A.C. WAVEFORM

The circuit works by placing an a.c. waveform on each lane of the track rather than the usual d.c. voltage. Each car on one particular lane responds to *either* the positive half cycles *or* the negative half cycles of this wave. Therefore, varying the amplitude of these half cycles varies the speed of the appropriate car—simple!

The 50Hz a.c. voltage from the mains step-down transformer is shown in Fig. 1a. In the conventional system a bridge rectifier is used to full-wave rectify this into the pulsating d.c. shown in Fig. 1b, it's amplitude under load being varied with a hand-held speed controller, thus altering the speed of the car.

Fig. 1c and 1d show how the *Quad Car Controller* can independently control the amplitude of the positive and negative half cycles from the transformer. However, as each car only responds to its appropriate half cycle, lasting 10 milli-seconds, the drive motor receives a current pulse for this time followed by a "rest" for the same period. Attempting to drive the car from this half-wave rectified d.c. results in a very bumpy ride—the car jitters at low speeds and sounds rough and noisy. To eliminate this, each car carries around its own reservoir capacitor to help smooth out the pulses; the effect of the capacitor on the voltage received by the motor is shown in Fig. 1e.

In practice it has been found that most cars contain plenty of room to hold a suitable capacitor and modification is fairly trivial.

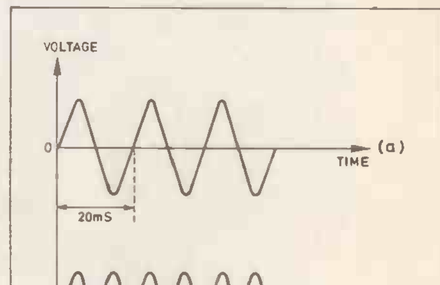


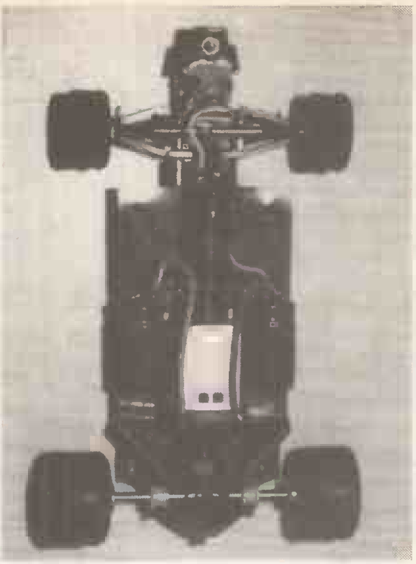
Fig. 1. Example waveforms showing various stages of operation. (a) 50Hz a.c. voltage from transformer; (b) full-wave rectification into pulsating d.c.; (c) and (d) independent control of positive and negative half cycles from transformer; (e) effect of car reservoir smoothing capacitor on the waveform.

MAIN UNIT

With reference to the circuit diagram shown in Fig. 2, T1 is a transformer having a mains primary winding protected by fuse FS1. LP1 is a neon lamp, used to indicate if FS1 blows. T1 has a multi-tapped secondary—the 15V tap is used because the current has to pass through two forward biased silicon diodes before reaching the car motors resulting in a voltage drop of about 1.4V. If the 12V tap was used, the cars would not be able to reach their maximum speed.

Conventional, "speed controllers" (high power variable resistors) are used in series to vary the current in the conventional way. These are plugged into jack sockets SK1 to SK4 thus enabling quick connection and change over. Notice that the "A" controllers only affect the positive half cycles due to diodes D1 and D3, similarly the "B" controllers affect the negative half cycles due to D2 and D4. A pair of "A" and "B" signals are then fed to each lane of the track. It is a straightforward task to extend the circuit for a four-lane track. although the power rating of the transformer may need to be increased.

Fuse FS2 protects the low voltage "trackside" part of the circuit. It is preferable to have a lower rated fuse in each controller circuit, but as this implies four fuses in all, FS2 situated in the "common" line is a good compromise. D1 to D4 are rated at 3 amps to allow for abuse such as short circuits; the car motors draw less then 0.5 amps when running at a steady speed.



THE CARS

Each car uses a diode to "filter out" the positive half cycles (if it is an "A" type) or negative half cycles (if "B" type). Following this is about 2000μ of smoothing capacitor in parallel with the motor. The circuit diagrams are shown in Fig. 3, notice that the small ceramic suppression capacitor, present before modification, is left connected to help reduce radio frequency interference.

COMPONENTS

Main Power Supply Unit

Transformer

T1 — 240V primary, 15V 2A secondary.

Semiconductors

D1-D4 — 1N5401 silicon diode (4 off)

Shop Talk

See page 594

Miscellaneous

JK1-JK4 — 1/4 inch mono jack socket (4 off). Also plugs for hand-held speed controllers.

FS1 — 200mA (or 250mA) anti-surge 20mm fuse.

FS2 — 3A (or 3.15A) anti-surge 20mm fuse.

LP1 — Panel mounting 240V neon lamp.

Aluminium instrument case (model S2/35), size 100×100×150mm, panel mounting 20mm fuse holders (2 off); 3 core mains cable; strain relief grommet; 4-way terminal block; connecting wire (16/0.2mm); heat-shrink sleeving.

Components for Each Car

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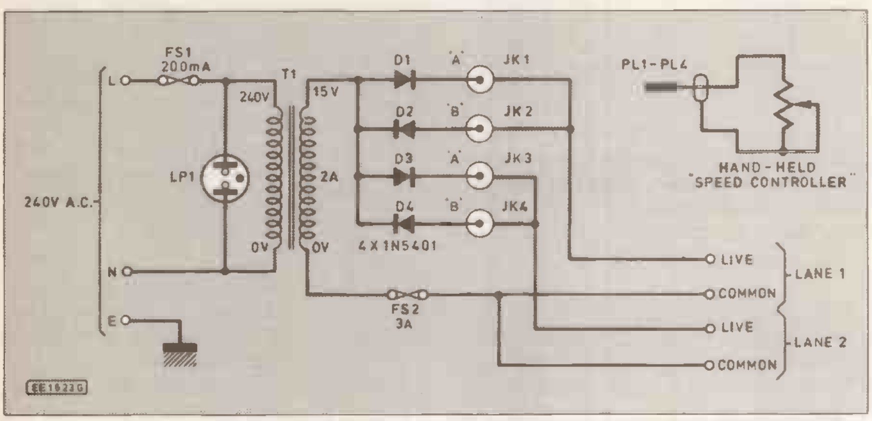


Fig. 2. Circuit diagram for the Power Supply Unit.

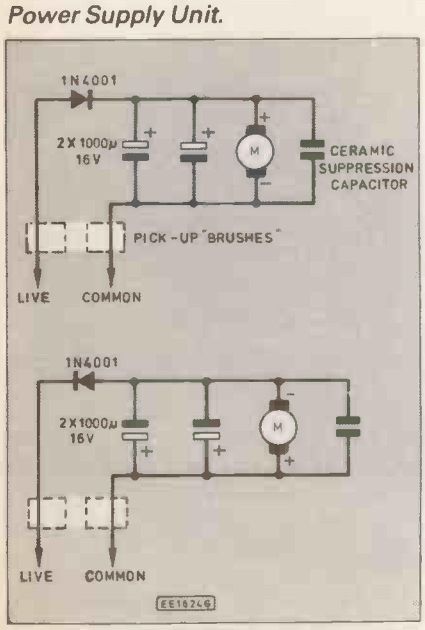


Fig. 3. Circuit diagram for type "A" (top) and type "B" cars.

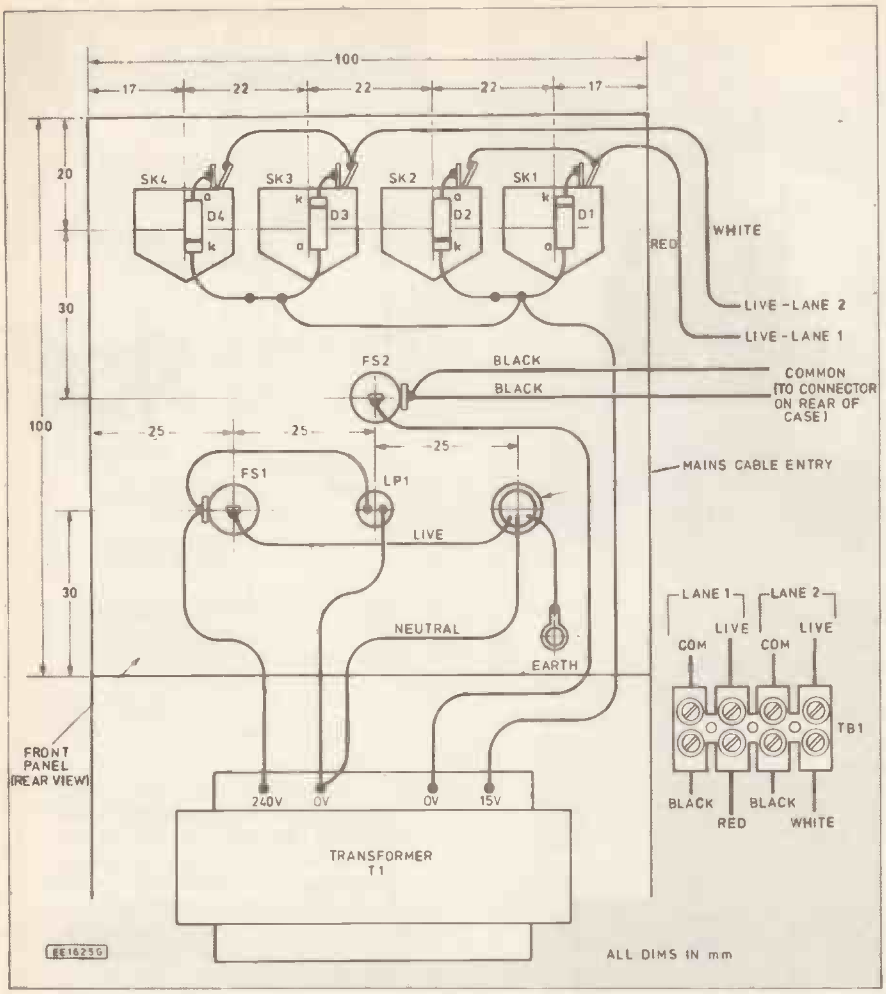


Fig. 4. Front panel layout, drilling details and interwiring for the main power supply unit. The track connecting terminal block TB1 is mounted on the outside of the rear panel.

CONSTRUCTION

The main power supply unit is housed in an aluminium instrument case measuring 100×100×150mm, the front panel being the square face. The recommended case contains an internal 'sub-chassis' on which T1 may be mounted if desired, alternatively it can be bolted directly to the bottom of the case.

Prepare the case by drilling four holes for mounting T1 followed by the eight holes on the front panel as shown in Fig. 4. Notice that the mains- connected components are kept towards the bottom of the case to minimise accidental contact during testing. The mains cable should enter the case through a "strain relief" grommet—*do not tie a knot in the mains cable!* This can damage the conductors and cause overheating and also does not prevent the cable from being forced into the case thus straining the soldered connections. Drill holes in the rear panel to anchor a terminal block for the track connections and also drill a cable exit hole (to be fitted with a rubber grommet) for wiring this up to the rest of the circuit inside the case.

It is a good idea to clean and then label the panel now using rub-down lettering. Two thin coats of spray-on clear lacquer, available from car accessory shops, will protect the legends from abrasion.

Insert T1, LP1 and the holder for FS1 and interwire the mains connections using Fig. 4 as a guide. It is important to insulate all exposed mains connections—this may seem trivial but working in close proximity to bare high voltage terminals is foolish. Take the trouble to slip some sleeving over the wires *before* soldering them. The sleeving can then be slid over the soldered connection. The use of heat-shrink sleeving is even better as this can be shrunk onto the joint using the heat from the soldering iron—it grips the joint and will not slip off. The metal case must be earthed by soldering the mains cable earth lead to a solder tag which is anchored under a mounting bolt for T1.

Mount the remainder of the front panel components and fasten a four-way terminal block on the rear of the case for the track connection. Wire up as shown using a fairly thick grade of insulated wire (16/0,2mm) to minimise internal resistance. The diodes are suspended by their leads, try not to overheat them too much whilst soldering. Remember to use the 15V tap on the transformer secondary winding.

CAR MODIFICATION

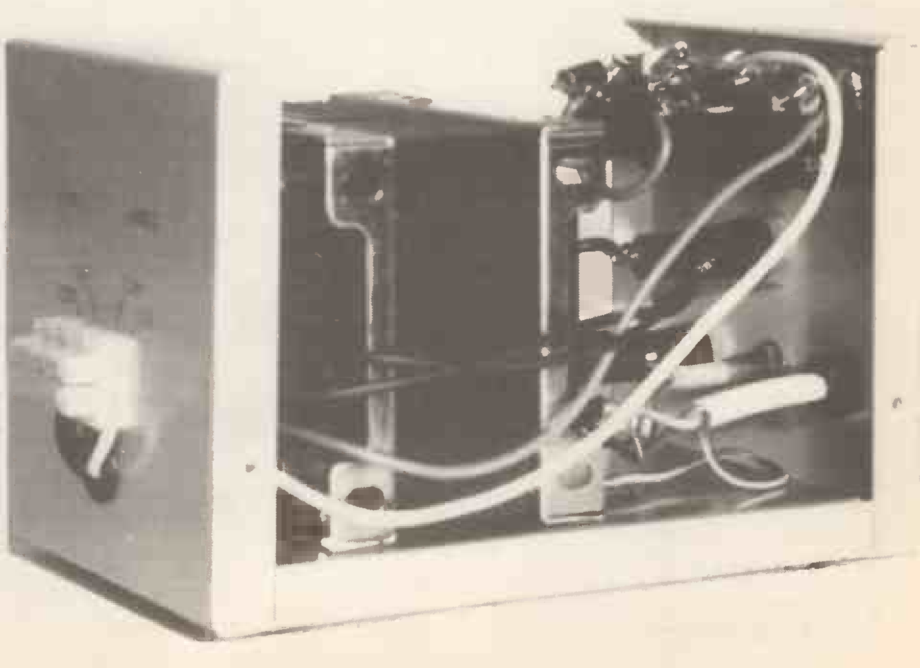
To race two cars independently on the same lane, one must be an "A" type and the other a "B" type—bear this in mind when modifying. However, "A" and "B" types on one lane will be transferred if the connections to that lane are reversed—see later.

Some model cars are easier to adapt than others because of the available space to accomodate 2000μ of capacitance. The majority of larger cars will easily hold two 1000μ 16V electrolytics, although these must be the "miniature" type measuring about 12.5mm in diameter and 25mm long. Radial leads may make wiring easier.

The capacitors should ideally be positioned on either side of the drive motor as this will have the minimum effect on shifting the car's centre of gravity which would affect it's road handling. Repositioning may be necessary for other car types, notice the Porsche in the photographs. The most tricky modification encountered was with the Formula One cars, these are very streamlined. The photographs show how three 470μ capacitors were squeezed in, with the side capacitors being squashed slightly in a vice before fitting. This is *not* recommended, but in this instance brute force seemed the only solution!

Exactly what combination of capacitors is used is left to the constructor. Remember that the total capacitance of several capacitors is the sum of the individual capacitances if they are connected in parallel.

Having decided how and where to place the capacitors, anchor them with a little glue. Disconnect the pickup brush wires from the motor—leave the small ceramic supression



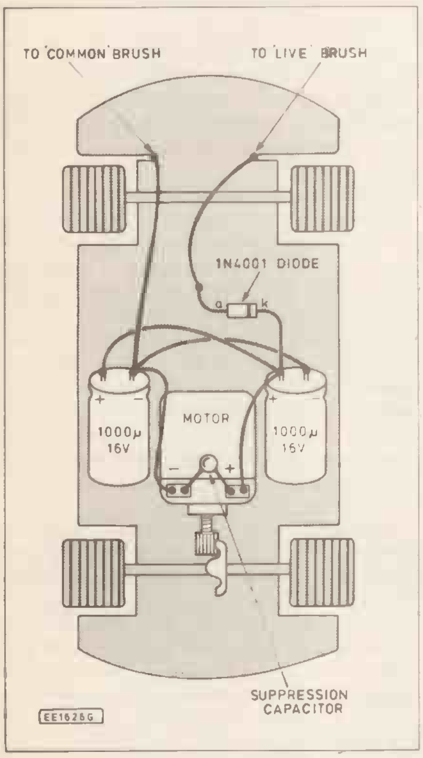


Fig. 5. Modification details and wiring for type "A" car.

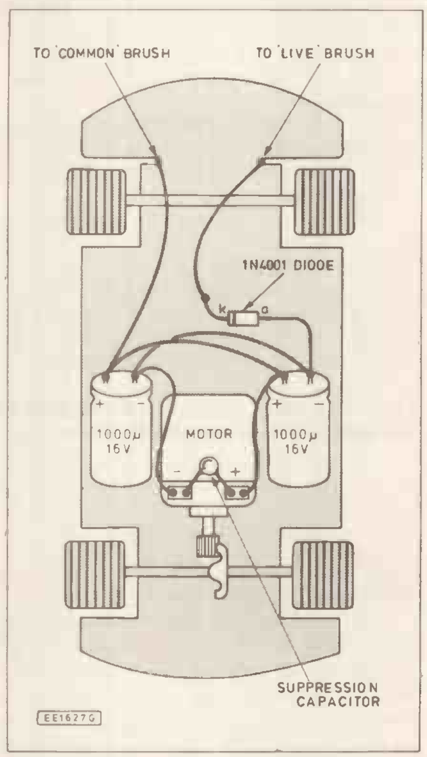
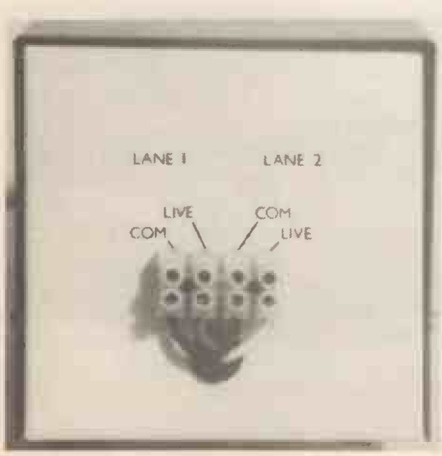
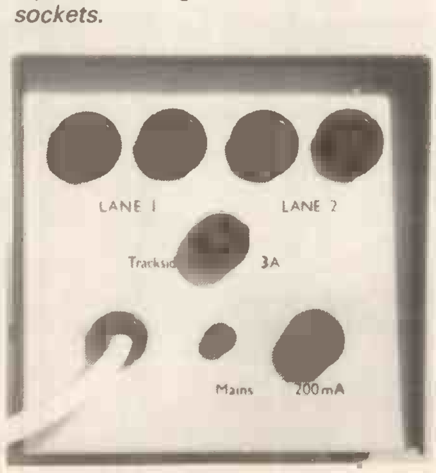


Fig. 6. Modification details and wiring for type "B" car.



Track connecting terminal block mounted on the rear panel.



Power supply front panel component layout showing the "hand control" sockets.

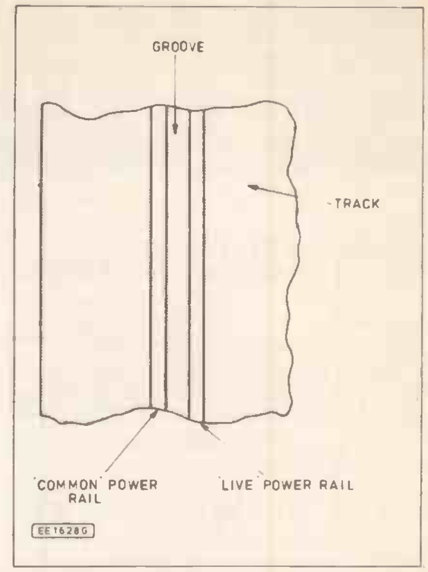


Fig. 7. Connecting up to the track (one lane shown) from the power supply terminal block.

capacitor in place. Check which is the positive connection on the motor (using a battery) and link this together with the positive lead of all the capacitors. Do the same for the negative side. If the car is to be an "A" type, solder the 1N4001 diode between the positive line from the motor and the right-hand brush wire (viewed from the top of the car) with the cathode towards the motor—refer to Fig. 5 for details. Solder the left-hand brush wire to negative on the motor.

For a "B" type, solder the diode between the right-hand brush and negative on the motor with cathode towards the brush. Solder the motor positive to the left hand brush—Fig. 6

It is important to leave plenty of slack in the wires going to the pick-up brushes to allow them to flex and avoid breaking.

In the above description I have adopted the convention of making the left- hand power rail of each lane (viewed from above) the "common" rail, and the right-hand is "live", as shown in Fig. 7. As mentioned earlier, if the connections from the main controller to one lane of the track are reversed, the "A" cars on that lane become "B" cars and vice-versa.

SETTING-UP AND USE

All that now remains is to solder 1/4 inch jack plugs to four speed controllers. Keep the track connecting plugs that are cut off the controller leads, they are difficult to obtain separately and can be used to connect the main unit to the track.

The novelty of two cars controlled independently on one lane has to be seen and personally experienced to be fully appreciated. Exactly how the facility is employed is left entirely to the enthusiast—it may just be used as a leisurely way of keeping up to four drivers content. Another suggestion is where two cars start a race at opposite sides of the course, on the same lane. The first to catch up with the other (and, perhaps knock him off!) wins. This can of course be run simultaneously on the other lane.

A great bonus with this project is that the original one-car-per-lane system is preserved.

Happy motoring! □

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Question Time

Journalists face a dilemma. If they ask a question at a press conference, then every other journalist in the room hears both the question and the answer.

This is exactly what some hack journalists rely on. They don't need to do any homework. Instead they just listen to the questions asked by specialist journalists, and the answers given them.

Why you may well ask, don't journalists wait until after a press conference, and ask their questions in private?

Firms will often fudge answers given in private. Sometimes they subsequently deny saying what they have said. But when someone is talking in front of a roomful of press, they are up for grabs.

Recently Pioneer of Japan announced firm plans to start selling a combination laser audio/video disc player in October. It was one of those times when questions just had to be asked in public—because there were representatives of the software companies present. So far they have refused to comment on their vital role in backing up the launch of CDV hardware with disc software. It was the golden opportunity to squeeze out some answers.

The Pioneer CLD 1200 will play all sizes and types of laser disc; 3in. CD audio single, 5in. CD audio disc, 8in. and 12in. video discs as well as the new 5in. CDV which can hold six minutes video as well as twenty minutes of sound-only.

The 5in. CDV is lynch pin of Philips' grand plan to re-launch the failed LaserVision video disc system in Europe, under the new format name CD Video. Philips wants the CDV tag applied to all sizes of discs which carry picture signals. Pioneer will use the name CDV for 5in. discs, and stick to using Laser Disc (Pioneer's brand name for player and discs according to the old Philips LaserVision format) for 8in. and 12in. discs.

Says Product Manager Geoff Pflaumer, *"This player will handle anything that is round and shiny"*.

There is a vital technical difference between old (LV/LD) and new (CDV) discs. From now on all video discs, of all sizes, will have digital soundtracks—instead of the analogue soundtracks used on previous video discs.

So success of CDV depends on software companies releasing video discs with digital sound tracks. So far none of the film companies has committed. But Pioneer says CDV will be "music-driven".

In Japan and the USA Pioneer pushed the LD/LV system by acquiring the rights to release its own music and feature film software. In Europe Pioneer has no such rights and does not want to spend money on acquiring them. It was obviously with this in mind that Pioneer had invited representatives of the software companies to attend the press conference to announce the sales of Combi players this October.

But no-one from CBS or Warner was there, and there was confusion over whether representatives from Island and Virgin had come—if they did, it was only very briefly. Polygram, Chrysalis, RCA and EMI were there, but sitting quietly in the audience.

Philips has promised to launch its own CDV Combi in September. Backing this, Polygram (which is of course owned by Philips) says it will definitely launch 68, 5in. pop CDVs, 16 pop, 8in. discs and 70, 12in. discs—30 pop and 40 classical—along with, or shortly after, the Pioneer Combi players reach the shops.

And other record companies?

"The dialogue continues", says Pflaumer.

So, to set the record straight I asked the software people skulking in the audience if they would like to clarify their position for the benefit of the press. Only Chrysalis spoke.

"We have no firm plans", said a Chrysalis spokesman.

All the other record companies remained silent.

I take that as meaning that you have no firm plans, I said.

Still there was silence.

So we can take that to mean that only Polygram has firm plans to launch CDV software to accompany the players to be sold by Pioneer and probably Philips.

All the signs are that the record companies, understanding little or nothing of the special difficulties involved in mastering and pressing video discs with digital sound, will place orders with the Philips pressing plant in Blackburn only when they have seen players in the shops.

It is not an auspicious start for CDV.

Hi-Band Agreement

First there was Hi-Band U-Matic, then Super Beta, S-VHS and ED Beta. All push up the f.m. carrier on tape to widen the frequency band and so capture more detail. Now forty-two electronics and photographic companies have agreed the specification for an improved "hi- band" still video recording system.

A camera, looking like a conventional Single Lens Reflex, contains a miniature version of a computer floppy disc instead of 35mm film. The disc is 47mm in diameter, spins at 3600r.p.m. and records up to 50 colour TV pictures which can either be displayed on a screen, printed onto paper or transmitted by telephone line.

The first prototype still video camera, called Mavica, was demonstrated in 1981 by Sony. Two years later 20 Japanese companies agreed a standard format. But the technology fell between two stools. Picture quality was not good enough to rival film, and the price of the system was too high for snapshot photographers.

The new hi-band format uses the same size disc as before, and the same analogue frequency modulation recording technique,which is similar to that used by domestic video recorders. But the disc is coated with finer particles of magnetic metal and this allows it to record higher frequencies which give crisper pictures.

The fact that photographic companies, including Kodak, have signed the Hi-Band agreement suggest that magnetic still photography may now at last take off. Newspapers like the idea because pictures can be sent as electric signals by telephone line.

Sony and Canon loaned disc cameras to Japanese photographers covering the 1984 Olympic Games in Los Angeles. The first Hi-Band cameras will be tested at the Seoul games.

Video Snapshots

Leading in the race to make magnetic photography a consumer product is Fuji. Disc cameras still cost several thousand pounds each but Fuji now sells a low cost compromise system in Japan.

Snapshot photographers take their pictures on film which is developed in the usual way. The processing laboratory then uses a video camera to scan the image and transfer it to magnetic disc. The photographer need only buy a disc player, costing around £200, to reproduce the pictures on a TV screen.

Fuji says it is not yet ready to launch still picture video in Britain. "We have to wait for perceptions to change" says Shozo Takeoshi, managing director of Fuji UK. "People who grew up with photographic film, expect high quality pictures. Young people who grew up with video and TV have lower standards".

The Hi-Band format is designed to address the problem of picture quality. The new standard provides also for a few seconds of digital sound to be recorded along with the pictures so that a photographer can record commentary notes either while taking a picture or later.

Just Tandy

In Barcelona recently, for a technical seminar, I went for a walk down by the harbour. There I saw the prize of the Spanish Navy–a gunboat, armed to the teeth with guns of all shapes and sizes, pointing in all directions of the compass.

The boat also positively bristled with communication technology; as well as conventional radar scanners, there were microwave dishes, whip aerials, long line aerials and literally dozens of Yagi aerials of every conceivable pattern and size. Heaven knows what they do with all this equipment.

There was, however, one comforting sight. In amongst all this high technology equipment, I spotted a cheap and cheerful Tandy u.h.f. TV aerial carefully sighted on the local city transmitter. I couldn't help wondering whether that was perhaps the only working aerial, and all the rest were dummies designed to scare away the Russians.

EE OCTOBER 1988

EASIWIRE FROM BICC-VERO ELECTRO

WHAT IS EASIWIRE?

Easiwire is an exciting new product from BICC-VERO which enables you to construct electronic circuits quickly, easily and cleanly – without solder or chemicals. It's a tried and tested system which produces reliable connections – as good as a soldered joint.

Easiwire is supplied in kit form and is complete with everything you need to construct a circuit:

- ☆ A high-quality wiring pen with built-in spring-loaded wire cutter. The tinned copper wire – rated at 1 A – is fed from the spool fitted at the top down through the pen.
- ☆ A flexible, injection-moulded wiring board with tapered holes which are drilled at the standard 2.54mm (0.1 in) pitch and hold the components firmly when inverted for wiring.
- ☆ The unwrap tool – a two-ended device ideal for anchoring the wire at the start of wrapping and for removing wired connections which need to be changed. The other end can be used to enlarge the board holes for components with large leads.
- ☆ Two sheets of double-sided self-adhesive material. Used to secure the wires in fixed positions when placing your wiring and prevent them from touching, or to hold insulating material at crossover points.
- ☆ Spring-loaded terminals and jacks for off-board power connections.
- ☆ A spare spool of wire, approx. 40 m long.
- ☆ A clearly written instruction book to provide guidance to the user.

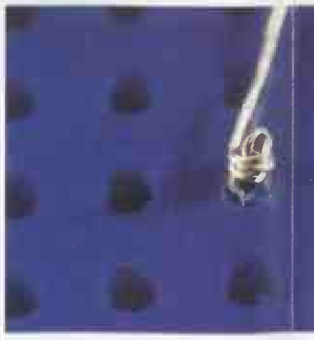
WHAT ARE THE BENEFITS OF EASIWIRE?

The main benefits of Easiwire are its simplicity and its versatility. The method of wiring is easily and quickly learned, and can be applied to straightforward or complex circuits. It's ideal for the designer and the hobbyist. Additionally the student can use it for project experiments – and progress from simple to complex circuits as he becomes more practised.

What's more, Easiwire is robust enough for industrial use. For harsh environments, simply apply a coat of insulating varnish or a conformal coating to the finished circuit as applied to conventional pcbs. Where vibration is of particular concern, Easiwire joints can be soldered for extra security.

Easiwire has another major benefit. When you change part or all of a circuit you can re-use the components. Connections are quickly removed by using the unwrap tool. Components can be re-located or replaced, then re-connected. It's so simple and versatile.

1. The special tinned copper wire – rated at 1 A – feeds smoothly through the pen from the reel fixed to its top, constructing the connection.



2. Just 4/5 turns up and 4/ the pin, and a reliable c made.

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CIRCUIGRAPH

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cutter.

Two-ended unwrap tool.

WHERE CAN EASIWIRE BE USED?

Easiwire is so versatile it can be used almost anywhere. In the simplest of circuits – and in the most sophisticated. Circuits for televisions and telephones have already been successfully constructed.

Easiwire can also be used in place of a matrix board with components soldered on the underside. Or in place of a stripboard configuration, where copper strip would normally be used for connections. The wiring system is so versatile, your circuit can be built onto any non-conductive material such as plain Veroboard or even cardboard, using the spike to produce the component mounting holes.

Easiwire is a practical, cost-effective means of prototyping circuits for the designer. And, of course, the hobbyist can use Easiwire in the same way. Experimenting with circuits is no problem at all because individual circuits can so easily be altered.

Easiwire can be used to copy printed circuits too – or diagrams shown in journals.

Easiwire. No soldering. No chemicals. Easy assembly. Easy modifications. Re-usable components.

Ready to try it? The order coupon is on the next page.

5 down, around
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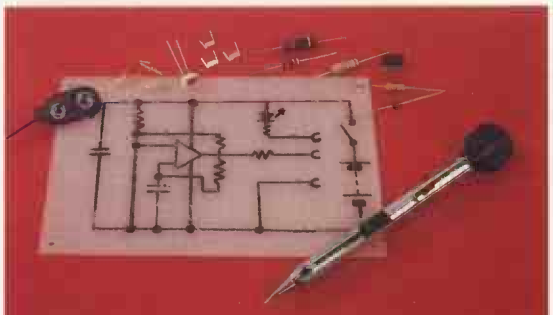
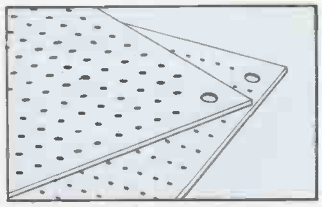


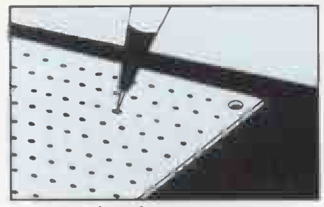
3. You can sketch your circuit directly on to the board and use it as a wiring diagram.

4. Changes are simple too – the unwrap tool is used to remove the connections so the component can be re-used.

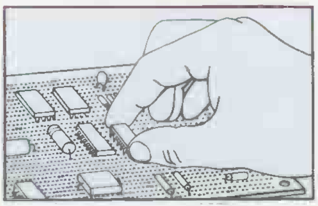
HOW TO USE CIRCUIGRAPH EASIWIRE



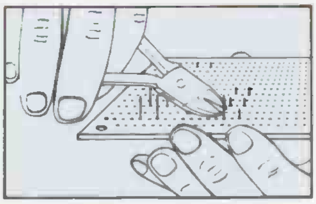
1. Translucent insulating board made of anti-static polypropylene plastic.



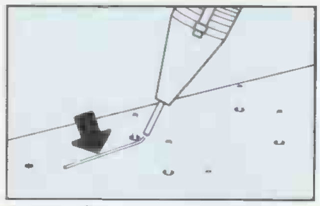
2. If the pins of a component are not standard size (i.e. too thick) enlarge the holes with the sharp end of the tool.



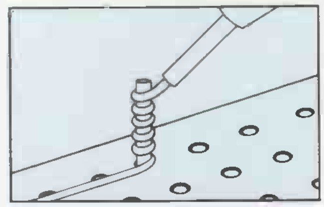
3. Insert the components from the side of the board with the wider holes.



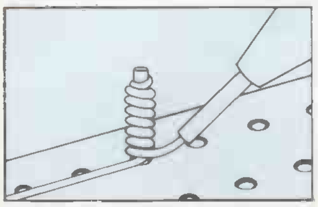
4. Turn the board over and cut the protruding component tails, leaving a length of about 3 mm (0.125 in).



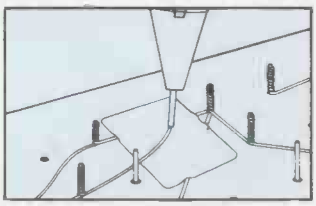
5. Now the component tails are ready for connection. Take the wrap tool and hold the wire to the board with a finger on the unwrap tool so that it will be held tight when the first pin is connected.



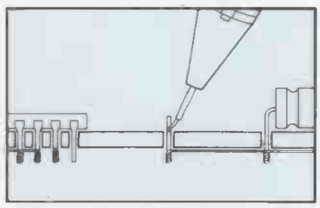
6. Roll the wire up the pin 4 or 5 turns.



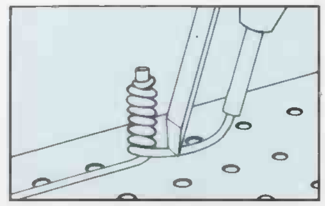
7. Roll back down the pin 4 or 5 turns.



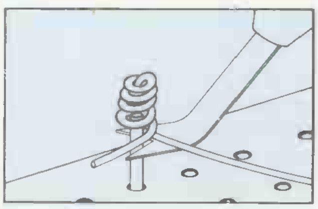
8. When necessary use a piece of insulating tape to allow wires to cross each other.



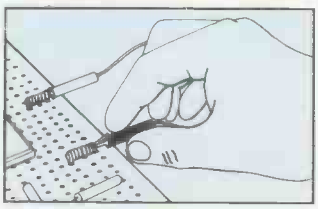
9. When a connection must run from one side to the other, use a small pin as a through connection point.



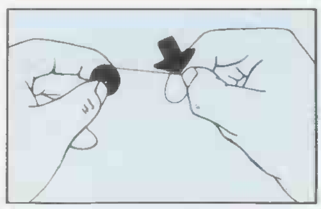
10. After finishing each connection chain, cut the wire close to the pin with the cutter on the wrap tool.



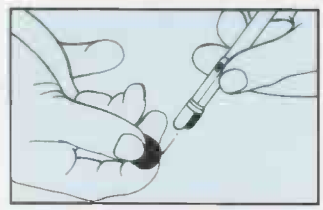
11. To undo a connection insert the fork of the unwrap tool underneath the wire loop on a pin and lever the connection up.



12. Test the circuit when it's completed.



13. To change the wire spool, remove it by pulling the spool directly away from the pen. **Never try to bend the spool mounting supports. They may break.** Take the spare wire spool with your right hand and pull the wire tight with your left hand until you have a length of wire slightly longer than the wrap tool.



14. Thread the wire into the wrap tool from the top and snap the spool in place. Do not bend the supports.

NOTE: NEVER BEND THE SPOOL MOUNTING SUPPORTS.

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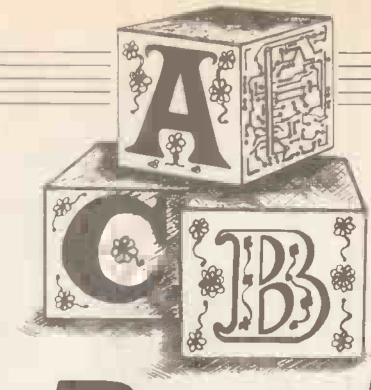
Constructional Project

AUDIO MINI-BRICKS



JOHN BECKER

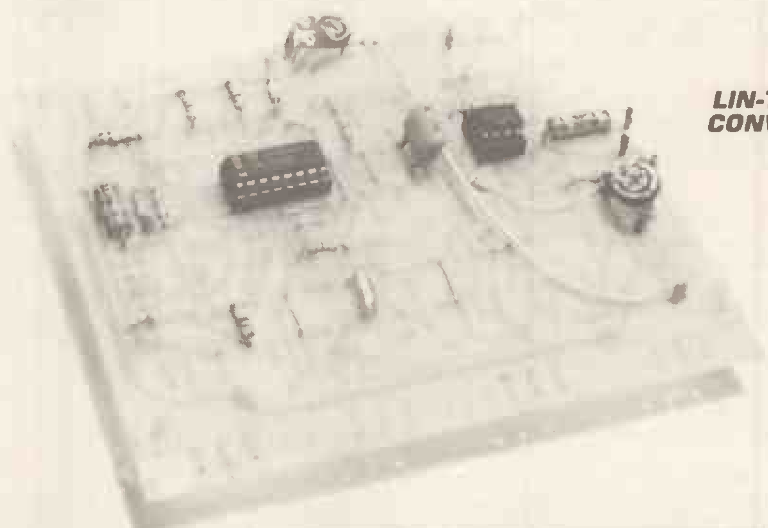
Part 5

A planned series of audio building "bricks" that can be connected together in numerous different ways to produce all kinds of sound effects. These basic building modules are examined in detail and, with one exception, all the circuits use identical i.c.s and a master printed circuit board.

The circuits are all self-contained and you can select whichever circuits you want to build. All projects are suited to assembly by novice and experienced constructor alike.

THIS month we conclude the Audio Mini Bricks series by introducing a versatile Delay Module, built up on its own small printed circuit board.

We explore some of the many sound effects possible by adding it so some of the other modules decribed in the series. But first, we investigate a Lin- to-Log Converter for controlling sound volume.



LIN-TO-LOG CONVERTER

LIN-TO-LOG CONVERTER

The LM13600 transconductance op. amp (TCA) used throughout this series can be readily configured as a linear to logarithmic voltage converter. Logarithmic progressions are usually associated with musical note relationships. Within the accuracy limits shown in Graph 10, the Lin- to-Log converter circuit diagram shown in Fig. 5.1 can be used for this purpose.

A typical need for a log converter is when a keyboard output produces note voltages that increase in linear steps. This is often the case with simple keyboard units as the necessary resistance divider chains are more readily constructed using identical resistor values.

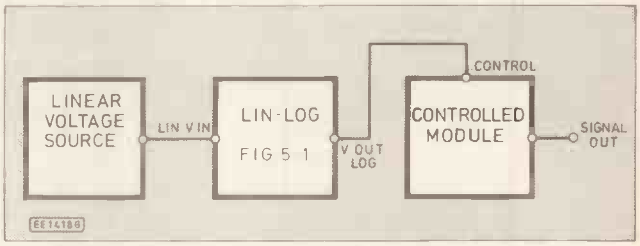
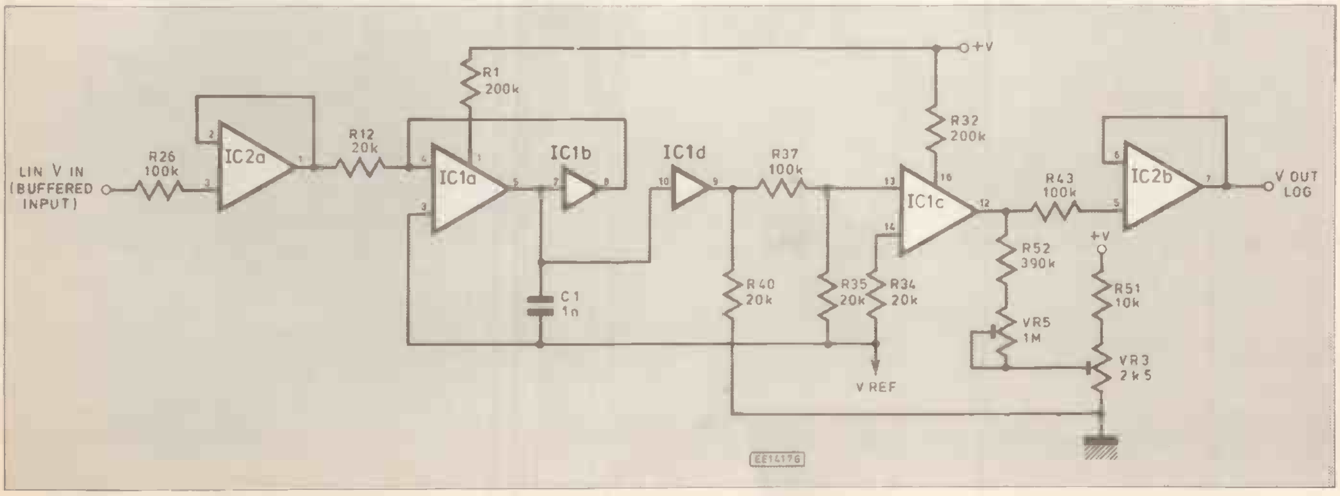


Fig. 5.2. Typical insertion point for the Lin-to-Log Converter.

Fig. 5.1. Circuit diagram for the Lin-to-Log Converter.



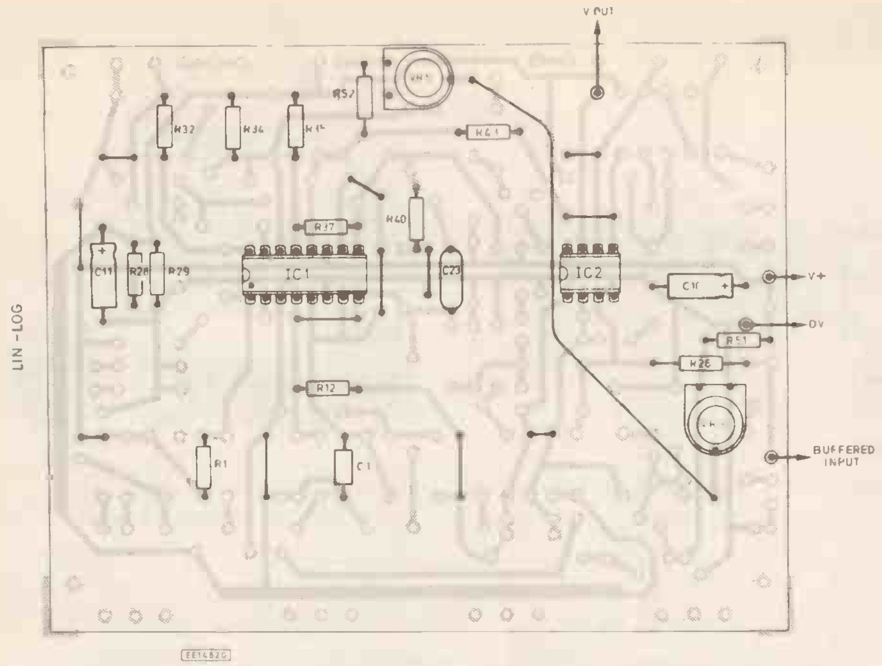


Fig. 5.3. Printed circuit board component layout for the Lin-to-Log Converter–Plan 1. The full size printed circuit copper foil master pattern appeared in Part One (June '88), Fig. 1.1.

Another use is for controlling a sound volume through a VCA. Using a linear control, increases in level appear to be most marked towards the maximum end of control.

The ear though is more perceptive to increases in volume when they are in logarithmic progressions. This is why volume controls are usually made with 'log' potentiometers rather than linear ones since the response increases more evenly.

In the Lin-to-Log circuit diagram Fig. 5.1, a linear input voltage is buffered by IC2a. The conversion takes place at IC1a in conjunction with the transistors contained in IC1b.

As with other transistors, a logarithmic output is derived in response to a linear input current. This is produced in the feedback configuration shown, with the current flow at capacitor C1 buffered by IC1d. Gain is given by IC1c which is followed by another buffer IC2b.

To maintain the same equivalent currents on both control nodes of IC1a and IC1c, which assists temperature stability, the gain in this instance is varied by using preset VR5 to change the load factor at the output of IC1c. The overall voltage range may be shifted up or down by adjustment of preset VR3. The block diagram Fig. 5.2 shows a typical insertion point for the converter.

CONSTRUCTION –PLAN I

The printed circuit board component layout for the Lin-to-Log Converter is shown in Fig. 5.3. The full size copper foil master pattern was given in Part One, Fig. 1.1 (June'88).

Commence construction by soldering the i.c. holders on the board. This should be followed by all the link wires and finally the rest of the components.

COMPONENTS

LIN–LOG CONVERTER

Resistors

R1, R32 — 200k (2 off)
R12, R34, R35, R40 — 20k (4 off)
R26, R37, R43 — 100k (3 off)
R28, R29 — 4k7 (2 off)
R51 — 10k
R52 — 390k
All 0.25W 5% carbon

Potentiometers

VR3 — 2k5 skeleon
VR5 — 1M skeleton

Capacitors

C1 — 1n polysty.
C10 — 1μ elec. 63V
C11 — 22μ elec. 16V
C23 — 100n polyester

Semiconductors

IC1 LM13600 transconductance op. amp
IC2 TL082 dual BIFET op. amp

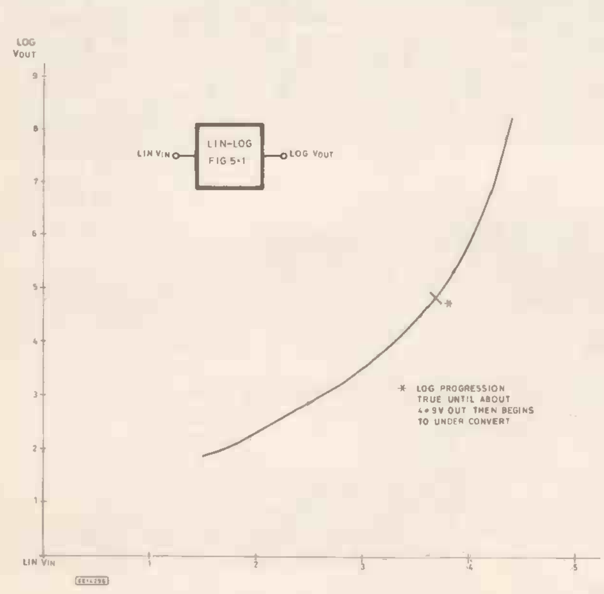
Miscellaneous

Printed circuit board, 255A; p.c.b. clips (4 off); 8-pin i.c. socket; 16-pin i.c. socket; connecting wire; solder, etc.

Approx. cost Guidance only **£13**

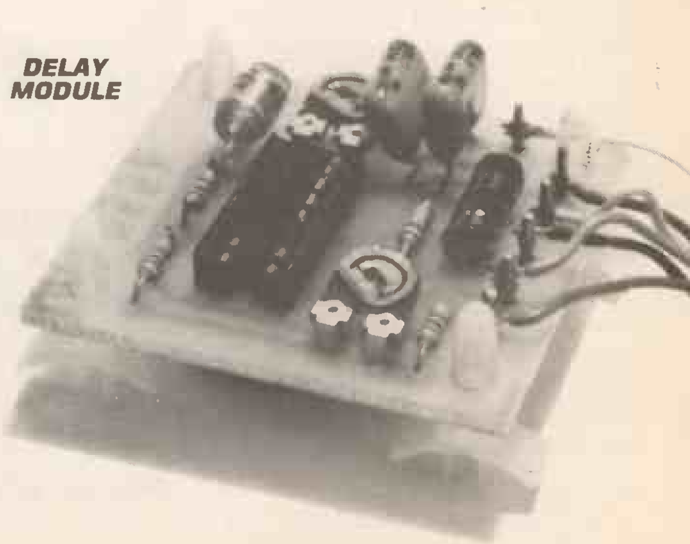
DELAY MODULE

So far the circuits described in this series have all been designed around a common "master" printed circuit board. In this concluding part, the delay module has its own small printed circuit board. It holds a single delay chip and the associated components. It



Graph 10. Lin-to-Log conversion curve.

DELAY MODULE



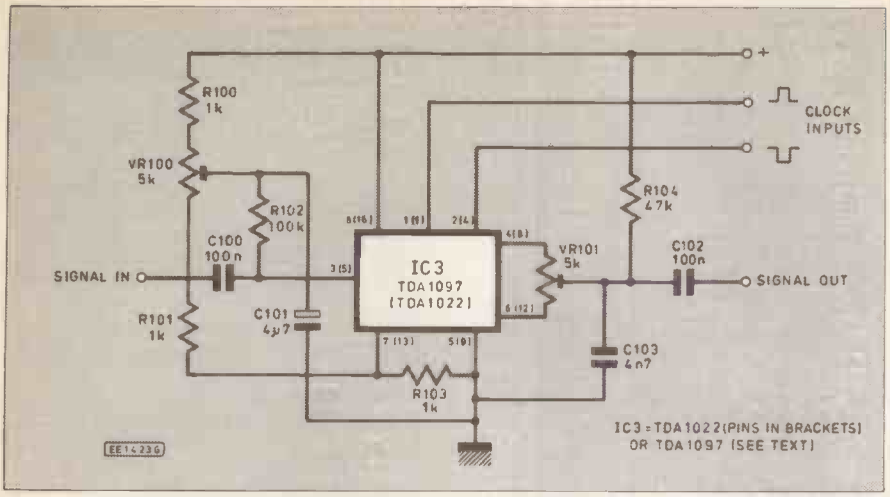
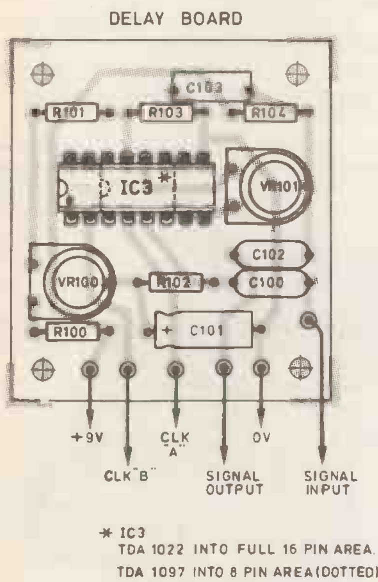


Fig. 5.4. Full circuit diagram for the Delay Line Module. Numbers in brackets refer to the 16-pin TDA1022 device.



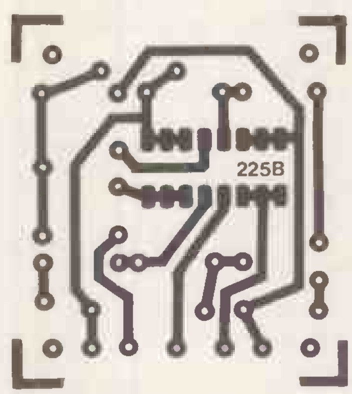


Fig. 5.5. Printed circuit board component layout and full size underside copper foil master pattern.–Plan J.

may be used in conjunction with many of the circuits already described, and several may be chained together to extend the delay time.

The circuit diagram for the Delay Line Module is shown in Fig. 5.4. It has been designed for either of two analogue bucket brigade charge coupled devices. These are the TDA1022 and the TDA1097. Either may be inserted without any change to component values.

The TDA1022 contains 512 stages, and the TDA1097 contains 1536. They both sample an input signal in a similar manner, and in response to two opposing clock signals transfer the sampled data from stage to stage.

The rate at which the samples come out at the far end depends on the rate at which they are clocked through. For similar clocking rates the 1097 provides a delay three times as long as the 1022.

The noise characteristics of the 1097 are also lower than those of the 1022. The maximum signal input level for the 1097 is 1.5V peak-to-peak, whereas the 1022 will typically accept 7V p-p.

The maximum clock frequencies that can be used are 100kHz and 500kHz respectively. The minimum is 5kHz in both cases The choice depends on the application.

Two preset potentiometers are used in the delay circuit. The first, VR100 sets a d.c. bias on the input pin 3(5). When setting up, this should be adjusted so that at maximum signal strength, minimum distortion occurs.

If viewed on an oscilloscope, the adjustment should be made so that clipping of both sides of the waveform is equal. The adjustment though can be just as readily carried out whilst listening to the result.

Preset VR101 is at the twin outputs of IC3, pins 4(8) and 6(12). This effectively sums the two signals and the wiper can be adjusted to give equal balance to both.

On a scope the adjustment will be obvious. If tuning by ear and no difference is heard, leave it midway and ignore. If it is not correctly set, the only danger is that a minor increase in noise levels could result.

CONSTRUCTION –PLAN J

The printed circuit board component layout for the Delay Module is shown in Fig. 5.5. Construction is fairly straightforward, the 16-pin i.c. holder and solder pins should be inserted first followed by the presets. Finally the resistors and capacitor should be soldered in place.

SOUND EFFECTS

A wide variety of sound effects can be produced by using a delay line. These include Echo, Reverb, Multitracking, Phasing, Flanging, and Vibrato, plus various combinations of these.

Usually the first three produce stronger effects with a longer delay. Generally speaking, with the last three, the effect can be satisfactorily produced using the shorter, and less expensive delay of the 1022.

When chaining several delays together, the same clock signal is connected to all chips simultaneously. The signal output of each board is fed to the input of the next, and for each subsequent board capacitor C100 may be omitted if preferred, though it does not need to be.

BASIC DELAY FUNCTIONS

A simple delay can be given to a signal by feeding it into the module and retrieving it at the output. In this instance the output is not mixed with the original. The clocking oscillator is kept at a fixed rate.

Double Tracking is produced by feeding both the original and delayed signals into a mixer, using level controls to balance the required volumes. If several delay modules are used, the signals can be tapped at each output and fed to the mixer. In this way multitracking occurs.

Reverb is produced by feeding the delayed signal back upon itself. This requires a mixer at the front end, into which both the original and feedback signals are fed.

The level control in the feedback path sets the reverb level, and should be adjusted so that howl is avoided. This can occur if the feedback signal is too strong. The effect is best with the delay set for only a few tens of milliseconds.

Echo is very similar to reverb, except that the delay time is measured in tenths of a second, or even longer, and the feedback signal is set so that each echo repeat is quieter than the preceeding one.

COMPONENTS

DELAY MODULE

Resistors

R100, R101, R103	1k (3 off)
R102	100k
R104	47k

All 0.25W 5% carbon

Potentiometers

VR100, VR101 — 5k skeleton (2 off)

Shop Talk
See page 594

Capacitors

C100, C102	100n polyester (2 off)
C101	4μ7 elect. 63V
C103	4n7 polysty.

Semiconductors

IC3	TDA1097 (or TDA1022– SEE TEXT)

Miscellanous

Printed circuit board, 255B; p.c.b. clips (4 off); 16-pin i.c. socket; connecting wire; solder, etc.

Approx. cost Guidance only **£14**

Flanging is produced using reverb feedback, but with the clocking oscillator having its frequency modulated by another much slower waveform. This normally is best with a triangle waveform running between about 6Hz and 30Hz. The effect is most apparent when the reverb level is carefully adjusted to just below the howl level.

Phasing requires a similar modulation of the clock, but the modulation rate is set for a period of several seconds. Feedback is not used, and the original and delayed signals are mixed at the output in identical proportions, as with double tracking.

The effect is most noticeable with sharp signal waveforms while their phases pass over each other. Using a mild fuzz unit beforehand can often enhance the effect.

Vibrato is the effect produced when a frequency is modulated so that its pitch is varied to either side of the original. In this case the clock modulating oscillator runs at about 6 or 7Hz.

The music signal is fed into the delay module, and picked up at the output. It is not mixed with the original.

FILTERS

For all of the above effects, two filter circuits are usually needed. One on the front, and one at the end.

Due to the nature of clocked sampling extra harmonics can be generated during the delay procedure. To minimise this effect, the input signal frequency should be restricted to less than one third of the clock frequency. The input filter prior to the first delay stage should thus conform to this lower bandwidth.

During sampling, the signal also retains the sampling steps. These are less pronounced when the clock rate is high, but a marked ledge occurs with slower rates. The processed signal must have these steps smoothed out by a second filter.

The parameters for the second filter should be set to eliminate the lowest clock frequency that can be expected. For very slow clocks, two or more filters may need to be cascaded to remove the residual clock steps. In a sophisticated unit, pre-emphasis is given to the upper frequency regions of the signal to counter balance the bandwidth restrictions of the clock filter.

SIMPLE REVERB

Two practical examples of simple delay orientated effects are shown in Fig. 5.6 and Fig. 5.7. These use the delay module in Fig. 5.4 and several of the modules described earlier.

Input and output filtering here are accomplished by the same module, the low pass filter from Fig. 1.5. The characteristics of the filter are modified with the respect to the clock oscillator rate, by controlling both with the same potentiometer, VR6.

The music or speech signal is fed via the level control VR8 to the filter, which also has a mixing facility. The input can if necessary be preceded by the pre-amp in Fig. 3.4 to increase low level signals.

The filter output goes through one or more delay boards. The longer the delay given so reverb will be extended to become echo.

The output from the final delay is returned to the filter-mixer at a level set by VR9. The filter is thus acting in two roles, both as an input frequency limiter, and as a clock residual extracter. VR4 is used to limit the maximum feedback so that howl is avoided at full setting of VR9.

COMPONENTS

Approx. cost Guidance only **£26**

Shop Talk
See page 594

SIMPLE REVERB

Resistors

R2, R12, R16, R19, R33, R37, R46, R47, R102	100k (9 off)
R3, R4, R34, R35, R100, R101, R103	1k (7 off)
R18	330k
R28, R29	4k7 (2 off)
R31, R104	47k (2 off)
R39, R40	10k (2 off)

All 0.25W 5% carbon

Capacitors

C1	15p polyst.
C10, C12, C14, C16	1µ elec. 63V (4 off)
C11	22µ 16V elec.
C15	56p polysty.
C23, C100, C102	100n polyester (3 off)
C101	4µ elec. 63V
C103	4n7 polysty.

Potentiometers

VR1	100k skeleton
VR4	250k skeleton
VR6, VR9	100k mono rotary (2 off
VR8	100k log mono rotary
VR100, VR101	5k skeleton (2 off)

Semiconductors

IC1	LM13600 transconductance op. amp
IC2	TL082 dual BIFET op. amp
IC3	TDA1097 (or TDA 1022)–SEE TEXT) CMOS analogue bucket brigade delay line

Miscellaneous

Printed circuit boards (255A & 255B); p.c.b. clips (8 off); 8-pin i.c. socket; 16-pin i.c. socket (2 off); knobs (3 off); connecting wire; solder, etc.

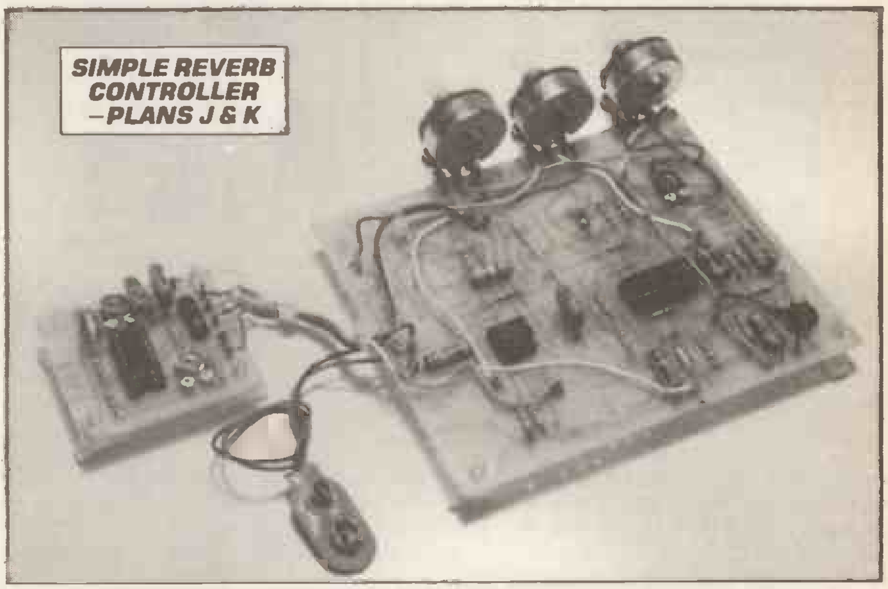
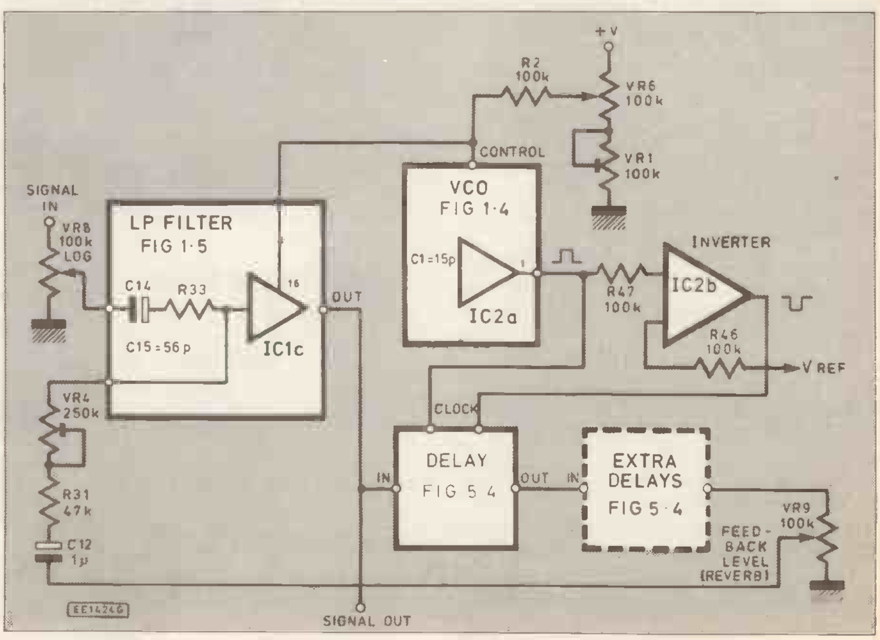


Fig. 5.6. Circuit arrangement for a Simple Reverb effects unit.–Plan K.



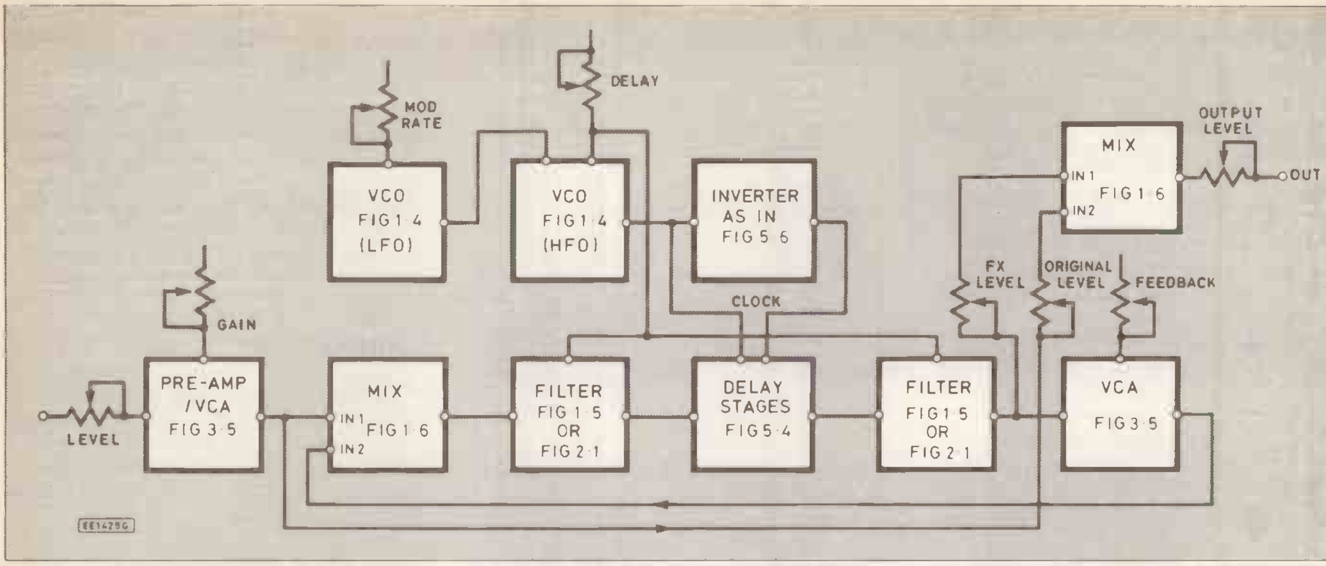
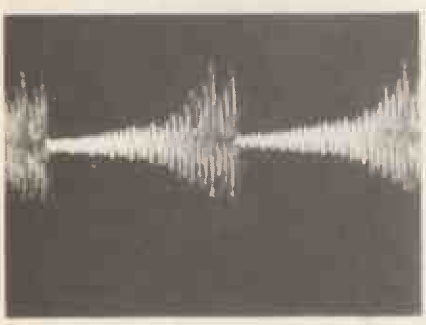


Fig. 5.7. Block diagram for a multipurpose unit for producing such effects as: reverb, phasing, flanging, double tracking and vibrato.

The clocking oscillator is the VCO from Fig. 1.4 using only its squarewave output. This is directly used as one phase controlling the delay module. The other phase is produced by inverting it in IC2b.



12–Reverberation envelope from pulsed input.

The final composite signal is taken from the filter. It may go direct to an ordinary amplifier system, or sent to other processing units. PCB Fig. 5.8 shows the component layout for the circuits used in conjunction with the delay board. A reverberation envelope from a pulsed input is shown in photo 12.

MULTIPLE DELAY UNIT

The block diagram in Fig. 5.7 shows a method of producing an extremely versatile combination of modules capable of creating Echo, Reverb, Phasing, Flanging, Double Tracking and Vibrato. It is assembled using several module boards linked together.

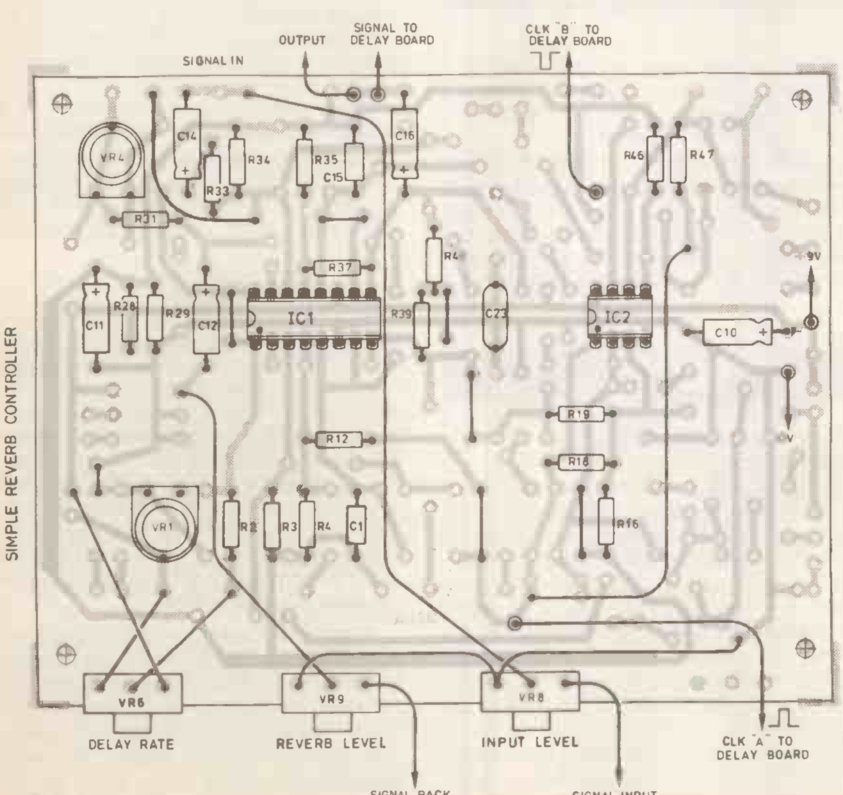
The functioning is in line with the general descriptions given above, and with those for the circuit in Fig. 5.6. The additional facilities here are the inclusion of a low frequency modulating oscillator, a pre-amp at the front, a mixer at both ends to cater for feedback and feed-forward routing, and also a VCA in the feedback path. This shows how a VCA can be used as a remote volume control since the level is varied by a voltage rather than by direct insertion of a potentiometer into the signal line.

BUILDING ONWARDS

Throughout this series of articles, it has been shown how various sound control modules can be built up and inter-linked. It has also been shown how similar parts can be encouraged to perform very different tasks.

It is not implied that the circuits described are always the best way of achieving an intended result. In specific custom designed applications different methods will be used to fit units to precise requirements. The consideration then will not only take into account optimum design characteristics, but also such factors as component availability and overall cost.

The modules described here though are ideal for experimenting with, and for achieving usable end results of a practical nature. Their use will add both to the immediate pleasure and future knowledge of the exciting world of electronics. □



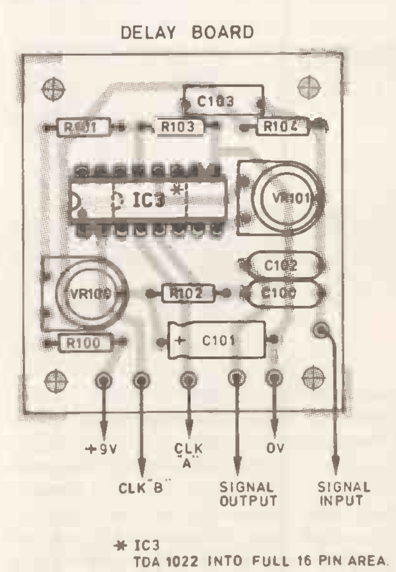
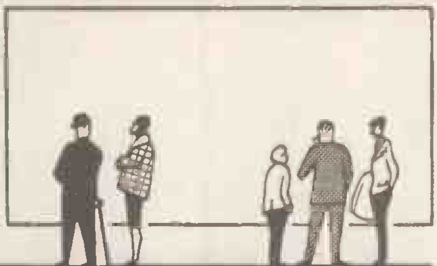


Fig. 5.8. Component layout for a Simple Reverb Controller combining two boards—Plan J and Plan K.

SHOP TALK



BY DAVID BARRINGTON

Catalogues Received

Although not as lavish as our more illustrious component suppliers, the latest 52-page catalogue from **Omni Electronics** certainly packs quite a range of products that the constructor is likely to need into its pages.

Items listed range from solderless breadboards and all materials and chemicals to produce printed circuit boards to TV aerial amplifiers. There are seven pages devoted to connectors covering jack plugs and sockets, DIN plugs and sockets, SCART plug and socket and a range of computer connectors.

They also carry quite a good range of semiconductor devices and are always willing to try to locate those rare devices that sometimes crop up in published designs.

Copies of the Omni Components catalogue may be obtained by sending two 18p stamps to **Omni Electronics, Dept EE, 174 Dalkieth Road, Edinburgh, EH16 5DX. ☎ 01-519 6149.**

Products such as rechargeable sealed lead acid batteries to solar panels are contained in the latest 24-page catalogue from **A & G Electronics.**

The catalogue also lists a range of key-operated switches and contains 10 pages of semiconductor devices. Copies of the *A & G Components Catalogue* are available free of charge from: **A & G Electronics, Dept. EE, P.O. Box 443, London, E14 6JU. ☎ 01-519 6149.**

We have just received the monster autumn catalogue from **Electromail,** the mail order arm of RS Components.

Containing over 1000 pages, they claim that with the sharp increase in production costs they now have to make a charge of £4.95 for the catalogue. They do point out however that it does contain over 19,000 products, many with technical information.

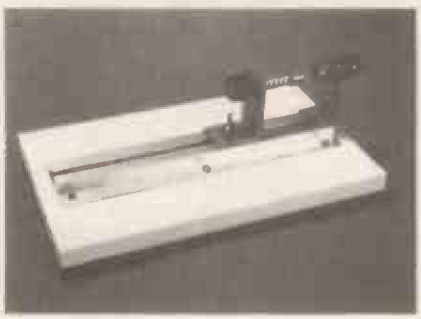
For more details and copies contact: **Electromail, Dept EE, P.O. Box 33, Birchington Road, Corby, Northants NN17 9EL.** ☎ *0536 204555.*

Assembly/Repair Jig

Knowing, from personal experience, the frustration that can arise when trying to mount and solder delicate components on a circuit board, John Everett of **Everett Workshop Accessories** set about designing his own "third hand" p.c.b. assembly jig. The results of his labours is a hand made fairly robust metal framework on a laminated chipboard base.

The thinking behind the design was that it had to be able to hold various sizes of circuit board and allow them to be flipped over for soldering once the components had been mounted in position. It also had to be reasonably stable on the bench and not go "walkabouts" as soon as you went near it with a soldering iron. This, of course, invariably happens when you try to assemble a board directly on the workbench surface.

Available in two versions, the Mini jig will take boards up to 145mm×85mm and the Standard version will accept boards up to 310mm×145mm. The jigs are normally supplied with heads for holding p.c.b.s and a pair of interchangeable rubber faced heads for holding items with surfaces that could easily be damaged.



Both models come complete with an "earthing" lead for use when working on CMOS devices, which are prone to damage from static electricity.

The Mini assembly jig costs £21.50 (inclusive p&p) and the Standard version costs £24.50 (inc. p&p) and are available direct from: **Everett Workshop Accessories, Dept EE, 5 Railway Terrace, Henllan, Llandyssul, Dyfed, SA44 5TH, Wales.**

CONSTRUCTIONAL PROJECTS

Soldering Iron Temperature Controller

The TDA1024 triac controller chip, with in-built zero crossing detection circuit, called for in the *Soldering Iron Temperature Controller* should be available from the majority of our advertisers. The one used in the prototype was purchased from **Maplin.** It is also currently listed by a **A & G Electronics and TK Electronics.**

If any readers have difficulty in locating a source for the mains transient suppressor (VDR1), this was obtained from Maplin, code HW13P (Mains Trans Supp). The 400V 3A triac (C206D) and the 1000V 1A diode (1N4007) should be available generally and not cause any buying problems. It is essential that the potentiometer VR1 be of the plastic spindle type.

A final word of warning, as mains voltages are present on the stripboard extreme care should be taken to ensure that no copper strips on the board underside are shorted out by careless "soldering". Also, ***never*** have the unit connected to the mains when carrying out any work on the controller; reseal the case before testing.

EPROM Eraser

Some of the components called for in the *EPROM Eraser* could be classified as "special" items and it could prove difficult to locate a local source. However, the TIP121 Darlington power transistor and the glass reed switch and magnet should be readily available.

Because of the dangers from ultraviolet light, it is most important that readers follow the construction instructions closely. The method of safety switching is particularly important. Never test the unit without first making sure that the u.v. tube is completely sealed in its case.

The choke L1 and the step-up transformer T1 are available as a kit (£4) of cores, formers and wire from **Magenta.** The 4W u.v. tube (£9.60) is also available from the same supplier. The only other source we have located is a RS type and is listed at about £3 more for a two tube pack.

A complete kit of parts (£24.95), including u.v. tube, case, board and choke and transformer parts, for the EPROM Eraser may be purchased from **Magenta Electronics, 135 Hunter Street, Burton-on Trent, Staffs, DE14 2ST.** Add £1 for post and packing per order.

The printed circuit board is available through the *EE PCB Service*, code EE620 (see page 616).

Battery Tester

An "old style" s.r.b.p. (Paxolin) tag strip is called for in the simple 1.5V *Battery Tester,* and, much to our surprise, seems to be listed by most of our component supplier advertisers.

If you use a metal case, instead of the plastic type specified, it would be advisable to insert a strip of cardboard between the bottom of the case and the tag board to avoid shorting out any of the solder tags. You can, of course, use board spacers.

AUDIO MINI BRICKS

The delay i.c. devices type TDA1097 and TDA1022 meeded for the *Audio Mini Bricks* series could cause many readers local sourcing problems as they seem to be in short supply. However, we understand that **Phonosonics** and **Cricklewood Electronics** ***(☎ 01-450 099)*** carry stocks.

The small *Delay Module* printed circuit board (255B–£2.68) and the "master" board (255A–£7.90) for the Audio Mini Bricks series of projects are available from **Phonosonics, 8 Finucane Drive, Orpington, Kent, BR5 4ED.**

We do not expect any component purchasing problems for the *Quad Car Controller* or the *Heads or Tails* project—this month's concluding demonstration circuit in the *Exploring Electronics* series. The 74164 8-bit shift register should be generally available from most component suppliers.

exploring electronics

OWEN BISHOP

This series is designed to explain the workings of electronic components and circuits by involving the reader in experimenting with them. There will not be masses of theory or formulae but straightforward explanations and circuits to build and experiment with.

Part 28 – Shift Registers

AT LAST we come to the end of the series and it is time to shift (excuse the pun!) on to something new. But, before we go, we will explore a type of logic circuit that we have not encountered before.

Shift registers, as their name implies, are used for shifting data. They have various designs, of which the one shown in Fig. 28.1 is a simple example. Here we have a register of four "flip-flops". Each flip-flop can be in the set or reset state, so the register as a whole can hold any of the 4-bit binary values 0000 to 1111.

The flip-flops are connected to each other in a chain and, when the clock input changes from low to high, the data is shifted one step along the chain. Let us see what happens.

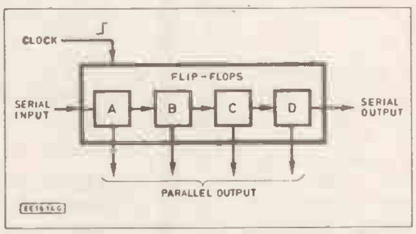


Fig. 28.1. A SISO/SIPO shift register.

SHIFT REGISTER –IN ACTION

A circuit for testing a shift register is shown in Fig. 28.2, and Fig. 28.3 shows how to set this up on a breadboard. The shift register used has eight flip-flops, *A* to *H*, but we use only the first four to begin with. The clock pulses that make shifting occur are provided by a 555 timer i.c. wired as an astable (*EE* Jan 1987).

With the resistors and capacitor indicated, the astable runs at 0.48Hz. It delivers an upward-going "clocking edge" to the register every two seconds, approximately. This register (IC2) has two inputs, useful for other applications, but here we input *A 'high'* and use input *B*. Fig. 3 shows the input wire unconnected. Before connecting the power to the circuit, push the free end of the input *B* wire into a +V socket in the top row of the breadboard. This gives a high input to *B*.

The four l.e.d.s (D1-D4) show the state of each of the flip-flops *A* to *D*, reading from left to right. When you first switch on, these l.e.d.s all come on, though perhaps not all at once. After a few seconds they are all on, since a high input is being fed into the chain of flip-flops.

Now put the flying lead into one of the sockets in the bottom row of the board (0V). Keep it there until diode D1 goes out, then return it to the top row. Watch the l.e.d.s. Can you see the "low" input being shifted along the chain? Repeat this a few times, until you understand just what is happening.

Try putting the flying lead into the 0 V socket for differing lengths of time. Watch the pattern of highs and lows being shifted along.

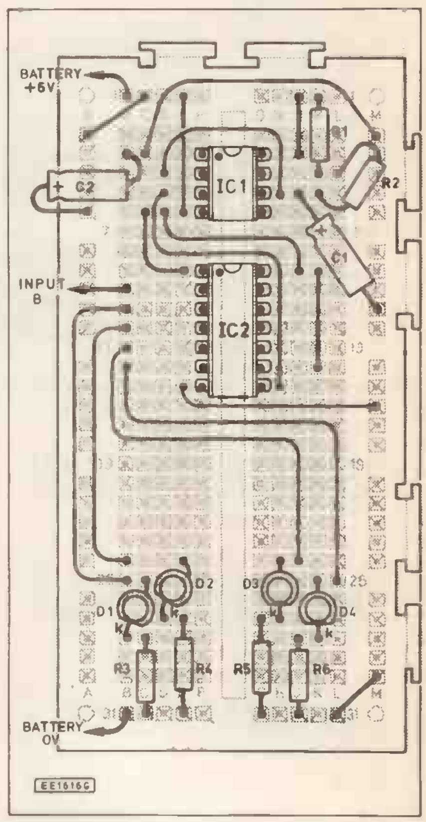
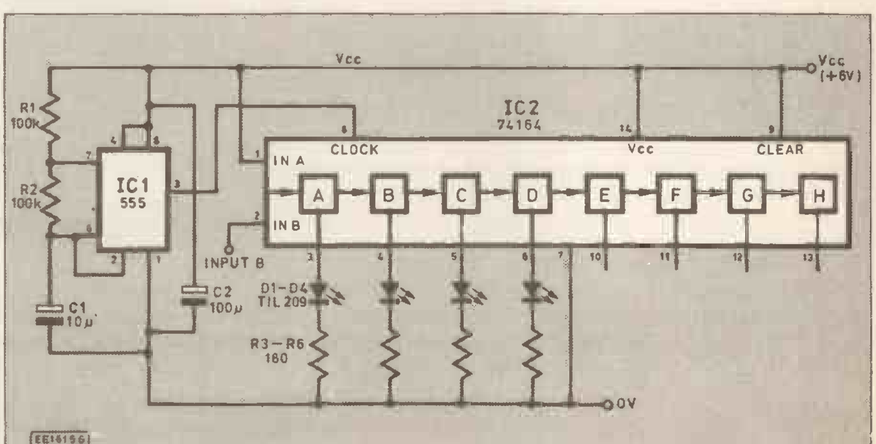
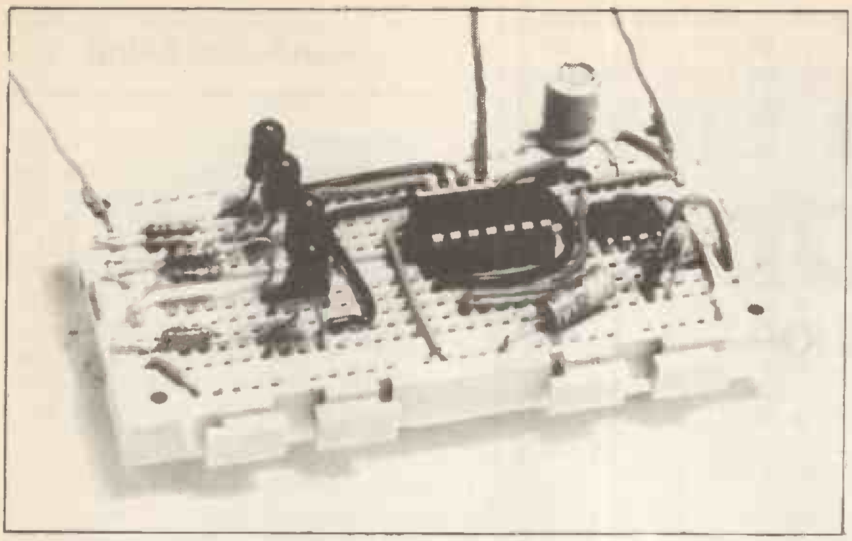


Fig. 28.2. Circuit diagram for investigating a shift register.

Fig. 28.3. Shift register demonstration board component layout.





COMPONENTS

SHIFT REGISTER
(INVESTIGATIONS)

Resistors
R1,R2 100k (2 off)
R3-R7 180 (5 off)
All 0.25W, 5% carbon

Shop Talk
See page 594

Capacitors
C1 10μ elec., 100n poly or lower (see text)
C2 100μ elec.

Semiconductors
D1-D5 TIL209 l.e.d. (5 off)
IC1 555 timer
IC2 74164 TTL 8-bit SIPO shift register
IC3 7400 TTL quad 2-input NAND gate

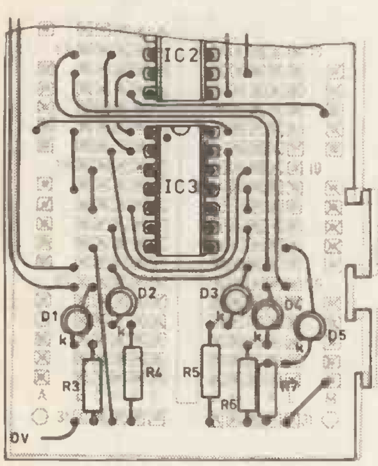
Miscellaneous
Breadboard (Verobloc); B1 6V battery and connector; connecting wire, etc.

Approx. cost Guidance only **£5** *(excluding Verobloc)*

When you have finished, leave the circuit connected, as we shall be adding to it later.

APPLICATIONS

The register used above has *serial input*; the data is fed into it one bit at a time. It has *parallel output*; each flip-flop has its own output terminal. Thus, this is a *serial- in/parallel-out* register, or SIPO for short.



If you want *serial* output (perhaps to feed to another 8-bit register) this can be taken from the output of register *H*. So this is also a SISO (serial-in/serial-out) register. Other types of register are available with parallel input and serial output (PISO) or with parallel input and parallel output (PIPO).

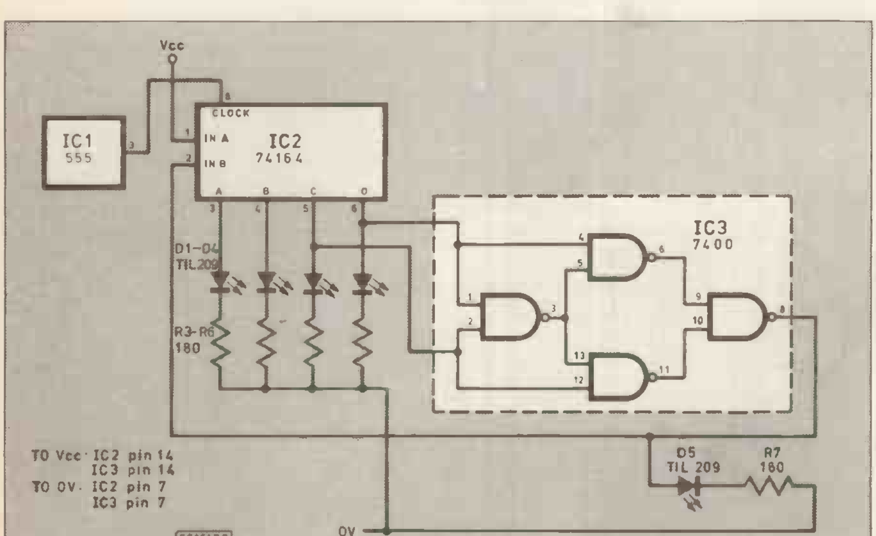
Each type has its uses, especially in computers where data often needs to be shifted. For example, you may have a byte of data that has to be sent along a pair of wires to a printer. The data is put into an 8-bit PISO register, eight bits at once. Then it is shifted out a bit at a time and fed down the wire to the printer.

Shifting is used for calculations in the microprocessor itself. For example, the decimal value 116 is represented in binary by:

1110100

Fig. 28.5 (left). Layout of additional components on "test-bed" to create random sequence.

Fig. 28.4. Circuit diagram for a Pseudo-random Sequence Generator.



If this is shifted one place to the right, it becomes:

0111010

This has the decimal value 58. Shifting the binary digits one place to the right is equivalent to dividing by two. Conversely, shifting one place to the left is equivalent to multiplying by two.

Shift registers shift either right (like the one we used above) or to the left, and some can be controlled so as to shift either way. With these we can rapidly multiply or divide by two or its multiples. We would normally use a PIPO register for such calculations.

RANDOM–OR AS GOOD AS

An extension of the demo shift register circuit to create a "random" sequence is shown in Fig. 28.4. Fig. 28.5 shows how to modify the breadboard component layout. The output from the two last stages of the register are fed to a network of NAND gates and the output from this network is fed back to the input, pin 2, of the register.

The gates are connected to make up an EX-OR (exclusive-OR) gate. We could have used a ready-made gate in a 7486. The logic of EX-OR is 'A or B but not *both*". Its truth table is:

INPUT		OUTPUT
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

A shift register with two of its outputs EX-ORed together and fed back to the input has interesting properties. Connect the battery and watch what happens.

If by chance none of the l.e.d.s comes on, disconnect the battery and try again. Obviously, if all flip-flops hold "0" (low), both outputs will be "0", the output of the EX-OR gate will be "0", and a series of zeros will be fed back, indefinitely.

If at least one of the flip-flops holds "1" (high) to begin with, try to write down the stages as they occur. How many different combinations of ' '0"s and "1"s can you record?

Do they occur in a regular sequence? Does the sequence repeat? If so, how often? The answers are on the opposite page.

Incidentally, if you find things shifting too fast, slow the clock down by substituting a 22μ or 47μ capacitor for C1.

You could try using other pairs of outputs from the register and find out what sequences you obtain. When you have finished, keep this circuit wired up as we shall be coming back to it later.

PSEUDO-RANDOM SEQUENCES

Given any one combination of "1"s and "0"s in the register it is not difficult to work out what the next combination will be. For example, if we have "0110", the last two digits are unalike, so their EX-OR is "1" (see truth table). Shifting the existing digits gives "–011", and the result of EX-ORing is put in on the left, giving "1011".

Working in this way, you can confirm that the sequence repeats itself after 15 steps, as listed opposite. However, though it is easy to do this in the simple case of 4-bits, it becomes tedious when there are many flip-flops in the register.

With seven flip-flops, there are 127 steps. With 33 flip-flops there are so many steps that it takes about two hours to run through the sequence *once*—even with the clock running at 1MHz (one million shifts per second). With 100 flip-flops and a clock rate of 10MHz, the time taken to run once through the sequence is longer than the age of the universe!

Even with a shift register of reasonable length (say, a dozen or so flip-flops) the sequence is so long that it is virtually imposible to memorise it. Although, strictly speaking, it is predictable, it is not practicable for anyone to know what the next combination of digits will be. It *appears* to be *un*predictable. In other words, the sequence is *pseudo-random*.

The situation is similar to that in computers in which a numerical algorithm is used to generate a series of pseudo-random numbers. Although the sequence repeats itself after many numbers have been generated, and although it is possible to calculate what the next number will be, it is just not practicable to do so and the series can be used as if it were truly random.

PSEUDO-RANDOM NOISE

Replace C1 with a 100n capacitor, to speed the clock up to 480Hz. Connect the battery and watch the l.e.d.s. They should now flicker in an *apparently* random way, like the flickering of a candle flame in a draught.

Connect a crystal earphone to the circuit, see Fig. 28.6. You should hear an *apparently* random series of crackles. This "random" noise is called "*white noise*". It is something that we often want to get rid of as it produces unwanted hissing and rushing sounds that spoil our hi-fidelity audio. But sometimes, we wish to generate white noise for sound effects and we normally do this by using a shift register.

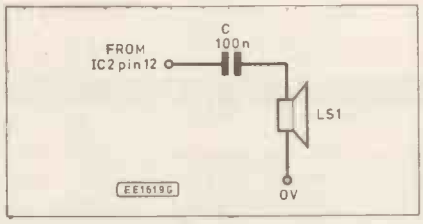


Fig. 28.6. Using a crystal earpiece to listen to the "random" output.

Sound effects chips contain a long register (about 17 flip-flops) used for this purpose. By clocking at different rates, and taking the output from different stages we are able to produce different kinds of white noise under controlled conditions.

When you listen to the white noise from a 4-bit register, you can hear that the sequence repeats fairly often. Try using seven flip-flops, taking the outputs from *F* and *G* (pins 11 and 12) instead of *C* and *D*. This gives 127 stages in the sequence. Try increasing the clock rate by further reducing the value of capacitor C1.

We cannot easily use all eight flip-flops because an 8-bit register needs three outputs to be EX-ORed to get a long sequence. With only two outputs the sequence is short—as you can work out for yourself, on paper.

HEADS OR TAILS

We conclude the series with a simple project to demonstrate the shift register i.c. and some of the components left over from previous months. Heads or Tails devices usually consist of a fast-running clock that you stop by pressing a button.

Depending on whether the clock is "high" or "low" when it is stopped, the result is "heads" or "tails". The randomness of this result depends on *you*, not the electronics.

Moreover, unless the clock's output is high for *exactly* as long as it is low (i.e. it has a mark-space ratio of exactly 1), then the result is biassed. An exact mark-space ratio is difficult to achieve and to maintain.

The Pseudo-random Heads or Tails circuit (Fig. 28.7), based on a 7-bit shift register, takes the output from register *G*. A high output turns on the red "heads" l.e.d. A low output turns on the green "tails" l.e.d.

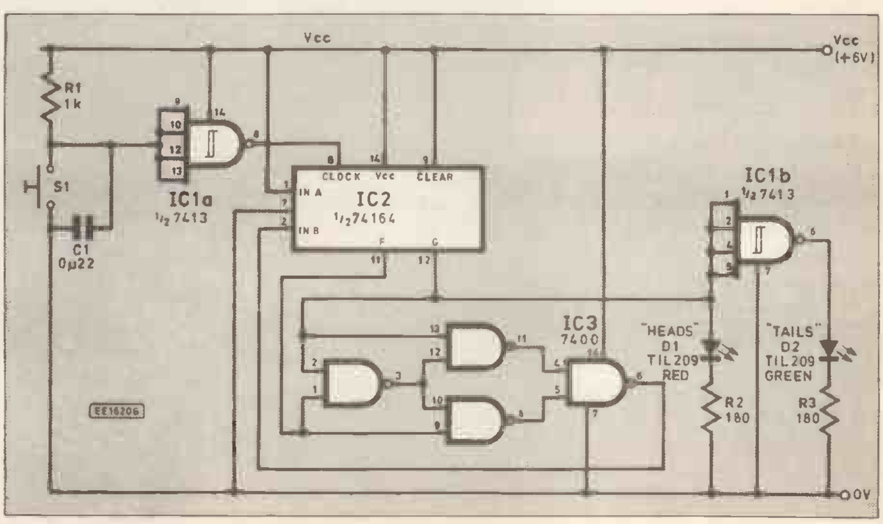
It is slightly biassed, since the 0000 state is not allowed, and in a continuous series of 127 "throws" there will be 64 heads and 63 tails. Betting on "heads" gives you a marginal chance of profit!

Remember that the sequence is only pseudo-random, not truly random. In theory, you could memorise it and be able to "predict" the next result. But it is highly unlikely that any normal person could succeed in such a feat of memory and recognise how far along they were in the sequence. So, *in practice*, this is as random as spinning a coin.

The "throw" is made by pressing switch S1. This is debounced by the Schmitt trigger gate IC1a, to give a single clean transition from low to high when S1 is pressed. It clocks the shift register IC2 one step. The EX- OR gate IC3 is made from four NAND gates, as before.

The output from flip-flop *G* is fed directly to the red l.e.d. (D1). It also

Fig. 28.7. Circuit diagram for creating a Pseudo-random Head or Tails?



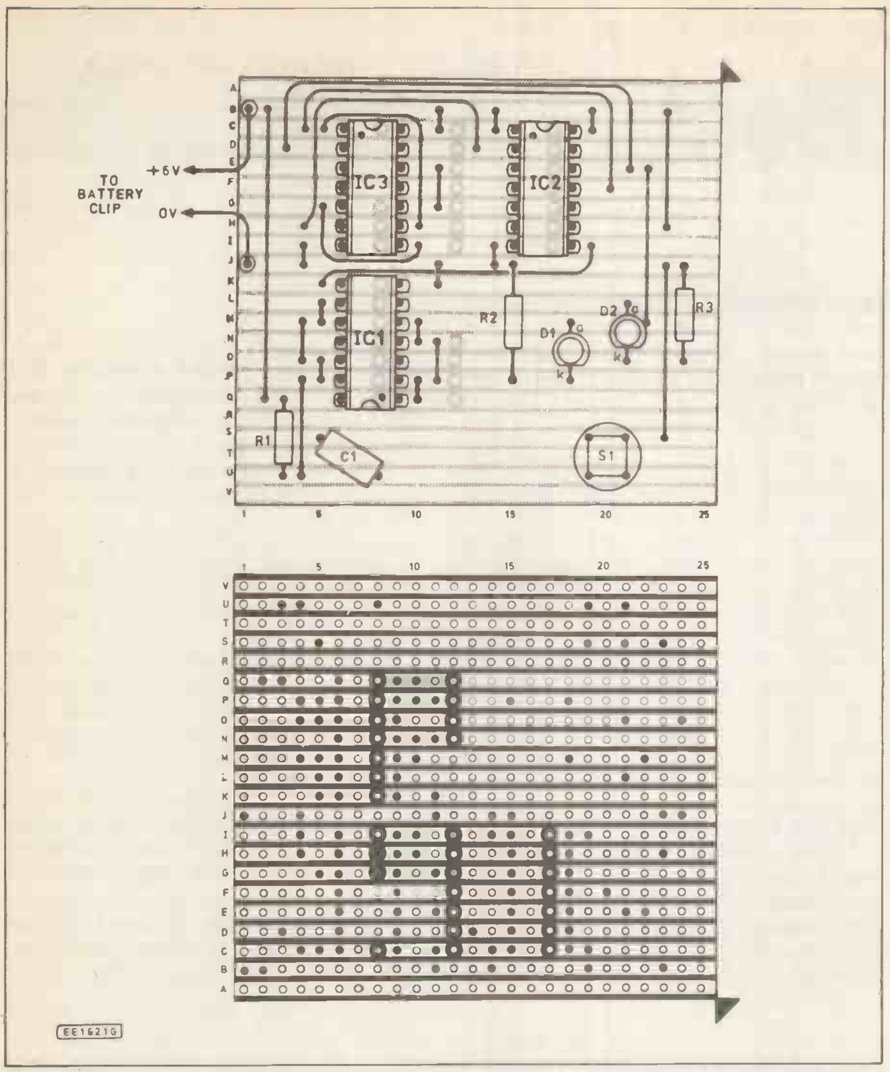


Fig. 28.8. Stripboard component layout and underside view, showing breaks in the copper strips, for the Pseudo-random Head or Tails? Make sure that all link wires are correctly positioned.

COMPONENTS

HEADS OR TAILS

Resistors
R1 1k
R2,R3 100 (2 off)
All 0.25W 5% carbon

Shop Talk
See page 594

Capacitors
C1 0μ22 poly. layer

Semiconductors
D1 TIL 209 red l.e.d.
D2 TIL 209 green l.e.d.
IC1 7413 TTL dual 4-input NAND Schmitt trigger
IC2 74164 TTL 8-bit SIPO shift register
IC3 7400 TTL quad 2-input NAND gate

Miscellaneous
Stripboard, 21 strips by 24 holes (55mm x 62mm); 14-pin d.i.l. sockets (3 off); S1 p.c.b mounting, press-to-make, push-button switch; B1 6V battery and connector; 1mm terminal pins (2 off); connecting wire,etc.

Approx. cost Guidance only **£5**

ANSWERS

The sequence is as follows: 1111, 0111, 0011, 0001, 1000, 0100, 0010, 1001, 1100, 0110, 1011, 0101, 1010, 1101, 1110, and then repeats.

There are 15 stages, representing all the 4-bit binary values, 0001 to 1111 (but not 0000, for reasons explained earlier).

goes to the other Schmitt gate IC1b, used simply as an inverter, to turn the green l.e.d. (D2) on when *G* is low.

CONSTRUCTION

The stripboard component layout for the Heads or Tails circuit is shown in Fig. 28.8. Commence construction by making all the breaks in the copper strips as indicated in the underside view. These should be checked carefully before tackling the topside components.

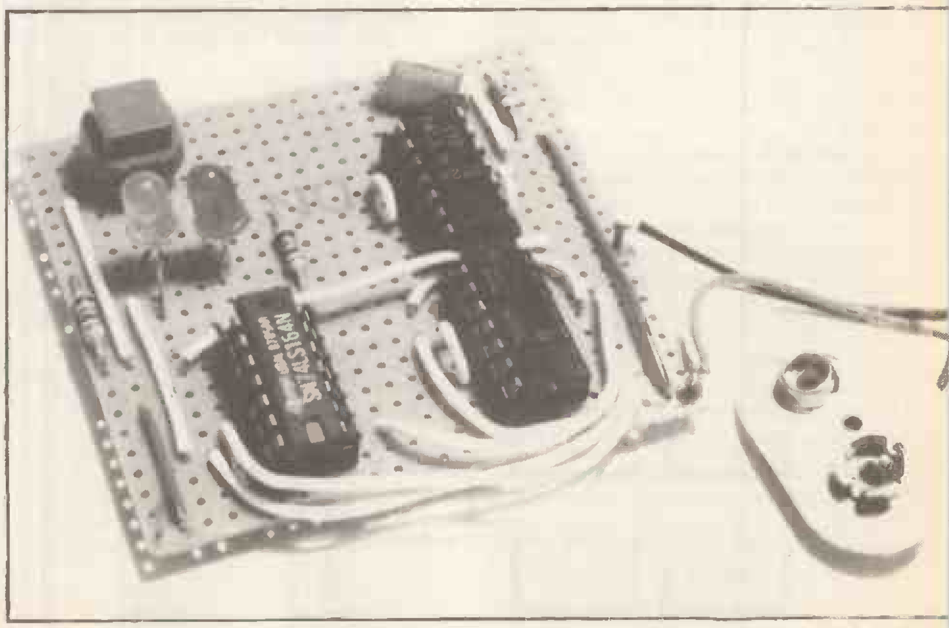
The i.c. holders, terminal pins and link wires should now be carefully soldered in position. It is a good idea to double-check these connections before finally soldering.

Next the resistors, capacitors, l.e.d.s and push switch S1 should be soldered in place. This should be followed by the supply leads and the completed board given a final checkover prior to connecting the battery B1.

OVER AND OUT

It seems a long time since July 1986, when this series began. We wonder how many readers have followed every one of the investigations.

Whether you are an "early explorer" or have joined us more recently, we hope that you have had a lot of fun and interest while joining us in exploring electronics. □



...Beeb...Beeb...Beeb...Beeb

... Heart Rate Monitor Interface Software ...

IN LAST month's article a simple Heart Rate Monitor Interface was described. This design is followed up here with some software for the unit, and we will also look at an alternative approach to heart rate monitoring.

Software

The heart rate monitor software is provided in the accompanying listing, which is really two separate programmes rolled into one. When the program is run you are provided with a brief explanation and instructions describing how to obtain the required function. The program can either monitor the pulses supplied to the digital input of the analogue port (PB0) or the analogue signal on channel 0.
the values received from the analogue port is displayed on the screen. This is a sort of storage oscilloscope type display and the effective sweep time is about 7 to 8 seconds.

It is just a matter of counting the tinuous sweep version of the program if desired, but in its present form only a single sweep facility is provided (which is probably the more useful). In order to exit the program you press the "Escape" key, and then "N" to go back to the initial screen or "Y" to exit the program altogether.

With the "R" option selected from the initial screen a beats-per-minute graph is produced. This provides much longer term monitoring, and with the porgram in its current form it takes over an hour to produce a complete graph (although a useful graph will be produced after several minutes of monitoring)!

There are several ways of converting the incoming pulses into a beats per minute value, but it boils down to two basic approaches. The most simple one, and the one used in this program, is the standard frequency meter method.

It is just a matter of time counting the number of input pulses in a given period of time and then applying some simple mathematics to give a meaningful answer. In this case the number of beats in a 15 second period are counted and then multiplied by four in order to give an answer in beats per minute.

It is obviously advantageous to use a counting period that is as short as possible in order to obtain a display that is updated as frequently as possible. On the other hand, the longer the counting period is made, the greater the accuracy of the system. A compromise therefore has to be sought, and a 15 second period is probably about the best one.

An alternative approach is to measure the time between each input pulse. The display can then be updated on each heart beat.

The time of each beat can be converted to beats per minute form by dividing 60 by the beat time in seconds. This is the more difficult method, since relatively small timing errors could have a significant effect on the accuracy of the system.

However, I doubt if an assembly language routine would be warranted, and a BBC BASIC routine should be able to cope. This method certainly represents an interesting line of pursuit.

Body Language

Optical methods of detecting the heart beat are safe and simple, but are perhaps less interesting than detecting the heart beat via the electrical signals in the body. There are actually a multitude of electrical signals in a standard issue human body, but those associated with the heartbeat are the strongest and the easiest to detect. The basic setup for a detector that responds to the electrical activity of the body is shown in Fig. 1.

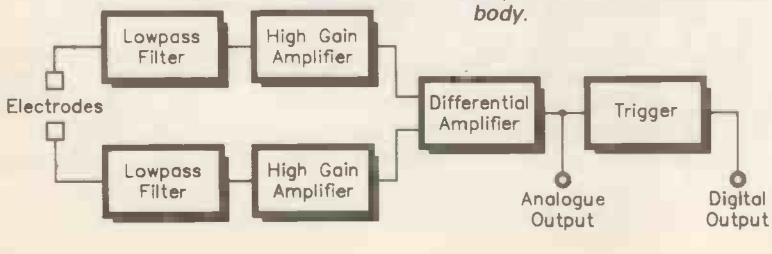
The electrodes are an important part of the system, and satisfactory results can only be obtained if they are in reliable and consistent contact with the user's body. The ideal method is to use proper electrodes which have a coating of conductive jelly to ensure that good contact with the skin is maintained. Quite good results can be obtained with the aid of a little improvisation though.

There are a number of possible sites for the electrodes, but it is basically a matter of having one on each side of the body. They then receive anti-phase signals and voltage differences are developed across them.

The signals from the electrodes are initially processed separately, and they are both subjected to lowpass filtering and a large amount of amplification. The filtering is needed to reduce any electrical noise picked up in the electrodes and connecting wires. This is likely to be predominantly mains "hum", but could also include radio frequency signals.

As we are only interested in very low frequencies of around 0.5Hz to 3Hz, lowpass filtering is reasonably efficient at combating any noise that is picked up. The signal levels provided by the electrodes are unlikely to be more than a few millivolts peak-to-peak, and could be less than this. A substantial amount of voltage gain is therefore needed in order to bring the signals to a high enough level to drive the analogue port of the BBC computer properly.

Fig. 1. Block diagram of a monitor that responds to the electrical activity of the body.



A differential amplifier is fed with the two amplified signals. As these signals are out-of-phase they are effectively added together by the differential amplifier, and they produce a strong output signal.

By contrast, any noise picked up by the electrodes or wiring will be in-phase, and will be cancelled out to a large extent. The differential amplifier thus acts as a final defence against any stray noise picked up by the equipment.

This is important as the noise could very well be many times stronger than the signal picked up from the user's body. The filtering might not be completely successful in removing it.

The output from the differential amplifier can be used to drive an analogue input of the BBC computer's user port. A trigger circuit is all that is needed in order to process this signal to produce a pulse output than can drive a digital input of the machine. Of course, for safety reasons, both signals must be fed to the computer by way of isolation circuits.

Next month: a practical circuit will be provided.

SOFTWARE

```
10 REM HEARTRATE MONITOR PROGRAM
20 REM E E 1988
30 REM J.W.P. 7/88
40  ON ERROR GOTO 1110
50 MODE 1
60 VDU 20
70 PROCinstructions
80 PROCscreen
90 IF choice$="R" OR choice$="r" PROC
grid:PROCratectrl
100 VDU24,104;304;1196;896;
110 IF choice$="B" OR choice$="b" PROC
beat
120 PRINTTAB(5,30)"PRESS ANY KEY TO RE
PEAT"
130 REPEAT UNTIL GET
140 CLG
150 GOTO 90
160 END
170 DEF PROCscreen
180 CLS:X%=100
190 MOVE 100,900
200 DRAW 100,300
210 DRAW 1200,300
220  IF choice$="b" OR choice$="B" THE
N PRINTTAB(10,28);"HEARTBEAT GRAPH":VDU2
3,1,0,0;0;0;0;:ENDPROC
230 MOVE 1200,300
240 DRAW 1200,900
250 DRAW 100,900
260 PRINTTAB(10,28);"HEART RATE GRAPH"
270 PRINTTAB(10,25);"BEATS PER MINUTE"
280 ENDPROC
290
300
310 DEF PROCinstructions
320 PRINTTAB(13,5);"HEART MONITOR"
330 FOR line=1 TO 5
```

```
340 READ text$
350 PRINTTAB(0,9+line);text$
360 NEXT line
370 PRINTTAB(5,20)"PLEASE PRESS B or R
"
380 REPEAT
390 choice$=GET$
400 UNTIL choice$="b" OR choice$="B" O
R choice$="r" OR choice$="R"
410 DATA This program can either draw
a graph of,your heartbeat pattern or a g
raph of,your heartrate against time.  Pr
ess B,for the heartbeat pattern or R for
 the,heartrate graph.
420 ENDPROC
430
440
450 DEF PROCbeat
460 REPEAT UNTIL FNspace
470 MOVE 100,600
480 FOR X=100 TO 1200
490 Y=(ADVAL(1)/110)+300
500 DRAW X,Y
510 NEXT X
520 ENDPROC
530
540
550 DEF FNrate
560 REPEAT UNTIL (ADVAL(0) AND 3)=1
570 REPEAT UNTIL (ADVAL(0) AND 3)=0
580 T%=TIME
590 FOR beats=1 TO 5
600 REPEAT UNTIL (ADVAL(0) AND 3)=1
610 REPEAT UNTIL (ADVAL(0) AND 3)=0
620 NEXT beats
630 avtime=(TIME-T%)/5
640 rate=6000/avtime
650 =rate
660
670
680 DEF PROCgrid
690 FOR Y=400 TO 800 STEP 100
700 MOVE 100,Y
710 PLOT 21,1200,Y
720 NEXT Y
730 FOR X=260 TO 1200 STEP 160
740 MOVE X,300
750 PLOT 21,X,900
760 NEXT X
770 VDU5
780 FOR Y=308 TO 908 STEP 100
790 MOVE 0,Y
800 PRINT STR$((Y-308)/10+60)
810 NEXT Y
820 FOR X=228 TO 1168 STEP 160
830 MOVE X,280
840 PRINT STR$((X-228)/16+10)
850 NEXT X
860 VDU4
870 VDU23,1,0,0;0;0;0;
880 ENDPROC
890
900
910 DEF PROCrategraph
920 REPEAT
930 R%=TIME
940 YVAL=(FNrate-60)*10+300
950 DRAW XVAL,YVAL
960 XVAL=XVAL+4
970 IF XVAL=1200 E%=TRUE
980 REPEAT UNTIL TIME>R%+1500
990 UNTIL E%
1000 ENDPROC
1010
1020
1030 DEF PROCratectrl
1040 E%=FALSE
1050 XVAL=100
1060  MOVE 100,300
1070 PROCrategraph
1080 ENDPROC
1090
1100
1110 IF ERR<>17 REPORT:PRINT " at line
";ERL
1120 PRINT "DO YOU WISH TO QUIT PROGRAM
(Y/N)"
1130 ans$=GET$
1140 IFans$="Y" OR ans$="y" THEN VDU23,
1,1,0;0;0;0;:STOP
1150 GOTO 50
1160
1170
1180 DEF FNspace
1190 PRINTTAB(5,30)"PRESS SPACE BAR TO
START"
1200 REPEAT UNTIL GET=32
1210 PRINTTAB(5,30)SPC(25)
1220 =TRUE
>
```

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URGENT. I need "Motorola" MC1357(PQ) chip (limiter discriminator) as soon as possible to complete a project. Mr. W. A. Jones, 14 Myrtle Terrace, Llanelli, Dyfed SA15 1LH.

WANTED complete or blank p.c.b. for Philips 14in. R.C. TV No. 21227601. Data diagrams also required £ neg. Mr N. Smith, 4 Mortimer Street, Leominster, Herefordshire HR6 8HT.

HITACHI V211/212 dual trace 20MHz oscilloscope and test leads, excellent condition £250 ono. Wolverhampton 335521.

1000 ¼W resistors at least 15 differet values £4.50. 500 mixed capacitors pots etc. £4.50. Mr J. N. Karajos, 42 Priory Road, Peterborough PE3 6ED.

BOOK: Mastering Machine Code On Your ZX81 by Toni Baker, £5 including p&p. O. Morris, Eric Liddell House, Eltham College, Grove Park Road, Mottingham, London SE9 4QF.

200 various electronic magazines: Television(72/81), Practical Electronics (78/84, Wireless World (80/83) £10. Tel. 01-648 6459.

WANTED BBC model A MOS Basic ROM urgent. Price to R. Stringer (0494 29188).

WANTED ZX81 Forth ROM, also any old Tandy equipment for student project. Must be cheap. D. Armstrong, 85 Lower Bagthorpe, Bagthorpe, Notts NG16 5HF.

WANTED trainee service engineer (ZX81 owner) requires cheap hardware, test gear etc., preferably working order. State price. Robert Hollings, c/o St. Loye's College (ES2 course) Topsham Road, Exeter EX2 6EP.

FOR SALE. YAESU FT.709 70cm hand held boxed with spare mic., charger etc., almost as new only £165. Mr B. Barwick, 0484 846253.

HEATHKIT laboratory oscilloscope 5 inch screen single beam 10MHz 10mV excellent condition £40. Tel: 01-748 1410.

WANTED Heathkit COA-2600/4 timing light with Advance meter to fit to CO-2600 ignition analyser. Tel. 01-676 9005.

MAPLIN Modem with interface for Spectrum, good working order £30 inclusive of postage, swop S.W. receiver. Mr M. R. Day, 39 Valnord Lane, St. Peter Port, Guernsey, Channel Islands.

REDIFFUSION RC1000 receiver control unit. Good cond. £120 ono. tel 065883-796 after 7 pm. Mr C. Clarkson.

BAG of components–includes resistors, caps, relays, bulbs, etc., £5 only. Daniel Gaunt, 11 Barber Street, Eastwood, Nottingham NG16 3EW.

PRACTICAL Wireless 1960 to 1964. 56 issues including circuits offers. Tel 0692 402950. Mr D. Clague.

LASER 10mW scanner head and control desk as new £550. Also 1mW sound scanner £150. Mr D. J. Grubb, 0905-29690 after 6 pm.

WANTED information on where I can buy a Dragon 32 power supply. Mr T. Caddell, 67 Muirdykes Road, Penilee, Glasgow G52 2QJ.

WANTED circuit diagrams and/or technical manual for Decwriter LA180. Mr D. E. Griffiths, Tel 01-549 8157.

WANTED: oscilloscope, Watford 32K shadow RAM–£40. Small electric guitar £135 ono. tel after 6 pm please. Milan Lad 0274 575484.

P.E. Quasar stereo cassette recorder £10. Buyer collects, record mode needs attention. G. Churcher, 021-353 9471.

Name & Address:			

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...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

RADIO SPORT

The *World Amateur Radio Direction Finding Championships* will be held in Switzerland this year, but thanks to a historical quirk there will be, as usual, no UK entries.

DF or Fox Hunting is a highly competitive activity which can best be described as a form of orienteering in which the contestants arrive at their destination by the skilful use of radio direction-finding equipment. There have been contests since the 1920's. The first *International Amateur Radio Union* (IARU) competition was held in Stockholm in 1961, and this event has developed into the present-day World championships.

Over the years, however, a mainly British form of DF has evolved quite different to that which is practised in Europe and the rest of the world. Firstly, the radio equipment used operates on "top band", 1.8MHz to 2MHz, as opposed to the 3.5 MHz and 144MHz bands used elsewhere. Secondly both motor and foot transport is used by the competitors to reach their destination while the World championships are run entirely cross-country on foot.

Top band has reasonably consistent propagation characteristics compared with other bands, making it very suitable for DF but for many years this band was only available for use in the UK. In Europe, where there is great enthusiasm for this form of "radio-sport", the other bands mentioned have, therefore, been used, hence the exclusion of British DF enthusiasts from the EU/world scene.

GO INTERNATIONAL?

Within the UK there are a number of clubs who enthusiastically pursue DF activities. There are local events throughout the year all held within well established rules and guidelines. National qualifying rounds lead to an annual National final, but there it stops–the difference in practice prevents Britain's champions going on to pit their considerable skills against the rest of the world.

In an attempt to rectify the situation, the Radio Society of Great Britain (RSGB) is now seeking to encourage European-style DF events in the UK by launching a "DF Initiative". It has published draft rules, which are a simplified version of the EU practice, which it believes will help British participants develop up to intermediate level in the sport. Going beyond that, the RSGB looks forward to the time when sufficient expertise and knowledge has been built up to enable British competitors to enter international competitions and for World championships to be organised and held here.

FIRST HOME

The basic idea in UK events is that at some distant point, or points, in the countryside, a radio transmitter is hidden away with an operator who transmits signals at specified intervals on particular frequencies. The competitors, equipped with large scale maps, compasses and special direction-finding radio receivers, then set off in vehicles to take a number of bearings on the signal in an attempt to pinpoint the position of the hidden station. When they think they are near it, they leave their cars to plunge deep into (usually) the underbrush of some densely wooded area in an attempt to be the first to find and reach the station.

This bland description gives no idea of the cunning used by the operators to hide the station, including the use of multi-wavelength aerials which give off misleading signals at half-wavelength intervals along the wire, some distance from the transmitter.

Equally, experienced competitors develop high skill in reading the signs and can sometimes home-in on the target station after taking just one bearing, using a mixture of experience and instinct. They can also be wrong, and find themselves at the rear of the pack, their gamble having failed to pay off!

One of the attractions of direction-finding is that only the operator(s) of the hidden station(s) need to be licensed amateurs. Competitors, and their teams of helpers, need not be, making DF an ideal activity to bridge the gap between amateurs and those with other interests.

EU-STYLE

The European style of DF differs in a number of ways. The distance to travel is not so great (about 5-7km), as the competitors are on foot. The transmitters operate on the 3.5MHz or 144MHz bands. They are not hidden, and are completely automatic, i.e. not manually operated.

In many countries the sport is taken very seriously, with even the armed forces training and entering teams. An article on amateur radio in the USSR, which appeared in *IARU Region 1 News* in 1986, described DF thus: *"The know-how of designing and improving amateur radio equipment, good physical training (necessary for cross-country racing), good knowledge of topography, skill in finding one's bearings on the ground–and in finding the "foxes" (transmitters).*

These are the qualities necessary to succeed in this field. Thousands of our radiosportsmen are involved annually in home ARDF contests. The best "hunters" qualify for the national championships and enter for the international contests."

It will be interesting to see if this completely different style of DF catches on in the UK. The RSGB hopes that its initiative will encourage more existing amateurs and SWLs to try the sport. It also hopes that members of the Scout and other youth movements, traditional orienteers, and others will come to consider DF as an extension of their usual activities.

Perhaps amateur radio clubs will start their meetings with "limber-up" sessions from now on. Perhaps the term "radio amateur" will become synonymous with "fitness fanatic". Perhaps on the other hand it won't!

An information pack is available from the ***RSGB, Lamda House, Cranborne Road, Potters Bar, EN6 3JE,*** for anyone interested in trying the new-style DF. Envelopes should be marked *"DF Initiative".*

HAM GLASNOST?

Mention of the USSR reminds me of a QSO (contact) I had in Morse Code with an amateur in the Ukraine on the 20 metre band recently. I had a good session with him and carried out a few experiments to see just how much I could reduce my power while he could still read my signals. I got down to about half a watt, much to his delight, and we both enjoyed the contact.

I have mentioned before that after a QSO, amateurs often exchange QSL cards as a memento or proof of the contact. I have also mentioned that cards to and from Soviet amateurs ***must*** be routed through the official QSL Bureau, Box 88, in Moscow.

Imagine my surprise then when we got round to confirming that we would send our QSLs to each other. He sent "QSL direct?" Thinking it a mistake, I replied "OK QSL via buro, Box 88."

"No, QSL direct–my address is..." He repeated this a couple of times to make sure there was no mistake. Rather doubtfully, I then sent him my address.

I duly sent off my card with some nice pictorial stamps on it for his collection, not really believing that it would get through, or that he would be able to reply except through Box 88.

As I write, only this morning, I was proved wrong. I received an airmail envelope covered with nice stamps and containing a QSL card, two postcards, a small calendar and a stick-on label in Russian that I can't read.

His English is not good–we did better with the international Morse code abbreviations–but I did like his phrase *"You very good man, op., dr Tony".* Whether he means I'm a good operator or just a good chap for sending my card direct I'm not sure.

Whatever he meant, the direct exchange of QSL cards is clearly a milestone, a further example of how amateur radio can break down artificial barriers between ordinary people. Just to be on the safe side though, I haven't mentioned his call-sign in case he did wrong–and someone in authority "over there" happens to be a regular reader of this column. (Some issues do go to Russia – Ed.).

Robot Roundup

NIGEL CLARK

THE START of the new school year is an opportune time to update last year's list of equipment available in the educational market. There has been a lot of activity during the past 12 months with much coming and going but the established names, Cybernetic Applications, LJ Electronics and Feedback Instruments are still going strong.

We hope we have listed all that is available and apologise if any products have been left out. The prices given are a guide and not precise, exact prices should be obtained from the companies.

ARMS

Alfred ***(Research Development Associates)*** 5-axis plus gripper, servo-driven with toothed belts, lift 170gm. Also sold as 1012 by **Feedback Instruments**. £300 plus VAT. The constructional details for the early model were first published in the *November 1985* issue of *EE*.

Armtech ***(Shesho-Tech)*** 5-axis plus gripper, stepper driven with toothed belt, lift 300gms. Can work with micro with 8-bit parallel port but no specific software. Based on old Armroid design. £495 plus VAT.

Atlas II ***(LJ Electronics)*** 5-axis plus gripper, stepper driven with toothed belts. Lift 1kg. On-board micro and teach pendant for stand-alone system. Wide range of operating software. Also controllable from BBC and IBM and IBM compatible machines. Work cell available. Arm costs £2,500 plus VAT, IBM interface £350.

Beasty Plus Arm ***(Commotion)*** 3-axis plus gripper, servo-driven, lift 75gm. Supplied as kit with instructions on how to build four different configurations. Kit costs £120 plus VAT and £35 for interface.

Cyber 310 ***(Computer Voice)*** 5-axis plus gripper, stepper driven with belt and cable transmission. Lift 250gm. Software for all usual micros. No longer being made but still available while stocks last. £700 plus VAT.

EMU ***(LJ Electronics)*** 4-axis plus gripper, servo-driven with direct mechanical linkages, lift 100gm, software for BBC B and LJ's Emma. Workcell extra. £325 plus VAT.

HRA 934 ***(Feedback Instruments)*** 5-axis plus gripper, hydraulically powered, lift 2.5kg, on-board processor and control by BBC B, Apple IIe, C64. £2,900 plus VAT.

MA 2000 ***(TecQuipment)*** 6-axis plus gripper, servo-driven with toothed belt transmission, pneumatic gripper. Lift 1kg. Software for BBC B and Open University's Hektor, was developed for Open University courses. Gripper is fitted to take pneumatic tools and wired for sensors £5,200 export price including basic software, discounts available for UK.

MA 3000 (TecQuipment) 5-axis plus gripper. Larger but simpler version of MA 2000. Can be linked with MA 2000 as part of manufacturing system. £10,500 plus VAT.

MARS ***(Research Development Associates)***. Also known as the Modular Automation Robot System. Modules can be fitted together in a number of ways including normal 5-axis arm and Scara. Servo-driven, lift 1kg.

Uses same on-board processor as Alfred software and can be controlled by most of usual micros except for Atari machines. £2000 plus VAT.

Mentor ***(Cybernetic Applications)*** 5-axis plus gripper. Servo-driven, lift 1kg. Can be controlled by small scale model simulator. Software for BBC, IBM and Apple. Can be networked with up to seven other Cybernetic machines and work cell. £900 plus VAT.

Naiad (Cybernetic Applications) 5-axis plus gripper, lift 500gms powered by hydraulics (water). All axes driven by different kinds of hydraulic piston, all cylinders made of see-through plastic. As with Mentor can be controlled by simulator and networked with up to seven other Cybernetic machines and work cell. Software for BBC, IBM and Apple. £1,625 plus VAT.

Neptune I (Cybernetic Applications) 5-axis plus gripper, Electro-hydraulically powered (water) lift 2.5kg. Software for BBC, IBM and Apple and on-board processor. As with Mentor can be controlled by simulator and networked with up to seven other Cybernetic machines and workcell. £3,790 plus VAT.

Neptune II (Cybernetic Applications) 6-axis gripper. Rest of the specifications the same as Neptune I with addition that can be controlled by touch sensors on all axes. £5,160 plus VAT.

RobotArm ***(Logotron and Resource)*** 5-axis plus gripper, bucket or magnet, servo-driven, battery powered and has two standard Atari joystick ports for control. Sold as educational package with interface for the BBC. £89 plus VAT, BBC interface £45 plus VAT.

SCARA ARMS

IVAX 901 ***(Feedback Instruments)*** 4-axis plus pneumatic gripper, servo-driven, lift 500gms, software for on-board processor, IBM, BBC and Apple. Work cell available. £3,380 plus VAT.

PW801 (Feedback Instruments) 4-axis plus gripper, servos on all axes except end rotation which has a stepper motor, lift 2kg. Software for IBM and Apricot. Work cell available, interchangeable gripper jaws. £7,300 plus VAT.

RTX ***(UMI)*** 6-axis plus gripper, servo-driven, lift 4kg, software for IBM. £7,250 basic, £7,280 for upgrade–faster and more accurate.

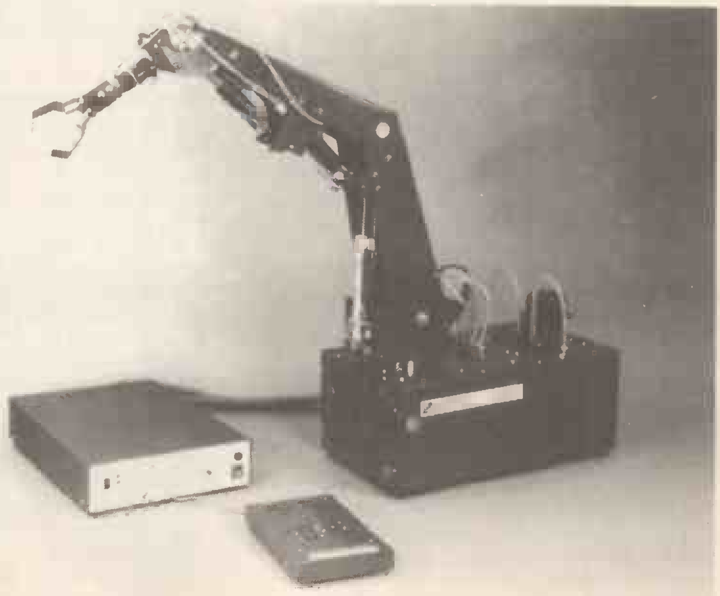
Serpent I ***(Cybernetic Applications)*** 4-axis plus gripper, servo-driven with pneumatic power for vertical movement of gripper, vertical movement of arm done manually, software for BBC, IBM and Apple. Can be networked with up to seven other Cybernetic machines and work cell. £2,665 plus VAT.

Serpent II ***(Cybernetic Applications)***. Same as above except that it has longer reach. £2,700 plus VAT.

OTHERS

Kestrel ***(Cybernetic Applications)*** gantry supported arm with 4-axis plus gripper, stepper-driven, works in x, y and z

Feedback Instruments HRA 934 hydraulically powered arm.



directions, lift 2kg, vacuum or two-fingered pneumatic gripper. Software for IBM can network with up to seven other Cybernetic machines and work cell. £3,870 plus VAT.

Tracer *(LJ Electronics)* Unique device based on *XY* plotter with gripper which can be raised and lowered. Steppers power *XY* axes with servos on the gripper. Comes with p.c.b. assembly kit. Also supplied with pen carrier for conversion to plotter. £750 plus VAT.

MOBILES

Jessop Turtle ***(Jessop Microelectronics)*** also known as Edinburgh Turtle, it looks like an upturned mixing bowl, one of the earliest turtles, controlled by a version of Logo.

Powered by servos with optical encoders, includes pen. Linked to computer by "umbilical" cord. Software for BBC and Apple, RML Nimbus and 480Z and IBM. £217 plus VAT retail, £195 plus VAT educational.

Lego Buggy ***(Lego and Resource)***. Two-wheeled servo-driven built from Lego kit with resource control board. Maze following, detecting obstacles, speed control and bar code reading can be done. Software in Buggy basic, Control and Control IT. £45.

Trekker ***(Clywd Technics)***. Two-wheeled, servo-driven. Developed by children at North Wales secondary school and given extensive in-house testing before being put on market with substantial software and documentation. Software for BBC and Commodores. £140 plus VAT, extra chip for Logotron Logo £10.

Valiant Turtle ***(Valiant Technology)***. Two-wheeled, servo-driven with pen, remote control via infra-red link, designed to resemble a turtle. Uses version of Logo for instructions. Recently upgraded for longer more reliable use.

Software for BBC, Apple, IBM. Microworlds being created in which to use turtle. £300 plus VAT retail, £250 plus VAT for education.

HEROS

Hero 1 ***(Maplin Professional Supplies)***. Large mobile. Has light, sound and motion detectors, rangefinder and speech. On-board processor, 4-axis arm driven by stepper motors, lift 8oz. Includes range of demonstration programs.

Easily built and dismantled to show how it works. Imported from the US and one of the first machines on the small robot market. £1200.

Hero 2000. More powerful version of Hero 1 with much larger memory and expansion options. Two-wheeled drive system using servos and arm expanded to five axes. Gripper has touch sensor to adjust gripping force, lift 1lb. Two specially-written courses.

KITS

The ***Fischertechnik*** computing kit includes two d.c. motors, two potentiometers, eight switches and a large selection of pieces for making computer-controlled models including plans for two arms. Interfaces and software available for BBC.

Arm and plotter/scanner kits. Arm has three axes and uses more powerful servos than computing kit, driven by work screws. Plotter uses stepper motors. Same interfaces and software as computing kit. Prices vary.

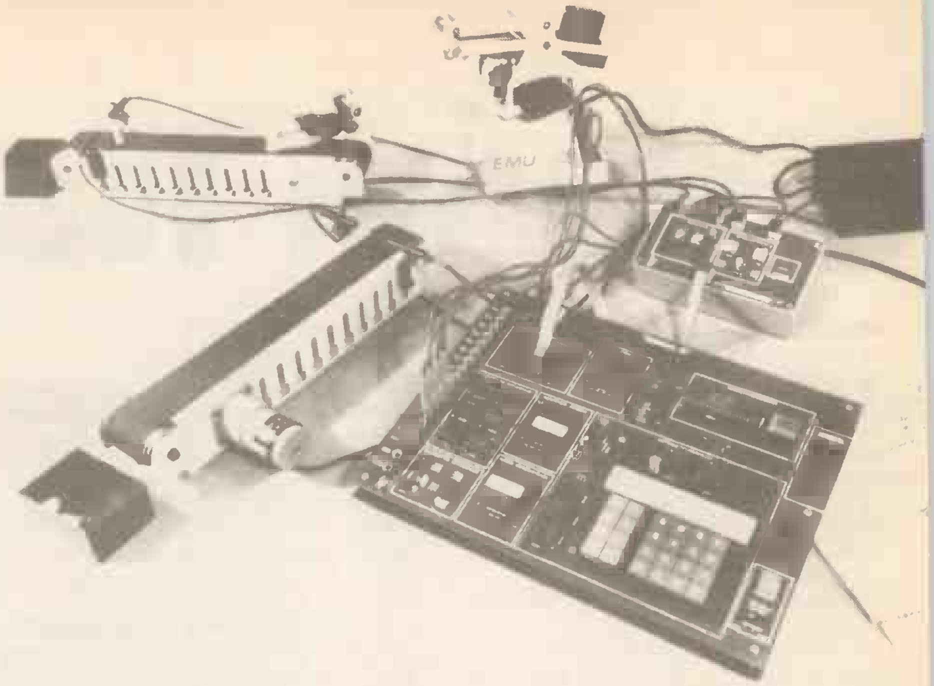
The ***Lego-technic*** series includes kits from which an arm, a plotter and a buggy can be made as well as a number of other devices, which can be controlled by computer. Servos with optical encoders are available as are programs and interface for BBC, and a battery-powered controller. Special kits for secondary and primary schools. Prices vary.

Meccano ***(Nottingham Educational Supplies)***. Come in various complexities. Contain motors but no specific instructions for robot devices or computer interfaces. Prices vary.

Robotech ***(Proops Brothers)***. Parts to make 3-axis arm on mobile base with gripper and remote control. All electronics and mechanical parts supplied except for structural parts for which templates are provided. £80.

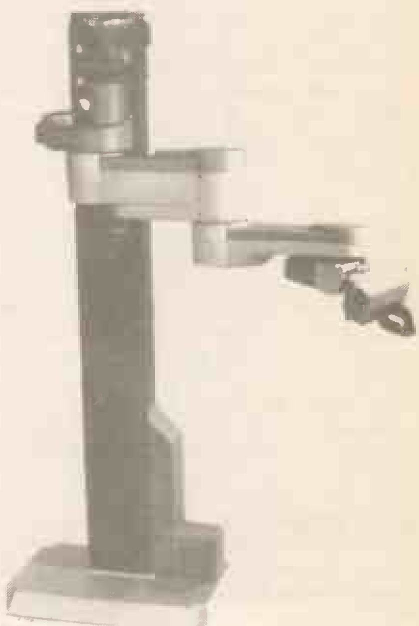
Plawcotech, ***Osmiroid*** and Robitix all provide collections of components, the more complex with motors but do not supply interfaces for computer control. Plawcotech available from ***Commotion***. Robotix from ***Milton Bradley*** mainly for creating toy space vehicles and monsters.

The ***Tribotics*** kit is based around 2in. drainpiping, large robust and inexpensive. Motors and hinges with the piping combine for a number of different robotic devices which can be connected to any micro with 8-bit parallel port. Prices vary.



EMU Robot together with its work-cell elements.

RTX SCARA arm.



Further Information

Clwyd Technics, *Antelope Industrial Estate, Rhydynwyn, near Mold, Clwyd.*
Commotion, *241 Green Street, Enfield, Middlesex.*
Cybernetic Applications, *West Portway Industrial Estate, Andover, Hampshire.*
Feedback Instruments, *Park Road, Crowborough, East Sussex.*
Jessop Microelectronics, *Unit 5, 7 Long Street, London E2.*
Logotron, *Dales Brewery, Gwydir Street, Cambridge.*
LJ Electronics, *Francis Way, Bowthorpe Industrial Estate, Norwich.*
Maplin Professional Supplies, *PO Box 77, Rayleigh, Essex.*
Nottingham Educational Supplies, *Ludlow Hill Road, West Bridgford, Nottingham.*
Osmiroid, *Fareham Road, Gosport, Hampshire.*
Proops Brothers, *52 Tottenham Court Road, London.*
Research Development Associates, *BTC, Bessemer Drive, Stevenage, Hertfordshire.*
Resource, *Exeter Road, Off Coventry Grove, Doncaster.*
Sheshotech, *Unit 2, Sapcote Trading Centre, 374 High Road, Willesden, London.*
TecQuipment, *Bonsall Street, Long Eaton, Nottingham.*
Tribotics, *27 Crawley Mill Industrial Estate, Witney, Oxfordshire.*
UMI, *UMI House, 9-15 St James Road, Surbiton, Surrey.*
Valiant Technology, *Gulf House, 370 York Road, Wandsworth, London.*

Constructional Project

BATTERY TESTER

T. R. de VAUX-BALBIRNIE

Get the best service from your batteries

THIS circuit checks 1.5V cells of all sizes and types apart from the nickel-cadmium (rechargeable) variety. By using an l.e.d. indicator, the cost of a meter is avoided and this reduces constructional costs.

Many pieces of household equipment–cassette players, radios, calculators and games use a set of 1.5V batteries to provide the working voltage. One common configuration is 4 cells to give 6V but arrangements of 2, 5, 6 and 8 batteries are in common use. People often ask the purpose of a tester when it is usually obvious when the batteries have failed–symptoms of distortion and low volume in audio equipment, for example. However, it often happens that only one cell in the set is exhausted and the others are capable of further service.

Since the cost of batteries is high, it makes sense to squeeze as much life from them as possible. It is also possible to put a failing cell into light-duty service to give a new lease of life. In this design the battery under test powers the circuit–this is better than using a separate internal battery which would itself have a limited life.

IN USE

In use, a switch (set load) presets a suitable current drain and probes are connected to the battery. The test switch is now operated; if the battery is in good condition, an l.e.d. on the front panel flashes. Two loads are provided. One for the larger C and D sizes often used in audio equipment and the other for smaller cells used in calculators, personal stereos and other miniature equipment.

The low-load setting may be used with larger batteries to see whether they would be suiable for use in lower powered pieces of equipment. The high load setting may be appropriate for small batteries of the alkaline type in situations where high current drain is expected (in photographic flash units, for example).

The circuit gives an indication of on-load terminal voltage and this provides a good measure of the general condition of the cell. As the battery ages, its internal resistance rises and this results in a lower available voltage when current is drawn. At the end of its life, this voltage is too small to drive an adequate current through the equipment.

The chief problem with using an l.e.d. in this application is that it requires approximately 2V between its terminals to glow–a 1.5V cell is insufficient to operate it directly. This is overcome in the present design by using a voltage doubler circuit.

CIRCUIT DESCRIPTION

The complete circuit of the Battery Tester is shown in Fig. 1. With S1 in the low position it has no effect and R1 alone is connected across the battery terminals. This sets a nominal 400mA load. With S1 in the high

COMPONENTS

Resistors

R1,R2	3Ω3 (2 off)
R3	12
R4	150

0.5W, 5% carbon

Potentiometer

VR1 100 horizontal preset 0.25W

Capacitor

C1 1000μ axial elec. 10V

Semiconductor

D1 5mm red l.e.d.

Miscellaneous

S1, S2 d.p.d.t. slide switches–2 off (see text)

Plastic box size 75×50×25 mm external; connecting wire; stranded wire for test probes; tag strip–2 rows of 11 tags required; small fixings.

Approx. cost Guidance only £2.50

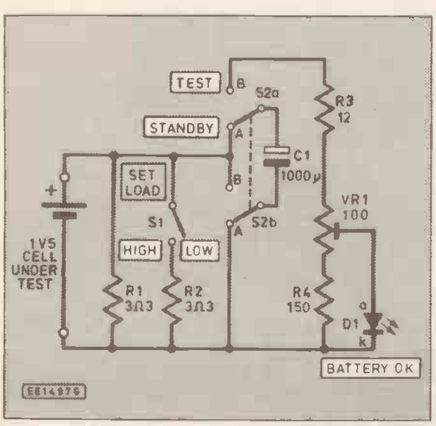
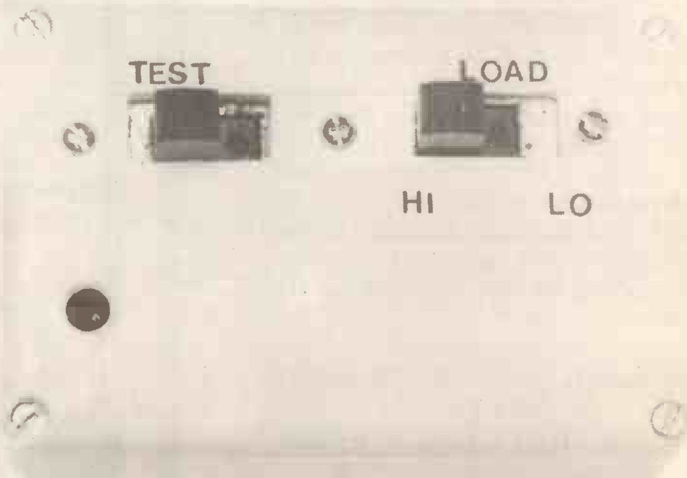


Fig. 1. Circuit diagram of the Battery Tester



position, R2 is connected in parallel with R1 so increasing the current to 800mA approximately. The effect of the load is to reduce the terminal voltage. It is considered that if this falls below 1.2V under load, the cell is unfit for further service.

With S2 in position A (standby), C1 charges from the supply. In a fraction of a second it will develop the full battery voltage (nominally 1.5V) between its terminals. With S2 now moved to position B (Test), the negative end of C2 is disconnected from supply negative and conected to supply positive. The positive end of C2 is connected to the top end of R3. Thus, there will exist a nominal 3V between the top end of R3 and supply negative (that is, the sum of the voltages across the battery and the capacitor). This doubles the available voltage allowing it to operate l.e.d., D1.

Resistors R3, VR1 and R4 form a potential divider with VR1 allowing an adjustment whereby D1 operates at the correct voltage level. Note that D1 flashes only briefly due to the limited amount of charge stored in C1.

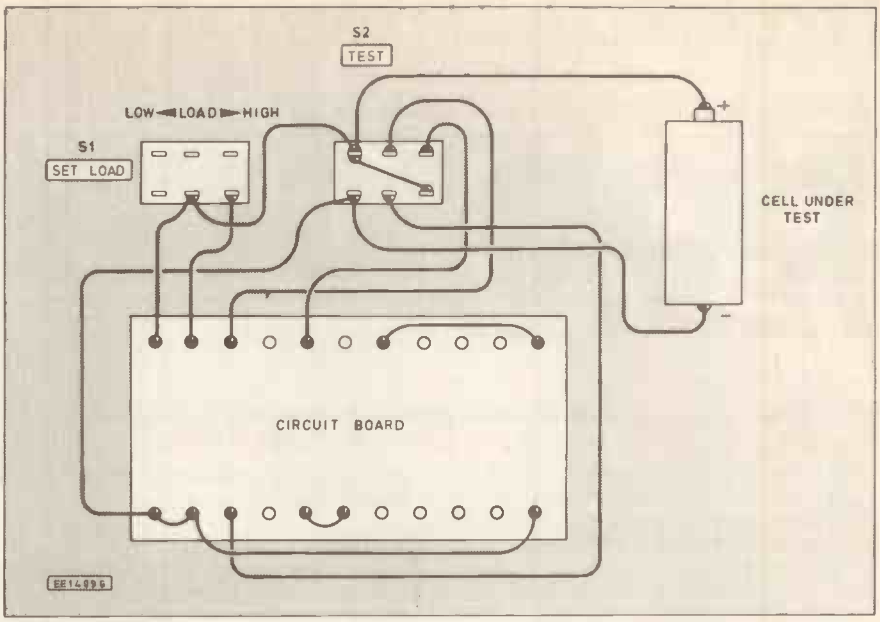


Fig. 3. Interwiring for the Battery Tester

CONSTRUCTION

Construction is based on the tag board layout shown in Fig. 2. Begin by connecting the four inter-tag link wires. Solder the components into position noting the polarities of C1 and D1. Use the full length of D1 wire ends and bend them with great care to avoid damage. Connect 10cm pieces of light-duty stranded connecting wire to the points indicated.

Prepare the case by drilling a hole in the lid for D1 to show through, also for S1, S2 and tag board mounting. Note that the constructional cost has been minimised by using inexpensive slide switches for S1 and S2. The disadvantage is that S2 must be returned to its original position after each operation. Readers willing to spend a little extra could use a d.p.d.t. push-button switch for S2 or a biased toggle type. Drill a small hole in the side of the case for the test probe wires to pass through. Refer to Fig. 3, mount the above components and complete all wiring.

To save space, S1 and S2 share a common centre fixing. Note the inter- contact link wire at S2. Pieces of stranded wire 15cm long should be used for the probes–red for positive and black for negative. Knot these together inside the case to prevent them pulling free in service. Remove 10mm of insulation from the end of each and tin the exposed copper ends. Fit the base of the box with self-adhesive feet to prevent scratching of the work surface. Before testing, adjust VR1 fully anti-clockwise.

TESTING

Note: When using the tester the polarity of the battery must be observed–the red wire to the positive terminal.

The best way to adjust the circuit is to use one good battery and one known to be in poor condition but not completely "dead". Select the appropriate load and connect the probes to the good cell. Next, operate S2 while observing the l.e.d.–this should flash. Return S2 to its original position and repeat with the poor battery. This time D1 should not flash. Advance VR1 a little and repeat the procedure. At some point, the l.e.d. will operate. Adjust VR1 anti-clockwise again until D1 just fails to flash.

This gives a near-correct setting of VR1—however, it may need small adjustments over a trial period for best results. Note that the action of the l.e.d. is not completely "sharp"–"bright" to "off" occurs over a certain range of VR1 rotation. This means that the "on" state will need to be interpreted to some extent. If the circuit fails to work, it is likely that S2 is operating in the opposite sense to that expected. With this tester, you will always be assured of the best service from your batteries. □

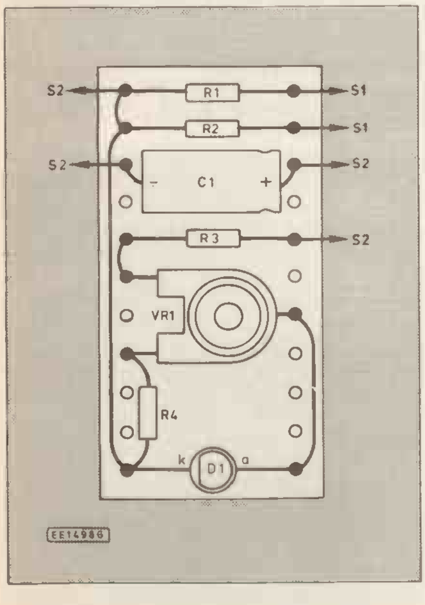
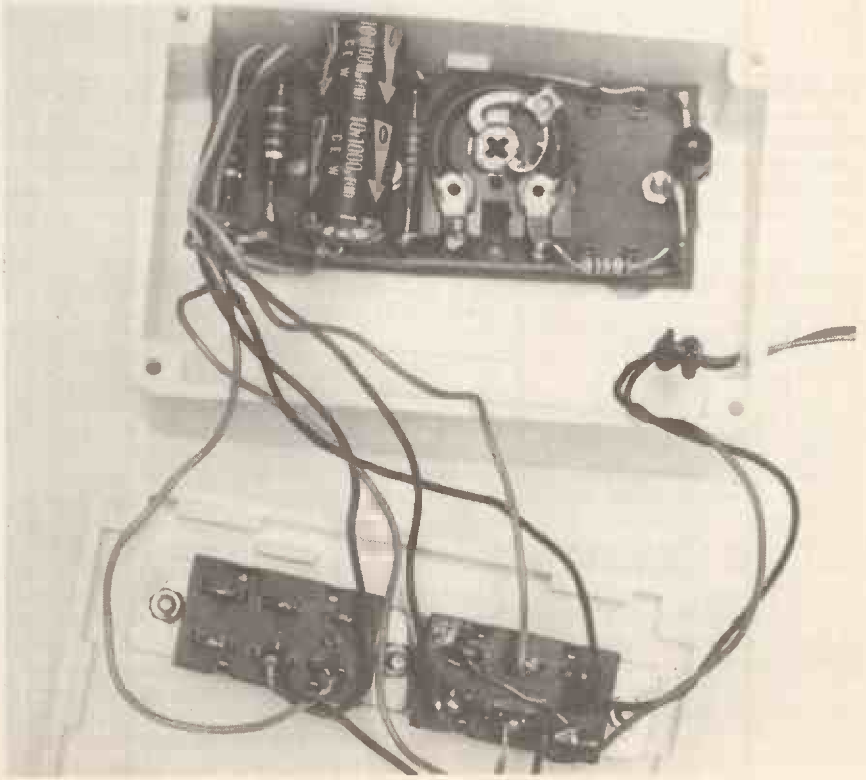


Fig. 2. Tagboard layout



ACTUALLY DOING IT!

by Robert Penfold

GETTING a really professional finish on a project is something that is far from easy. It can be done, and the use of photographically produced panels to give very tough and neat results is something that has been covered in a previous *Actually Doing It* (September 1987 issue). This method gives superb results, but is quite expensive. In fact many constructors probably feel, with some justification, that the money would be better spent on more components for further projects than on beautifying existing projects. I suppose that in an extreme case the front panel could cost more than the electronic components in a project!

So, are there any relatively cheap methods of producing a really smart finish? Well, there are a number of useful dodges which will certainly give much neater results at quite low cost, but it is debatable as to whether these really give a quality of finish that will result in people mistaking your projects for the "real thing". They do provide what most constructors find to be a good compromise between cost and standard of finish.

BRUSHED ALUMINIUM

A lot of commercially produced electronic goods, particularly hi-fi gear, benefits from the extensive use of brushed aluminium for front panels. You can obtain a similar effect by using wire-wool or a scouring pad ('Brillo' etc.) to produce hundreds of fine scratches along the length of a panel. In order to get a good effect it is important to run the pad in long continous strokes along the full length of the panel. A somewhat different but quite good effect can be obtained by taking the pad in criss-cross patterns, etc., but this needs to be done very neatly if the finished panel is going to look (if you will pardon the expresssion) up to scratch. Thoroughly rub the panel with a soft cloth once the "brushing" has been finished, so as to remove any aluminium dust left on the surface.

Aluminium has quite a good natural finish if it is polished with a soft cloth and Solvol Autosol (available from car or motorcycle accessory shops), it can have virtually a mirror finish. Unfortunately, many cases which have aluminium front panels are supplied in less than scratch-free condition. Light scratches can often be polished out but deep scratches might prove to be unmovable. It is then a matter of putting up with them, or using a front panel finish that will cover and hide them. The imitation brushed aluminium effect described previously can be quite useful in this role. A good tip to remember is that metal polish is also quite effective for polishing out scratches on most types of plastic case.

TARNISH

An important point to keep in mind with aluminium panels is that aluminium tends to tarnish, particularly if it is kept where there is a damp atmosphere (such as in a kitchen). It also shows up finger marks very well. An impressively bright and shiny project can look pretty terrible a few months later.

To prevent tarnishing it is a good idea to spray aluminium panels with a clear lacquer such as Scotch Sprayfix. A thin coating of clear lacquer will let the natural finish show through very well, and should totally eliminate any discolouration even over a period of a few years. If you are going to use rub-on transfers for panel legends, these should be added before the panel is sprayed. When adding the labels it is difficult to avoid leaving finger marks on the panel, and so a final (careful) polish should be applied before the panel is sprayed.

These clear sprays are useful for giving a degree of protection to panel transfers when using any type of case. The transfers are still rather vulnerable to abrasion even after they have been sprayed, but they are rendered a bit more scuff-resistent. One word of warning though—some plastics dissolve in these clear lacquers! As they are mostly very fast drying this does not necessarily have really disastrous consequences. However, it can give what is virtually a mat finish instead of the expected high gloss type, and can sometimes result in a rather blotchy or textured finish. If this should happen, matters can often be improved by letting the coating thoroughly dry, and then applying a second (light) coating. This process can be repeated two or three times if necessary.

Self-adhesive clear plastic material is widely available from stationers, etc., and this can give good protection to an aluminium panel, plus a very good appearance. The thicker grades of material give the best results in this application, but seem to be difficult to obtain these days. With the thinner grades of material it can be difficult to avoid the odd small air bubble, but if necessary a pin can be used to burst the bubble, and the covering should then press down nicely into place.

Ideally the covering would be placed over the panel transfers so as to protect them. This would give a degree of ruggedness and finish to rival photographically produced panels. Unfortunately, it is a risky way of doing things. The self adhesive plastic material has to be placed in position at the first attempt with no peeling back and repositioning. Peeling back the material is almost certain to result in some of the transfers coming away on the material. This is potentially a way of obtaining very good results, but my efforts at this method have mostly resulted in wasted time and materials.

PLASTIC ALUMINIUM

A really good brushed aluminium effect can be obtained using a self-adhesive veneer. The brushed aluminium veneers I have encountered do not seem to include a significant metal content, and are probably a plastic laminate. They are very convincing though, and give really professional results. In fact much ready made equipment would seem to benefit from the use of this type of veneer! They provide an extremely tough and durable finish.

These veneers are relatively thick and difficult to cut. I have found that they can be cut down to size using a sharp modelling knife plus a large steel rule (or strip of steel) and a cutting board. An alternative is to roughly cut out an over-size piece of the material, and to then fix this onto the panel. It can then be trimmed down to match the panel using a modelling knife and/or a file. Either way any knife will need to be really sharp, and due care must be taken.

When using any veneer it is advisable to complete any cutting and drilling on the panel before fitting the veneer. This avoids the risk of damaging the veneer while working on the panel. Also, many of these coverings, but particularly the brushed aluminium types, can make it difficult to work on a panel. If you should wish to work on a panel after a veneer has been added, any drilling etc. must be carried out from the side of the panel to which the covering has been fixed. otherwise, the veneer will tend to be ripped away from the panel, possibly stretching it so that it can never fit back into place properly. With the covering fixed to a completed panel there should be no difficulty in cutting out any holes or larger cut outs using a modelling knife.

COVER-UP

The brushed aluminium effect type is just one of what must be hundreds of available veneers. At the top end of the range there are "real" wood types, but

With care a good looking finished unit can be produced.

apart from high quality louspeaker cabinets these are little used in electronics. Of more use for general project work are the "Contact" style self-adhesive plastic coverings which are obtained in rolls. Many of these have patterns which do not seem very appropriate for electronic projects, but some can be used to good effect. The plain types fall into this category, and the wood-grain pattern variety can also give very neat looking results.

Covering a single panel is not very difficult, and the method of using an over-size piece of material and then trimming it down to size once it has been fixed on the panel can be used. In my experience though, the covering is likely to come unstuck at the edges before too long, and it is generally better to use a piece of material that is substantially too large, and to then fold it over at the edges.

Very often you will want to cover something more awkward than just a single panel, such as a box which is in the form of a removable rear panel plus the other five sides as a single entity. Provided the box has square corners it is usually possible to cover five sides with a single piece of veneer. I find the easiest way to do this is to remove the backing from the veneer and lay it sticky side uppermost on a table. Then place the case in position in the middle of the veneer with its front panel facing down, and press it firmly onto the veneer. Next cut from each corner of the case to the corresponding corner of the covering. This gives four flaps of material which can, one by one, be folded into place and used to cover one side of the case, trimming each one down to size before tackling the next.

Using this method it is possible to obtain very neat results, but you might prefer to simply take one side of the case at a time. A different approach is needed with a lot of cases due to their rounded corners. About the only practical method with these is to use one piece for the front panel, and then another piece which is wrapped around the four sides.

This leaves the problem of hiding the join, with no corners to disguise it. To make the join as neat as possible, overlap the material, and then cut through both layers using a sharp knife. With the two scraps of material this cuts off then removed, the two ends of the veneer should butt together perfectly. This may still leave a visible join, and it is advisable to arrange things so that this join is tucked away out of sight on the underside of the case.

When using these thin self-adhesive coverings, try to avoid two sticky surfaces coming into contact with one another. If they should stick together it can be all but impossible to separate them again.

PAINTING

Most cases that would benefit from painting are supplied ready-painted. If you do need to paint a case the most important thing is to meticulously follow the manufacturer's recommendations. In particular, follow any instructions pertaining to the use of primers and undercoats. Without a suitable primer most paints have very poor adhesion to metals. I will not say that looking at the case too hard would then leave scratch marks, but anything more than that certainly will!

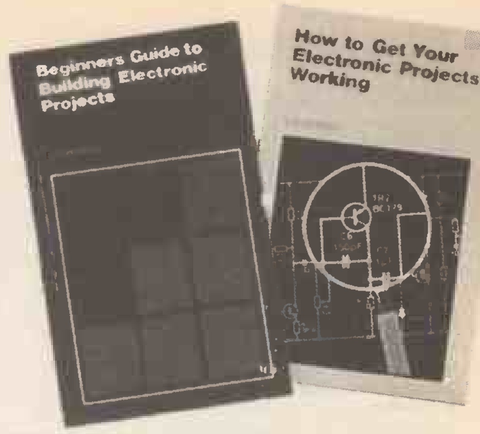
Plastic cases do not usually need a primer, and I have never actually come across a plastic primer (no doubt someone manufactures one). As when painting any surface, it is important that it should be scrupulously clean. Again, read the manufacturer's recommendations very carefully. Some paints are not suitable for use with many plastics as they tend to dissolve them. Also bear in mind that some paints will not adhere properly to many soft plastics. A lot of cases seem to be made from these p.v.c. type plastics these days. Rubbing them down with fine grade wet and dry paper can help to provide a good mechanical key, but is not always a complete answer to the problem.

Spray paints are likely to give a better finish than brush-on types, but in my experience it is best not to use spray-on types indoors. Apart from problems with inhaling fumes, it is difficult to avoid getting some of the paint well off target. Wait for a calm day, and spread plenty of newspaper over and around the work area. Once again, follow the paint manufacturers instructions "to the letter", and heed all warning notices.

Probably the most common problem when using spray paint is to apply coats that are far too thick. Results are likely to be much better using two or three thin coats instead of one heavy one. If you experience problems with air bubbles, spray from a little further back and apply a thinner coating.

DIRECT BOOK SERVICE

The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.



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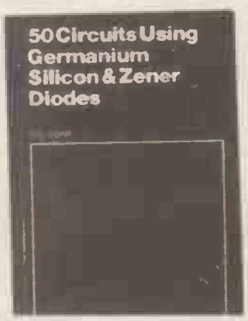

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A MICROPROCESSOR PRIMER
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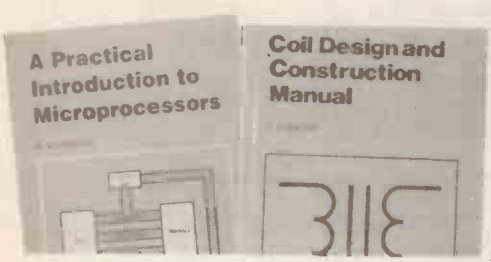
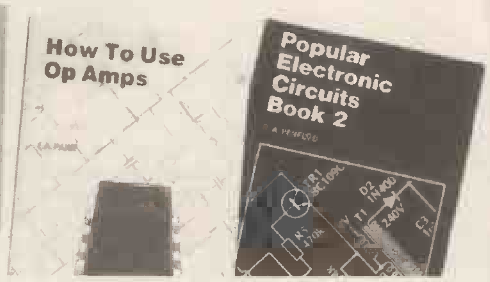
Starts by designing a small computer which, because of its simplicity and logical structure, enables the language to be easily learnt and understood. The shortcomings are then discussed and the reader is shown how these can be overcome by changes and additions to the instruction set. In this way, such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

A PRACTICAL INTRODUCTION TO MICROPROCESSORS
R. A. Penfold
Provides an introduction which includes a very simple microprocessor circuit which can be constructed so that the reader can experiment and gain practical experience.
96 pages Order code BP123 £2.50

ELECTRONIC CIRCUITS HANDBOOK
Michael Tooley BA
This book aims to explode two popular misconceptions concerning the design of electronic circuits: that only those with many years of experience should undertake circuit design and that the process relies on an understanding of advanced mathematics. Provided one is not too ambitious, neither of these popularly held beliefs is true.
Specifically, this book aims to provide the reader with a unique collection of practical working circuits together with supporting information so that circuits can be produced in the shortest possible time and without recourse to theoretical texts.
Furthermore, information has been included so that the circuits can readily be modified and extended by readers to meet their own individual needs. Related circuits have been grouped together and cross-referenced within the text (and also in the index) so that readers are aware of which circuits can be readily connected together to form more complex systems. As far as possible, a common range of supply voltages, signal levels and impedances has been adopted.
As a bonus, ten test gear projects have been included. These not only serve to illustrate the techniques described but also provide a range of test equipment which is useful in its own right.
277 pages Order code NE05 £14.95





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

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

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

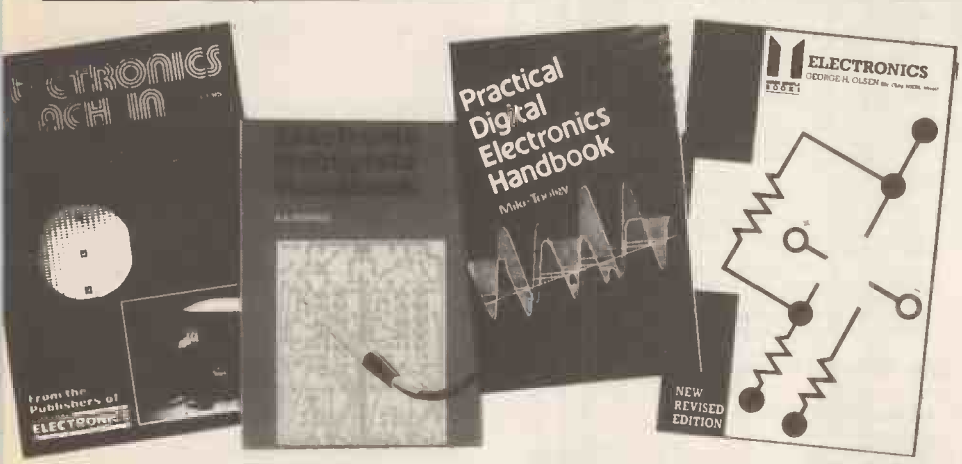
POPULAR ELECTRONIC CIRCUITS –BOOK 1
POPULAR ELECTRONIC CIRCUITS –BOOK 2
R. A. Penfold
Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up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

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF MODEL RAILWAYS
R.A. Penfold
Home computers may easily be applied to the control of model railways and really quite sophisticated control, which needs only simple programming, is not too difficult to achieve. The main problem lies in interfacing the computer to the layout, but fortunately it is not too difficult or expensive to build suitable interfaces, and this book shows you how.
The projects consist of various types of controller, including a high quality pulse type, as well as circuits for train position sensing, signal and electric points control etc. The use of computers does not have to be restricted to massive layouts. Something as simple as an oval of track with a single siding can be given a new dimension by adding computer control and much fun can be had from these relatively simple set-ups.
88 pages Order code BP180 £2.95

MODERN OPTO DEVICE PROJECTS
R.A. Penfold
In recent years, the range of opto devices available to the home constructor has expanded and changed radically. These devices now represent one of the more interesting areas of modern electronics for the hobbyist to experiment in, and many of these devices have useful practical applications as well. This book provides a number of practical designs which utilize a range of modern opto-electric devices, including such things as fibre optics, ultra bright l.e.d.s and passive IR detectors etc.
While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.
104 pages Order code BP194 £2.95

ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS
Robert Penfold
Robots and robotics offer one of the most interesting areas for the electronics hobbyist to experiment in. Today the mechanical side of robots is not too difficult, as there are robotics kits and a wide range of mechanical components available. The micro controller is not too much of a problem either, since the software need not be terribly complex and many inexpensive home computers are well suited to the task.
The main stumbling block for most would-be robot builders is the electronics to interface the computer to the motors, and the sensors which provide feedback from the robot to the computer. The purpose of this book is to explain and provide some relatively simple electronic circuits which bridge this gap.
92 pages Order code BP179 £2.95

DATA AND REFERENCE



ELECTRONICS TEACH-IN
Michael Tooley BA and David Whitfield MA MSc CEng MIEE (published by *Everyday Electronics*)
This value for money *EE* book provides a comprehensive background to modern electronics including test gear projects. A complete course in basic electronics; designed for the complete newcomer it will however also be of value to those with some previous experience of electronics. Wherever possible the course is related to "real life" working circuits and each part includes a set of detailed practical assignments. Includes details of eight items of related test gear giving full constructional information and diagrams for each one. They are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator. An excellent companion for anyone interested in electronics and invaluable for those taking G.C.S.E. and BTEC electronics courses.
104 pages (A4 size) **Order code EE/T-I** **£1.95**

PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.
The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
256 pages **Order Code BP53** **£2.95**

ESSENTIAL THEORY FOR THE ELECTRONICS HOBBYIST
G. T. Rubaroe, T.Eng (C.E.I.), Assoc.I.E.R.E.
The object of this book is to supply the hobbyist with a background knowledge tailored to meet his or her specific requirements and the author has brought together the relevant material and presented it in a readable manner with minimum recourse to mathematics.
128 pages **Order Code 228** **£2.50**

MICROPROCESSING SYSTEMS AND CIRCUITS
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A truly comprehensive guide to the elements of microprocessing systems which really starts at the beginning. Teaches the reader the essential fundamentals that are so important for a sound understanding of the subject.
256 pages **Order Code BP77** **£2.95**

ELECTRONIC HOBBYISTS HANDBOOK
R.A. Penfold
Provides an inexpensive single source of easily located information that the amateur electronics enthusiast is likely to need for the day-to-day pursuance of this fascinating hobby. Covers common component colour codes. Details the characteristics and pinouts of many popular semiconductor devices, including various types of logic ICs, operational amplifiers, transistors, FETs, unijunctions, diodes, rectifiers, SCRs, diacs, triacs, regulators and SMDs, etc. Illustrates many useful types of circuits, such as timers and oscillators, audio amplifiers and filters, as well as including a separate section on power supplies. Also contains a multitude of other useful data.
88 pages **Order code BP233** **£4.95**

AUDIO
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Analysis of the sound wave and an explanation of acoustical quantities prepare the way. These are followed by a study of the mechanism of hearing and examination of the various sounds we hear. A look at room acoustics with a subsequent chapter on microphones and loudspeakers then sets the scene for the main chapter on audio systems—amplifiers, oscillators, disc and magnetic recording and electronic music.
320 pages **Order Code BP111** **£3.50**

HOW TO IDENTIFY UNMARKED ICs
K. H. Recorr
Shows the reader how, with just a test-meter, to go about recording the particular signature of an unmarked i.c. which should enable the i.c. to then be identified with reference to manufacturers' or other data. An i.c. signature is a specially plotted chart produced by measuring the resistances between all terminal pairs of an i.c.
Chart **Order code BP101** **£0.95**

RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery leads, speakers, etc. It is particularly useful for finding the values of old components.
Chart **Order code BP7** **£0.95**

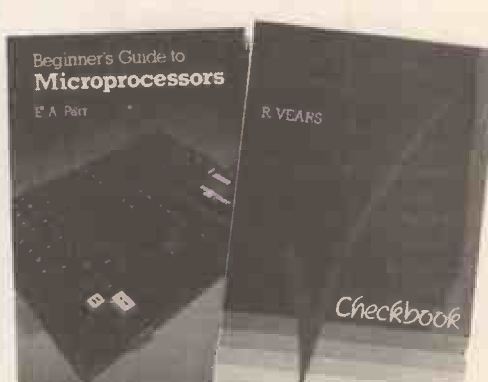
CHART OF RADIO, ELECTRONIC, SEMICONDUCTOR AND LOGIC SYMBOLS
M. H. Banani, B.Sc.(Eng.)
Illustrates the common, and many of the not-so-common, radio, electronic, semiconductor and logic symbols that are used in books, magazines and instruction manuals, etc., in most countries throughout the world.
Chart **Order Code BP27** **£0.95**

RECOMMENDED READING

FOR INTRODUCING DIGITAL ELECTRONICS

ELECTRONICS—A "MADE SIMPLE" BOOK
G. H. Olsen
This book provides excellent background reading for our *Introducing Digital Electronics* series and will be of interest to everyone studying electronics. The subject is simply explained and well illustrated and the book assumes only a very basic knowledge of electricity.
330 pages **Order code NE10** £4.95

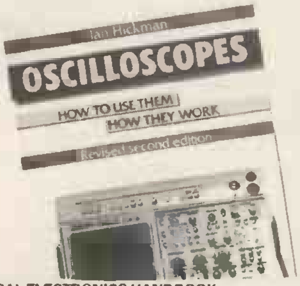
PRACTICAL DIGITAL ELECTRONICS HANDBOOK
Mike Tooley (Published in association with *Everyday Electronics*)
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques. Contents: Introduction to integrated circuits; basic logic gates; monostable and bistable devices; timers; microprocessors; memories; input and output devices; interfaces; microprocessor buses. Appendix 1: Data. Appendix 2: Digital test gear projects; tools and test equipment; regulated bench power supply; logic probe; logic pulser; versatile pulse generator; digital IC tester; current tracer; audio logic tracer; RS-232C breakout box; versatile digital counter/frequency meter. Appendix 3: The oscilloscope. Appendix 4: Suggested reading. Appendix 5: Further study.
208 pages **Order code PC100** **£6.95**



BEGINNERS GUIDE TO MICROPROCESSORS
E.A. Parr
An excellent grounding in microprocessors, this book is broadly relevent to the whole of our Introducing Microprocessors course. It is easy to read and well illustrated.
224 pages **Order code NE03** £4.95

MICROELECTRONIC SYSTEMS 2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
194 pages **Order code NE04** £4.95

OSCILLOSCOPES: HOW TO USE THEM–HOW THEY WORK
Ian Hickman
Oscilloscopes are essential tools for checking circuit operation and diagnosing faults, and an enormous range of models is available. But which is the right 'scope for a particular application? Which features are essential, which not so important? What techniques will get the best out of the instrument?
Ian Hickman, experienced in both professional and hobbyist electronics, has revised this well-established book to help all oscilloscope users–and potential users.
133 pages **Order code NE09** **£5.95**

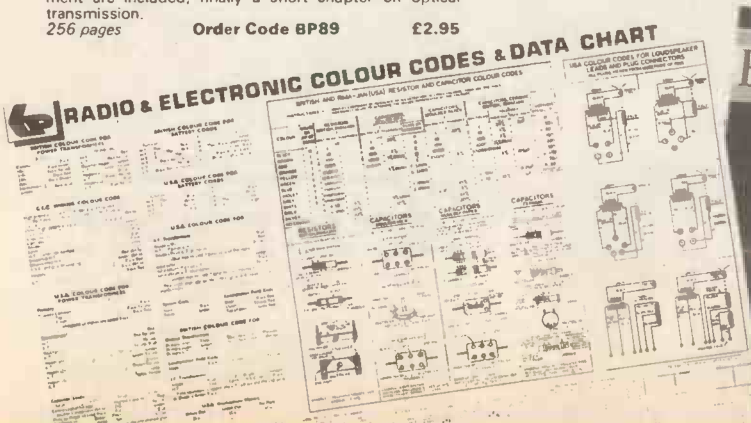


PRACTICAL ELECTRONICS HANDBOOK
Ian Sinclair
Ian Sinclair has now revised this useful and carefully selected collection of standard circuits, rules-of-thumb, and design data for professional engineers, students and enthusiasts involved in radio and electronics. Covering passive and active components, discrete component circuits (such as amplifiers, filters and oscillators) and linear and digital i.c.s, the book includes many items which are not elsewhere available in a single handy volume. The operation and functions of typical circuits are described, while mathematics is limited to that necessary for deciding component values for any application.
This revised edition contains more details on computers and microprocessors and has been brought up to date throughout.
199 pages **Order Code NE06** **£7.95**

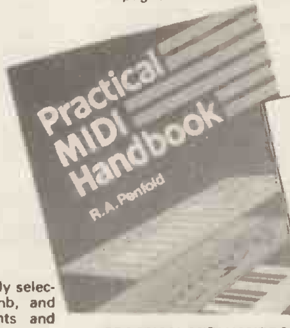
BEGINNER'S GUIDE TO HI-FI
Ian Sinclair
The *Beginner's Guide to Hi-Fi* will appeal to the audio enthusiast, whether newly won over by advances in technology or well established and wondering whether to update equipment. The book deals with the sound from its sources in the studio to its ultimate end in your ears, and shows what sound is, how it is recorded and how it is reproduced.
Every aspect of Hi-Fi, from pickup cartridges to loudspeakers, has been covered, and the emphasis has been on explaining design aims. Cassette systems have been given considerable prominence, including the more modern Dolby C and dbx noise reduction systems. The CD record has been covered in detail so that you can find out just why this system of sound reproduction is so superior.
194 pages **Order Code NE07** **£4.95**

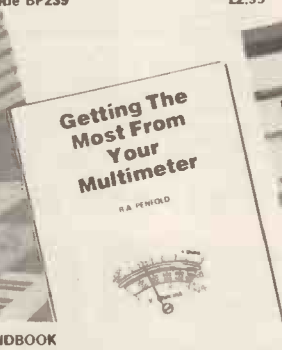
ELECTRONICS-BUILD AND LEARN
R. A. Penfold
The first chapter gives full constructional details of a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components–resistors, capacitors, transformers, diodes, transistors, thyristors, fets and op amps. Later chapters go on to describe how these components are built up into useful circuits, oscillators, multivibrators, bistables and logic circuits.
At every stage in the book there are practical tests and experiments that you can carry out on the demonstrator unit to investigate the points described and to help you understand the principles involved. You will soon be able to go on to more complex circuits and tackle fault finding logically in other circuits you build.
120 pages **Order Code PC103** **£5.95**

COMMUNICATION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
A look at the electronic fundamentals over the whole of the communication scene. This book aims to teach the important elements of each branch of the subject in a style as interesting and practical as possible. While not getting involved in the more complicated theory and mathematics, most of the modern transmission system techniques are examined including line, microwave, submarine, satellite and digital multiplex systems, radio and telegraphy. To assist in understanding these more thoroughly, chapters on signal processing, the electromagnetic wave, networks and transmissions assessment are included, finally a short chapter on optical transmission.
256 pages **Order Code BP89** **£2.95**



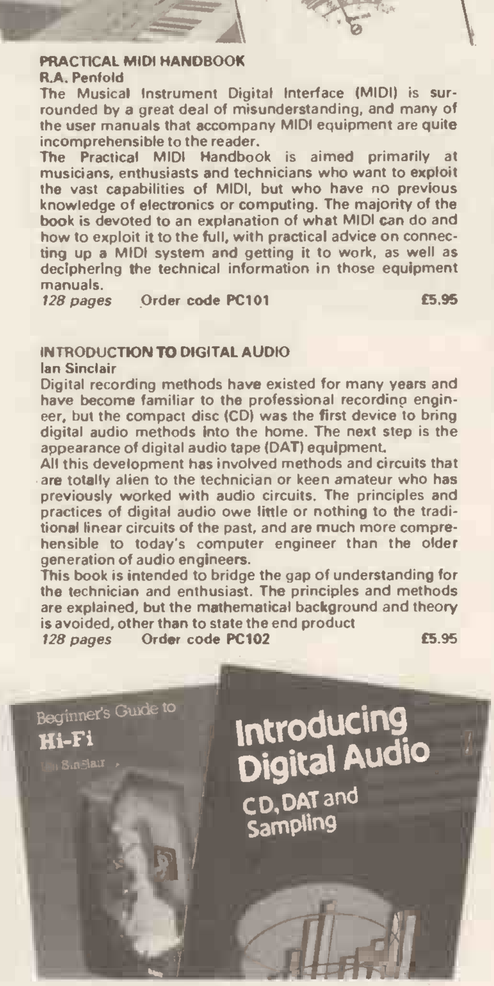
GETTING THE MOST FROM YOUR MULTIMETER
R.A. Penfold
This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.
In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.
96 pages **Order code BP239** **£2.95**



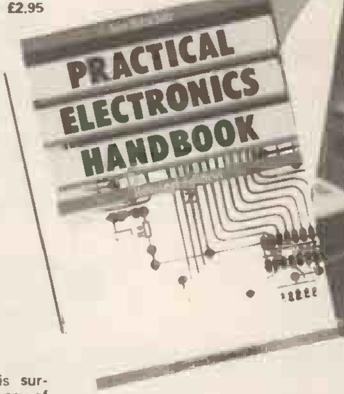


PRACTICAL MIDI HANDBOOK
R.A. Penfold
The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding, and many of the user manuals that accompany MIDI equipment are quite incomprehensible to the reader.
The Practical MIDI Handbook is aimed primarily at musicians, enthusiasts and technicians who want to exploit the vast capabilities of MIDI, but who have no previous knowledge of electronics or computing. The majority of the book is devoted to an explanation of what MIDI can do and how to exploit it to the full, with practical advice on connecting up a MIDI system and getting it to work, as well as deciphering the technical information in those equipment manuals.
128 pages **Order code PC101** **£5.95**

INTRODUCTION TO DIGITAL AUDIO
Ian Sinclair
Digital recording methods have existed for many years and have become familiar to the professional recording engineer, but the compact disc (CD) was the first device to bring digital audio methods into the home. The next step is the appearance of digital audio tape (DAT) equipment.
All this development has involved methods and circuits that are totally alien to the technician or keen amateur who has previously worked with audio circuits. The principles and practices of digital audio owe little or nothing to the traditional linear circuits of the past, and are much more comprehensible to today's computer engineer than the older generation of audio engineers.
This book is intended to bridge the gap of understanding for the technician and enthusiast. The principles and methods are explained, but the mathematical background and theory is avoided, other than to state the end product
128 pages **Order code PC102** **£5.95**



INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels
Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages **Order code BP85** **£2.95**



TRANSISTOR RADIO FAULT-FINDING CHART
C. E. Miller
Used properly, should enable the reader to trace most common faults reasonably quickly. Across the top of the chart will be found four rectangles containing brief description of these faults, *vis*—sound weak but undistorted, set dead, sound low or distorted and background noises. One then selects the most appropriate of these and following the arrows, carries out the suggested checks in sequence until the fault is cleared.
Chart **Order code BP70** **£0.95**

DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.
256 pages **Order code BP140** **£4.95**

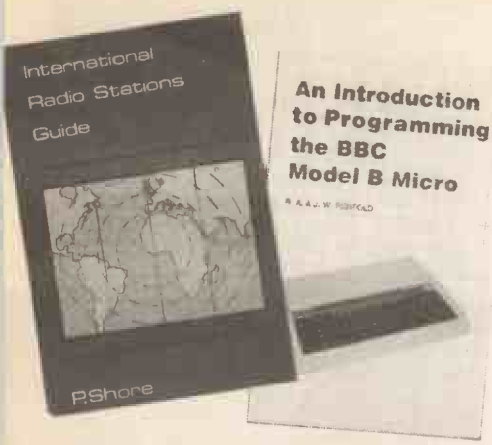
LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese linear i.c.s. Also includes details of functions, manufacturer and country of origin.
320 pages **Order code BP141** **£4.95**

INTERNATIONAL DIODE EQUIVALENTS GUIDE
A. Michaels
Designed to help the user in finding possible substitutes for a large selection of the many different types of diodes that are available. Besides simple rectifier diodes, also included are Zener diodes, l.e.d.s, diacs, triacs, thyristors, OCIs, photo and display diodes.
144 pages **Order code BP108** **£2.25**

NEWNES ELECTRONICS POCKET BOOK
E. A. Parr
Newnes Electronics Pocket Book has been in print for over twenty years and has covered the development of electronics from valve to semiconductor technology and from transistors to LSI integrated circuits and microprocessors. To keep up to date with the rapidly changing world of electronics, continuous revision has been necessary. This new Fifth Edition takes account of recent changes and includes material suggested by readers of previous editions. New descriptions of op.amp. applications and the design of digital circuits have been added, along with a totally new chapter on computing, plus other revisions throughout.
315 pages (hard cover) **Order Code NE02** **£8.95**

TRANSISTOR SELECTOR GUIDE
This unique guide offers a range of selection tables compiled so as to be of maximum use to all electronics engineers, designers and hobbyists.
Section 1: Covers component markings, codings and standards, as well as explaining the symbols used.
Section 2: Tabulates in alpha-numeric sequence the comprehensive specifications of over 1400 devices.
Section 3: Tabulates the devices by case type.
Section 4: Considers particular limits to the electrical parameters when compiling the tables.
Section 5: Illustrates package outlines and leadouts.
Section 6: Consists of a surface mounting device markings conversion list.
192 pages **Order code BP234** **£4.95**

RADIO/TELEVISION



AN INTRODUCTION TO RADIO DXING
R. A. Penfold
Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
112 pages **Order code BP91** **£1.95**

INTERNATIONAL RADIO STATIONS GUIDE
P. Shore
Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the ever more complex radio bands. This new edition has been completely revised and rewritten and incorporates much more information which is divided into the following sections:
Listening to Short Wave Radio; ITU Country Codes; World-wide Short Wave Radio Stations; European, Middle East and North African Long Wave Radio Stations; European, Near East and North African Medium Wave Radio Stations; Canadian Medium Wave Radio Stations; USA Medium Wave Radio Stations; Broadcasts in English; Programmes for DXers and Short Wave Listeners; UK FM Radio Stations; Time differences from GMT; Abbreviations; Wavelength/Frequency Conversion.
320 pages **Order code BP255** **£4.95**

BEGINNER'S GUIDE TO AMATEUR RADIO
F.G. Rayer Second edition revised by Gordon King G4VFV.
Whether you are new to radio, or have become interested by way of CB, it is hoped that this book, will further whet your appetite and put you in good stead for passing the Radio Amateur's Examination and becoming a licensed radio amateur.
188 pages **Temporarily out of print**

AN INTRODUCTION TO SATELLITE TELEVISION
F.A. Wilson
As a definitive Introduction to the subject this book is presented on two levels. For the absolute beginner or anyone thinking about purchasing or hiring a satellite TV system, the story is told as simply as such a complex one can be in the main text.
For the professional engineer, electronics enthusiast, student or others with technical backgrounds, there are numerous appendices backing up the main text with additional technical and scientific detail formulae, calculations, tables etc.
There is also plenty for the DIY enthusiast with practical advice on choosing and installing the most problematic part of the system—the dish antenna.
104 pages **Order code BP 195** **£5.95**

COMPUTING

GETTING THE MOST FROM YOUR PRINTER
J. W. Penfold
Details how to use all the features provided on most dot-matrix printers from programs and popular word processor packages like Wordwise, Visawrite and Quill, etc. Shows exactly what must be typed in to achieve a given effect.
96 pages **Order Code BP181** **£2.95**

A Z80 WORKSHOP MANUAL
E. A. Parr, B.Sc., C.Eng., M.I.E.E.
This book is intended for people who wish to progress beyond the stage of BASIC programming to topics such as machine code and assembly language programming, or need hardware details of a Z80 based computer.
192 pages **Order Code BP112** **£3.50**

AN INTRODUCTION TO 68000 ASSEMBLY LANGUAGE
R. A. & J. W. Penfold
Obtain a vast increase in running speed by writing programs for 68000 based micros such as the Commodore Amiga, Atari ST range or Apple Macintosh range etc., in assembly language. It is not as difficult as one might think and this book covers the fundamentals.
112 pages **Order code BP184** **£2.95**

THE ART OF PROGRAMMING THE ZX SPECTRUM
M. James, B.Sc., M.B.C.S.
It is one thing to have learnt how to use all the Spectrum's commands and functions, but a very different one to be able to combine them into programs that do exactly what you want them to. This is just what this book is all about—teaching you the art of effective programming with your Spectrum.
144 pages **Order code BP119** **£2.50**

AN INTRODUCTION TO PROGRAMMING THE COMMODORE 16 & PLUS 4
R. A. Penfold
Helps you to learn to use and program these two Commodore machines with the minimum of difficulty by expanding and complementing the information supplied in the manufacturer's own manuals.
128 pages **Order code BP158** **£2.50**

AN INTRODUCTION TO PROGRAMMING THE BBC MODEL B MICRO
R. A. & J. W. Penfold
Written for readers wanting to learn more about programming and how to make best use of the incredibly powerful model B's versatile features. Most aspects of the BBC micro are covered, the omissions being where little could usefully be added to the information provided by the manufacturer's own manual.
144 pages **Order code BP139** **£1.95**

THE PRE-BASIC BOOK
F. A. Wilson, C.G.I.A., C.ENG., F.I.E.E., F.I.E.R.E., F.B.I.M.
Another book on BASIC but with a difference. This one does not skip through the whole of the subject and thereby leave many would-be programmers floundering but instead concentrates on introducing the technique by looking in depth at the most frequently used and more easily understood computer instructions. For all new and potential micro users.
192 pages **Order code BP146** **£2.95**

AN INTRODUCTION TO COMPUTER PERIPHERALS
J. W. Penfold
Covers such items as monitors, printers, disc drives, cassette recorders, modems, etc., explaining what they are, how to use them and the various types and standards. Helps you to make sure that the peripherals you buy will work with your computer.
80 pages **Order code BP170** **£2.50**

COMPUTER TERMINOLOGY EXPLAINED
I. D. Poole
Explains a wide range of terms that form the computer jargon used by enthusiasts. Includes a reference guide to the more commonly used BASIC commands.
96 pages **Order code BP148** **£1.95**

AN INTRODUCTION TO PROGRAMMING THE ACORN ELECTRON
R. A. & J. W. Penfold
Designed to help the reader learn more about programming and to make best use of the Electron's many features. Adds considerably to the information already supplied in the manufacturer's own instruction manual.
144 pages **Order code BP142** **£1.95**

AN INTRODUCTION TO PROGRAMMING THE ATARI 600/800 XL
R. A. & J. W. Penfold
Especially written to supplement the manufacturer's own handbook. The information supplied will help the reader to master BASIC programming and to make best use of the Atari's many powerful features.
128 pages **Order code BP143** **£1.95**

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a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month, as promised, we shall look at speeding up the Dual DAC using machine code. We shall also attempt to provide a few more answers to some of the queries raised by readers, and take a look at some books on the much neglected FORTH programming language.

Speeding up the Dual DAC

By now, many readers will have put the Dual DAC through its paces using the BASIC program provided last month. One obvious disadvantage of using BASIC to drive the dual DAC is the rather slow speed of execution. This, in turn, restricts the maximum frequency of operation, making it extremely difficult to generate accurate waveforms with a large number of steps at frequencies much greater than a few tens of Hertz.

The solution, of course, is the use of machine code routines. To provide readers with a few clues as to how such routines should be constructed we shall describe two representative routines which respectively generate a positive going ramp (comprising 256 rising steps in a time interval of approximately 2.5ms) and a sine wave (having a frequency of approximately 3.3kHz).

The following assembly language module is required to generate the ramp waveform:

```
                    ORG   8000H     ; Relocateable code
F3        RAMP      DI              ; Disable interrupts at start
AF                  XOR   A         ; and clear accumulator
D3 7F     CYCLE     OUT   (0FFH),A  ; Output a step
3C                  INC   A         ; and get ready for the next
FE FF               CP    0FFH      ; All steps done?
20 F9               JR    NZ,CYCLE  ; No, so do some more!
FB                  EI              ; Yes, enable interrupts
3E 7F               LD    A,7FH     ; and check for the
DB FE               IN    A,(0FEH)  ; BREAK key so that
1F                  RRA             ; that we can leave.
D0                  RET   NC        ; BREAK pressed, so exit
18 EE               JR    RAMP      ; No BREAK, do another cycle
                    END
```

Those fortunate enough to have an assembler to hand can enter the above code as it stands. Alternatively, readers can make use of our *On Spec Hex Code Loader* (available as part of our *On Spec Update)*. In this case readers need to enter the hex code values (given in the left hand columns) using the *Edit Memory* command. For demonstration purposes the code can start at address 8000 hex.

Readers who have neither an assembler nor a copy of our *Hex Code Loader* can make use of the following BASIC loader:

```
10 FOR x=32768 TO 32785
20 READ y
30 POKE x,y
40 NEXT x
50 DATA 243,175,211,127,60,254
60 DATA 255,32,249,251,62,127
70 DATA 219,254,31,208,24,238
```

Thereafter the ramp waveform can be produced by a direct command or program statement of the form:

RANDOMIZE USR 32768

Machine code sine wave

The problem of generating a sine wave can be solved quite easily without recourse to complex mathematics by storing a table of values in memory and referring to these whenever a voltage level is to be generated. This *look-up table* is first produced by calculation and then stored in a "safe" region of memory.

Assuming that we are going to locate our look-up table at A000 hex. (40960 decimal) and that we synthesise the sine wave by producing values in 7.5 degree steps (i.e. 48 steps per cycle) the values in the table would be along the following lines:

The first entry in the table (00) corresponds to a negative peak and the last (FF) to a positive peak. The sine wave will thus have a peak to peak voltage swing equal to the full-scale output from the DAC. A total of 24 values are required in the look-up table (rather than 48) since we shall increment through the table to produce the positive going half of a sine wave (i.e. from 270 deg. to 90 deg.) and decrement through the table to produce the negative half of the sine wave (i.e. from 90 deg. to 270 deg.) using the Z80's OTIR (Output, Increment, and Repeat) and OTDR (Output, Decrement, and Repeat) instructions. If this is beginning to sound rather complex, don't panic—the assembly language program is quite straightforward! See the listing at the foot of this page.

Again, readers can make use of an assembler to enter and assemble the code, alternatively our *On Spec Hex Code Loader* can be pressed into service (entering only the hex code values given in the left hand column from address 9000 hex). The *Hex Code Loader* can also be used to enter the look-up table. The *Edit Memory* command is again used for this purpose with data starting at A000 hex. To assist readers, the *Dump* command should produce the following values if the table has been set up correctly (see table at the head of the next page).

Address		Data	
(hex.)	(decimal)	(hex.)	(decimal)
A000	40960	00	0
A001	40961	01	1
A002	40962	04	4
A003	40963	0A	10
A004	40964	11	17
A005	40965	1A	26
A006	40966	25	37
A007	40967	32	50
A008	40968	40	64
A009	40969	4F	79
A00A	40970	5F	95
A00B	40971	6F	111
A00C	40972	81	129
A00D	40973	91	145
A00E	40974	A1	161
A00F	40975	B1	177
A010	40976	C0	192
A011	40977	CE	206
A012	40978	DB	219
A013	40979	E6	230
A014	40980	EE	238
A015	40981	F5	245
A016	40982	FB	251
A017	40983	FE	254
A018	40984	FF	255

```
                    ORG   9000H      ; Relocateable code
0E 7F     SINE      LD    C,7FH      ; Port address, DAC Channel B
F3        CYCLE     DI               ; Disable interrupts at start
21 00 A0            LD    HL,0A000H  ; Point to start of table
06 18               LD    B,24       ; Size of table (in bytes)
ED B3               OTIR             ; Do the positive going half
06 18               LD    B,24       ; Size of table (in bytes)
ED BB               OTDR             ; Do the negative going half
FB                  EI               ; Enable interrupts at end
3E 7F               LD    A,7FH      ; and check for the
DB FE               IN    A,(0FEH)   ; BREAK key so that
1F                  RRA              ; that we can leave.
D0                  RET   NC         ; BREAK pressed, so exit
18 EB               JR    CYCLE      ; No BREAK, do another cycle
```

Address	Data							
A000	00	01	04	0A	11	1A	25	32
A008	40	4F	5F	6F	81	91	A1	B1
A010	C0	CE	DB	E6	EE	F5	FB	FE
A018	FF	00	00	00	00	00	00	00

(all subsequent data values displayed should be 00)

If required, a BASIC loader can be quite easily produced along the lines of that used for the ramp routine. However, due to restrictions on space, I will leave this particular exercise to the more enthusiastic of our readers! Readers who do choose to adopt this approach should note that two FOR . . . NEXT loops will be required within the program. One will be concerned with loading the machine code routine (starting at address 36864) whilst the other should be responsible for loading the look-up table (starting at address 40960).

One final point is worth making about our sine wave machine code. The need to detect a BREAK key depression results in a small discontinuity of the waveform at the peak of the negative excursion. In practice, this problem can be minimised by either using more steps or by adopting a different technique for handling the look-up table (i.e. abandoning the "automatic" OTIR and OTDR instructions) and calling a time delay between successive output steps. Note that, in either case, a lower frequency sine wave will be produced.

Problem Corner

D. Puttock from Kent has asked me to explain the use of the Spectrum's **OPEN #** and **CLOSE #** commands. Mr Puttock says that these are "not explained at all in the original Spectrum manual". The Spectrum has a neat and powerful way of transferring information between "streams" and "channels" (i.e. logical and physical devices). It is, therefore, rather unfortunate that relatively few users are aware of just how useful this facility can be!

The **OPEN #** command may be used to link a specified stream to a particular channel. The stream is given a number (between 1 and 15) whilst the channel may take any of the following values:

- **k** for keyboard (the lower portion of the screen)
- **p** for printer
- **s** for screen
- **m** for microdrive (followed by drive number and filename)
- **n** for network (followed by station number)
- **b** for RS-232 binary data transfer
- **y** for RS-232 text transfer

The following command will, for example, link stream number 2 to the keyboard:

OPEN # 2, "k"

The **CLOSE #** command is used to disconnect (unlink) a stream from a channel. The default conditions (which are reverted to whenever streams 0 to 4 are unlinked using an appropriate **CLOSE #** command) link the following streams and channels:

Stream Number	Default Channel
0	Keyboard, k
1	Keyboard, k
2	Screen, s
3	Printer, p

Finally, here is a little demonstration routine for those of you lucky enough to have a printer connected to your Spectrum and who would like to experiment a little with streams and channels:

```
10  REM This goes to the screen
20  PRINT "Screen output"
30  REM This goes to the printer
40  OPEN # 2,"p"
50  PRINT # 2;"Printer output"
60  CLOSE # 2
70  REM This goes to the keyboard/
80  REM lower screen
90  OPEN # 15,"k"
100 PRINT # 15;"Keyboard output"
110 CLOSE # 15
120 PAUSE 100
130 PRINT "Finished!"
```

Mike Neville, a keen software developer, telephoned to ask if I was aware of some faults in the way in which ZX-BASIC handled logical operations (such as AND and OR). To be fair, the problems which Mike has pinpointed are not faults, they are simply symptomatic of another of the Spectrum's many idiosyncracies in its "non-standard" implementation of BASIC.

On other microcomputers, logical operations are invariably assumed to be "bit-wise" (i.e. the numeric value concerned is converted to binary and the logical operation is performed on each pair of bits in turn). As an example, the result of bit-wise OR'ing decimal values of 129 and 128 would be as follows:

128 decimal = 10000000 binary
and 129 decimal = 10000001 binary
OR'ing the two would result in:

```
  1 0 0 0 0 0 0 0
  1 0 0 0 0 0 0 1
  ---------------
  1 0 0 0 0 0 0 1 (or 129)
```

Readers may now like to try this little exercise using the Spectrum:

PRINT 128 OR 129

The Spectrum obediently prints out 1 as a result! Now try:

PRINT 128 AND 129

This yields 128, apparently the correct answer! Finally, how about:

PRINT NOT 128

The answer is apparently 0!

The reason for this somewhat baffling behaviour is simply that, when used with numeric values, the Spectrum's AND, OR, and NOT keywords have the following effect:

x **AND** y returns the value of x if y is non-zero or 0 if y is zero

x **OR** y returns the value of x if y is zero or 1 if y is non- zero

NOT x returns 0 if x is non-zero or 1 if x is zero

I hope that this begins to make sense however, if anyone can offer a better explanation, please let me know . . .

Books on FORTH

Richard Stewart writes from Essex to ask if I can supply any information on "a little documented language called FORTH". Apparently, Richard has just acquired Abersoft's excellent FORTH interpreter for the Spectrum. The version of FORTH is based on the popular "fig" (*F*ORTH *I*nterest *G*roup) standard.

Unfortunately, FORTH is still not receiving the support that it really deserves. It is often regarded as a "quirky" language but its devotees would argue that it offers very significant advantages over many of today's most popular computer languages. FORTH is, in fact, fast, compact, and extensible. This latter characteristic means simply that the language can be extended to cope with an almost infinite variety of applications. My own opinion, for what it is worth, is that FORTH is unsurpassed for controlling hardware and thus is ideal for all control applications

Abersoft's fig-FORTH dates back to 1983 and it provides a number of specialised extensions for the Spectrum owner. These deal with, amongst other things, screen and graphics control. It is, therefore, an ideal vehicle from which to learn more about the beauties of FORTH but some additional help will be required.

For some time now, the accepted book for newcomers to FORTH has been Leo Brodie's *Starting FORTH* (published by Prentice-Hall ISBN 0-13-842922-7). This rather expensive book is both informative and entertaining (a rare enough quality in programming texts!) and it provides an excellent overview of the language for beginners. Don Thomasson's *Advanced Spectrum FORTH* (published by Melbourne House, ISBN 0-86161-142X) is written specifically for the Spectrum and contains numerous examples written using Abersoft's fig-FORTH. The book is moderately priced and contains a detailed appendix which describes the Abersoft fig-FORTH dictionary in condensed form and provides machine code descriptions related to the Spectrum's Z80 processor.

Finally, two budget priced books on FORTH can also be recommended. These are Richard Olney and Micheal Benson's *Fundamental FORTH* and *FORTH Techniques*. Both books represent excellent value for money and are extremely comprehensive. The publisher is Pan/PCN and the respective ISBN are 0-330-28960-8 and 0-330-28961-6.

Next month: we shall be taking a look at a reader's customised Spectrum "workstation". In the meantime, if you would like a copy of our *On Spec Update*, please drop me a line enclosing a large (250mm×300mm) *adequately* stamped addressed envelope. Mike Tooley, Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

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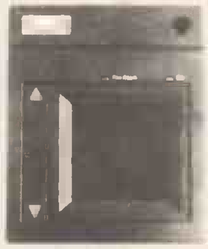

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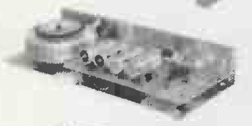

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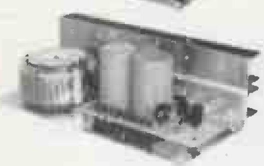

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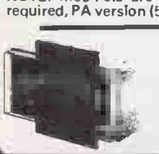

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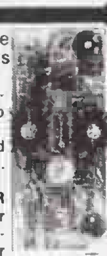

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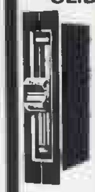

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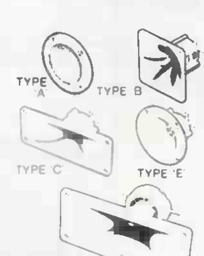

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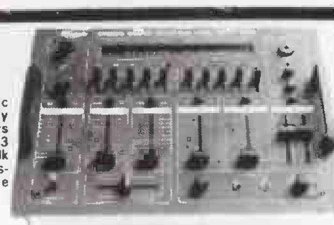

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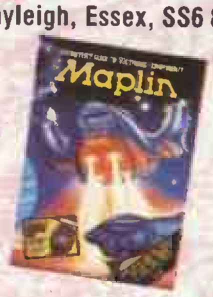

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