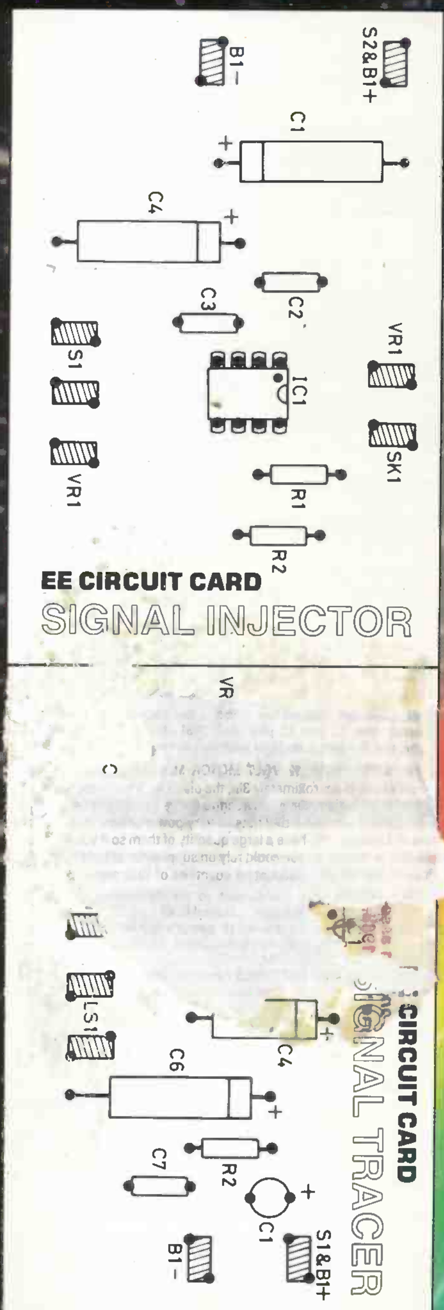
EVERYDAY ELECTRONICS

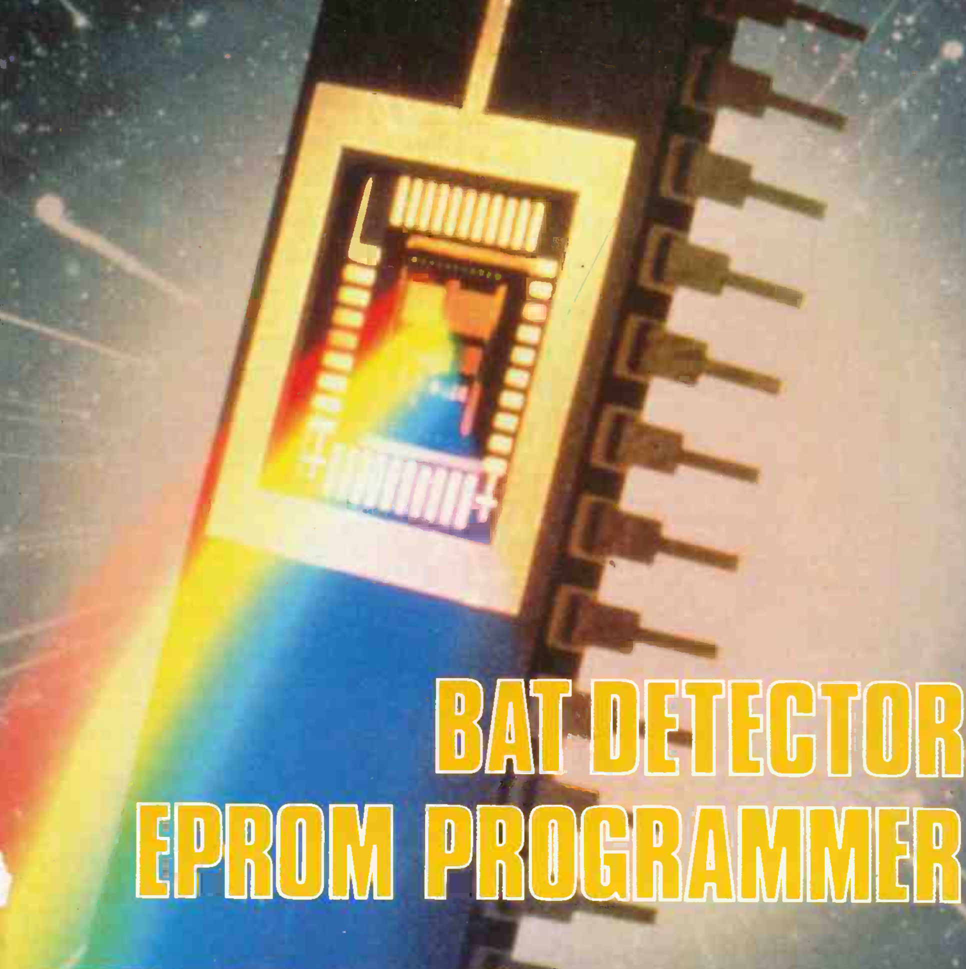
JUNE 1989

INCORPORATING ELECTRONICS MONTHLY

£1.40

FREE! CIRCUIT CARDS to build a SIGNAL INJECTOR & TRACER





BAT DETECTOR
EPROM PROGRAMMER

FREE INSIDE
SCS COMPONENTS CATALOGUE

The Magazine for Electronic & Computer Projects

No. 2 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.

BD4	5	Surface mounting 5amp switches. Intended for mains but equally suitable for battery circuits.
BD5	3	White flush switches. Will replace any standard size switch.
BD8	2	30 volt 80 watt brass cased elements. Ideal for frost protection, pet warmers.
BD14	4	Photo transistor Mullard reference OCP70.
BD16	4	Reel to reel tape heads. 2 record, 2 erase.
BD17	1pr	Ultrasonic trandsducers. 1 to transmit the other to receive.
BD20	4	Different mains micro switches, each average 1,000,000 operations.
BD23	1set	Loud speaker cross-overs up to 40 watt for woofer, mid-range and tweeter.
BD26	2	Counters, belt driven as in tape decks.
BD36	2	Air spaced tuning condensers. ¼in spindle with trimmers.
BD37	2	Ditto, but solid di-electic.
BD41	6	Standard size rocker switches. 13 amp at 230 volts.
BD46	1	Time-on switch. Stays on up to 6 hours, depending on control setting.
BD48	2	Reed relays. 4-8 volt coil operated.
BD51	1	12 volt relay. Miniature enclosed with 2 change-over contacts. 700ohm coil.
BD57	5	Miniature switches for battery circuits, dolls houses, etc.
BD60	4	Ferrite rods. 4in long, ¼in diameter. Suitable for aerials, inverter transformers, etc.
BD64	10	Assorted control knobs, ¼in spindles, push-on and grub screw type.
BD65	4	Different thermostatic switches. Control mains or battery devices.
BD69	2	25 watt 8ohm variable resistors (pots).
BD71	4	Wire wound pots with built-in knob. One each 18ohm, 35ohm, 50ohm and 100ohm.
BD78	5	5amp stud rectifiers, 50 volt.
BD82	4prs	Porcelain fuse carriers and fuse holders (make your own fuse board).
BD84	10	.1mfd 250 volt mains supressor condenser (cut out the clicks).
BD85	1	Mains shaded-pole motor with ¼in shaft.
BD86	2	5in aluminium fan blades. Will fit ¼in shaft.
BD93	4	11 pin bases for relays, etc.
BD94	5	B7G valve bases.
BD95	4	B9A valve bases with metal skirt.
BD98	1	Motor driven stud switch. Ex-fruit machines.
BD101	1	Delayed-on switch. Can be set at any time up to 2 hours. 115 volt so supplied with dropper.
BD104	1	Cased mains unit. 4.5 volt regulated output.
BD106	2	12 volt alarms. Round, approximately 2in diameter. Sounds like a car horn.
BD109	10	Assorted ¼in spindle volume controls.
BD110	10	Slider type volume controls.
BD114	1	2 watt amplifier made by Mullard, their reference 1172.
BD115	1	Wall mounting thermostat, 24 volt.
BD126	4	Batten holders, MES, will take torch bulbs, etc.
BD133	1	Case for micro-radio in zipped pouch.
BD135	15	Large and 15 small screwit connectors for high speed hook-ups.
BD137	1	6½in. 10 watts PM speaker, 4 ohm, fits our cabinet BD11.
BD138	1	9in. x 3in. 8 ohm 5 watts per speaker.

CAMERAS. Three cameras, all by famous makers, Kodak, etc. One disc, one 35mm and one instamatic. All in first class condition, believed to be in perfect working order, but sold as untested. You can have the three for £10 including VAT, which must be a bargain—if only for the lenses, flash gear, etc. Our ref 10P58.

VERY POWERFUL 12 VOLT MOTORS—⅓rd HORSEPOWER. Made to drive the Sinclair C5 electric car but adaptable to power a go-kart, a mower, a rail car, model railway, etc. Brand new. Price £15.00 plus £2.00 postage. Our ref 15P8.

WHITE CEILING SWITCH 5 amp 2 way surface mounting with cord and tassle. Made by the famous Crabtree Company. Price £1 each. Our ref BD528.

13A SWITCH SOCKETS Top quality made by Crabtree, fitted in metal box with cutouts so ideal for garage, workshop, cellar, etc. Price £2 each. Our ref 2P37.

MAINS TRANSFORMER Upright mounting Normal mains input, gives 28V at 3.5A so should be ideal for big amplifier, etc. Price only £4. Our ref 4P24, please add £1 postage.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder—a complete mains operated kit, case included. **£12.50+£2 P&P.** Our ref 12P5/1.

ORGAN MASTER Is a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers. We can supply information sheet. Brand new, only £15 plus £3 postage. Our ref 15P15.

ULTRA SONIC INTRUDER ALARM Small, nicely cased, will detect movement in a room up to 10m x 10m. Ingenious construction makes it independent of the mains; cannot be switched off, even with its on off switch, until you know the secret; has delayed action enabling you to switch it on and leave the room; it has an inbuilt piezo sounder which is very penetrating and high pitched and would frighten away most intruders. Has internal switching and could be coupled to an outdoor alarm if required. It is the basis of a very efficient burglar alarm, or has other uses. For instance: you could disconnect the internal sounder and using the internal switches you would know when somebody arrives without that person being aware that you know. Similarly, the unit could be used to operate other equipment ultra-sonically. It is brand new, guaranteed OK, complete but less battery (PP3 alkaline type). Price is £20 plus £3 insured delivery. Our ref 20P11.

110 DECIBEL HORN For use with the ultra sonic intruder detector. Ideal for external positioning to attract the attention of neighbours should you have an intruder. This unit has its own mounting bracket and comes complete with good length of lead. Price £7. Our ref 7P9. Incidentally, this could also be used as a loud speaker.

3½in FLOPPY DISC DRIVE—DOUBLE SIDED, DOUBLE DENSITY, 80 TRACK Shugart compatible, has 34 way IDC connector and will interface with almost any computer. Made by the famous Japanese NEC Company. Price £59.50 plus £3 insured post. post.

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

65XE COMPENDIUM Contains: 65XE Computer, its data recorder XC12 and its joystick, with ten games for £62.50 plus £4 insured delivery.

TIME AND TEMPERATURE LCD MODULE This is a 12 hour clock, a Celcius thermometer, a Fahrenheit thermometer, a too hot alarm and finally a too cold alarm. Nice size, approx 50mm x 20mm, with 12.7mm digits which clearly display the time or temperature. Requires only a 1.5V battery and a few switches. Comes complete with circuit diagram and explanation. Price £6. Our ref 6P12.

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

PHILIPS LASER

This is helium-neon and has a power rating of 1.6mW. Completely safe so long as you do not look directly into the beat when eye damage could result. Brand new, full spec, £30 plus £3 insured delivery. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. Battery operated P.S.U. now available at £15.

HAND-HELD VIDEO LAMP. Mains operated and will enable you to take professional standard videos. Made by the famous Ferguson Company, this uses a 1000w halogen lamp in a fan cooled, hand-held and hand-switched metal housing. Comes complete with optional barn-door assembly and camera bar. Obviously intended to retail at over £60, we offer these at £30 each plus £3 insured delivery. Our ref 30P3.

HIGH RESOLUTION MONITOR. 9in black and white, used Philips tube M24/306W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. **£16 plus £5 post.** Our ref 16P1.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape (4½in x 4½in x 1¾in). The electronically run fans not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc., or for a caravan. **£8 each.** Our ref 8P26.

ACORN COMPUTER DATA RECORDER (ref ALFO3) this is a mono data recorder with switchable motor control intended for use with the Acorn Electron or BBC computer but also functions with almost any other computer and can be used for normal record and play back of music and speech. Can be battery operated but is supplied with a mains adaptor. Brand new in manufacturer's wrapping. Price £10. Our ref 10P44.

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

FDD BARGAIN

3½in made by Chinon of Japan. Single sided, 80 track, Shugart compatible interface, interchangeable with most other 3½in and 5¼in drives. Completely cased with 4 pin power lead and 34 pin computer lead **£40.** Our ref 40P1.

OUR ALADDIN'S CAVE. You may be a new reader and now know that we have a shop at 12 Boundary Road, Hove, where you can go and have a browse around at our assortment of 'goodies'. Unfortunately, because of staff shortages, we cannot be open on Saturdays yet, so the hours are 9.30am to 5pm, Monday to Friday. We of course still serve callers at 250 but request that you bring a completed order form as 250 is really the mail order depot.

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. –minimum £5. Phone (0273) 734648 or 203500.

POPULAR ITEMS

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

EHT TRANSFORMER 4kv 2mA Ex-unused equipment. £5. Our ref 5P139.

FOIL CAPACITORS Axial ended .33uf 1,000v. 4 for £1. our ref BD672. Many other sizes in stock, send for May newsletter.

4 CORE TINSEL COPPER LEAD As fitted to telephones, terminating with flat BT plug. 2 for £1. Our ref BD639.

EHT TRANSFORMER 8kv 3mA. £10. Our ref 10P56.

DOUBLE MICRODRIVES. We are pleased to advise you that the Double Microdrives which we were offering at about this time last year as being suitable for the 'QL', 'OPD' and several other computers are again available, same price as before namely £5. Our ref 5P113.

SOFTWARE FOR REMAKING. Just arrived. Large quantity of mainly games. All are on normal tape spool in cassette holders and should be suitable for wiping out and re-making into games or programmes of your own design. We offer 5 different for £2 or 100 assorted for £20. Important note: We cannot say which titles you will get nor accept orders for specified titles or 'so many, all different', etc., so only order if you can take them as they come. Order ref 5 for £2 is 2P224, 100 assorted is 20P10.

VERY USEFUL MAGNETS. Flat, about 1in long, ½in wide and ¼in thick. These are polarised on their faces which makes them ideal to operate reed switches in doors and windows or to hold papers or labels, etc., to metal cabinets, or even to keep cupboard doors firmly closed. Very powerful. 6 for £1. Our ref BD274(a).

ACORN COMPUTER DATA RECORDER REF ALFO3 Made for the Electron or BBC computers but suitable for most others. Complete with mains adaptor, leads and handbook. £10.00. Ref 10P44.

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 £6. Our ref. 6P3

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.

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. Price £2. Order ref. 2P191.

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.

13A PLUGS Pins sleeved for extra safety, 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.

VERY RELIABLE CAPACITOR 4.7μ 400v not electrolytic so not polarised, potted in ali can, size 1¾x¾x1½in high. A top grade capacitor made for high class instrument work. Ideal for PCB mounting. 2 for £1. Our ref BD667.

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

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

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

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

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.

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

3 VOLT MOTOR Very low current so should be very suitable for working with solar cells. £1 each. Our ref BD681.

MINI SPEAKERS to use instead of headphones with your personal stereo—simply plug in to earphone socket. Excellent sound quality, only £4 per pair. Our ref 4P34.

SEALED LEAD ACID BATTERIES Japanese made re-chargeable and maintenance-free. Leak-proof construction, so could be used in any position. Long life expectancy—usually four to five years. 12V 2.6Ah, £10 each. Our ref 10P59. 6V 1Ah, £5 each. Our ref 5P135.

INNER EAR STEREO HEADPHONES Ideal for lady listeners as they will not mess up your hair do! Come complete in a neat carrying case. Price £3. Our ref 3P56.

STEREO HEADPHONE AMPLIFIER Very sensitive. A magnetic cartridge or tape head will drive it. Has volume control and socket for stereo headphones. 3V battery operated. £1 each. Our ref BD680.

FET CAPACITOR MICROPHONE EAGLE CI.200 Output equivalent to a high class dynamic microphone while retaining the characteristics of a capacitor microphone. Price £1. Our ref BD646.

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

SUB-MIN PUSH SWITCH DPDT. Single hole fixing by hexagonal nut. 3 for £1. Our ref BD650.

DISPLAY 16 CHARACTER 2 LINE As used in telephone answering and similar machines. Screen size 85mm x 36mm x 9.3mm. Alpha-numeric, dot matrix module with integral CMOS micro processor. LCD display. Made by the EPSON Company, reference 16027AR. Price £10. Our ref 10P50.

VOL 18 No 6 JUNE 1989

EVERYDAY ELECTRONICS

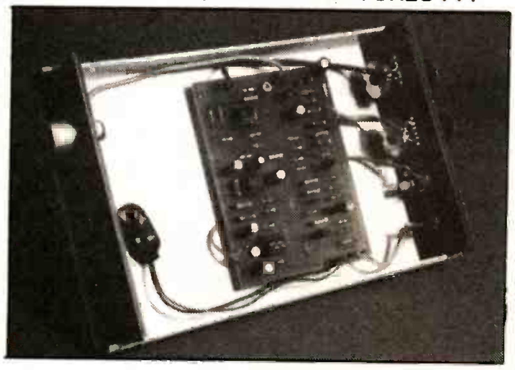
INCORPORATING ELECTRONICS MONTHLY

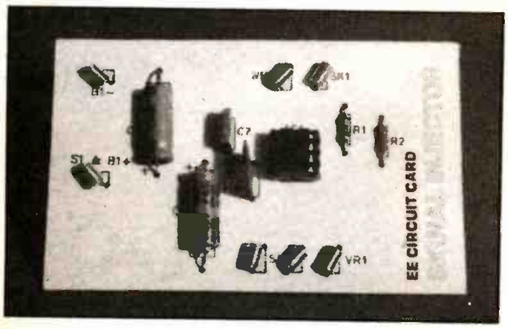
ABC

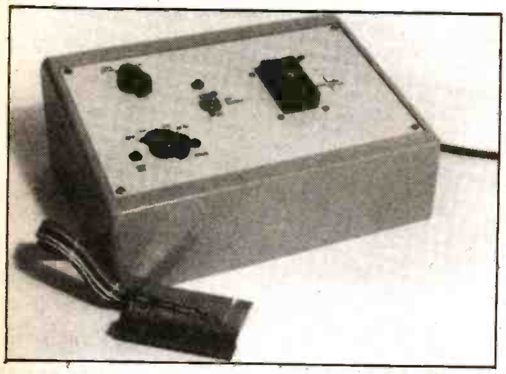
The Magazine for Electronic & Computer Projects

ISSN 0262-3617

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







Projects

Series

Features

Our July '89 Issue will be published on Friday, June 2, 1989. See page 355 for details.

MAGENTA ELECTRONICS Ltd.

A SELECTION OF OUR BEST PROJECT KITS

As usual these kits come complete with printed circuit boards, cases, all components, nuts, screws, wire etc. All have been tested by our engineers (many of them are our own designs) to ensure that you get excellent results.

INSULATION TESTER

An electronic High Voltage tester for mains appliances and wiring. An inverter circuit produces 500 volts from a PP3 battery and applies it to the circuit under test. Reads insulation up to 100 Megohms. Completely safe in use.

OUR KIT REF 444 £19.58

'EQUALISER' IONISER

KIT REF 707 £15.53

A mains powered Ioniser that produces a breeze of negative ions in the air. A compact, safe, simple unit that uses a negligible amount of electricity.

3 BAND SHORTWAVE RADIO

OUR KIT REF 718 £26.53

Covers 1.6-30 MHz in 3 bands using modern miniature coils. Audio output is via a built-in loudspeaker. Advanced design gives excellent stability, sensitivity and selectivity. Simple to build.

DIGITAL CAPACITANCE METER

Simple and accurate (1%) measurements of capacitors from a few pF up to 1,000 uF. Clear 5 digit LED display indicates exact value. Three ranges – pF, nF, and uF. Just connect the capacitor, press the button and read the value.

£41.55 OUR KIT REF 493

ULTRASONIC PET SCARER

Produces high power ultrasound pulses. L.E.D. flashes to indicate power output and level. Battery powered (9V-12V or via *Mains Adaptor).

KIT REF 812 £13.80
***Mains Adaptor £1.98**

VISUAL GUITAR TUNER

Crystal controlled, with a super rotating LED display. Indicates high, low, and exact degree of mistuning. Use with pick-up or mic. Also has audible output.

KIT REF E711 £21.99

COMPONENTS, KITS, BOOKS, TOOLS, MOTORS, GEARS, PULLEYS, OPTICAL FIBRES, ROBOTICS, AND MUCH MUCH MORE–IN OUR CATALOGUE £1.00

MOSFET VARIABLE BENCH 25V 2.5A POWER SUPPLY

OUR KIT REF. 769 £49.73

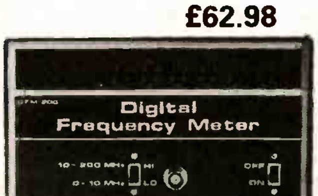
A superb design giving 0-25V and 0-2.5A. Twin panel meters indicate Voltage and Current. Voltage is variable from zero to 25V.
Current-Limit control allows Constant Current charging of NICAD batteries, and protects circuits from overload. A Toroidal transformer MOSFET power output device, and Quad op-amp IC design give excellent performance.

TOP KITS

DIGITAL FREQUENCY 200 MHz METER

KIT REF 563 £62.98

An 8 digit meter reading from A.F. up to 200 MHz in two ranges. Large 0.5" Red LED display. Ideal for AF and RF measurements. Amateur and C.B. frequencies.



PROJECT KITS FOR E.E. (Just a selection more in our catalogue)

Magenta supply Full Kits: Including PCB's (or Stripboard), Hardware, Components, and Cases (unless stated). Please state Kit Reference Number, Kit Title, and Price, when ordering.
REPRINTS: If you do not have the issue of E.E. which includes the project, you will need to order the instruction reprint as an extra: 80p each. Reprints are also available separately–Send £1 in stamps.

REF NO.	KIT-TITLE	PRICE
812	ULTRASONIC PET SCARER May 89	£13.80
811	MIDI PEDAL Mar 89	£39.98
810	MIDI MERGE Mar 89	£11.59
809	CALL ALERT Mar 89	£13.51
807	MINI PSU Feb 89	£22.71
806	CONTINUITY TESTER Feb 89	£10.28
505	4 CHANNEL LIGHT DIMMER Feb 89	£37.99
803	REACTION TIMER Dec. 88	£29.98
802	PHASOR (Light Controller) Dec 88	£25.61
801	DOWNBEAT METRONOME Dec 88	£17.57
800	SPECTRUM EPROM PROGRAMMER Dec 88	£26.97
796	SEASHELL SYNTHESISER Nov 88	£24.99
795	I.R. OBJECT COUNTER Nov 88	£29.63
790	EPROM ERASER Oct 88	£24.95
786	UNIVERSAL NICAD CHARGER July 88	£6.99
780	CABLE & PIPE LOCATOR April 88	£15.35
775	ENVELOPE SHAPER Mar 88	£14.99
769	VARIABLE 25V-2A BENCH POWER SUPPLY Feb 88	£49.73
	CAR LAMP CHECKING SYST. Feb 88	£7.10
763	AUDIO SIGNAL GENERATOR Dec 87	£13.64
739	ACCENTED BEAT METRONOME Nov 87	£20.95
740	ACOUSTIC PROBE Nov 87 (less bolt & probe)	£16.26
744	VIDEO CONTROLLER Oct 87	£29.14
745	TRANSTEST Oct 87	£9.70
734	AUTOMATIC PORCH LIGHT Oct 87	£17.17
736	STATIC MONITOR Oct 87	£8.66
723	ELECTRONIC MULTIMETER Sept 87	£46.96
728	PERSONAL STEREO AMP Sept 87	£14.31
730	BURST-FIRE MAINS CONTROLLER Sept 87	£13.57
724	SUPER SOUND ADAPTOR Aug 87	£38.39
718	3 BAND 1.6-300MHz RADIO Aug 87	£26.53
719	BUCCANEER I.B. METAL DETECTOR inc. coils and case, less handle and hardware July 87	£26.45
720	DIGITAL COUNTER/FREQ METER (10MHz) inc. case July 87	£67.07
722	FERMOSTAT July 87	£12.14
711	VISUAL GUITAR TUNER Jun 87	£22.99
715	MINI DISCO LIGHT Jun 87	£12.59
707	EQUALIZER (IONISER) May 87	£15.53
700	ACTIVE I/R BURGLAR ALARM Mar 87	£35.65

REF NO.	KIT-TITLE	PRICE
581	VIDEO GUARD Feb 87	£8.39
584	SPECTRUM SPEECH SYNTH. (no case) Feb 87	£20.92
578	SPECTRUM I/O PORT less case Feb 87	£9.44
569	CAR ALARM Dec 86	£12.47
563	200MHz DIG. FREQUENCY METER Nov 86	£62.98
561	LIGHT RIDER LAPEL BADGE Oct 86	£10.20
560	LIGHT RIDER DISCO VERSION	£19.62
559	LIGHT RIDER 16 LED VERSION	£13.64
556	INFRA-RED BEAM ALARM Sept 86	£28.35
544	TILT ALARM July 86	£7.82
542	PERSONAL RADIO June 86	£11.53
528	PA AMPLIFIER May 86	£26.95
523	STEREO REVERB Apr 86	£26.44
513	BBC MIDI INTERFACE Mar 86	£27.94
512	MAINS TESTER & FUSE FINDER Mar 86	£8.82
497	MUSICAL DOOR BELL Jan 86	£18.72
493	DIGITAL CAPACITANCE METER Dec 85	£41.55
481	SOLDERING IRON CONTROLLER Oct 85	£5.47
464	STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£11.68
	1D35STEPPER MOTOR EXTRA	£14.50
	OPTIONAL POWER SUPPLY PARTS	£5.14
461	CONTINUITY TESTER July 85	£6.20
455	ELECTRONIC DOORBELL June 85	£7.56
453	GRAPHIC EQUALISER June 85	£26.94
444	INSULATION TESTER Apr 85	£19.58
430	SPECTRUM AMPLIFIER Jan 85	£6.91
392	BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£36.25
387	MAINS CABLE DETECTOR Oct 84	£5.53
386	DRILL SPEED CONTROLLER Oct 84	£8.68
362	VARICAP AM RADIO May 84	£13.15
337	BIOLOGICAL AMPLIFIER Jan 84	£24.14
263	BUZZ OFF Mar 83	£5.68
242	2-WAY INTERCOM no case July 82	£5.69
240	EGG TIMER June 82	£6.86
205	SUSTAIN UNIT Oct 81	£17.63
108	IN SITU TRANSISTOR TESTER Jun 78	£9.42
106	WEIRD SOUND EFFECTS GEN Mar 78	£7.82
101	ELECTRONIC DICE Mar 77	£6.26

EE77 135 HUNTER STREET
BURTON-ON-TRENT, STAFFS DE14 2ST
ADD £1.00 P&P TO ALL ORDERS

PRICES INCLUDE VAT
SHOP OPEN 9-5 MON-FRI, 9-2 SAT.
OFFICIAL ORDERS WELCOME

0283 65435

NEXT MONTH

POCKET MONEY PROJECTS

Rain Alarm
Snap Switch

The first two articles in an on-going series of relatively inexpensive projects aimed at those who need easy to build designs. Whilst being well suited to inexperienced readers these designs will also provide plenty of circuits and ideas for everyone.

PROGRAMMABLE POCKET TIMER

Human beings are notoriously bad at keeping track of time, especially when preoccupied. This can have embarrassing or downright dangerous consequences. Enter the Programmable Pocket Alarm! Small enough to carry in a pocket or handbag, simple to operate, and, carrying a penetrating alarm, the device can accurately time any period from 15 minutes to 3 hours 45 minutes in 15 minute steps.

POWER SUPPLY SERIES

This short series will introduce a few practical stabilized power supply projects which are reasonably simple to build and have good specifications. It will also delve into the basic theory of p.s.u. design and look at potential problems.

EVERYDAY ELECTRONICS

JULY ISSUE ON SALE JUNE 2 1989

HIGH GRADE COMPONENT PARCELS

COMPONENT PACKS

This month we have a delicious selection of top grade component packs for you. They all contain brand new components of the very highest quality – ideal for experiment, circuit design and development, or education. All the packs are £1 (+ VAT) each, but if you order five packs you can select another pack **FREE.** Order ten packs and you can have three extra packs **FREE.**

FOR THE EXPERTS – Just look at those ICs! They are all at the very top of their class, made for peak performance without compromise. The kind of ICs it's a delight to design with.

Of course, there's no point in buying an expensive IC unless you know exactly how to use it, so each comes with its own data sheet, specifications, design ideas and circuits. The nicest thing of all is that any one of them could be **yours** in a few days time if you order right now!

PASSIVE COMPONENTS

PACK 1 – 200 RESISTORS. Mostly ¼W carbon film. Lots of E12 values with some E96.
PACK 2 – 100 CAPACITORS. Ceramics, metallised film, all types. A fine selection!
PACK 3 – 30 ELECTROLYTICS. Values to 500µF.
PACK 4 – 15 LARGE ELECTROLYTICS. Values to 5,000µF.
PACK 5 – 10 TANTALUM CAPACITORS. Values to 47µF.
PACK 6 – 20 HIGH VALUE POLYESTER CAPS. Values to 2µ2.
PACK 7 – 15 DIL RESISTOR NETWORKS.
PACK 8 – 20 CARBON AND CERMET TRACK PRESETS.

OPTO ELECTRONICS & DISPLAYS

PACK 11 – 10 5mm LEDs: 4 red, 2 yellow, 2 orange, 2 green.
PACK 12 – 10 3mm LEDs: 4 red, 2 yellow, 2 orange, 2 green.
PACK 13 – 2 CQY89A high power infra-red emitters.
PACK 14 – 2 HIGH POWER SENSORS. Matched to emitters in PACK 13.
PACK 15 – 2 FND10 0.1" miniature 7-segment CC LED displays.
PACK 17 – 20 NEON BULBS (use 100k series resistor for mains).
PACK 18 – 2 INFRA-RED COMPONENTS. Emitter and phototransistor.
PACK 19 – 3 FLASHING LEDs. A built-in IC makes the LED flash.
PACK 21 – 1 SLOTTED INFRA-RED OPTO SWITCH.
PACK 23 – 10 RECTANGULAR GREEN LEDs. For bar graph, etc.

SEMICONDUCTORS

PACK 26 – 3 TAG136D MAINS TRIACS (400V, 4A).
PACK 27 – 30 IN4000 SERIES RECTIFIERS.
PACK 28 – 30 MIXED SEMICONDUCTORS. Transistors, diodes, SCRs, ICs, FETs, etc.
PACK 29 – 20 ASSORTED ICs. CMOS, TTL, linear, memory, all sorts.
PACK 30 – 20 TRANSISTORS. High grade general purpose NPN.
PACK 31 – 1 CF 585 CALCULATOR IC. With data.

MISCELLANEOUS

PACK 36 – 4 12V BUZZERS.
PACK 37 – 3 PANEL NEON LAMPS.
PACK 39 – 5 'BEEHIVE' TRIM CAPS.
PACK 40 – 3 VDRs. Mains transient suppressors – just wire between L and N of plug.
PACK 42 – 12 PP3 BATTERY CONNECTORS.
PACK 43 – 100 MYSTERY PACK. At least 100 top grade components.
PACK 44 – 1 MINI BIO-FEEDBACK KIT. With PCB, components and instructions.
PACK 45 – 1 MINI DREAM MACHINE KIT. With PCB, components and instructions.

EXTRA PACKS

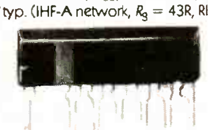
PACK 50 – 12 BC212 TRANSISTORS. General purpose PNP.
PACK 51 – 12 BC213 TRANSISTORS. General purpose PNP.
PACK 52 – 2 PIEZO BUZZERS. Use as microphone, speaker or buzzer.

HI-FI PRE-AMPLIFIER IC — £2.80! + VAT

The HA12017 is a top grade Hi-Fi pre-amplifier, turning in a THD of less than 0.002% over the entire audio bandwidth! The low noise, wide dynamic range and excellent power supply ripple rejection make this IC the first choice for an audio pre-amplifier of formidable specifications.

Eac 'C is supplied with its own data sheet giving perfo ,iance figures and graphs, the circuit for a top flight pre-amplifier and a PCB foil pattern and component layout.

SPECIFICATIONS
THD = 0.002% typ. (f = 20Hz to 20kHz, V_{out} = 10V RMS, RIAA)
Input noise V_n = 0.185µV typ. (IHF-A network, R_g = 43R, RIAA)
Supply rejection:
SVR+ = 56dB typ. (f = 100Hz, R_g = 43R)
SVR– = 45dB typ. (f = 100Hz, R_g = 43R)



POWER AMPLIFIER IC — £3.90! + VAT

As easy to use as an ordinary op-amp, the L165V's massive ±3A current handling make it the ideal choice for a minimum component Hi-Fi amplifier.

This IC's data sheet includes circuits for a basic amplifier, a motor controller and a power oscillator. A separate sheet gives circuits and construction details for two high quality audio amplifiers, one giving 20W and the other 50W output. All information comes free with the IC. PCBs for the amplifiers are available separately, if required.

SPECIFICATIONS
Output current: ±3A — Frequency range: DC to 200kHz
Supply voltage: 12V to 35V — Input noise: 2µV (10Hz to 10kHz)

ACCESSORIES
20W Hi-Fi amplifier PCB £1.20 + VAT
50W Hi-Fi amplifier PCB £1.60 + VAT

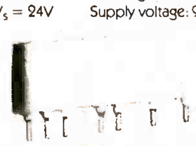
UHF AMPLIFIER — £12.20! + VAT

The OM335 is a high gain wideband amplifier (10MHz to 1.4GHz) for VHF and UHF signals. It can be used as a masthead amplifier for better TV reception, a booster for indoor aerials, a distribution amplifier, and so on. The only external component needed is a decoupling capacitor for the power supply!

Each amplifier is supplied with a data sheet giving specifications, design hints and performance figures. A separate leaflet, also supplied with the IC, gives a complete design for a TV aerial booster, with layout and construction details. A PCB for the amplifier is available separately, if required.

SPECIFICATIONS
Frequency range: 10MHz to 1.4GHz — Noise figure: 5.5dB typ.
Mid-band gain: 26dB at V_s = 24V — Supply voltage: 9V to 26V

ACCESSORIES
PCB for TV aerial booster £1.80 + VAT
Screening piece 80p + VAT



BAR GRAPH DISPLAY — £3.60! + VAT

For visual impact, there's nothing to beat a bar graph display – you can see at a glance exactly what's going on. The LM3915 needs only ten LEDs and a few resistors to make a moving dot or expanding bar display. The logarithmic response means that the graph will automatically be scaled in dBs and will cover a wide dynamic range – ideal for audio work.

The data we supply with the IC gives circuits for a peak detector, VU meter, vibration meter, light meter, audio power meter, and a dozen more project ideas!

SPECIFICATIONS
Range: 30dB in 3dB steps
Supply voltage: 3V to 25V
Outputs: direct LED drive (no series resistors needed)

A/D CONVERTER — £4.80! + VAT

Built-in clock generator, easy interface to microprocessors, outputs suitable for MOS **and** TTL, differential inputs – the ADC0804's got the lot! As a stand alone converter, it needs only one external resistor and one small cap. What could be easier?

The converter comes with its own data sheet, giving full specifications, design hints and over 25 circuit ideas! Stocks limited on this one I'm afraid, and at this price they'll be gone in no time, so reserve yours now.

SPECIFICATIONS
Resolution: 8 bits — Access time: 135ns
Supply voltage: 5V — Outputs: MOS **and** TTL.

COMMUNICATION THROUGH THE MAINS — £6.20! + VAT

Messages through the mains is the function of the LM1893. Although intended for reliable, long distance data communication, it can just as easily become a powerful mains intercom – the instructions tell you how. Each IC contains a transmitter which sends an FSK modulated signal along the mains wiring of your house or office. The IC also has a receiver to pick up and decode the signals, so two ICs will give you full two-way communication without any wires or cables!

The instruction leaflet gives detailed design procedures, circuits, and everything you need to know to build a speech or digital communications system.

SPECIFICATIONS
Transmission rate: up to 4.8kBaud
Carrier frequency: selectable 50kHz to 300kHz
Power boost: optional x10 power boost with single transistor

UK Orders: Please add 80p postage & packing and 15% VAT to the total (including postage).
Europe and Eire: Please add £2.50 carriage and insurance. No VAT.
Outside Europe: Please add £4.50 carriage and insurance. No VAT.

HIGHGRADE COMPONENTS LTD UNIT 11, 8 Woburn Road, Eastville, Bristol BS5 6TT.

PCB DESIGNER

FOR THE 48K ZX SPECTRUM

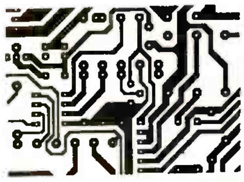
Now you can produce high quality printed circuit boards/circuit diagrams/component layouts on your 48K ZX Spectrum. If you don't own one it's worth getting one just for this suite of programs!

Comprehensive manual included with getting started tutorial.

FULL SUITE FOR ONLY **£30.00** INC.

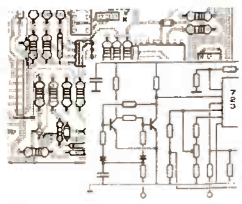
PCB LAYOUT:

Produce quality printed circuits directly from your EPSON RX/FX or compatible dot matrix printer using a dense 1:1 printout on positive photoresist coated board. Or super quality using x2 printout and photoreduction. Many features such as 15 track widths; 15 pad sizes; 16 transistor/ic/corners; 20 connectors; large multiscreen WYSIWYG display gives a clear uncluttered view of pads, tracks and drill holes; 0.1in. grid on/off; Block move; copy; mirror; rotate; erase; area fill (ideal for earth plane); preview; undo; dimensionally accurate printer routine with quick print; 1:1 or 2:1 dumps. Custom pad design and library.



COMPONENT LAYOUT

Draw component layouts directly or from existing pcb layouts using a unique track reducing facility. The following components are provided: resistors, capacitors, ics, diodes, transistors, line drawing, printout and block commands as above.



CIRCUIT DIAGRAMS

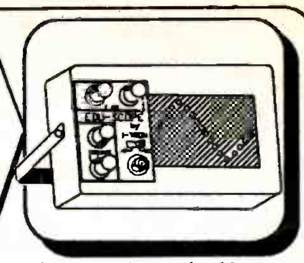
Features similar to the above programs with a library of electronic symbols including resistors, capacitors, diodes, transistors, fets, op amp, switches, inductors, logic gates.

LAYOUT ACTUALLY PRODUCED ON PCB

Version now available for EE Centronics Interface – see Jan issue. State version required from: Disciple/+D; Discovery; +3; Microdrive & Tape. *Important! Tape and Microdrive users please state Centronics interface in use.*

KEMSOFT THE WOODLANDS, KEMPSEY, WORCESTER WR5 3NB. Tel. 0905 821088 after 6 p.m., or see us on A.I.X-386 BULLETIN BOARD 0905 52536/754127 on any computer with modem.

EDU-SCOPE Build your own solid state oscilliscope - complete kit of parts excluding case £29.99
EDU-SCOPE CASE KIT . . £10.95
LOW COST LEAD/PROBE. £3.95



BUG-89 Micro sized surveillance transmitter - can be received by any FM/VHS radio or our MICRO-FM - PCB size only 50x20mm £4.99

MICRO-FM A micro miniature personal FM receiver - High quality IC design (no alignment problems) - Great for surveillance work or for just listening to your favourite radio shows! (cased) £7.99

ROBO-VOX Instantly transforms your voice into into Dalek/Robot type - also amazing feedback sound effects possible (cased) £9.95

ROBOT CIRCULAR Unique radio controlled robot - can also be converted to control via computer £16.95

THERAMIN MUSIC GENERATOR An electronic device based on an ancient legendary mystical instrument (cased) £12.75

SOLARTRONICS-88 Enter the exciting world of Solar Electronics with our Solar Designer's experimenter kit £7.75

SUPER SOUND-FX MICROCOMPUTER An easy to use and program single chip sound effects Micro completely self contained - Incredible sound routines already masked programmed into the device - this is our most popular kit at present £9.95

SOUND-FX PRO CONSOLE CASE KIT £3.99

Please add 15% VAT and £0.95 per order for P&P. For FREE Datapack on all our Kits/ Products send SAE. - Allow up to 14 days for delivery - Make Cheques/Po's payable to :-
ITRON U.K.
Castle Mill, Lower Kings Road
BERKHAMSTED
Hertfordshire HP4 2AD

I–TRON U.K.

A Division of Design Innovations Ltd.

OSCILLOSCOPES

TEKTRONIX 2215 Dual Trace 60MHz Delay Sweep Dual TB . £475
TEKTRONIX 465 Dual Trace 100MHz Delay Sweep £500
TEKTRONIX 454 Dual Trace 150MHz Delay Sweep £400
TRIO CS 1065 Three Trace 60MHz Delay Sweep £500
HITACHI V1050F Dual Trace 100MHz Delay Sweep £560
THANDAR T0315 Dual Trace 15MHz Mains/Battery. Unused £300
TELEQUIPMENT D755Dual Trace 50MHz Delay Sweep £275
KIKUSUI 5530A Dual Trace 35MHz £250
HAMEG 203 4 Dual Trace 20MHz £240
H P 1220A Dual Trace 15MHz £200
GOULD/ADVANCE OS1100 Dual Trace 30MHz £210
GOULD/ADVANCE OS255 Dual Trace 15MHz £210
COSSOR CDU 150 Dual Trace 35MHz Delay Sweep
Solid State Portable 8 x 10cm Display £180
Optional front cover containing 2 probes etc £10
SE LABS SM111 Dual Trace 18MHz Solid State Portable
AC or external DC operation 8 x 10cm Display £130
SCOPEX 4D10B Dual Trace 10MHz £150
TELEQUIPMENT S54A Single Trace 10MHz Solid State £90

MARCONI TF2006 AM/FM 10MHz—1GHz Sig Gen £500
MARCONI TF2008 AM/FM 10MHz—510MHz Sig Gen £375
MARCONI TF2015 AM/FM 10—520MHz Sig Gen with
Synchroniser TF2171 .... £550
MARCONI TF2015 without Synchroniser £425
MARCONI TF2016 AM/FM 10MHz—120MHz with
Synchroniser TF2173 .... £400
MARCONI TF2016 without Synchroniser £300
MARCONI/SANDERS SIG SOURCE 6055B.
850-2150MHz £500
DYMAR 1525 AM/FM 0.1—184MHz Sig Gen £200
H. P. 694 SWEET OSCILLATOR 7—12.4GHz £600
H. P. 620 Signal Generator 7—11GHz £400
H. P. 614A Signal Generator 800—2100MHz £450
FERROGRAPH RTS2 Recorder Test Set £275
WOELKE Wow & Flutter Meter ME 108 .... £100
LEADER LMV 186A Two channel Millivoltmeter
5Hz—500KHz: 100uV—300V £100
LEVELL TG200DM 1Hz—1MHz Sine/Square £125
MARCONI Automatic Distortion Meter
TF2337A. 400Hz or 1KHz. Measures down to 0.01% £150
MARCONI TF2700 UNIVERSAL LCR Bridge.
Battery Operated .... From £150
PHILIPS PM6456 FM Stereo Generator £95
TRIO RF SIGNAL GENERATOR Type SG402
100kHz—30MHz Unused (P & P £7) .... ONLY £75
ADVANCE SG62B AM 150KHz—220MHz .... £45 (P & P £7)

STEPPING MOTORS

Type 1 200 Steps per rev. 4 Phase (5 wire) 12/24V Torque 25oz inch will run on 5V with reduced torque £15.00
Type 2 6/12 steps per rev. 3 Phase 12/24V (will work on 5V) £2 each 5 off £7.50
Type 3 NORTH AMERICAN PHILIPS 24 Steps per rev. 4 wire 5V 3.3Amps 0.250rpm 0.200PPs .... £6 each
Type 4 200 Steps per rev. 120V (3 wire) Torque 25oz inch .... £4 each
Type 7 WARNER 24 Steps per rev. 3 phase (6 wire) 28V. Holding torque 45oz. inch .... £5 each

SPECIAL OFFER

HAMEG MODULAR SYSTEM

HM8001 Main Frame with HM8032 Sine Wave Generator 20Hz—20MHz; HM8030 2 Function Generator 0.1—1MHz Sine/sq/Triangle; and HM8011 2 Digital Multimeter 4½ digit.

ONLY £400

DISK DRIVE PSU 240V In. 5V 1.6A & 12V 1.5A Out.
Cased. Unused .... ONLY £10 each (P&P £3)
FARNELL SWITCHED MODE PSU
5V 40A & ±12V 5A .... £30 each (P&P £4)
OTHER SWITCHED MODE PSUs available. Please enquire.
DISK DRIVES 5¼in DS/DD 80 track .... from £50
SOME KEYBOARDS AVAILABLE—PLEASE ENQUIRE

MULTIMETERS (P&P all AVOs £10)

AVO 8 Complete with Batteries & Leads .... From £50
AVO 8 MkV Complete with Batteries & Leads £90
AVO TEST SET No 1 (Military version of AVO 8)
Complete with Batteries and Leads £65
TEST LEADS suitable for AVOMETERS. Red & Black
with 2 Croc-clips & 2 Prods .... £5 (P & P £3)
Black "Ever-Ready" case for AVOs. Unused .... £15 (P & P £4)

AVO VALVE TESTER CT160. Suitcase style. 22 Bases
(P & P £7) .... ONLY £25 each
AVO TRANSISTOR ANALYSIS Mk2 CT446 Suitcase style
complete with batteries and operating instructions
.... ONLY £25 EACH (P & P £7)
MARCONI AF POWER TF893A 20Hz—35KHz
20MW—10W with manual .... ONLY £35 (P & P £7)
MARCONI RF POWER METER TF1152A/1 DC 500MHz
0.5 to 25W 50 Ohm with manual .... ONLY £45 (P & P £7)

NEW EQUIPMENT

HAMEG OSCILLOSCOPE 604 Dual Trace 60MHz.
Delay Sweep. Component Tester + two probes £575
HAMEG OSCILLOSCOPE 203.6. Dual Trace 20MHz.
Component Tester with two probes £314
All Other Models Available.

BLACK STAR COUNTER TIMERS (P & P £5)
APOLLO 10—100MHz Radio/Period/Time interval etc £222
APOLLO 100—100MHz (As above with more functions) £295
BLACK STAR FREQUENCY COUNTERS
(P & P £4) Meteor 100—100MHz £99
Meteor 600—600MHz £129
Meteor 1000—1GHz £178
BLACK STAR JUPITOR 500 FUNCTION GENERATOR.
Sine/Square/Triangle. 0.1Hz—500KHz. (P & P £4) £110
ORION COLOUR BAR GENERATOR Pal TV/Video £209

HUNG CHANG DMM 7030. 3½ digit. Hand held 28 ranges including 10amp AC/DC 0.1%. Complete with batteries & leads.
(P & P £4) £39.50
As above DMM 6010 0.25% £33.50
Carrying cases for above .... £3 each

OSCILLOSCOPES PROBES. Switched ×1×10 (P & P £3) £11

USED EQUIPMENT – WITH 30 DAYS GUARANTEE. MANUALS SUPPLIED IF POSSIBLE. This is a VERY SMALL SAMPLE OF STOCK. SAE or Telephone for Lists. Please check availability before ordering. CARRIAGE all units £16. VAT to be added to Total of Goods & Carriage.

STEWART OF READING
110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Telephone: 0734 68041 Fax. 0734 351696
Callers welcome 9 am-5.30 pm Mon.-Fri. (until 8 pm Thurs.)

FRASER ELECTRONICS

42 Elm Grove Southsea Hants PO5 1JG

☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

BUDGET PACK SELECTION

The packs listed below are selected from our full list of 140 packs (sent free with all orders). Note that our prices include VAT and carriage charges—**NO HIDDEN EXTRAS**. All orders subject to a minimum value of £3.00. Access and Barclaycard accepted—and you can 'phone orders to

Portsmouth (0705) 815584

from 9.00am 'till 5.30pm any weekday

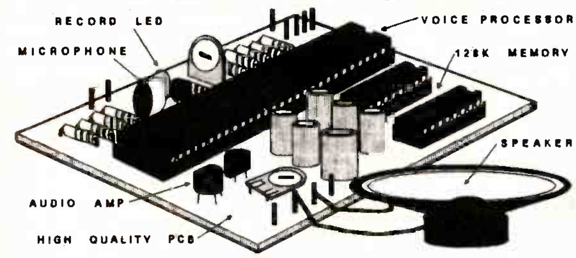
Qty.	Device	Description	Cost
100	1N4148	Signal diode 75mA/75V	£2.00
15	BC547	NPN GP transistor	£1.00
25	LED5R	5mm red LED	£2.00
5	7812	1A/12V regulator	£2.00
10	555	8-pin DIP timer	£1.80
10	741	8-pin DIP op.-amp	£1.80
12	4011BE	Quad-2 NAND gate CMOS	£2.00
10	74LS00	Quad-2 NAND gate TTL	£2.00
12	DIL-14	14-pin DIL socket	£1.00
5	DX25PZ	D-min RS232 solder plug	£2.00

KITS & COMPONENTS

ELECTRONIC GUARD DOG

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

VOICE RECORD/PLAYBACK KIT



This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or lights reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places, in fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daughter's £8 doll to an £80 talking doll!!

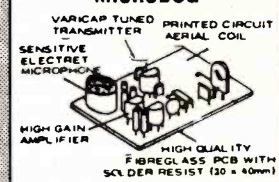
Size .... 78×60×15 mm
Message time .... 1–5 secs normal speed, 2–10 secs slow speed

XK129 .... **£22.50**

TEN EXCITING PROJECTS FOR BEGINNERS

This kit contains a solderless breadboard, components and a booklet with instructions to enable the absolute novice to build ten fascinating projects including a light operated switch, intercom, burglar alarm and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section on component identification and function is included, enabling the beginner to build the circuits with confidence.
XK118 .... **£15.00**

SUPER-SENSITIVE MICROBUG



Only 45×25×15mm, including built-in mic. 88-100MHz (standard FM radio). Range approx. 300m depending on terrain. Powered by 9V PP3 (7mA). Ideal for surveillance, baby alarm etc. £5.50

DISCO LIGHTING KITS

DL8000K 8-way sequencer kit with built-in opto-isolated sound to light input. Only requires a box and control knob to complete £31.50
DL1000K 4-way chaser features bi-directional sequence and dimming 1kW per channel £19.25
DLZ1000K Uni-directional version of the above. Zero switching to reduce interference £10.80
DLA/1 (for DL & DLZ1000K) Optional opto input allowing audio 'beat'/light response 77p
DL3000K 3-channel sound to light kit, zero voltage switching, automatic level control and built-in mic. 1kW per channel £15.60

POWER STROBE KIT

Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 80×50×45.
XK124 STROBOSCOPE KIT £13.75

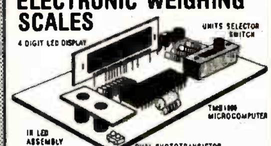
MULTIMETER BARGAINS

A high accuracy **Autoranging** meter with **Display Hold, Memory** features.
AC volts 0-2-200-750 1.2%
DC volts 0-0.2-2-200-1000 0.8%
AC current0-2m-200mA 1.2% 0-10A 2%
DC current .... as for AC
Resistance. 0-200-2K-20K-200K-2M 1%
Continuity. . Buzzer sounds at /20 ohms
Size 127x69x25mm
405 207 .... **£31.75**

A 15 range **Autoranging** multimeter with 4AC, 5DC and 6 resistence ranges. Only 8x55x108mm. Complete with wallet.
405 206 .... **£19.50**

Ask for a leaflet on our range of meters

ELECTRONIC WEIGHING SCALES



Kit contains a single chip microprocessor, PCB, displays and all electronics to produce a digital LEDreadout of weight in Kgs or Sts/lbs. A PCB link selects the scale – bathroom/ two types of kitchen scales. A low cost digital ruler could also be made.
ES1 .... £6.50

VERSATILE REMOTE CONTROL KIT

Includes all components (+transformer) for a sensitive IR receiver with 16 logic outputs (0–15V) which with suitable interface circuitry (relays, triacs, etc – details supplied) can switch up to 16 items of equipment on or off remotely. Outputs may be latched to the last received code or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits. Supply: 240V AC or 15–24V DC at 10mA. Size (exc. transformer) 9×4×2 cms. Companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available – MK9 (4-way) and MK10 (16-way).
MK12 IR Receiver
(inc transformer) £16.30
MK18 Transmitter £7.50
MK9 4-way Keyboard £2.20
MK10 16-way Keyboard £6.55
601133 Box for Transmitter £2.60

SIMPLE KITS FOR BEGINNERS

Kits include all components (inc. speaker where used) and full instructions.
SK1 DOOR CHIME play a tune when activated by a pushbutton £3.90
SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command £3.90
SK3 SOUND GENERATOR produces FOUR different sounds, including police/ambulance/fire-engine siren and machine gun £3.90

SPECIAL OFFERS ON KITS FOR SCHOOLS AND TRAINING CENTRES – contact Sales Office for discounts and samples

★ ★ ★ BARGAIN COMPONENT PACKS ★ ★ ★

Refill those empty component drawers at a fraction of the normal price and don't be caught out. All components supplied are to full spec, and are not seconds or surplus stock. Prices exclude VAT (15%).
Pack A: 650×25 watt resistor 47R-10M £4.25
Pack B: 60×Radial electrolytes 1uf – 1000uf £3.25
Pack C: 30×Polyester capacitors a or 0.01uf-1uf £4.50
Pack D: 35×horizontal presets 1k – 1M £3.00
Pack E: 30×IC sockets 8, 14, 16 pin £2.00
Pack F: 25×Red 5mm LEDs £1.75
Pack G: 25×Green LEDs £2.00
Pack H: 30×5mm LEDs 10 Red, 10 Green, 10 Yellow £2.50
Pack J: 50×1N4148 silicon diodes £1.00
Pack K: 40×npn/pnp transistors BC/548/558 General Purpose. . £2.25
FREE Solderless Breadboard (verobloc type) when you buy all ten packs.

MICROPROCESSOR TIMER

Kit controls 4 outputs independently switching on /off at 18 preset times over a 7-day cycle. LED display of time/day easily programmed. Includes box.
CT6000K £47.20

XK114 Relay kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts £4.30
701115 Additional relays £1.80

TK ELECTRONICS

TK ELECTRONICS
13 Boston Road
London W7 3SJ
Tel: 01-567 8910
Fax: 01-566 1916

ORDERING INFORMATION All prices exclude VAT. Free p&p on orders over £50 (UK only), otherwise add £1+VAT. Overseas p&p: Europe £3.50 elsewhere £10.00. Send cheque/PO/Barclaycard/Access No. with order. Giro No. 529314002. Local authority and export orders welcome. Goods by return subject to availability.

VISA · ACCESS

ORDERS: 01-5678910 ***24 HOURS***

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

VOL. 18 No. 6 June '89

Editorial Offices
EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 881749
FAX: (0202) 841692
See notes on **Readers' Enquiries** below—we regret that lengthy technical enquiries cannot be answered over the telephone
Advertisement Offices
EVERYDAY ELECTRONICS ADVERTISEMENTS
HOLLAND WOOD HOUSE, CHURCH LANE,
GREAT HOLLAND, ESSEX CO13 0JS.
Frinton (0255) 850596

IT GREW IN THE TELLING

The SCS catalogue which is presented free inside this issue was billed last month as being 64 pages. By the time SCS had covered everything they sell the catalogue turned out to be 80 pages! So you have even more value, more reading, more kits and bits than we promised.

CIRCUIT CARD

The last in our line of Circuit Cards appears this month, these designs have all been very popular. Should you have missed any our back numbers service can still supply them. The previous cards covered *Infra Red, Remote Control Transmitter* and *Receiver* (December 1988), *Tilt Alarm* and *Siren* (January 1989) and *Metal Detector* and *Radio* (May 1989).

We hope to do another free gift based on Easiwire later in the year, it certainly is a popular method of construction especially for the less experienced hobbyists.

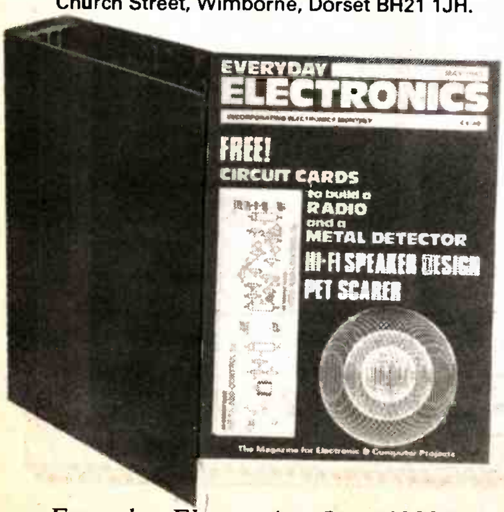
FIRST AGAIN

Once again *Everyday Electronics* has topped the circulation figures for U.K. monthly electronic hobbyists magazines. In fact our U.K. circulation lead over our nearest rival is now more than 5,000 copies per month; thank you for buying Everyday Electronics. These figures are not guesses or wishful thinking—the circulation of *Everyday Electronics* is audited to the strict professional standards administered by the Audit Bureau of Circulations.

To keep us on the straight and narrow we always like to hear your views on our content. Please keep your letters flowing, whilst we cannot undertake to publish everything everyone wants, we can and do try to shape the magazine to meet your general needs. *Everyday Electronics* has now, with your help, been number one in the U.K. for the last four years and we intend to keep it that way!

SUBSCRIPTIONS

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



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

BACK ISSUES

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

BINDERS

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

READERS' ENQUIRIES

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

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

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

OLD PROJECTS

We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

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

ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide,* the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or are in the form of inserts.

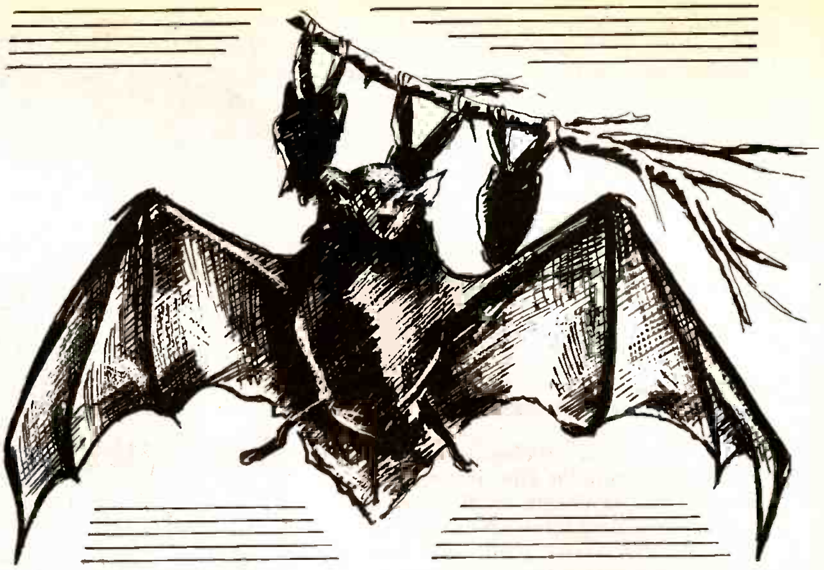
The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should address them to the advertiser or should consult a local trading standards office, or a Citizen's Advice Bureau, or a solicitor.

TRANSMITTERS/BUGS

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

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

BAT DETECTOR



R. A. PENFOLD

Explore the fascinating world of bats and unravel some of their mysteries with this low cost instrument

A STEADY stream of readers' suggestions for projects is received in the offices of *EE*, and one idea which seems to crop up fairly regularly is for a "bat detector". In other words, a unit that will effectively extend human hearing so that the ultrasonic sounds produced by bats, or any other sounds at similarly high frequencies, can be heard.

Apparently units of this type do have practical applications in such diverse fields of interest as nature study and the detection of gas leaks. The unit described here may well be suitable for serious applications, but it was really only designed for its interest value.

It it surprising how much ultrasonic sound there is in the average house. Some quite loud sounds such as moving furniture around seem to have little or no ultrasonic content. Other sounds seem to contain little audio frequency content, but have quite significant ultrasonic levels. Dropping a pin or some other small object onto a hard surface produces little audio frequency sound, but seems to be readily detectable using this unit.

DETECTION METHODS

Detecting ultrasonic soundwaves is not very difficult technically, and the *Breaking Glass Alarm* in the September 1988 issue of *Everyday Electronics* is a basic detector of this type. Processing the received signal to give a useful audio frequency output signal is a little more difficult.

Some means of reducing the frequency of the received soundwaves is clearly needed, but the method used must not affect the relative amplitudes of the signals or otherwise severely distort the signal. What is needed is a system that not only gives some form of audio output, but one which also gives the sort of sound that you would hear if your ears could detect the ultrasonic input frequencies unaided.

One obvious approach is to use some form of frequency division systems. Dividing input frequencies by (say) five, would effectively extend the 20Hz to 20kHz audio frequency range to a 100Hz to 100kHz range. Bats apparently operate at around 35kHz to 80kHz or so, and this should enable them to be detected.

Unfortunately, the only reasonably simple frequency divider circuits are digital types which only deal in pulse signals. Using one of these would give a very distorted and crude form of output signal.

HETERODYNE APPROACH

The other obvious approach, and the one adopted in this design, is to utilize the heterodyne principle. This is the same effect that is used in most radio receivers and television sets.

In these applications it is used to convert a signal at a high radio frequency to one at a lower radio frequency. Here the frequencies involved are much lower, but the principle of operation is exactly the same. Heterodyning mixes two signals to generate an output signal that contains new frequencies, plus the input frequencies.

By using a balanced or double balanced mixer it is possible to remove one or both of the input signals from the output. In this case both the input frequencies will be at ultrasonic frequencies, and failing to remove them will not necessarily prevent the unit from functioning properly. However, there is some advantage in removing both input frequencies in that this avoids problems with these signals overloading or otherwise having adverse effects on the output stages of the unit.

SUM AND DIFFERENCE

The new frequencies produced by the heterodyning technique are the sum and difference frequencies. As a simple example we will assume that a bat is using a frequency of 60kHz for its "RADAR". If we heterodyne this with the 55kHz output from an audio frequency oscillator, the *sum frequency* is 115kHz (60kHz + 55kHz = 115kHz), and the *difference frequency* is 5kHz (60kHz−55kHz=5kHz). The sum frequency is of no interest as it is at an even higher frequency that the input signal, but the difference frequency provides the desired effect with the input signal being brought down to an audio frequency output.

In effect, the heterodyning technique reduces all the input frequencies by an amount which is equal to the frequency of the signal with which they are mixed. By using a suitable oscillator frequency it is therefore possible to bring a signal at any frequency down into the audio range.

The relative strengths of the input frequency components is reflected in the relative strengths of the output components that they generate. The output signal consequently reflects the nature of the input signal. A single input tone will give a single output tone—a noise input signal will produce a noise signal from the output.

FREQUENCY RANGE

This system does have its limitations, and one of these is that a single oscillator frequency will not provide coverage of the full ultrasonic range. This is simply because

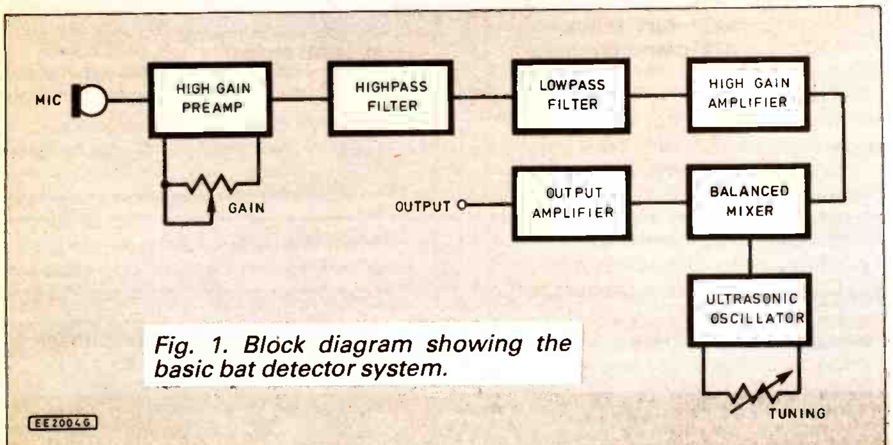


Fig. 1. Block diagram showing the basic bat detector system.

the ultrasonic range covers a much wider span of frequencies than the audio frequency range. With this method you can only cover 20kHz chunks of the ultrasonic spectrum.

Another problem is that signals at frequencies below the oscillator frequency can also produce an output at audio frequencies. In our previous example a signal at 60kHz was reduced to 5kHz using an oscillator frequency of 55kHz. An input signal at 50kHz would also give a 5kHz audio output signal (55kHz − 50kHz = 5kHz).

Having the oscillator above the signal frequencies inverts the audio output signal. The lower the input frequency, the higher the output frequency.

In practice these problems do not seriously detract from the effectiveness of the unit. For best results the oscillator should be set at something approaching the lowest frequency that gives a good audio output signal. The audio output signal should then give a good idea of the type of input signal that is being received.

BASIC SETUP

The block diagram of Fig. 1 shows the basic setup used in the Bat Detector. A microphone detects the ultrasonic soundwaves and converts them into corresponding electrical signals.

There is a slight problem here in that ordinary microphones are only designed to operate efficiently over the audio frequency range. Most have responses that fall away rapidly above 20kHz, and some do not even operate well to the upper limit of the audio range.

We opted for a 40kHz ultrasonic transducer of the type used in remote control units, burglar alarms, etc. Although these have peak efficiency at a frequency of about 40kHz, they seem to work reasonably well from the upper part of the audio range to a frequency of around 80kHz.

Their frequency response is far from flat, but they provide reasonable sensitivity and quite good results overall. Of course, if you can find an ordinary miocrophone that works well at frequencies well into the ultrasonic range, then it should work perfectly well with this unit.

Whatever type of microphone is used, its output is unlikely to be anything other than very weak. A high gain preamplifier stage is therefore used to boost the input signal.

A gain control permits the gain of the unit to be backed off if a strong input signal causes overloading. This is followed by highpass and lowpass filters.

HIGHPASS FILTER

The highpass filter is important as it severely attenuates any audio frequency output signals from the microphone. This helps to keep any audio frequency breakthrough to the output down to an insignificant level. When using a fairly low oscillator frequency it also avoids having audio frequency input signals reacting with the oscillator to produce further audio frequency signals at the ouptut.

The lowpass filtering might seem to be unnecessary, since the response of the microphone is unlikely to provide any significant output at frequencies beyond about 80kHz. It is not signals from the microphone that are likely to be troublesome, a more likely cause of difficulties is stray pick-up of radio frequency (r.f.) signals.

These r.f. signals could cause breakthrough in demodulated form at the output of the unit, or they could react with harmonics of the oscillator signal to produce heterodyne "whistles" on the output signal. The lowpass filtering eliminates both these possibilities.

Even after being boosted by the preamplifier the signal is still quite weak, and a further high gain amplifier stage is used to raise it to a more useful level. The signal is then applied to one input of a balanced mixer. The other input is fed from a variable frequency oscillator.

A dual balanced mixer is used, and both input signals are suppressed at its output. This avoids the need for any complex filtering at the output of the mixer, and a simple passive lowpass filter is all that is needed in order to prevent high frequencies on the output (the sum signal) signal from producing any problems. An output amplifier provides a certain amount of additional voltage gain, but its main purpose is to provide buffering so that a crystal earphone or medium impedance headphones can be driven from the output of the unit.

COMPONENTS

Resistors

R1, R13	1M (2 off)
R2, R8, R12, R14	2k2 (4 off)
R3, R26	390 (2 off)
R4, R15, R16, R22, R23	4k7 (5 off)
R5	2k7
R6, R7	68k (2 off)
R9, R10, R11	1k (3 off)
R17	18k
R18, R24	10k (2 off)
R19, R25	100k (2 off)
R20	5k6
R21	270

All 0.25 watt 5% carbon

Potentiometers

VR1	4k7 rotary, log
VR2	47k rotary, lin.

Capacitors

C1, C19, C20, C21	100µ radial elec. 10V (4 off)
C2, C3, C10 C12, C13	10n polyester (5 off)
C4, C5, C5, C11	1n polyester (4 off)
C7	3n3 polyester
C8, C16	4n7 polyester (2 off)
C9	330p ceramic plate
C14	2µ2 radial elec. 63V
C15	10µ radial elec. 25V
C17	2n2 polyester d25V
C18	4µ7 radial elec. 63V

Semiconductors

TR1, TR2, TR3, TR4	BC549 *npn* silicon (4 off)
IC1	LF353 dual op. amp
IC2	SL1640C double balanced mixer
IC3	µA741C op. amp

Shop Talk
See page 398

Miscellaneous

MIC1	40kHz ultrasonic transducer (see text)
S1	s.p.s.t miniature toggle
B1	9V (e.g. 6×HP7 size cells in holder)
JK1	3.5mm jack socket

Printed circuit board, available from *EE PCB Service,* code EE647; case, about 125×190mm×45mm; 8 pin d.i.l. i.c. holder (3 off); battery connector; control knob (2 off); connecting wire; pins; solder, etc.

Approx. cost Guidance only **£30** excl. batteries.

CIRCUIT DESCRIPTION

The full circuit diagram for the Bat Detector appears in Fig.2.

The output from Mic.1 is fed to the input of a high gain common emitter amplifier based on transistor TR1. This has its output fed to potentiometer VR1 which is connected as a volume control style variable attenuator.

The output of the amplifier is fed, via the wiper of VR1, to the input of the highpass filter which is a three stage (18dB per octave) active type which has transistor TR2 as the buffer amplifier. The cutoff frequency of this stage is approximately 30kHz.

Transistor TR3 is used as the basis of the lowpass filter, which is again a three stage type. This has a cutoff frequency at about 100kHz. The second high gain amplifier stage is another common emitter amplifier (TR4).

The dual balanced mixer, IC2, is a device which is primarily intended for use as an s.s.b. (single side-band) modulator/demodulator and other communications applications. However, it works equally well in its current role, where the only real difference is that it is operating with relatively low input frequencies.

The SL1640C used in the IC2 position is not a particularly cheap device, but it provides a high level of performance. It also has the advantage of achieving accurate balancing without the need for any setting up. It requires a six volt supply, and this is derived from the main 9V supply via dropper resistor R21 and decoupling capacitor C15.

The local oscillator signal is generated by a standard operational amplifier square/triangular oscillator circuit. IC1a functions as the Miller integrator while IC1b provides the trigger function. In this case it is the triangular waveform (with its relatively low harmonic content) that is required.

The frequency response limitations of IC1 seem to round the waveform slightly, which gives an even lower harmonic content. There is still a significant harmonic content on the output signal, but is not large enough to prevent the unit from working properly.

Using a high quality sinewave generator as the local oscillator seems to give no noticeable improvement in performance. Potentiometer VR2 is the frequency control, and this gives a frequency coverage from just over 20kHz to a little under 100kHz.

The audio output of IC2 is processed by a two stage passive lowpass filter (R22—C16—R23—C17) which attenuates any high frequency components on the output signal (which will primarily be the sum signal). IC3 is a simple inverting mode amplifier, and this provides a voltage gain of about 20dB (ten times). It also provides a certain amount of current gain so that medium impedance headphones can be driven from the output.

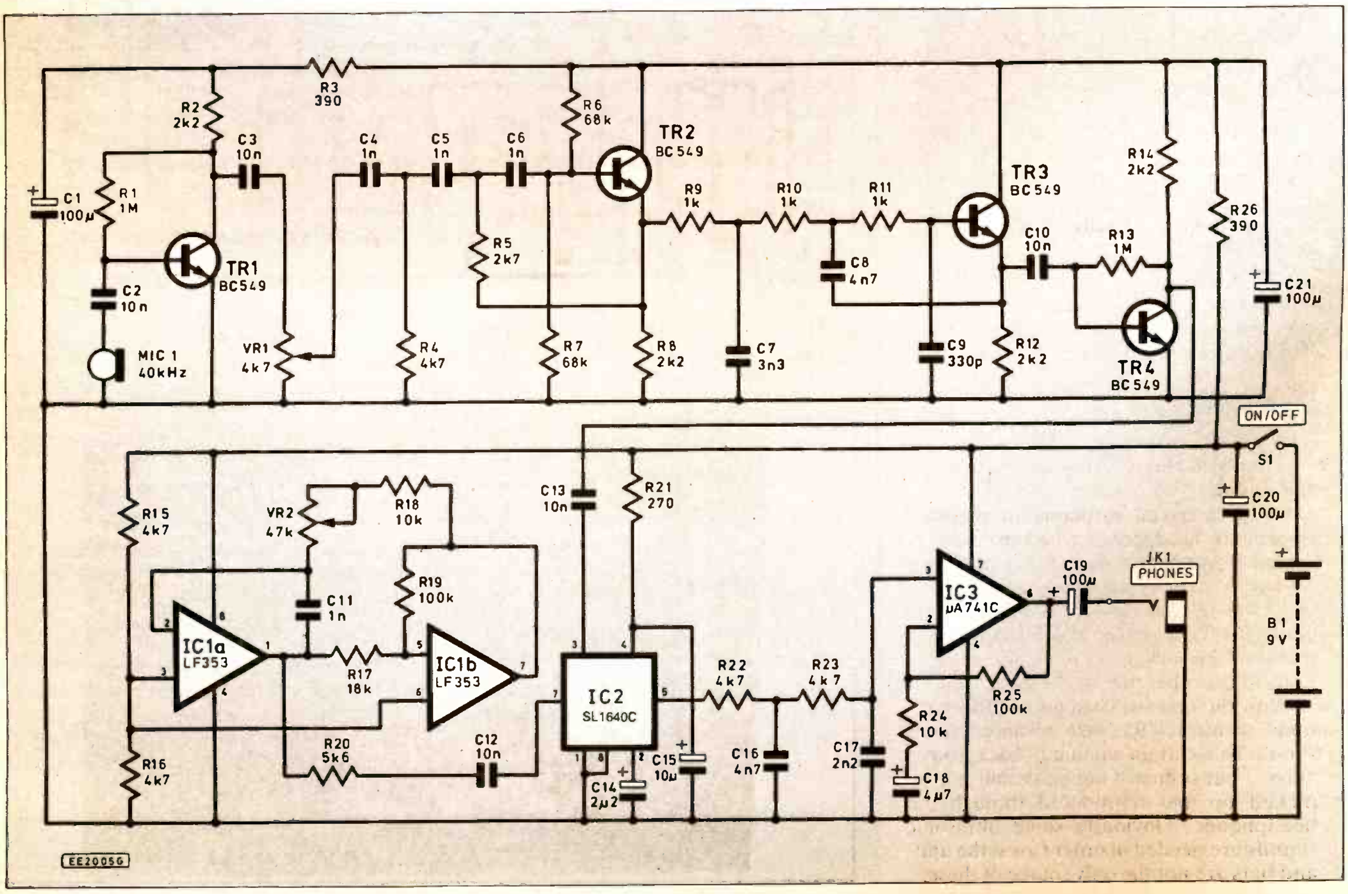
Power is obtained from a 9V battery, and the current consumption is about 10 milliamps or so. For economic operation a fairly high capacity battery is required, such as six HP7 size cells in a plastic battery holder.

CONSTRUCTION

The component layout and full size copper foil master pattern for the Bat Detector is shown in Fig.3. This board is available from the *EE PCB Service*, code EE647 (see page 000).

None of the semiconductors are static sensitive devices, but the SL1640C used for

Fig. 2. Complete circuit diagram for the Bat Detector. The battery B1 is made up from six HP7 type cells.



IC2 is sufficiently expensive to warrant a socket anyway. In fact it is recommended that i.c. sockets be used for all three integrated circuits.

Do not overlook the single link wire between transistor TR4 and resistor R25. This can be made from 22 s.w.g. tinned copper wire, or a piece of wire trimmed from a resistor leadout should suffice.

Construction of the board is not particularly difficult, but it does demand that the proper miniature components are used. In particular, the electrolytic capacitors must be radial (vertical mounting) components, and the polyester capacitors must be printed circuit mounting types having a lead spacing of 7.5 millimetres. Other types could be very difficult to fit into the layout. At this stage only single-sided pins are fitted to the board at the positions where connections to off-board components will eventually be made.

CASE

There are a number of plastic boxes that are suitable as the housing for this project. The prototype model used a low-profile case having removable front and rear panels. The headphone socket and controls being mounted on the front panel, with the microphone fitted on the rear panel.

A 3.5 millimetre jack socket was used for JK1, but this can be changed for any type of socket that will match the plug on the particular earpiece or headphones you will be using with the unit. For medium impedance headphones a 3.5 millimetre stereo jack socket will usually be needed.

Mounting ultrasonic transducers can be difficult as there is not usually any built-in mounting of any description. It is usually a matter of drilling two small holes to accommodate their terminals, and then gluing them in position on the front surface of the panel. A good quality gap-filling adhesive is required, and an epoxy resin type is ideal.

The printed circuit board is mounted on the base panel of the case using 6BA mounting bolts and spacers, or plastic stand-offs. Mount it well towards the front of the case so that there is sufficient space for the battery at the rear of the unit.

The board is wired to the off-board components using multi-strand p.v.c. insulated connecting wire. Details of this wiring is shown in Fig.3.

With many ultrasonic transducers one terminal connects to the component's case, and with a component of this type it is this terminal that should connect to the negative supply rail. Connection to the battery holder is via an ordinary PP3 style battery clip.

IN USE

Either a crystal earphone or medium impedance headphones (the type sold as replacements for personal stereo units) can be driven from the output of the Bat Detector. If headphones are used they should be connected in series (ignore the chassis terminal of the socket and make the connections to the other two tags).

With the unit switched on and the "volume" control VR1 well advanced there should be a certain amount of background "hiss", but ordinary noises should not be picked up and reproduced through the headphones. Obviously some ultrasonic sounds are needed in order to test the unit, and bats are not the only source of these.

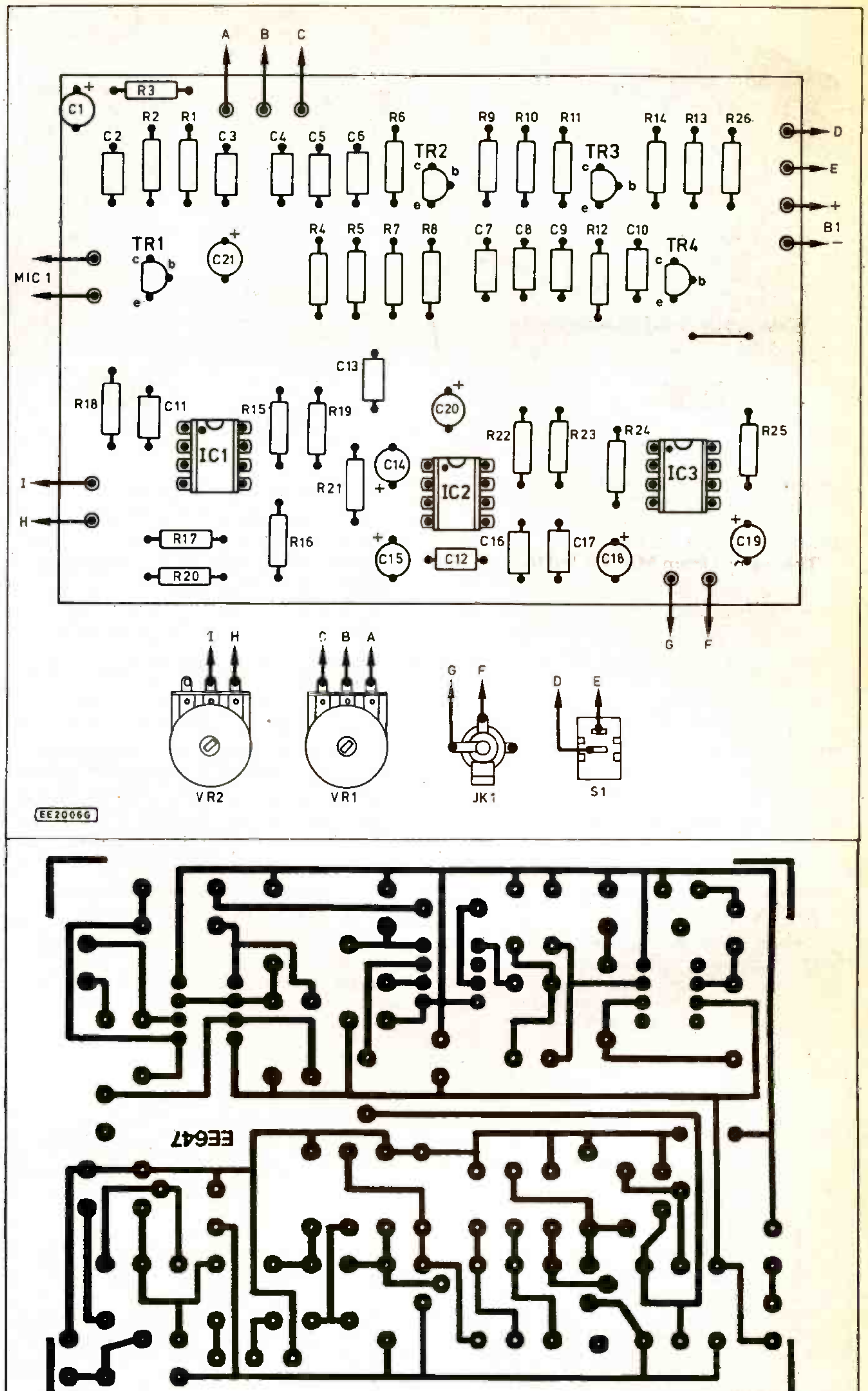
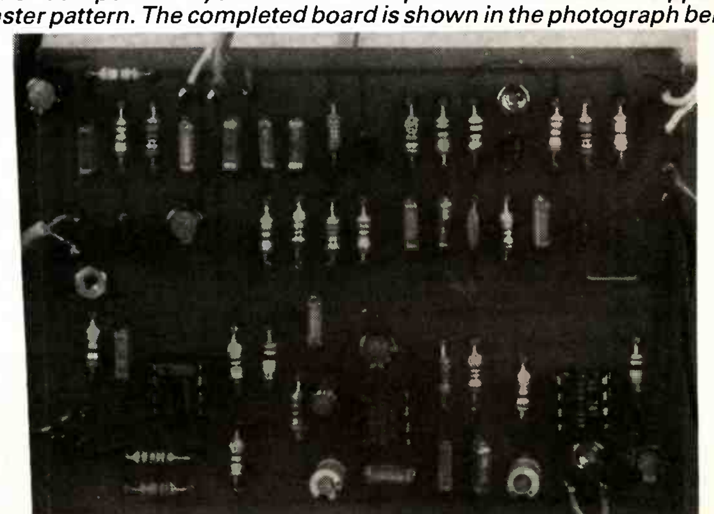
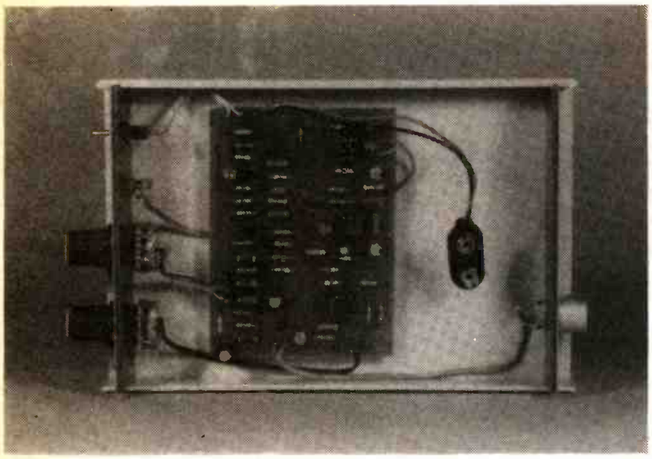
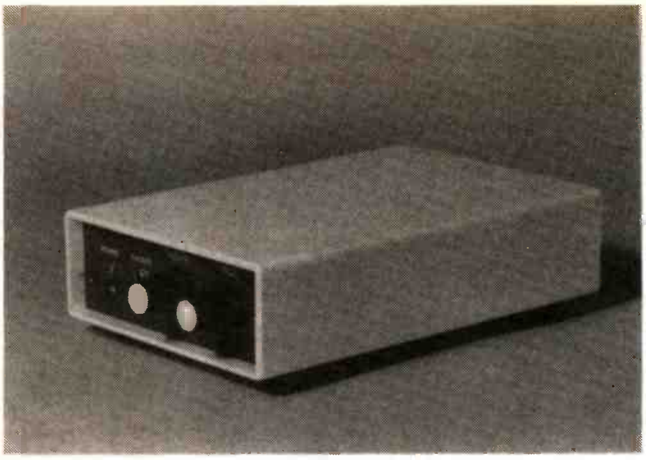


Fig. 3. Component layout and full size printed circuit board copper foil master pattern. The completed board is shown in the photograph below.





Completed unit showing wiring to ultrasonic "sensor" (Mic 1). Leave plenty of room for the batteries.



Layout of front panel controls.

An ultrasonic remote control transmitter will provide a test signal, but there are much more simple methods that will suffice. Simply rubbing your fingers together about 300 millimetres in front of the transducer should produce a noise sound from the headphones.

Adjustment of the "frequency" control VR2 should have some effect on the pitch of this noise. Dropping a pin, small needle, or very short pieces of wire onto a table-top should also produce a signal that can be readily detected by the unit.

With suitable adjustment of VR2 the sound from the headphones may well sound very similar to the audio frequency sound of the pin (or whatever) dropping. A little experimentation should soon find some other sources of ultrasonic sound.

When using the detector bear in mind that ultrasonic sound waves tend to highly directional. The unit will probably be insensitive to sounds unless the transducer is aimed at the source reasonably accurately.

Also bear in mind that the unit covers less than the full ultrasonic range at any one setting of VR2. Some adjustment of this control may be needed before an ultrasonic sound will give an audible output from the unit.

Avoid using the unit very near television sets, computer monitors, or other apparatus that generates electrical signals in the ultrasonic range. If the unit is used very close to equipment of this type it is almost inevitable that it will pick up a certain amount of interference from them. □

BAT WATCH

Under the Wildlife and Countryside Act 1981 *it is illegal for anyone without a licence to intentionally kill, injure or handle a bat of any species in Great Britain; to possess a bat, whether alive or dead (unless obtained legally); or to disturb a bat when roosting.*

Ringing or marking bats or photographing them (except when in flight outdoors) requires a licence from the Nature Conservancy Council. It is also an offence to sell or offer for sale any bat, whether alive or dead, without a licence.

The law does allow you to tend a disabled bat in order to release it when it has recovered, or to kill a seriously disabled bat which has no reasonable chance of recovery.

Habits

Only very basic information is available about bats and until recently their study had been confined to a handful of sites where local interest had stimulated further investigations.

But why do we want to know about bats? For a start, there is much in common between bats and humans. Both are warm-blooded mammals with a high parental care for their "children" and also like living together with others of their own species.

Bats are relatively intelligent, with good eyesight and hearing, preferring clean dry places in which to roost—particularly houses. In most cases, it is their liking for houses that brings them into contact with humans and can cause conflict, even though they are completely harmless.

Bats change their roost sites seasonally and are inquisitive creatures, constantly investigating potential roosts. It is not understood why they choose a particular site, but temperature seems to play an important part. Their summer roosts would have been mainly hollow trees, but these are now a very rare feature of the countryside.

As social creatures they tend to gather in groups, the size of which varies—about 30 to 40 Horseshoe Bats to a roof but up to hundreds if it's the common Pipistrelle species. Whatever their numbers they do no damage, they will not gnaw the rafters nor do they build nests like birds.

Senses

Bats are not blind but have good eyesight which is used mostly for navigation. Their most highly developed sense is that of hearing. They use a form of sonar for obstacle avoidance and for locating food. High-frequency sounds are emitted which enable bats to "see" or discriminate fine detail even in complete darkness, but their range is limited to a few metres. This is why bats have a twisting turning flight as they only notice insects or obstacles when close to them.

Unlike most other mammals, bats do not have a steady body temperature. In flight, their body temperature of 42°C and pulse rate of 1000 per minute are much higher than man's 37°C and 75 per minute. After landing, their temperature rapidly falls 10 degrees for digestion and later falls to the surrounding temperature, helping to conserve energy.

Feeding

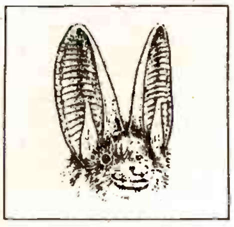
British bats all feed on insects caught in flight or picked off water, the ground or foliage. During summer, they consume vast numbers, many of which are crop pests. One pipistrelle may eat up to 3,500 insects each night.

Because few insects are available in winter, bats put on about one third extra weight during autumn and then hibernate from October to April. Body temperatures approximate their surroundings, which may be down to zero.

In very cold weather, they may be seen moving to alternative hiberation sites with a more suitable temperature. Bats should never be disturbed during hibernation as if this happens they use up vital energy reserves and may die.

Pipistrelle ►
40-50kHz
Location:
Throughout
Gt Britain & Ireland

Habitat:
Buildings—Trees



◄ Brown Long-eared
35-60kHz
Location:
Throughout
Gt. Britain & Ireland

Habitat:
Buildings—Trees

Serotine ►
20-60kHz
Location:
S. Britain

Habitat:
Buildings

◄ Greater/Lesser Horseshoe
80-110kHz
Location:
S/W England, Wales, North to Yorkshire

Habitat:
Buildings—Caves

FOR FURTHER INFORMATION CONTACT:

Nature Conservancy Council,
Northminster House, Peterborough, PE1 1UA.
Tel: 0733 40345

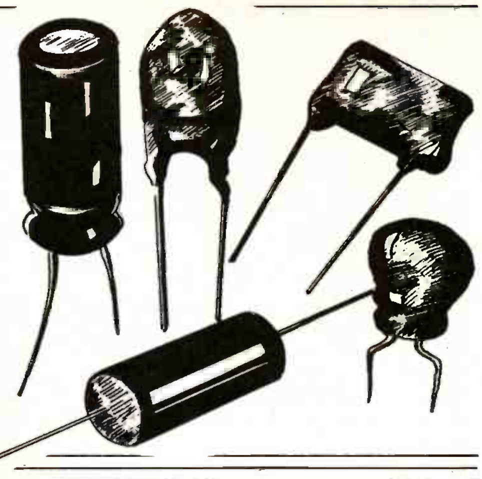
or your local bat group

Fauna and Flora Preservation Society,
c/o Zoological Society of London, Regent's Park,
London NW1 4RY. Tel: 01-387-9670

Mammal Society, Baltic Exchange Buildings,
21 Bury Street, London EC3A 5AU.
Tel: 01-283-1266

Constructional Project

CAPACITOR TESTER



T. R. de VAUX-BALBIRNIE

Check-out those spare capacitors with this low-cost instrument

CAPICTORS are very common components and appear in most electronic circuits. The value is usually marked on the body with either a type of colour code or expressed in alphanumeric form, for example, 223K—the value of this capacitor will be explained at the end of the article. The markings are not always clear, however, and to make matters worse different manufacturers appear to use their own variations in expressing the value.

Since a multitester cannot be used to check capacitors, there is a need for an amateur instrument which can perform this function. Such meters that are available are expensive—typically around £40. The Capacitor Tester described here is less accurate than these but is more than adequate for amateur electronics work and may be constructed for a fraction of the cost.

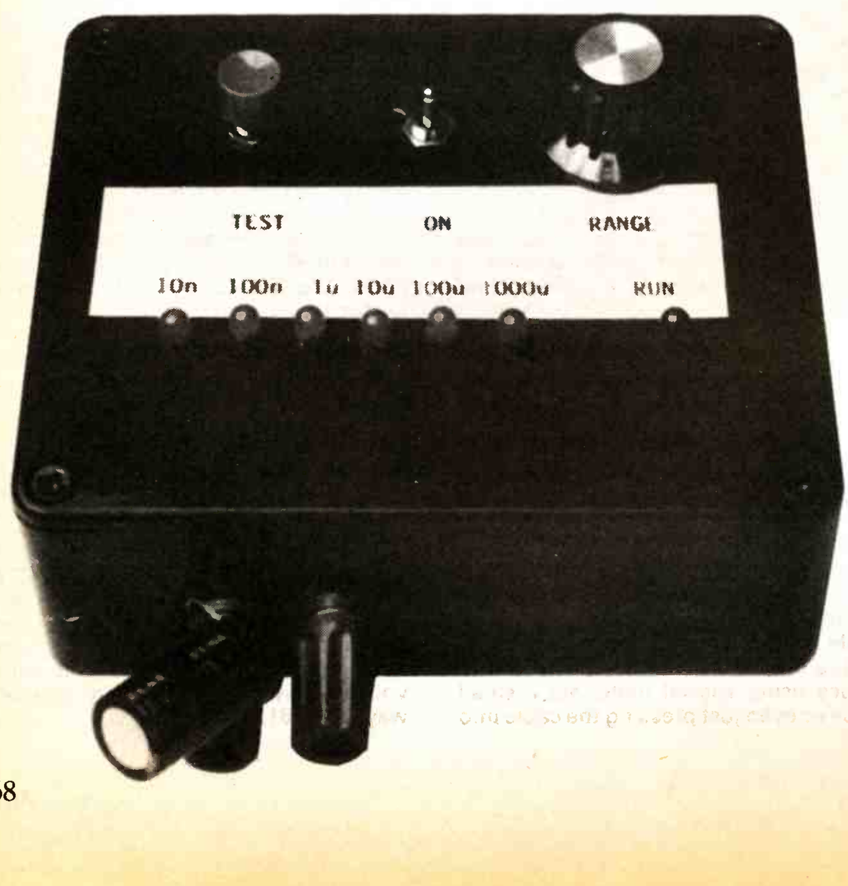
The device operates from a small internal battery and, in occasional use, the life of this will be very long. The standby current requirement is 15mA approximately.

OPERATION

In use, the capacitor under test is connected to a pair of terminals (TB1 and TB2) on the side of the instrument. The unit is switched on and the range selected by means of a rotary switch. One of a row of green l.e.d.'s lights to indicate the chosen range.

A "push-to-test" button is now operated and a red l.e.d. flashes at the rate of about three per second then goes off. This flash rate may be adjusted, within limits, to suit the user.

The number of flashes gives the value of the capacitor taking account of the range.



Thus, with the range switch set to "10n", five flashes will indicate a value of 50nF. The ranges provided by the prototype unit are: 10nF; 100nF; 1μF; 10μF; 100μF; and 1000μF. When the value of a capacitor is completely unknown, the range is quickly found by trial and error.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Capacitor Tester is shown in Fig. 1. IC1 is a CMOS operational amplifier and, as such, has an exceptionally high input resistance—one million megohms approximately. The importance of this point will be explained later. The capacitor under test (C1) is connected to the input terminals TB1 and TB2. The purpose of capacitor C2 will also be explained later.

Assume that switch S2 (TEST) is in its relaxed (unpressed) state and that switch S3 (ON-OFF) is on. If capacitor C1 is charged for any reason, for example from a previous test, it will rapidly discharge through the normally-closed (n.c.) contacts of switch S2 and series resistor, R8. Resistor R8 is included to prevent large discharge currents which could damage S2 contacts especially where large-value capacitors were involved.

If switch S2 is now pressed (test position) capacitor C1 charges from the supply through one of the range resistors R2 to R7, as determined by the setting of rotary switch S1b (RANGE), and S2 normally-open (n.o.) contacts. The voltage across capacitor C1 therefore rises from zero towards the battery voltage. IC1 *inverting* input pin two, receives this voltage. Meanwhile, IC1 *non-inverting* input, pin three, receives a fixed voltage whose value is determined by the setting of preset potentiometer VR1 connected across the supply. While the voltage applied to the inverting input remains lower than applied to the non-inverting one, the op-amp will be on with its output, pin six, high (positive supply voltage). This will be the case when S2 is first pressed.

ASTABLE

As the voltage across capacitor C1, hence at IC1 pin two rises, a time will come when the voltage at the non-inverting input is exceeded and IC1 switches off with pin six going low (negative supply voltage). The high or low voltage state of IC1 pin six is applied direct to IC2 reset input, pin four. IC2 and associated components are connected as an astable multivibrator and,

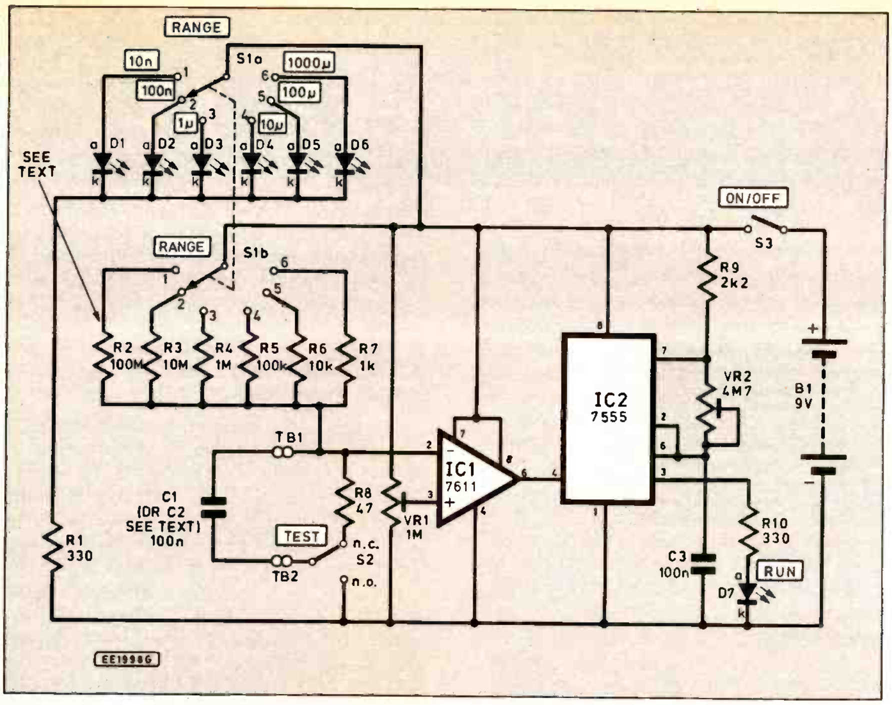


Fig. 1. Circuit diagram of the Capacitance Tester.

while pin four is high this delivers square-wave pulses at its output (pin 3).

The rate at which pulses are produced is determined by R9, VR2 and C3. With the values specified this will be approximately three per second and adjustable within limits using preset VR2. Thus the l.e.d. connected to IC2 output, pin three, via current-limiting resistor, R10, will flash at this rate. When pin four is low, IC2 is inhibited and produces no pulses.

At the start of the test, l.e.d. D7 will flash but after a time dependent on the values of C1, R2 to R7 and VR1 the flashes will stop. With presets VR1 and VR2 correctly adjusted at the end of construction and with the values of R2 to R7 being accurately known (since they are close-tolerance components) the number of flashes is determined by C1 alone.

The capacitor C2 is a close-tolerance type which provides an accurately known reference value. This is connected to the terminals to enable accurate setting of potentiometer VR1 at the end of construction.

With switch S2 in its relaxed state, IC1 pin two is kept high through R2—R7 so the op.-amp will be off. This inhibits IC2 and D7 does not flash. The instant S2 is pressed, IC1 pin two goes low and flashes are delivered in the manner already described.

RANGE INDICATION

Switch S1 is a two-pole six-position rotary switch. S1b selects the range resistor as mentioned earlier. S1a operates one of six green l.e.d's, D1 to D6 confirming the selected range—these could be omitted and the range marked around S1 control knob if desired. However, in such a case it would be wise to use an l.e.d. indicator to remind the user that the unit was switched on.

For the small cost involved, the green l.e.d.'s seemed worthwhile and were included in the prototype unit. Note that these share a common current-limiting resistor, R1. This is possible since only one l.e.d. is illuminated at a time.

For greatest accuracy, resistors R2 to R7 should be of the close-tolerance (one or two per cent) variety specified in the components list. Note that resistor R2 (100M) has an unusually high value and, as such, may not be readily available. Some high-value components are sold as "high voltage" resistors having a tolerance of five per cent—it would be acceptable to use these.

However, in the prototype unit, resistor R2 was constructed by connecting 10 off 10M resistors in series (see Fig. 3). Accuracy is then limited chiefly by the fact that the value can only be expressed to the nearest flash below the voltage needed for IC2 to switch off. Accuracy is therefore less with small numbers of flashes. On the other hand, it improves with large numbers of pulses but counting them becomes tedious!

Accuracy is maintained even with an ageing battery since IC1 is used in *comparator* mode. The relative voltage levels at pins two and three do not depend on the battery voltage so will always occur at the same time. Eventually, however, the battery will reach such a poor state of charge that it will fail to operate the l.e.d's effectively and it will be obvious when battery replacement is due.

The high input resistance of IC1 is important since, otherwise, appreciable current would flow into the i.c. with less current available to charge the capacitor "under test". This would lead to considerable inaccuracy especially with small value capacitors.

CONSTRUCTION

Construction is based on a main circuit panel made from 0.1in. matrix stripboard size 30 holes ×9 strips. The component layout and underside details are shown in Fig. 2. Cut this to size, drill the two fixing holes and make all track breaks and inter-strip links as indicated.

Solder all on-board components into position but do not insert the i.c's in their holders until the end of construction. Note that C2 (calibration capacitor) is not soldered into the circuit—it is not used until the end of construction.

COMPONENTS

Shop Talk

Resistors see page 398

R1, R10	330 (2 off)
R2, R3	10M (11 off—see text)
R4	1M
R5	100k
R6	10k
R7	1k
R8	47
R9	2k2

All 0.25W or 0.4W ± 1%, except R1, R8 and R10 may be 0.25W ± 5%

Potentiometers

VR1	1M sub-min. vertical preset
VR2	4M7 sub-min. horizontal preset

Capacitors

C2, C3	100nF polyester, 5%

Semiconductors

D1 to D6	5mm green l.e.d's (6 off)
D7	5mm red l.e.d.
IC1	ICL7611 CMOS op-amp.
IC2	ICM7555 CMOS 555 timer

Miscellaneous

S1	2-pole 6-way rotary switch
S2	Push-button switch with single-pole change-over contacts
S3	Miniature s.p.s.t. toggle switch

Stripboard, 0.1in matrix size 30 holes×9 strips; 8-pin d.i.l. sockets (2 off); B1, PP3 battery and connector; TB1, TB2 4mm terminal posts (black and red); plastic box, size 115mm×95mm×43.5mm internal; single strand wire; standed connecting wire; adhesive fixing pad; self-adhesive plastic feet (4 off); solder etc.

Approx. cost
Guidance only **£14**

After a careful check for errors—particularly for accidental "bridging" of adjacent copper tracks, solder 15cm pieces of light-duty stranded connecting wire to strips A, C, D, G, H and I along the left-hand side of the circuit panel. Use of "rainbow" ribbon cable here will keep the wiring neat and prevent errors. Set VR1 and VR2 sliding contacts to approximately mid-track position.

Prepare "resistor" R2 (100m) by connecting 10 off 10M resistors in series (see Fig. 3) unless a single component of this value is available. Solder R2 to R7 to rotary switch S1 contacts as indicated in Fig. 3.

Drill holes in the lid of the case for the switches and l.e.d's. Drill two holes in one of the case sides, for the terminals TB1 and TB2, and in the base for the circuit board. Attach all remaining components and com-

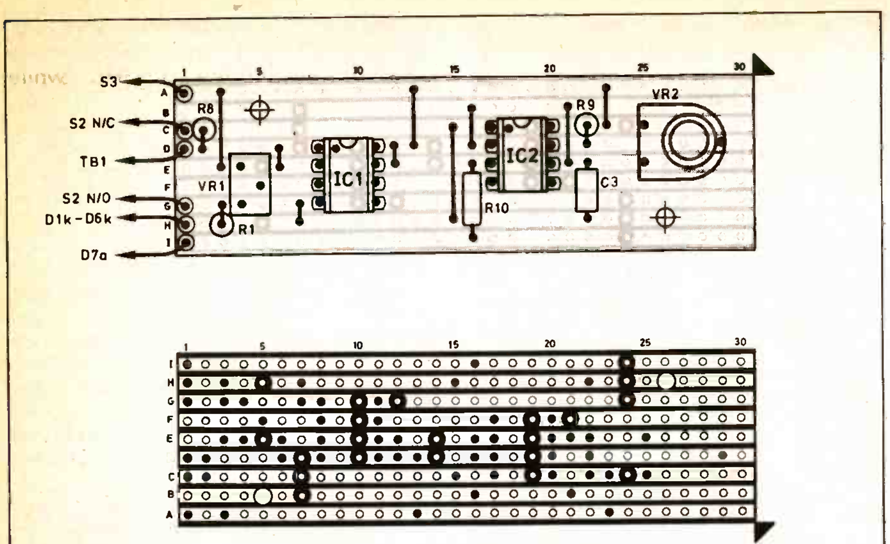
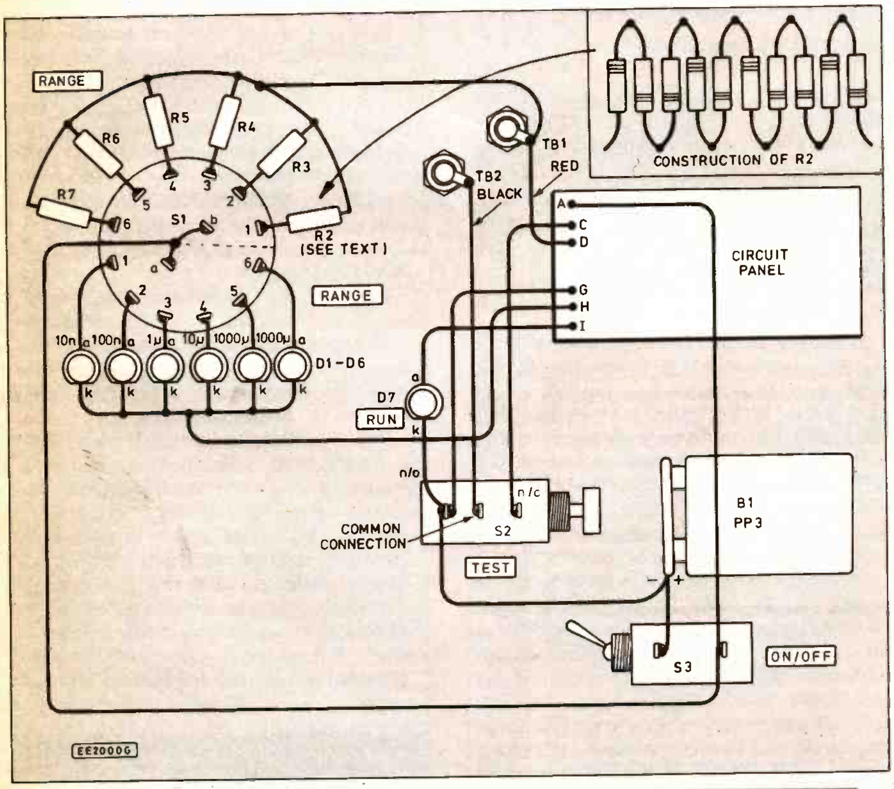
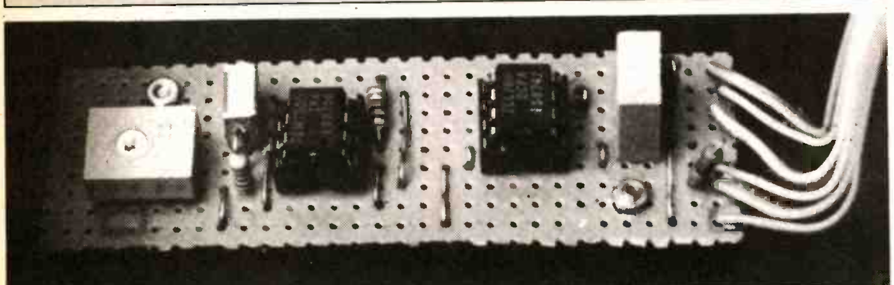


Fig. 2. Veroboard construction.

Fig. 3. Control interwiring.





plete the internal wiring paying attention to the polarities of all l.e.d's. The l.e.d's should be a tight push fit in the holes and secured, if necessary, with a dab of quick-setting epoxy resin adhesive.

Again, it is a good idea to use ribbon cable between switch S1 connections and the green l.e.d's. Note the link wire between S1a and S1b moving contacts and the common (k) connection at D1 to D6.

When wiring the terminals, note that TB1 is coloured RED and connected to strip D on the circuit board. TB2 is BLACK and connected to switch S2 moving contact.

Remove the i.c's from their special protective packing and, without touching the pins, insert them into their sockets with the correct orientation. Care must be taken in handling the i.c's since they are CMOS devices and can be damaged by static charge which may exist on the body.

Attach the circuit board to the base of the box using the holes drilled for the purpose, small fixings and short stand-off insulators. Connect the battery and secure it to the base of the unit using an adhesive fixing pad. Fit a control knob to switch S1 and self-adhesive plastic feet to the base of the case to prevent scratching of the work surface by the protruding bolt heads.

TESTING AND CALIBRATION

For the initial test, bridge the terminals TB1 and TB2 with a short piece of connecting wire. Check operation of the green (RANGE) l.e.d's, D1 to D6, by switching on S3 and rotating switch S1 through all its positions. Each l.e.d. should light in the correct sequence with D7 remaining off.

Press S2 and, keeping it pressed, check that D7 flashes. Adjust preset VR2 to obtain three flashes per second (clockwise adjustment increases the number). It is possible to choose a slightly different rate to suit the user. Note that if any l.e.d. fails to light it is probably because it has been connected the wrong way round.

Now transfer attention to adjustment of the preset VR1. Set the range switch S1 to "10n". Remove the wire bridging the terminals (TB1 and TB2) and connect the "calibration capacitor" C2 in its place. Press S2 and, keeping it pressed, adjust VR1 until exactly 10 flashes are given—clockwise adjustment decreases the number.

The procedure should be repeated until a consistent result is obtained. Note that there may be some slight eccentricity in the last flash—this is of no consequence. The instrument should now give accurate results for any capacitor connected to the "test" terminals.

An occasional calibration check may be made but the prototype unit was found to maintain its accuracy over a long period of time. It would be wise to tape the calibration capacitor inside the case so that it cannot become lost.

It may be necessary to make two short test leads each with a small crocodile clip at one end. These will be used to make connections to very small capacitors and those with rigid end wires.

It now only remains to label the switches and l.e.d's and to put the unit into service. Note that the terminals are polarised—red for positive, black for negative and it is important to observe this when measuring the value of an ***electrolytic*** capacitor. The body of such a capacitor is clearly marked with the polarity—the end connected to the metal body being the negative. Note that its voltage rating should not be *less* than 9V.

CAPACITOR VALUE

The value of the capacitor mentioned at the beginning of the article is 22,000 pF (22nF or 0.022µF) with a tolerance of ±10 per cent. This is arrived at in the following way.

The first two digits give the first two numbers of the value—in this case, 22. The third digit gives the number of zeros to express the value in picofarads. Suffix letter K means that the tolerance of this capacitor is ±10 per cent. □

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Air Entertainment

If you are one of the lucky few who fly first class because your air tickets are paid for by someone else's tax deductions, you will notice some interesting changes. The rest of us must content ourselves with an interest in the technology.

First class passengers on four of British Airways Boeing 747s will spend the next six months helping BA choose between two rival inflight entertainment technologies. Both give passengers the opportunity to choose what films they watch, and when.

One of the systems on trial takes advantage of a failed venture by Kodak. Although this lowers the capital cost, airlines will still need to spend several thousand pounds to equip each seat. In the end passengers will pay for their freedom to choose in higher fares.

Currently airlines show films either on a large projection screen or individual liquid crystal displays (l.e.d.) on the seat backs. Passengers all have to watch the same film and at the same time, chosen by the airline. The two new systems give passengers the chance to choose their own films and watch them whenever they like.

Each seat has its own l.c.d. screen and video tape cassette player built into the arm rest. After take-off, the cabin crew offer passengers a choice of 50 films on video cassette. They then plug in, switch on and watch when they want. The 8mm video format is used instead of VHS because it offers at least two hours playing time from a video cassette no larger than an audio cassette.

Both systems rely on technology from Japan. One, designed by Avicom, a subsidiary of the Lockheed Corporation, uses an 11cm l.c.d. made by NEC and a video player from Sanyo.

The other, called Skyview, is designed by British company Fieldtech and uses a 10cm l.c.d. made by Toshiba. Fieldtech hit on the clever idea of buying its 8mm video players from Kodak. Four years ago Kodak spent heavily on trying to break into the video market, by badging 8mm equipment made under contract by Matsushita of Japan. The venture flopped and Kodak was left with unsold stock, some of which is now used for Skyview. Fieldtech says it will ask Matsushita to start production again if it wins the BA contract. So the price is likely to be higher than for the unsold stock.

Both companies are cagey about price, because they are in competitive tender. But Skyview admits that even with bulk orders it will still need to charge the airlines around £2,500 per seat. So passengers will have to pay dearly for the privilege of making their own choice of film.

Both systems use equipment of Japanese/US NTSC TV format. So any passengers tempted to steal tapes will find they do not play on European PAL TV equipment.

Skyphone

Meanwhile, after three years of tests, passengers on some flights between London and New York can now make a telephone call to their home or office. The service, called Skyphone, is a joint venture between Racal, British Airways and British Telecom.

Racal developed the airborne credit card phones and the aerials which bounce signals off an *Inmarsat* satellite to BT's Goonhilly earth station in Cornwall. BT's research laboratory at Martlesham developed the equipment which converts analogue speech into digital code which streams slow enough for the small airborne aerials to handle.

Despite publicity for commercial launch of the service, British Airways is playing very safe. So far BA has equipped only one Boeing 747 aircraft with four phones in First and Club class cabins. The hardware, worth nearly half a million dollars, is on loan from Racal. BA earns nearly $3 a minute from every call made.

Currently pilots communicate with control centres on the ground by conventional h.f. and v.h.f. radio links which travel direct along line of sight from ground to air. Existing airline phone systems, as used in the US, work in a similar way and have limited range. Speech quality is often very poor.

Technicalities

There is no room on an aircraft for the large dish aerials normally needed to communicate with a low power satellite. Skyphone gets round the problem by using two different sets of frequencies for different legs of the journey and converting speech into low speed digital code.

The plane transmits and receives signals to and from the satellite in the L-band, at around 1.5GHz, while Goonhilly transmits and receives signals to and from the same satellite in the C band at 4GHz and 6GHz. Although C band needs high power and a directional aerial dish many metres wide, L band can be made to work with a small blade aerial on top of the fuselage which is omnidirectional. The trick is to convert the speech into digital code which runs very slowly and thus occupies only a narrow frequency bandwidth with low risk of errors.

Skyphone speech is converted into a data stream running at only 9.6 kilobit/second. By comparision, conventional terrestrial digital telephone systems rely on a data rate of 64 kbit/second.

The Skyphone data stream is compressed by analysing the speech before coding, ignoring gaps when there is no energy content, and re-structuring the speech at the other end of the link. Efficiency is improved by dividing the speech into several separate frequency bands and handling each band separately.

Initially the system will bounce signals only off the *Inmarsat* satellite over the Atlantic Ocean, but later satellites over the Indian and Pacific Oceans will be used to give worldwide coverage.

So far calls must be manually patched into the telephone network by an operator at Goonhilly. International trunk dialling is promised for later this year with fax transmission next year.

BA plans to fit four more phones in a second 747 in March '90. Capital cost, borne by Racal, is around $500,000 per plane. BT and Inmarsat are charging BA a flat rate of $6.70, from anywhere to anywhere. BA hikes this to $9.50 from anywhere to anywhere. The cost to BA, other than fitting, is $4,000 a year in fuel to carry the extra weight and compensate for aerodynamic drag from the aerial.

Passengers who regard a long haul flight as a way of escaping the 'phone will be relieved to hear that the system does not allow incoming calls. Yet!

Revolutionary?

Sir Clive Sinclair has always had a talent for creating publicity. Every product launch is preceded by tantalising information leaks, calculated to stir up interest. As often as not the product does not live up to the interest. The C5 electric "car", for instance, was a joke—a pedal trike with ordinary car battery back-up. But the lap top computer was a far more serious product, despite its odd keyboard. More recently we have been getting leaks about a "revolutionary" new satellite aerial for receiving programmes like Sky from Astra. It was finally unveiled at the third annual cable and satellite show which ran for four days at Olympia in March.

Sir Clive, of course, cannot use his own name—he sold it to Amstrad—so the new Sinclair flat aerial for Astra is called the Cambridge, after Sir Clive's computer company Cambridge Computers. The call it "radically different" as well as "revolutionary".

It turns out to be a big white plastic box that clamps to the wall or roof. Significantly all the models on display were sealed and opaque. What mysteries lie inside? Nothing more than a conventional 60cm dish and front-mounted LNB, all packaged in a flat white plastic box, inevitably larger than a conventional dish.

The only novelty is that the curve of the dish is made to focus incoming signals on a point close to the dish surface, near the bottom edge. So the microwave feed horn and LNB can be mounted low and close—otherwise the box would be enormous. Other than that, it's just packaging.

According to Sir Clive Sinclair it is "much more elegant" and weather-proof. Some will argue that it is simply more obtrusive than a bare dish, and question whether there is any real weather-proofing problem on existing dishes anyway. "Museum piece —master piece" is the Sinclair slogan which adorns a picture of conventional and covered dish.

There is talk of a smaller, flatter version. Just as there was talk of a more efficient C5!

Introducing DIGITAL ELECTRONICS

Part 9 Transformers, Induction and Inductance

By Michael J. Cockcroft
Training Manager, Peterborough ITeC

We focus, this month, on the single objective in section 4.4 of the City and Guilds log book:
4.4 Transformers
4.4.1 State, in very simple terms, the action of a transformer.

Transformers

A variety of transformers are shown in Fig. 9.1. A transformer is a device for converting a.c. voltage (from the mains, for example) into a higher or lower value. The mains transformer inside a bench power supply, for example, steps down the 240V mains to five or six volts for supplying low voltage electronic circuits. A transformer, like this, which reduces the amount of voltage in a circuit is called a step-down transformer. One that is used to increase the voltage in a circuit is called a step-up transformer; an example of which is the high voltage transformer that produces several thousand volts for driving the tube inside a television set.

Transformers work on the principle of induction and so, before explaining transformer action, we need to expand on our previous treatment, in Part 6, of the principles of magnetism and electromagnetic induction.

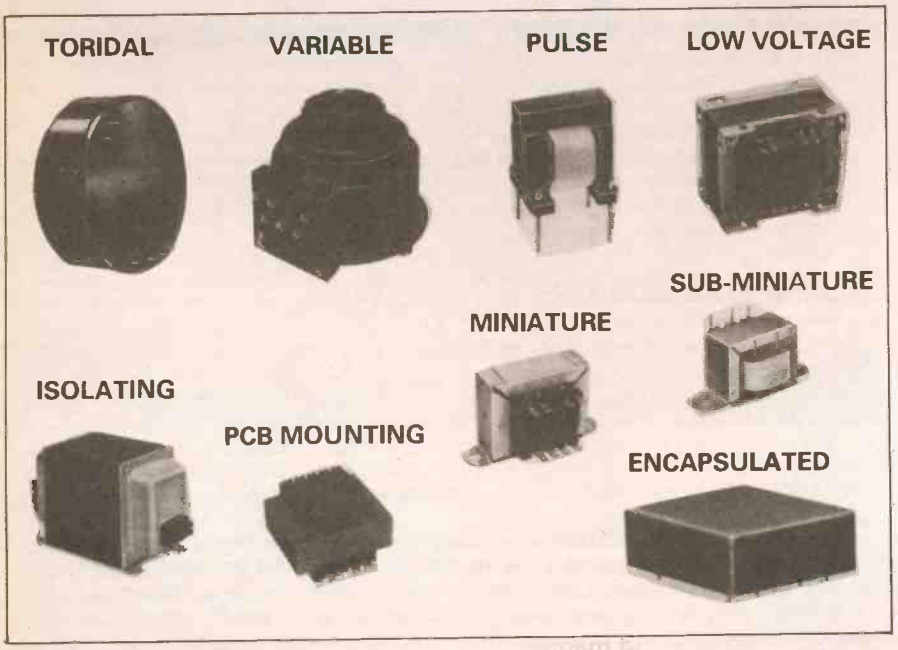


Fig. 9.1. Various transformers.

Magnetism

In ancient times the Greeks discovered that certain specimens of stone found in the ground (called natural magnets or lodestones) attracted small particles of iron ore. The Chinese, in later years, learned that the same stone when freely suspended always came to rest pointing in a North-South direction.

The end of the magnet that, when freely suspended (as shown in Fig. 9.2), points to the earth's north magnetic pole is termed the "north-seeking pole" or the "north pole" of the magnet; the opposite end is the "south-seeking pole" or the "south pole" of the magnet.

Natural magnets (lodestones) are magneticlly weak but their properties can be imparted artificially to iron and steel to produce much stronger permanent magnets and electromagnets. You will recall from Part 6 that permanent magnets retain their magnetic properties for a long period of time under normal conditions, and electromagnets lose their magnetic properties once the magnetising influence (the current) is removed.

The magnetic field

If, as shown in Fig. 9.3, the north pole of one suspended magnet is

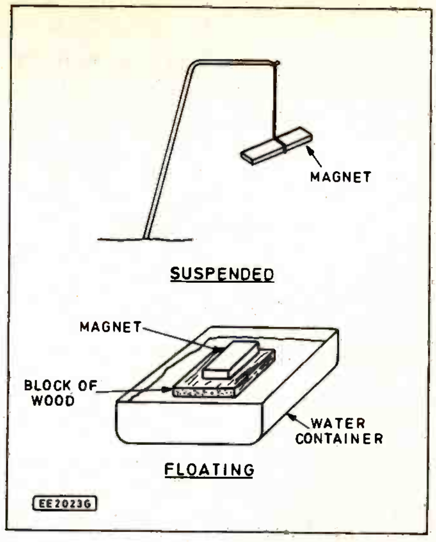


Fig. 9.2. A suspended magnet seeks the earth's magnetic poles.

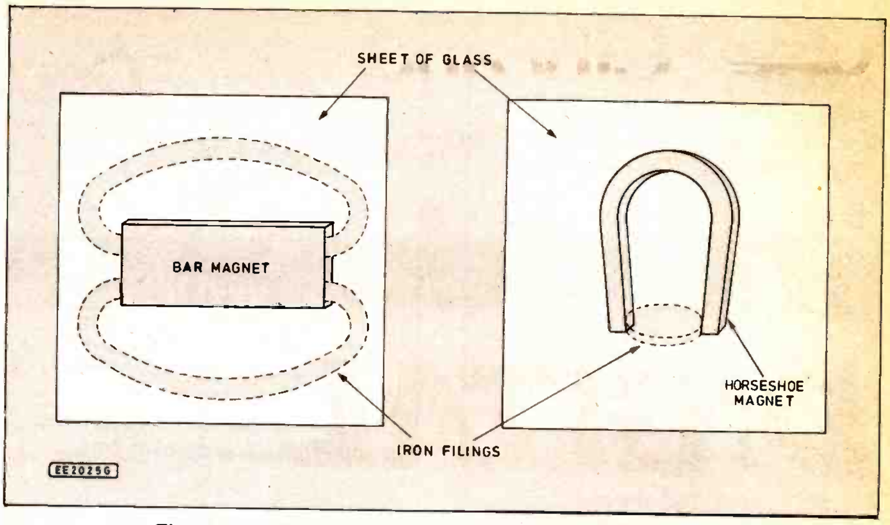


Fig. 9.5. Using iron filings to "see" the lines of force.

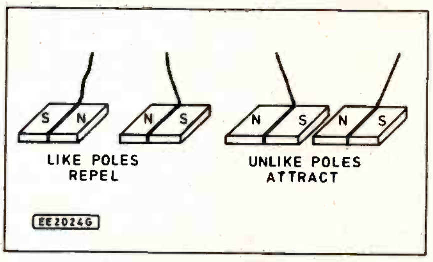


Fig. 9.3. Like poles repel, unlike poles attract.

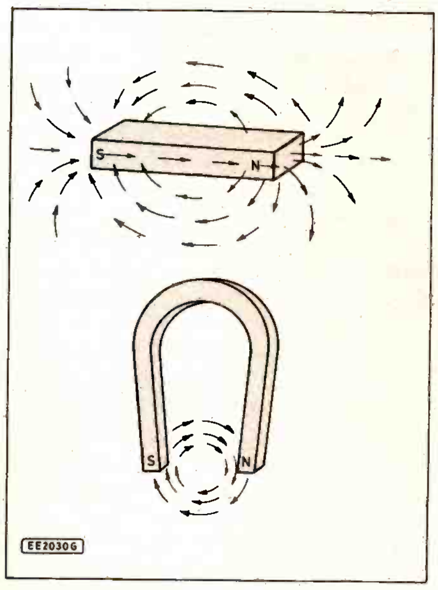


Fig. 9.4. Lines of magnetic field.

brought near the north pole of another suspended magnet, the two poles repel each other; if, on the other hand, the opposite poles of two suspended magnets are brought near to each other, the two poles are attracted:

Like poles repel and unlike poles attract.

The induced energy in the space around a magnet is called the magnetic field. Magnetic fields are shown in diagrams as lines of force running parallel to each other out of one pole, through the magnet, and into the other pole; Fig. 9.4 illustrates this idea using a bar magnet and a horseshoe magnet as examples.

These lines are invisible but they can easily be detected. Magnetic lines of force can be seen by performing a simple experiment using a permanent magnet, a sheet of glass or acrylic (Perspex), and some iron filings. Lay the transparent sheet over the magnet, as shown in Fig. 9.5, and sprinkle a thin layer of iron filings onto its surface. You may need to raise the sheet a little above the magnet (or just tap it a few times) but the iron filings should form a definite pattern displaying the lines of force, as shown in the figure.

The direction of the magnetic field is shown by the arrows in the previous figure (Fig. 9.4). This is the direction that a compass needle would point if placed in the field: from north to south in the space outside the magnet and in the opposite direction (from south to north) inside the magnet.

Magnetic Flux Density

The total number of lines of force per unit area surrounding the magnet determines the strength, or flux density, of the magnet. The practical unit of magnetic flux density is the *tesla* which corresponds to 10^4 lines per square centimeter.

The Magnetic Circuit

The closed loop formed by the lines of flux is referred to as a magnetic circuit. It is interesting to compare electric and magnetic circuits in order to illustrate the similarities. We know from previous work that electromotive force causes current to flow in an electric circuit, and resistance acts to limit the flow of current. In a magnetic circuit the energy that creates the flux lines is **magnetomotive force** and the opposition that some materials offer to lines of magnetic flux is called **reluctance.**

Table 9.1 shows that flux lines in a magnetic circuit is equivalent to current in an electric curcuit, magnetomotive force (m.m.f.) is equivalent to electromotive force (e.m.f.), reluctance is equivalent to resistance, and magnetic materials (e.g. iron and steel) are equivalent to conductors of electricity.

A magnetic circuit is given in Fig. 9.6. The lines of flux are created by an electromagnet (an iron core placed inside a solenoid connected across a voltage source—see Part

TABLE 9.1

How electric and magnetic circuits compare

Electric circuit	Magnetic circuit
e.m.f.	m.m.f.
resistance	reluctance
current	lines of flux
conductors	iron and steel

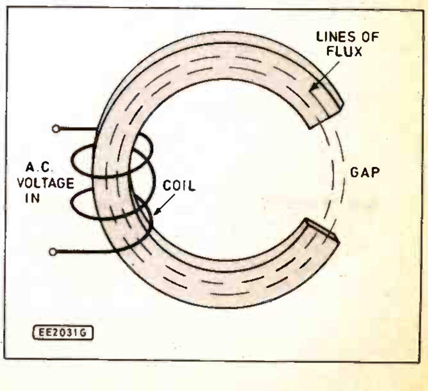


Fig. 9.6. A magnetic circuit.

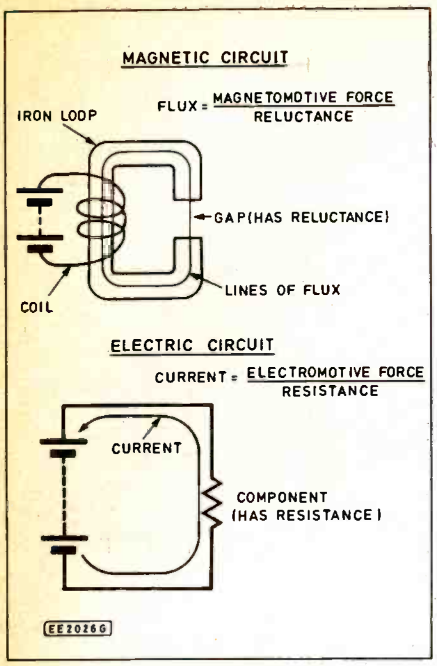


Fig. 9.7. Comparison of a magnetic circuit (a) and an electric circuit (b).

6.) and limited by the reluctance of the air in the gap between the two ends of the iron core. The magnetic circuit is therefore partly in the iron and partly in the air between the two ends of the iron.

A simple magnetic circuit and an expression for evaluating the amount of flux within it is shown in Fig. 9.7a; for comparision, Fig. 9.7b shows an electric circuit with an equivalent Ohm's law expression for evaluating the current.

Electromegnetic Induction

Passing a current through a straight conductor creates a magnetic field around it, as shown in Fig. 9.8. The lines of flux are at right angles to the conductor and spaced uniformly a fixed distance away from each other. The magnetic field can be made stronger by coiling the conductor to form a solenoid so that the lines of flux are physically brought closer together and concentrated (this was illus-

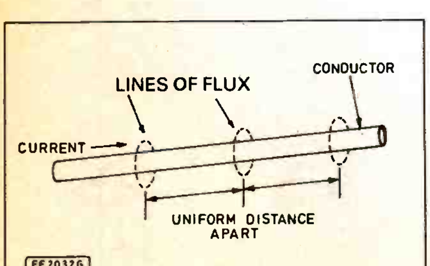


Fig. 9.8. Passing current through a conductor creates a magnetic field around it.

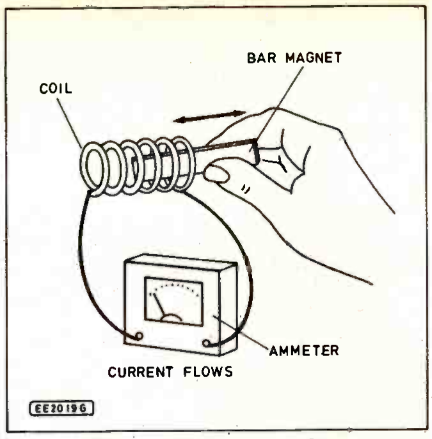


Fig. 9.9. Inducing an e.m.f.

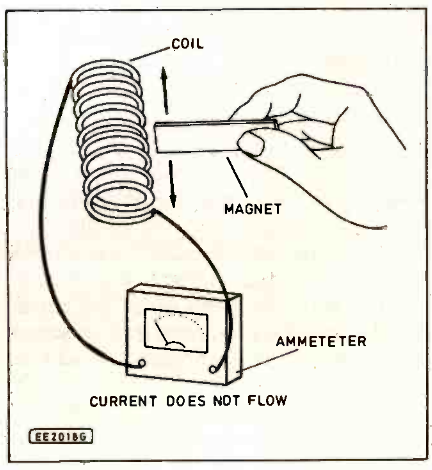


Fig. 9.10. The lines of flux must cut across the conductor to induce an e.m.f.

trated in Fig. 6.17 of the March issue—we will not reiterate here).

When a bar magnet is moved back and forth in a solenoid, as depicted in Fig. 9.9, an e.m.f. is inducted by the magnet; we call this **electromagnetic induction**. Experimentation with electromagnetic induction, during the last century, by an English physicist called Michael Faraday revealed the following points:

(a) An e.m.f. is induced in the conductor only when there is relative motion between the magnet and the coil.

(b) The greater relative motion, the greater is the magnitude of the induced e.m.f.

(c) The stronger the magnetic field around the bar magnet, the greater will be the induced e.m.f. for the same relative motion between the magnet and the coil.

(d) The conductor must cut across (the conductor or the field or both can be in motion) lines from flux before an e.m.f. is induced in the conductor. If the lines of flux are parallel with the turns in the coil, as shown in Fig. 9.10, the conductor is not "cutting across" the flux lines.

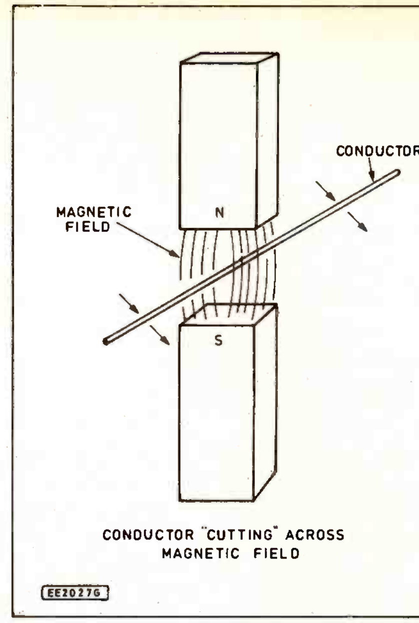


Fig. 9.11. The induced e.m.f. tends to oppose the movement generating it.

So, from the foregoing, we know that if a length of conductor is passed through a magnetic field, as shown in Fig. 9.11, an e.m.f. will be induced in the conductor (notice that the conductor is at right angles to the lines of flux and, therefore, cutting across them). The important point to grasp now about this action is that the lines of flux generated by the induced e.m.f. will tend to oppose the motion producing it; for example, if the conductor is moving from left to right, as in Fig. 9.11, the e.m.f. is directed towards the right in an attempt to move the conductor to the left. Since induced e.m.f. opposes its very cause, induced e.m.f. is often called **back e.m.f.**

Inductance

An e.m.f. is induced in any conductor if the current flowing through it changes in any way and, at the same time, this induced e.m.f. will oppose the change in the value of current. Any circuit with varying (increasing or decreasing) current therefore possesses this property and is called **self-inductance** (symbol L).

Inductors

All conductors have a value of inductance; conductors formed into coils to increase the inductance to specific values are called **inductors**. Inductors are not really off-the-shelf components like most electronic components, they are usually formed by coil winding companies to order. A few common values are available from compo-

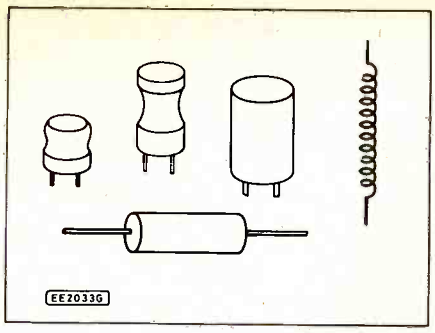


Fig. 9.12. A few types of inductor.

nent suppliers and often look like those in Fig. 9.12. The inductor circuit symbol is also shown in the digram.

The unit of inductance is the henry (symbol H). Typical inductors have values ranging from a few micro-henrys to many henrys. The unductance value of inductors determines the amount of back e.m.f. induced for the change of current with respect to time:

Self-inductance=

$$\frac{\text{back e.m.f.}}{\text{rate of change of current}}$$

An inductor (or circuit) has an inductance of one henry if a current in it, changing at the rate of one ampere per second, induces an e.m.f. of one volt across it.

Inductance of Inductors

A number of factors influence the inductance value of an inductor. The inductance of a coil is determined by:

(a) The number of turns in the coil.
(b) The material around which the coil is formed (the core).
(c) The diameter of the coil.

The inductance of a coil is proportional to the square of the number of turns in the coil: twice the turns gives four times the inductance, three times the turns gives nine times the inductance . . . and so on (see Fig. 9.13). The magnetic permeability (the amount of magnetic flux it produces with a given current) of the core around which the coil is formed affects its inductance; as shown in Fig. 9.13c, different core materials inside the same coil change the inductance value. Finally, as shown in Fig. 9.13b, increasing the diameter of the coil increases the inductance.

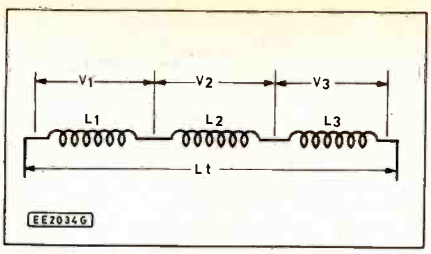


Fig. 9.14. Inductors in series.

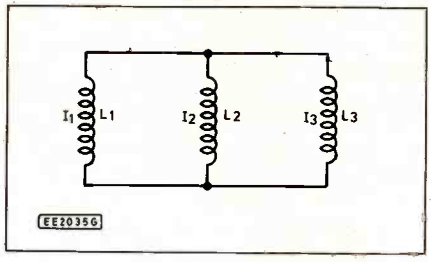


Fig. 9.15. Inductors in parallel.

Inductors in Series

Three series connected inductors are shown in Fig. 9.14; total inductance for inductors connected in series is the sum of the individual self-inductances:

$$L_t = L_1 + L_2 + L_3 \ldots + L_n$$

Inductors in Parallel

Three parallel connected inductors are shown in Fig. 9.15; total inductance for inductors connected in parallel is the reciprocal of the sum of the reciprocals of the individual self-inductances:

$$L_t = \frac{1}{1/L_1 + 1/L_2 + 1/L_3 \ldots + 1/L_n}$$

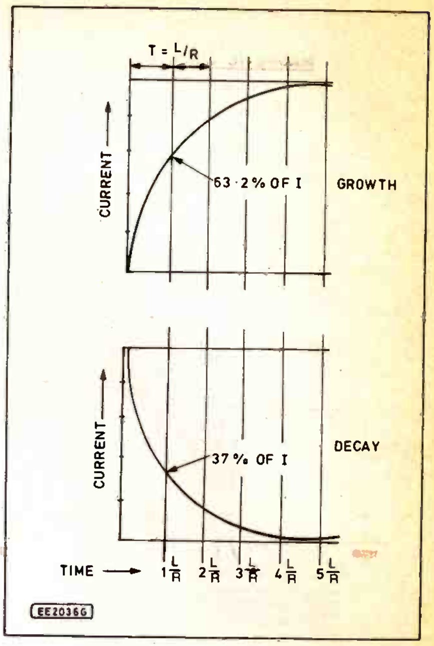


Fig. 9.16. Current change in an inductive circuit.

Inductive Circuits

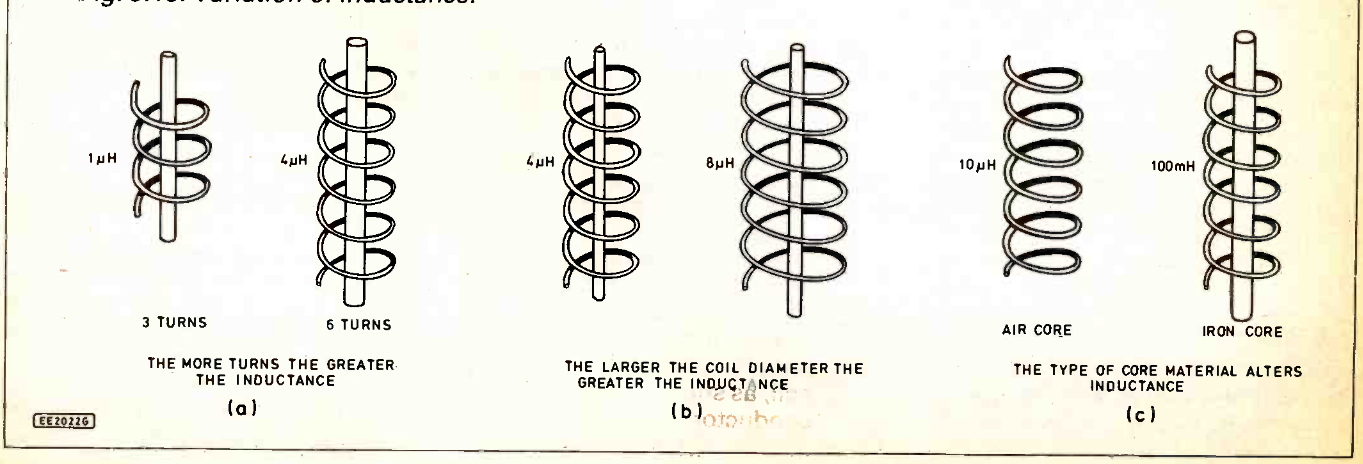
Full treatment of inductive circuits is beyond the scope of this course but we include some interesting points which will allow you to compare the similarities between inductive circuits and capacitive circuits.

The time taken for current in an inductive circuit to either rise or fall through a resistance is measured in terms of *inductance-resistance time constants* (usually abbreviated to L/R time constants). The L/R time constant is the time taken for current to rise through an inductor to a voltage equal to 63.2 per cent of its maximum value when connected to a supply, or fall by 63.2 per cent of its maximum value when disconnected from the supply. The time constant (T) of an L/R circuit is calculated as follows:

$$T = L/R$$

It can be seen from the graph of Fig. 9.16 that it takes about five L/R

Fig. 9.13. Variation of inductance.



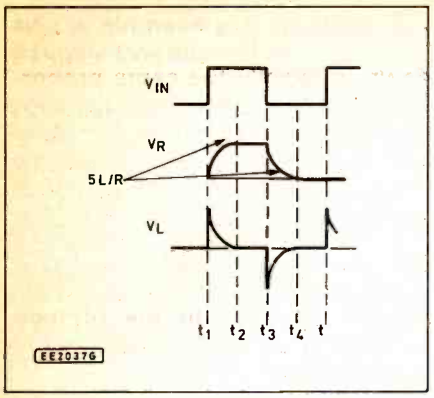


Fig. 9.17. Graphs of the variation in voltage across the resistor and inductor in Fig. 9.18.

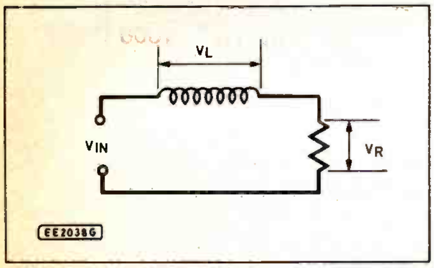


Fig. 9.18. Circuit for graphs of Fig. 9.17.

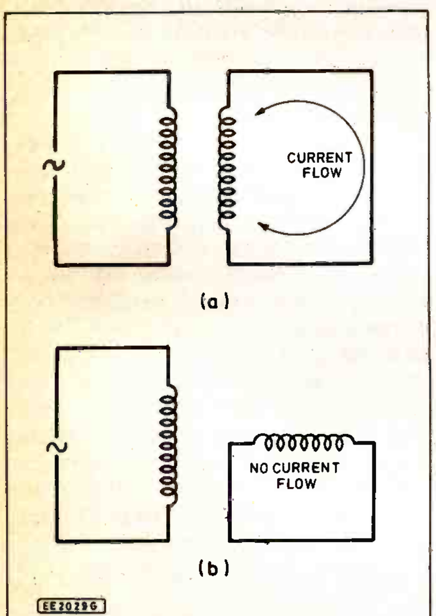


Fig. 9.19. Current will flow in a secondary circuit if the two coils are linked by the magnetic field.

time constants to rise to maximum current or fall to zero. Again, like the time taken to fully charge or discharge a capacitor (see Part 8), this is a rule of thumb: theoretically, the current in an inductor would never quite rise to its maximum value or fall completely to zero.

Fig. 9.17 is mainly for your interest and for you to compare it with Fig. 8.22, last month; it shows graphs of the variation in voltages across the inductor and resistor of the circuit in Fig. 9.18 when a square wave is applied to its input.

Transformer Action

If two inductors are placed sufficiently near to each other, the changing current and associated magntic field around the coil in one circuit induces current in the other. Applying an a.c. voltage to one coil, and thus creating an alternating current in it, creates a magnetic field around it. Some of this flux, due to the close proximity of the second coil to the first, cuts the second coil and induces a voltage across it.

If the circuit of the secondary is closed, as shown in Fig 9.19a, a current will flow. These two circuits are linked such that energy is transferred from one circuit to the other by *transformer action*.

The Transformer

Any arrangement in which two or more coils are magnetically coupled to one another constitutes a transformer. The transformer just descirbed would be termed an air-cored transformer, but iron-cored transformers are more common because they are more efficient (the permeability of iron is high and the reluctance of an iron magnetic circuit is very low compared to that of air, so nearly all the flux in an iron-cored transformer is transferred from one coil to another); however, the principles of air-cored and iron-cored transformers are the same.

A basic iron-cored transformer is made up of two coils wound on the same core, as depicted in Fig. 9.20; one coil of the transformer (the input) is called the primary winding, the other coil (the output) is called the secondary winding. The two windings are insulated from the core and from each other.

The primary winding, as shown in the figure, is connected to an a.c. voltage source, and the secondary winding is connected to the load. A transformer without a load acts like an inductor.

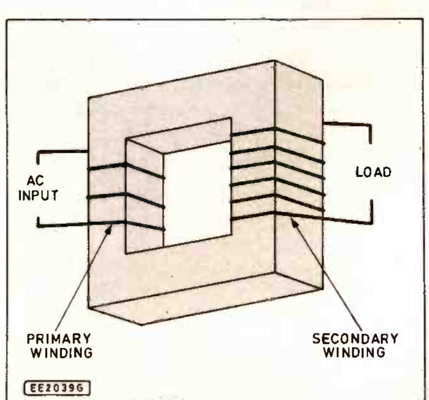


Fig. 9.20. Basic transformer.

The size of the voltage induced in the secondary coil (and whether it is increased or decreased) is determined by the difference in the number of turns in the two coils. If both windings of the transformer have the same number of turns, the voltage induced in the secondary will be equal to the voltage applied to the primary. If the secondary has half the windings of the primary, then the output voltage will be half of the input voltage; if the secondary has twice the windings of the primary, then the output voltage will be twice that of the input voltage.

The Transformation Ratio

The difference in the number of turns is known as the *transformation ratio* of the transformer. The relationship between the number of turns in the primary and secondary circuits and the voltages induced in them is expressed as follows:

$$\text{Transformation ratio} = \frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Equ. 1

In which V_p is the primary voltage, V_s is the secondary voltage, N_p is the number of turns in the primary winding, and N_s is the number of turns in the secondary winding.

The transformation ratio can be set up to step up (if N_s is greater than N_p) the primary voltage or, if N_s is less than N_p, step it down. A step-down transformer is one where the result of N_s/N_p is less than 1 and a step-up transformer is one where the result of N_s/N_p is greater than 1. A transformer with 10 times more turns on the primary side than on the secondary side has a step-down ratio of 10:1, and a transformer with 10 times fewer turns on the primary side than on the secondary side has a step-up ratio of 10:1.

By rearranging Equ. 1, above, any one of the four factors can be calculated if the other three are known; for example, if 240V is connected to the primary of the transformer with 1000 primary turns and 200 secondary turns, the voltage at the secondary may be calculated as follows:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

Multiply both sides of the equation by V_p

$$V_s = \frac{N_s}{N_p} \times V_p \rightarrow V_s = \frac{N_s \times V_p}{N_p} \quad (\text{Equ. } V_s)$$

$$\therefore \frac{200 \times 240}{1000} = \frac{48{,}000}{1000} = 48V$$

To arrange this equation (Equ. V_s) for calculating the primary voltage

(V_p), first divide both sides by N_s to get

$$V_s=\frac{N_s \times V_p}{N_p} \rightarrow \frac{V_s}{N_s}=\frac{V_p}{N_p}$$

and then multiply both sides by N_p

$$\frac{V_s}{N_s}=\frac{V_p}{N_p} \rightarrow \frac{V_s}{N_s} \times N_p=V_p$$

$$V_p=\frac{V_s \times N_p}{N_s} \qquad \text{(Equ. } V_p\text{)}$$

The arrangement for finding the number of turns in the secondary winding is derived by multiplying both sides of the original equation (Equ. 1) by N_p

$$\frac{V_s}{V_p}=\frac{N_s}{N_p} \rightarrow \frac{V_s}{V_p} \times N_p=N_s$$

$$N_s=\frac{V_s \times N_p}{V_p} \qquad \text{(Equ. } N_s\text{)}$$

Finally, the only arrangement left is the one for finding the number of turns in the primary winding. From the above equation (Equ. N_s), first divide both sides by V_s to get

$$N_s=\frac{V_s \times N_p}{V_p} \rightarrow \frac{N_s}{V_s}=\frac{N_p}{V_p}$$

then multiply both sides of this by V_p

$$\frac{N_s}{V_s}=\frac{N_p}{V_p} \rightarrow \frac{N_s}{V_s} \times V_p=N_p$$

$$N_p=\frac{N_s \times V_p}{V_s} \qquad \text{(Equ. } N_p\text{)}$$

These are all the possible forms of Equ. 1 for calculating transformer primary and secondary a.c. voltages and primary and secondary turns; the results are summarised in Table 9.2.

TABLE 9.2

$V_s=\frac{V_p \times N_s}{N_p}$	$V_p=\frac{V_s \times N_p}{N_s}$
$N_s=\frac{V_s \times N_p}{V_p}$	$N_p=\frac{V_p \times N_s}{V_s}$

The current in the secondary of the transformer is related to the current in the primary and the transformation ratio in exactly the same way as voltage:

$$\frac{I_s}{I_p}=\frac{N_s}{N_p}$$

This equation can be transposed for calculating transformer primary and secondary curents and primary and secondary turns in the same way as shown above for voltages and turns; we will not repeat the examples but the results are summarised in Table 9.3.

TABLE 9.3

$I_s=\frac{I_p \times N_s}{N_p}$	$I_p=\frac{I_s \times N_p}{N_s}$
$N_s=\frac{I_s \times N_p}{I_p}$	$N_p=\frac{I_p \times N_s}{I_s}$

Transformer Efficiency

The above equations assume that the efficiency of the transformer, given by

$$\frac{\text{Output Power}}{\text{Input Power}} \times 100,$$

is ideal; in practice, however, it is impossible to manufacture a perfect transformer. The efficiency of any transformer will always be less than 100 per cent because of factors such as resistance in the windings, flux losses (all the primary flux will not be transferred to the secondary), and a certain amount of power being dissipated as heat.

All this does make it sound as though there is more power lost than retained, but this is not so, transformers are very efficient—it is possible to achieve 99 per cent efficiency.

The power consumed in the secondary circuit must be supplied by the primary circuit. As the voltages in each circuit are fixed, the current in the primary circuit must vary to meet the power required by the secondary circuit. The power supplied by the primary is the primary current multiplied by the primary voltage (P=IV);

$$I_p \times V_p$$

and the power delivered by the secondary is

$$I_s \times V_s$$

Therefore, assuming no power losses, the primary power is equal to the secondary power.

Illustrative Example

A perfect (100 per cent efficient) transformer steps up to a 100 volt supply to 650 volts. The primary has 1,000 turns.

(a) How many turns are there in the secondary winding?

$$N_s=\frac{N_p \times V_s}{V_p} \text{ (from Table 9.2)}$$

$$\frac{1{,}000 \times 650}{100}=\frac{650{,}000}{100}$$

6,500 turns

(b) A 65ohm resistor is connected across the secondary. What current will it draw?

$$I=\frac{V}{R}=\frac{650}{65}$$

=10 amps

(c) What will be the power consumption in the secondary?

P=IV
=650×10
=6,500 watts

(d) What power must be supplied to the primary winding?
The same as the power at the secondary
=6,500 watts

(e) What is the primary current?

$$I=\frac{P}{V}=\frac{6500}{100}=65 \text{ amps}$$

A study of this example shows that the current output was stepped down in exactly the same proportion that the output voltage was stepped up (the voltage was stepped up from 100V to 650V and the current was stepped down from 65A to 10A), and that the ratio of the primary voltages and currents to the secondary voltages and currents is the same as the ratio of the number of turns in the primary winding to the number of turns in the secondary winding:

Primary Voltage =100
Secondary Voltage=650

$$\text{Transformation ratio}=\frac{V_s}{V_p}=\frac{650}{100}=6.5$$

$$\text{Also } \frac{V_s}{V_p}=\frac{N_s}{N_p}=\frac{6500}{1000} \text{ .... } 6.5$$

Primary Current =65
Secondary Current=10

$$\text{Transformation ratio}=\frac{I_p}{I_s}=\frac{65}{10}=6.5$$

$$\text{Also } \frac{I_p}{I_s}=\frac{N_s}{N_p}=\frac{6500}{1000} \text{ .... } 6.5$$

A little more experimentation with these equations will reveal that if the voltage is stepped up by a transformer, current is stepped down; and if voltage is stepped down, current is stepped up.

National Grid

This very property is why transformers are so important to the national grid system which supplies the mains electricity to our homes and industry. Voltages generated at power stations are stepped up to very high voltages for transmission over long distances because power at high voltages carries less current than power at low voltages (since P=IV). This allows the transmission wires to be of a smaller cross sectional area.

A transformer can have one or more primary (or input) windings and one or more secondary (or output) windings; for example, the diagram of Fig. 9.21 shows a low voltage mains transformer and its symbol. Notice that the primary windings can be wired in series for 240 volt operation or can be wired in parallel for 120 volt operation (for use in the U.S.A., for example). The secondary side of this particular transformer has multiple taps or connections to give a choice of output voltage. Some commonly available types of transformer are depicted in Fig. 9.1.

Next month: Diodes.

Questions

1. What curent would be found at the primary of the transformer below (assuming the transformer is ideal)?

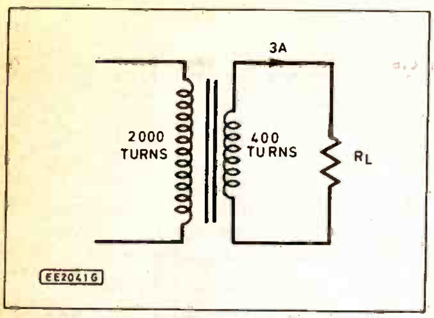
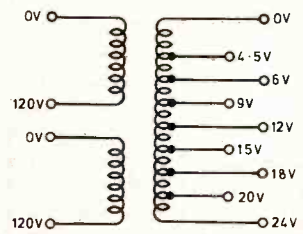
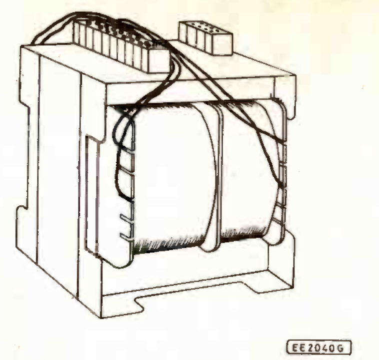
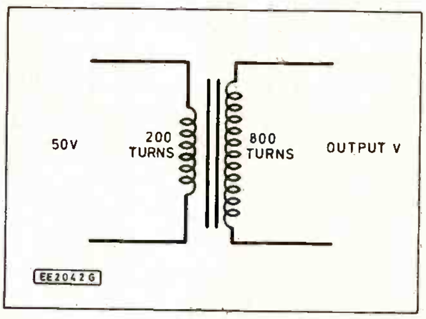


Fig. 9.21. A low voltage mains transformer.



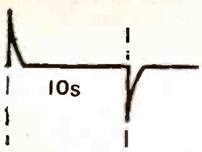


2. What is the relationship between the power at the primary and the power at the secondary of a transformer?
3. What is the step-down ratio when the secondary side of a transformer has half the turns of the primary?
4. What is the step-up ratio when the secondary side of a transformer has twice the turns of the primary?
5. Does induced current flow in the primary or secondary of a transformer?
6. Explain, in a few sentences, how a transformer works.
7. If a transformer has 500 turns in the primary winding and 1000 turns in the secondary, what a.c. voltage is required at the input to produce 12 volts a.c.?
8. What will be the output voltage of the transformer on the right?

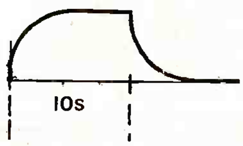


ANSWERS TO LAST MONTH'S QUESTIONS

1.



2.



3. 6μ

4. 0μ66

5. 33μ

6. Since the capacitor is uncharged the current is a maximum at the instant the switch is made, it is limited only by the resistance in the circuit.

7. 10V

MARKET PLACE

FREE READERS ADS.
RULES Maximum of 16 words plus address and/or phone no. Private advertisers only (trade or business ads. can be placed in our classified columns). Pen pals or items related to electronics only. No computer software. EE cannot accept responsibility for the accuracy of ads, or for any transaction arising between readers as a result of a free ad. We reserve the right to refuse advertisements. Each ad. must be accompanied by a **cut-out valid** "date corner". Ads. will not appear (or be returned) if these rules are broken.

DIGITAL CAPACITANCE meter, will read values from a few picofarads to 100μF. Very accurate £20. Tel. 091 2677833.
WANTED Amstrad CPC464 power supply modulator, keyboard cabinet. S. Ditchburn, 21 Rigby Street, Salford M7 0BJ.
SINCLAIR USER 1984-86. Your Sinclair 1985-86. ZX Computing 1984-87. Offers the lot. Buyer collects. D. O'Brien, 36 Lindale Ave., Royton, Oldham OL2 6UU. Tel. 061-620 0696.
FEMALE TEENAGE PENPAL. About 16. My interests include digital circuits, processors and electronic music projects. Simon Harrison, 20 Waylands Drive, Hunts Cross, Liverpool, Merseyside L25 0NA.
LARGE amount of electronics mags. £3, buyer collects. Warren, 8 Brooklyn Road, South Norwood SE25 4NH.
MAGAZINES from 1968 onwards. Practical Electronics, Practical Wireless, Everyday Electronics, E.T.I., Hobby Electronics. Coleshill 62308.
REALISTIC mixer four channel stereo mic. and phono (eight inputs) includes leads. Boxed as new, £15. R. Fraser, Seannlios Farm, Kirkhill, Inverness-shire, Scotland. Tel. 0463 83658.
GOODMANS 18in. SPEAKER unit £30. Collaro transcriptor £12. Grampian f.m. tuner 571/H £25, s.a.e. Interesting Oldies. J. Willmot, 5 Southcourt Avenue, Bexhill on Sea TN39 3AR.
BBC 'B' with DDFS, 5 ROMS. 32K Ramcard, mouse, music synth, software, £280 or telephone Ian and offer on (0572 85) 335 or at 2 St Marys Road, Manton, Nr. Oakham, Leics. LE15 8SU.
CLEARING all my surplus components. Generous assortment £3 (includes postage) or send s.a.e. for lists. J. Allen, 150 Magheralane Road, Antrim, Co. Antrim BT41 2PD.
LARGE BOX of vintage "Practical Wireless" from 1961. List of workshop clearance items. Tel. Richard West 01-949 6020 (New Malden, Surrey).
FOR SALE. Resistors, capacitors, diodes, transistors. Mixed bag of 200 items £3.50 inc. postage. C. Moore, 17 Inhams Way, Silchester, Reading RG7 2QA. Tel. (0734) 700657.
SALE 2 full boxes, 1 comput. caps res. chips, calc. spares, h/ware, bargain £25. Tel. 01-450 9820, 10 am-3 pm.
HITACHI VM-906E 9in. monochrome video monitor, composite video input, £12.50. Tel. 03224 39866. I. Rumbles, 55 Shinglewell Road, Erith, Kent DA8 1NF.
JUPITER ACE wanted, cassettes, hardware, documentation. Contacts with FORTH users. John, 17 Springwood Close, Chesterfield. Tel. 237555.
CUPBOARD CLEARANCE assorted components, switches, fibre board etc. £5 per pack inc. p&p. C. J. Ashley, 7 Grafton Road, Ellesmere Port, South Wirral L65 2BD.
555 TIMER ICs. Brand new. No rejects, only 24p each or 20 for £4.40 p&p included. S. Lord, 6 Stubbing Brink, Hebden Bridge, W. Yorks HX7 6LR.
LOWE TECH. manual HF.125, new £8.50. Post free. Wanted Xtals from Trio JR310 or old chassis. S. Harmer, 9 Park Sq. East, Jaywick, Essex CO15 2NL.
WANTED any BBC or Commodore computer parts, damaged or working. Please write giving parts and prices. A. Collins, 4 Fleming Way, Folkestone, Kent CT19 6JX.
CREED 7B, v.g.c., base, cover, page printer att. paper, tuning fork, lit. £15. Tel. 0702 295369.

ANDOR ELECTRONICS

FREE OFFER FOR MAY
Set of Miniature Radial Electrolytic Capacitors 1uF to 100uF. 7 values.
2 of each value. 14 capacitors.
Worth £1.08
FREE WITH ALL ORDERS OVER £5.00

SPECIAL OFFER!

Ex Equipment I.C's
EPROMS
2764 250nS 12.5 - 21vpp 150p
27128250nS 12.5 - 21vpp 225p
2716 125p
2732 150p
Eprom Erased-Blanked Check
STATIC RAMS
65256 32K 200nS 400p

CAPACITORS
New Miniature Radial
10uF 50V 5p
47uF 16V 5p
1uF 35V Tant Axial 5p

ANALOGUE I.C's
NE555 Timer 22p
LM741 OPA 22p
LM324 Quad 35p
uA733 Video 95p
ICL7660 Neg 220p
7805 5V Reg 35p
7812 12V Reg 35p
7905 5V Reg 35p
7912 12V Reg 35p
ZN426 8 Bit D/A 250p
ZN429 8 Bit D/A 220p
ZN449 8 Bit A/D 375p

I.C's 74HC
74HC00 22p
74HC02 22p
74HC04 22p
74HC08 22p
74HC10 22p
74HC14 50p
74HC20 22p
74HC27 22p
74HC30 22p
74HC32 22p
74HC42 40p
74HC74 39p
74HC75 39p
74HC123 44p
74HC125 50p
74HC138 50p
74HC151 50p
74HC157 50p
74HC161 62p
74HC163 65p
74HC175 50p
74HC193 58p
74HC195 54p
74HC240 75p
74HC242 77p
74HC244 77p
74HC257 50p
74HC366 62p
74HC390 77p
74HC393 77p
74HC4016 90p
74HC4040 62p
74HC4051 75p
74HC4066 90p

BUZZER
Min PCB 6V 75p
CRYSTALS
32.768 Khz 95p

I.C's 74F
74F00 32p
74F02 32p
74F04 32p
74F08 32p
74F10 32p
74F20 32p
74F74 45p
74F86 45p
74F157 64p
74F161 140p
74F164 140p
74F175 90p
74F240 100p
74F244 100p
74F257 65p
74F373 100p

I.C's 74HCT
74HCT00 32p
74HCT02 32p
74HCT04 30p
74HCT08 32p
74HCT10 32p
74HCT14 55p
74HCT20 32p
74HCT32 32p
74HCT42 70p
74HCT73 50p
74HCT74 46p
74HCT75 52p
74HCT86 52p
74HCT93 80p
74HCT123 80p
74HCT138 60p
74HCT157 62p
74HCT161 86p
74HCT163 95p
74HCT164 90p
74HCT175 75p
74HCT193 99p
74HCT195 99p
74HCT242 110p
74HCT244 80p
74HCT257 80p
74HCT366 80p
74HCT390 95p
74HCT393 95p
74HCT4016 95p
74HCT4040 95p
74HCT4051 105p
74HCT4066 95p
74HCT4511 120p

I.C's 74LS
74LS00 20p
74LS02 20p
74LS04 20p
74LS08 20p
74LS10 20p
74LS13 30p
74LS14 35p
74LS20 20p
74LS27 20p
74LS30 20p
74LS32 20p
74LS42 45p
74LS47 70p
74LS74 25p
74LS75 35p
74LS86 28p
74LS90 38p
74LS93 38p
74LS95 55p
74LS123 50p
74LS125 30p
74LS138 40p
74LS151 45p
74LS155 45p
74LS157 45p
74LS161 50p
74LS164 55p
74LS174 50p
74LS175 50p
74LS191 65p
74LS193 60p
74LS240 70p
74LS244 70p
74LS245 70p
74LS257 48p
74LS373 60p
74LS374 60p
74LS390 60p
74LS393 60p

I.C. SOCKETS
Low Profile
6 Way 5p
8 Way 5p
14 Way 7p
16 Way 9p
18 Way 11p
20 Way 12p
24 Way 14p
28 Way 17p
40 Way 22p

L.E.D's
3mm & 5mm
Red 10p
Green 12p
Yellow 14p

LED CLIPS
3mm & 5mm 5p

LED DISPLAYS
0.56" Dual Digit
Red CA 199p
Red CC 199p
Green CA 220p
Green CC 199p

10 Segment Dil Array
Bar array red 190p

CAPACITORS
Min Radial Lead
470pf 200V 5p
1nF 100V 7p
2.2nF 100V 7p
4.7nF 100V 7p
10nF 100V 7p
22nF 100V 7p
33nF 50V 7p
47nF 63V 10p
100nF 50V 10p
100nF 100V 10p

ELECTROLYTICS
1.ouF 63V 7p
2.2uF 63V 7p
4.7uF 16V 10p
10uF 16V 10p
22uF 25V 10p
47uF 16V 5p
100uF 16V 10p
220uF 16V 15p
470uF 16V 25p

AXIAL LEAD
47pf / 180pF
390pF / 680pF
820pF ● 3p
0.1 Decoupling
1 ● 5p
10 ● 30p

ZENER DIODES
BZX55 500mW 7p
BZX85 1.3W 15p
C3V3 C5V6 C12
C3V6 C6V2 C15
C4V7 C7V5 C24
C5V1 C9V1 C36

EPROMS
32K*8 12.5vpp
27C256 250nS 490p

RAMS
64K*1 Dynamic
4164 150nS 220p

BRIDGE RECTIFIERS
1.5A 300V 30p
1.5A 600V 32p
3A 200V 50p
3A 600V 60p
6A 200V 85p

DIODES
IN5401 3A 10p
IN5404 3A 12p
IN4148 3p
IN4004 1A 400V 5p

RESISTORS
METAL FILM 0.4W
Min 7mm * 2.5mm
1 Ohm - 1 Meg
E12 Range 5%
1 off 2p
10 off 17p
100 off 150p
METAL FILM 0.6W
E24 Range 1%
1 off 4p
10 off 35p
100 off 300p
CARBON FILM 0.25W
10 Ohm - 1 Meg
E12 Range 5%
1 off 1p
10 off 9p
100 off 70p
Prices for same value not mixed

Standard DIL Switches
4 way 70p
8 way 90p

Switches
Sub-miniature toggle
SPST 60p
DPDT 80p

RESISTOR PACK
CARBON FILM 0.25W
10 off each value
10 Ohm - 1 Meg
610 Resistors 490p

PLUGS & SOCKETS
Black Phono Plugs 12p
Black Phono Sockets 19p
1/4" Stereo Jack Socket 30p
1/4" MonoJack Socket 27p
1/4" Stereo Jack Plug 35p
1/4" Mono Jack Plug 20p
3.5mm Stereo Jack Plug 25p
25 Way D Cover 55p
25 Way D Type IDC Plug 190p
25 Way D Type IDC Socket 199p
25 Way D Type Solder Plug 70p
25 Way D Type Solder Socket 75p
34 Way IDC Card Edge 150p
36 Way IDC Centronics Plug 199p
36 Way Centronics Plug 155p

SOLDER 60/40
5 Metre 22 swg 95p
3 Metre 18 swg 95p
2 Metre 16 swg 95p
Black Stick on Feet
10mm x 10mm 4 off 25p
PCB 20mm Fuse Holder 12p

TRANSISTORS
NPN
BC182 12p
BC184 12p
BC547 7p
BC548 7p
BC549 7p
PNP
BC557 7p
BC558 7p
BC559 7p
OPTOCOUPLERS
6N138 220p
6N139 220p

NUTS & BOLTS
All Steel & Zinc Plated
CHEESE HEAD / COUNTERSUNK BOLTS
6 BA 1/2" 10 ● 15p
100 ● 120p
6 BA 3/4" 10 ● 20p
100 ● 160p
4 BA 1/2" 10 ● 25p
100 ● 200p
4 BA 1" 10 ● 30p
100 ● 240p
FULL NUTS
6 BA 10 ● 12p
100 ● 96p
4 BA 10 ● 15p
100 ● 120p

ODDS & ENDS
Sleeved Grommet 1 ● 5p or 5 ● 20p
Resistor
0.4W 27 ohm CF 5% 0.5p
0.4W 360 ohm MO 5% 1p
0.4W 210 K MO 1% 2p
Resistor
1.0W 47 ohm MO 2% 2p
1.0W 2.7 K MO 2% 2p
DILNetworks 15*3.3K 20p

STOCK ITEMS BY RETURN.
ADD 75p P&P
ALL PRICES INCLUSIVE.
SEND CHEQUE or P.O. to...

ANDOR ELECTRONICS,
DEPT EE, VICTORIA HOUSE,
PAXTON STREET, HANLEY,
STOKE-ON-TRENT, ST1 3SD
TEL: 0782 283642.

MARCO TRADING

THE MALTINGS, HIGH STREET, WEM,
SHROPSHIRE SY4 5EN. DEPT EE6
Tel: 0939 32763. Telex 35565. Fax 33800

Electronic Component Mail Order Company–Established 1972
100+PAGE CATALOGUE AVAILABLE–SEND £1 FOR YOUR COPY
Including Discount Tickets–50p off £5+order; £1 off £10+order; £5 off £50+ order.

PLEASE ADD £1 POSTAGE & PACKING

WE RESERVE THE RIGHT TO CHANGE THE PRICES WITHOUT PRIOR NOTICE

JUNE SPECIAL OFFER
★★★★★★★★★★★★★★★★★★★★★★★
HOME ALARM PACKAGE

INCLUDES:—
* Four zone—no key—touch pad panel Enter your own Security Code etc.
* External Red Bell Box.
* 2×1 Internal Passive I.R.
* 2×Door Contacts * Siren for Bell Box
* 100 mts cable and clips
* Full fitting instructions

PRICE: ONLY
£115.00
INC. VAT
(Plus £2.50 carriage)

(Please ring for further information)

VISIT OUR RETAIL SHOPS
WEM (MARCO), The Maltings, High St. (0939) 32763
WOLVERHAMPTON (WALTONS), 55A Worcester St. (0902) 22039
BIRMINGHAM (SUPERTRONICS), 65 Hurst Street (021) 666 6504

"CLOSED-CIRCUIT" TELEVISION SYSTEM
PRICES **£160** (Plus £12.00 carriage)
1×CAMERA 1×MONITOR 1×CAMERA BRACKET

12V RECHARGEABLE UNIT
10×D size Ni-Cads (4Ah) encapsulated in a black plastic case, fused holder, gives 12V output when fully charged. Ex-equipment–fully tested and guaranteed. 245×75×75mm.
£9.19 plus £2.12 P&P CHARGER FOR UNIT **£11.50** plus £2.12 P&P

ADDITIONAL KITS
Disc ceramic 50V 125 pieces 3.99
Zener Diodes 5ea 55 pieces 4.00
Electrolytics R 100 pieces 8.50
Fuses Q/Blow, 20mm 80 pieces 4.75
Fuses T/Delay, 20mm 80 pieces 8.50
Pre-set Pots-H 120 pieces 7.75
Pre-set Pots-V 120 pieces 7.75

RESISTOR KITS each value individually packed
1/4W pack 10 value E12-10R to 1M 610 pce. £5.10
1/4W pack 5 value E12-10R to 1M 305 pce. £3.75
1/4W popular 10 value 10R-M10 1000 pce. £6.99
1/2W pack 10 ea value E12-2R2 to 2M2 730 pce. £8.75
1/2W pack 5 ea value E12-2R2 to 2M2 365 pce. £5.40
1/2W pack popular 2R2 to 10M 1000 pce. £10.75
1 Watt pack 5 ea value E12-2R2 to 1M 353 pce. £15.25
2 Watt pack 5 ea value E6-10R to 2M 2317 pce. £25.00

BOOKS
Data Volume 1—Trans data & drawings A–Buy £9.99
Data Volume 2—as above C-Z £10.75
Data Volume 3—2N-2N6735 £10.20
Data Volume 4—2SA & on £13.50
Diodes Volume 1 £10.75
Diodes Volume 2 £10.65
Both Volumes £20.60
I.C. CMOS £8.95
I.C. TIL £19.50
I.C. LIN Volume 1 £6.95
I.C. LIN Volume 2 £6.99
Both Volumes £13.00
Thyristors A-Z £10.45
Transistors A-Z £5.40
Transistors 2N-3N £5.50
Both Volumes £10.00

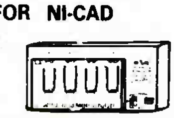
NI-CAD RECHARGEABLE BATTERIES

	1 off	10 off
AAA	£1.50	£1.30
AA	95p	85p
C	£1.95	£1.80
D	£2.00	£1.85
PP3	£3.90	£3.20

SOLDER 60/40
A 500g reel of 22 swg multicore solder 60% tin, 40% alloy non-corrosive.
£5.75 ALSO 18swg

FULL RANGE OF BABANI BOOKS IN STOCK

CHARGER FOR NI-CAD BATTERIES
Charges AA, AA, C, D & PP3 NI-CADS
£4.99



JUST ARRIVED
High quality Desoldering Pump, European made ONLY **£3.44**
(Normally £8.99). Spare tip 69p

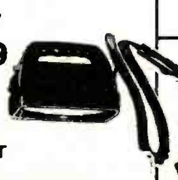
ANTEX SOLDERING KITS
C iron £7.65
CS iron £7.75
XS iron £7.85
Auto repair £10.75
SK5 £10.75
ST4 Stand £2.99 SK6 £10.85
Spare elements £3.75
Spare tips £1.60

STANDARD ABS BOXES
HIGH IMPACT ABS
COLOUR: BLACK

INTERNAL DIMENSIONS (MM)

A	B	C		
76	58	35	BOX MB1	£1.19
95	71	35	BOX/MB2	£1.31
115	95	37	BOX/MB3	£1.54
140	90	55	BOX/MB5	£2.16
207	122	77	BOX/MB4	£4.14
213	142	57	BOX/MB6	£3.10

ONLY £5.99
QUARTZ-HALOGEN SPOTLIGHT



Full range of equipment cases (Aluminium)

12V Twin Fluorescent lamp 12" Double Tubes
IDEAL FOR BOATS, CARAVANS, VANS, ETC

ATTRACTIVE WHITE FITTING, RIBBED PERSPEX DIFFUSER, ON/OFF SWITCH, 3ft CABLE, TRANSISTORISED CIRCUITRY, KEYHOLE FIXING. 12V D.C. 8W TUBES
£5.99 EACH 368×67×43mm

FM TRANSMITTER
Very High Quality 'MINI-BUG' –Ideal for Baby Alarm etc **£9.78**

ORYX PORTASOL GAS SOLDERING IRON
Price (1+) £18.75
Spare tips 1, 2.4, 3.2,4mm £5.50

LATEST CATALOGUE £1

BLACK STAR FREQUENCY COUNTERS—NEW
METEOR 100-100MHz £115.00 Carriage £2.50
METEOR 600-600MHz £149.00 (including VAT)

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month we shall be devoting the whole of *On Spec* to the subject of interrupts. For the practically minded, we shall be including details of a practical Interrupt Controller designed by one of our regular readers.

Interrupts

Interrupts are essential to the operation of all real-time control systems as they provide an efficient means of both alerting the processor to the occurrence of a particular event such as a key depression or end-of-conversion signal. The ability to handle interrupts at various levels, to differentiate between them, and to make an appropriate response, is thus crucial to any microprocessor-based control system. Unfortunately, the Spectrum was designed as a low-cost home computer (rather than a real-time controller) and thus it is very poorly catered for as far as interrupt control is concerned.

Regular readers may recall that I provided some information on the use of interrupts (together with a simple demonstration routine) in the January 1988 instalment of *On Spec*. (If you missed out on this there is no need to despair as I have included the relevant details in the current On Spec Update!).

Bill Buick (from Newtyle, Perthshire) has gone one step further and has provided a novel solution to the problem of lack of interrupt control for the Spectrum. Bill's solution is based upon the Z80 Counter/Timer Circuit (CTC) and the complete circuit of his Interrupt Controller is shown in Fig. 1. Bill writes:

The design of the Interrupt Controller centres on the Z80-CTC which is easy to interface to the ZX Spectrum. Address lines A5, A6 and A7 are used to select the device and program the internal registers. This allows the user to realise unique and flexible capabilities for his or her system, using the full power of vectored interrupts and machine code speed.

The Z80-CTC has four independent counter/timer channels. Each channel can be individually programmed with two bytes, a Channel Control Byte and a Time Constant Byte. The Channel Control Byte configures each channel either as a counter or as a timer. The Time Constant Byte sets an internal counter which is decremented each time a pulse occurs on the CLK/TRIG inputs to the chip. These pulses can be selected by the programmer to be rising or falling edges (positive or negative going). When the internal counter reaches zero, the CTC interrupts the CPU in the vectored interrupt mode.

The channels are numbered 0 to 3 and are selected by the binary information on lines A5 and A6. A7 operates as the chip select line. The CTC is unique in that it can modify the vector supplied to the CPU in such a way that the CPU can jump directly to the Interrupt Service Routine specific to the channel that caused the interrupt. The channels have an order of priority, Channel 0 has the high-

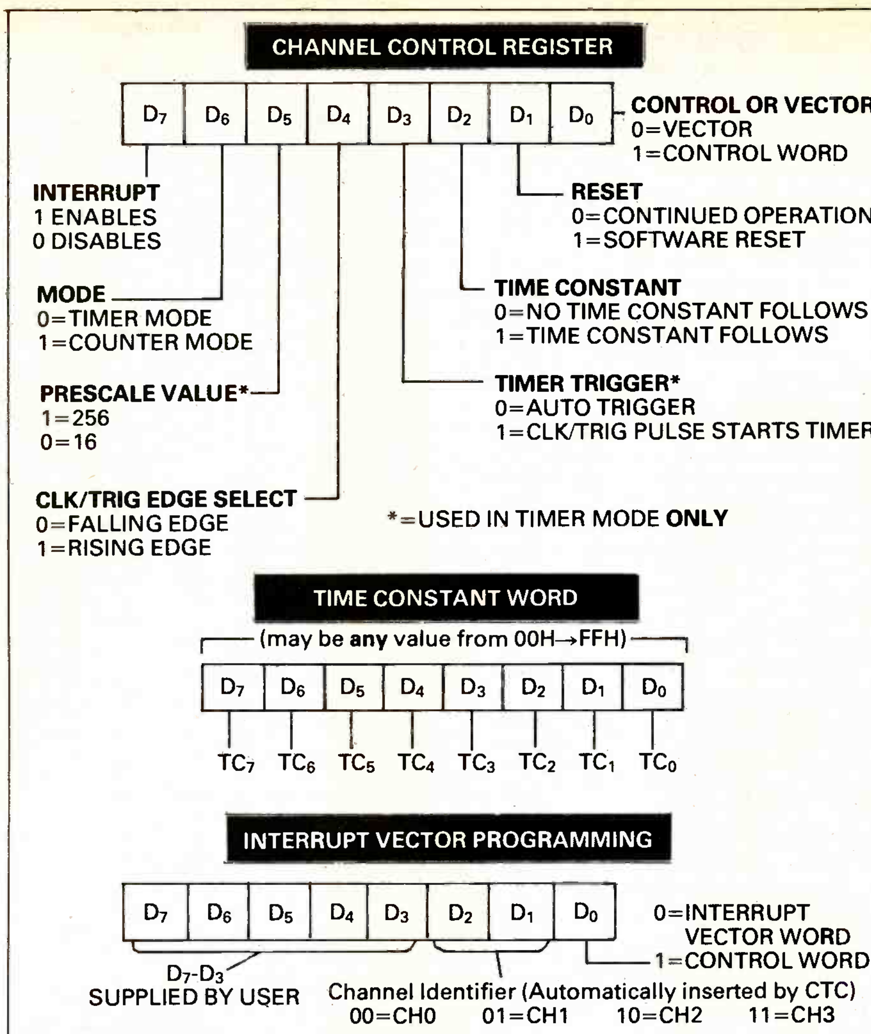


Fig. 2. Internal Registers of the Z80-CTC

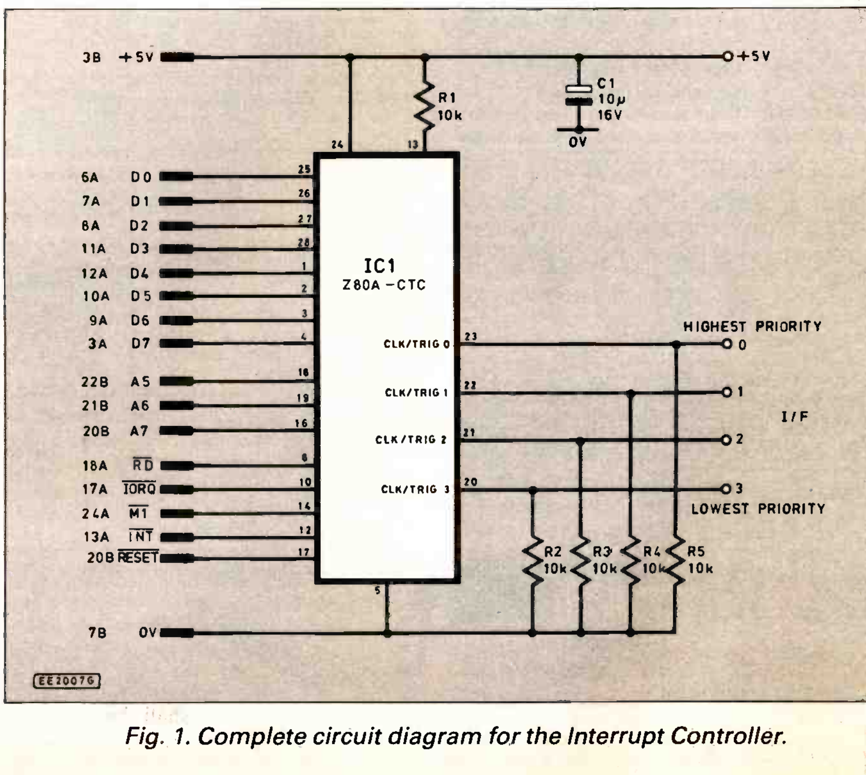


Fig. 1. Complete circuit diagram for the Interrupt Controller.

est and Channel 3 has the lowest. The vectored interrupt mode is a method of combining information from the CPU's Interrupt (I) register with a byte from the interrupting device.

Construction of the Interrupt Controller is quite straightforward and should follow the same general lines as that recommended for our previous *On Spec* projects. Bill makes the following points:

As there is only one chip, construction is relatively easy but care has to be taken as errors may damage the Spectrum. The use of an i.c. socket is advisable. Notice also that the CLK/TRIG pins are pulled to 0V by resistors. These are essential to prevent undesired operation of these inputs.

Also, the IEI pin (Interrupt Enable In) must be pulled to +5V via a resistor. This is because the "daisy chain" method is used by Zilog in assigning priority to interrupting devices; the device which is electrically closest to the CPU has the highest priority.

Interrupt software

The Interrupt Controller is designed to take advantage of the most powerful of the Z80's interrupt modes. This mode caters for a variety of different responses to interrupts; the source of the interrupt can be identified by the processor and an appropriate interrupt service routine executed. Bill offers the following explanatory notes:

Unfortunately, the Spectrum is initialised at power-up to a non-vectored interrupt mode. It therefore has to be "fooled" into accepting IM2 (vectored interrupt) mode. First of all, a specific sequence of events has to occur to program the CTC as an interrupt controller. This involves programming the registers described previously, initialising all four channels as counters and setting the Time Constant Register to 01H. Also, the interrupt service routines for each channel have to be created and identified.

This process involves the creation of a "vector table". This table is a series of memory locations which contains the address of the area in memory which the CPU will jump to when an interrupt occurs. The location of the vector table in memory is very important. On receiving an interrupt, the contents of the CPU's Interrupt (I) register is joined with the byte supplied from the CTC to make a pointer to the location in memory which has the address of the interrupt service routine(s).

*This is then loaded into the Program Counter in the CPU and program execution continues from there. Notice also, that all interrupt service routines must terminate with the **RETI** instruction which will allow further interrupts to occur properly.*

To ensure that the Spectrum will operate properly, an additional "dummy" routine has to be programmed. This is because every 20ms the ULA is interrupting the CPU and when the CPU is programmed to Interrupt Mode 2 (IM2), it will be looking for the 8-bit vector normally supplied by the interrupting device.

However, the ULA does not supply this and the data bus lines are pulled to +5V by resistors. Thus, the pointer formed in this case will be the contents of the interrupt register joined to FFH. Therefore, it will be necessary to include this to avoid a "crash".

*Once the CTC has been correctly programmed, interrupts on the Spectrum must be disabled while the interrupt modes are changed. The final instruction in the initialisation program is **JP 0038H**, which causes the Spectrum to return to the "Maskable Interrupt Routine" and it continues operation from there, unaware of the mode change.*

```
                  ORG 8000H

                  LOAD 8000H

8000  F5                  PUSH AF
8001  E5                  PUSH HL          :SAVE REGISTERS
8002  21 57 80            LD HL, CH0
8005  22 20 9F            LD(9F20H), HL
8008  21 62 80            LD HL, CH1
800B  22 22 9F            LD(9F22H), HL
800E  21 6D 80            LD HL, CH2       :SET UP VECTOR TABLE
8011  22 24 9F            LD(9F24H), HL
8014  21 78 80            LD HL, CH3
8017  22 26 9F            LD(9F26H), HL
801A  21 51 80            LD HL, DMMY
801D  22 FF 9F            LD(9FFFH), HL

8020  3E 20               LD A, 32         :LOAD VECTOR TO CTC
8022  D3 1F               OUT(31),A
8024  3E D5               LD A, 213        :CONFIGURE CHANNEL AS COUNTER
8026  D3 1F               OUT(31),A
8028  3E 01               LD A, 01         :LOAD COUNTER WITH 01
802A  D3 1F               OUT(31),A
802C  3E D5               LD A, 213        REPEAT FOR OTHER CHANNELS
802E  D3 20               OUT(32),A
8030  3E 01               LD A,01
8032  D3 20               OUT(32),A
8034  3E D5               LD A, 213
8036  D3 40               OUT(64),A
8038  3E 01               LD A,01
803A  D3 40               OUT(64),A
803C  3E D5               LD A, 213
803E  D3 60               OUT(96),A
8040  3E 01               LD A,01
8042  D3 60               OUT(96),A
8044  F3                  DI
8045  3E 9F               LD A,9FH         :SWITCH INTERRUPT MODES
8047  ED 47               LD I,A
8049  ED 5E               IM2
804B  FB                  EI
804C  E1                  POP HL        :RESTORE REGISTERS
804D  F1                  POP AF
804E  C3 38 00            JP 0038H      :JUMP TO MASKABLE INTERRUPT ROUTINE
8051  F3          DMMY:   DI
8052  00                  NOP           :DO NOTHING
8053  FB                  EI
8054  C3 38 00            JP 0038H


8057  F3          CH0:    DI            :CHANNEL 1 INTERRUPT SERVICE ROUTINE
8058  3E 41               LD A,"A"
805A  FD CB 02 86         RES 0,(IY+02)    :SIGNAL MAIN SCREEN
805E  D7                  RST 10H       :PRINT
805F  FB                  EI
8060  ED 4D               RETI          :RETURN FROM INTERRUPTS

8062  F3          CH1:    DI            :REPEAT FOR OTHER CHANNELS
8063  3E 42               LD A,"B"
8065  FD CB 02 86         RES 0,(IY+02)
8069  D7                  RST 10H
806A  FB                  EI
806B  ED 4D               RETI

806D  F3          CH2:    DI
806E  3E 43               LD A,"C"
8070  FD CB 02 86         RES 0,(IY+02)
8074  D7                  RST 10H
8075  FB                  EI
8076  ED 4D               RETI

8078  F3          CH3:    DI
8079  3E 44               LD A,"D"
807B  FD CB 02 86         RES 0,(IY+02)
807F  D7                  RST 10H
8080  FB                  EI
8081  ED 4D               RETI
```

Fig. 3. ZX Spectrum Interrupt Controller demonstration program.

Demo. program

The demonstration assembly language program shown in Fig. 3 allows users to test the interrupt controller. The program may be entered using an assembler or with the aid of our own Machine Code Loader (provided in the Update package). The demonstration program will print A, B, C, or D on the screen, depending on which one of the CLK/TRIG pins of the CTC is taken to +5V.

Next month: We shall be providing details of a simple mother-board for the Spectrum. This novel arrangement allows users to extend the Spectrum's bus system so that a number of external modules can be simultaneously connected. We shall also be reviewing the quaintly named "Pick-POKE-It" software package available from MGT.

In the meantime, please drop me a line enclosing a large (250mm×300mm) *adequately* (i.e. 42p UK postage) stamped addressed envelope if you would like to receive a copy of our *On Spec Update.* Please note that I can no longer provide individual replies to queries but instead will do my best to provide answers through On Spec or through the Update. Mike Tooley, Faculty of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

CABLE & SATELLITE '89

Ian Graham

WITH Astra already in orbit relaying television programmes to Europe, and BSB's television satellite due to be launched in August, 1989 has been heralded as the beginning of a new era in television. To mark the increased importance with which the industry now views itself, the annual broadcasting and communications industry show has transplanted itself from Wembley, where it started in 1987, to Olympia. The new and more spacious venue accommodated more than 120 exhibitors for *Cable & Satellite '89* (March 16-19).

All aspects of the industry were represented—programme makers, satellite operators, receiver manufacturers, signal distributors, aerial installers and video service companies. More than two dozen new products, mostly satellite receivers, were either launched or previewed.

FERGUSON

Ferguson exhibited its SAP1 Astra receiver with 64cm dish. The package will sell for around £300 (or £330 with the larger 80cm dish needed to cope with the weaker signals reaching the north of the Kingdom). The 32-channel receiver, equipped with an infra-red remote control, comes with Astra's 16 channels already programmed in.

Ferguson also announced that it will be supplying the Videocrypt decoder for use with Sky Television's subscription channels. Videocrypt is a signal scrambling system developed by Ferguson's parent company, Thomson Consumer Electronics.

The decoder will be used in conjunction with a Smart Card, a plastic card with a microchip embedded in it, developed by News Datacom a subsidiary of News International. Inserting the card in the decoder authorises the decoder to unscramble Sky Movies and the Disney Channel. The decoder can be used on a simple subscription basis or pay-per-view or pay-per-time. It will be available from this autumn for around £80.

Ferguson's BSB (British Satellite Broadcasting) reception package, the SBP1, will be available from September for about £300. It consists of a 10-programme remote control receiver with digital stereo sound decoder and built-in Eurocypher decoder, and of course the famous (or notorious) "Squarial" flat plate antenna.

NOKIA

Nokia Consumer Electronics showed its new range of satellite products, including the 5902 Astra compatible stereo receiver. This is available in the UK as the ITT-Nokia Sat 1100 and the Salora 5902. Its 48-channel capacity will cater for the two additional 16-channel Astra satellites planned for launch in the next few years. The current Astra satellite's 16 channels are pre-programmed into the receiver.

Receiving dishes are available in a range of sizes, from 55cm to 85cm, to meet different requirements in different parts of the country. The Sat 1100 with a 55cm dish will sell for about £379. In addition, ITT-Nokia is offering TV sets with built-in satellite receivers. The 66cm 7190 and 59cm 6390 also have a built-in FM radio, radio/TV remote control and 60 station presets.

ECHOSPHERE

American manufacturer Echosphere International unveiled two new receivers for Astra—the Echostar SR-1 and SR-2. Both are pre-programmed with the Astra frequencies. The SR-1 has a 10-keypad remote control, on-screen graphics, mono sound and video fine tuning. The SR-2 has full-featured stereo sound, parent lock and a 24-key remote control.

The European market in satellite television products has such a growth potential that the Colorado-based company has now opened a new office in Almelo in The Netherlands.

SENTRA

Sentra Electronics describes itself as "a determined newcomer to the satellite scene". Its SX1000 Astra receiver, launched at Cable & Satellite '89, has 16 channel presets, infra-red remote control and a 60cm dish with a wall mounting kit—and all at the competitive price of £259.

THE SATELLITE OPERATORS

Astra's operator, Société Européenne des Satellites, occupied a modest stand beside British Telecom. The two companies have a close business relationship too. SES took the plunge and launched Europe's first privately-owned television satellite in December 1988. After a perfect launch by Ariane rocket, the satellite performed faultlessly and went operational in February this year. SES has relentlessly and aggressively promoted Astra to programme makers, hardware manufacturers and the High Street dealers who will sell the receivers.

BSB's stand, twice the size of Astra's, reflected the more difficult circumstances in which BSB finds itself. Despite the small numbers of viewers with satellite dishes and receivers, Astra seems to be well on its way to commercial success. BSB is coming along after Astra, with a new broadcasting system, requiring a different type of receiver, and with a satellite in a different position in the sky, requiring a second dish (or a single motorised dish). There must be a question-mark over the viewers' willingness to shell out for what amounts to a second satellite system if they are reasonably satisfied with Astra's output. There have also been technical problems with the flat receptor, the Squarial, that BSB has made so much of; no one has yet seen a working Squarial!

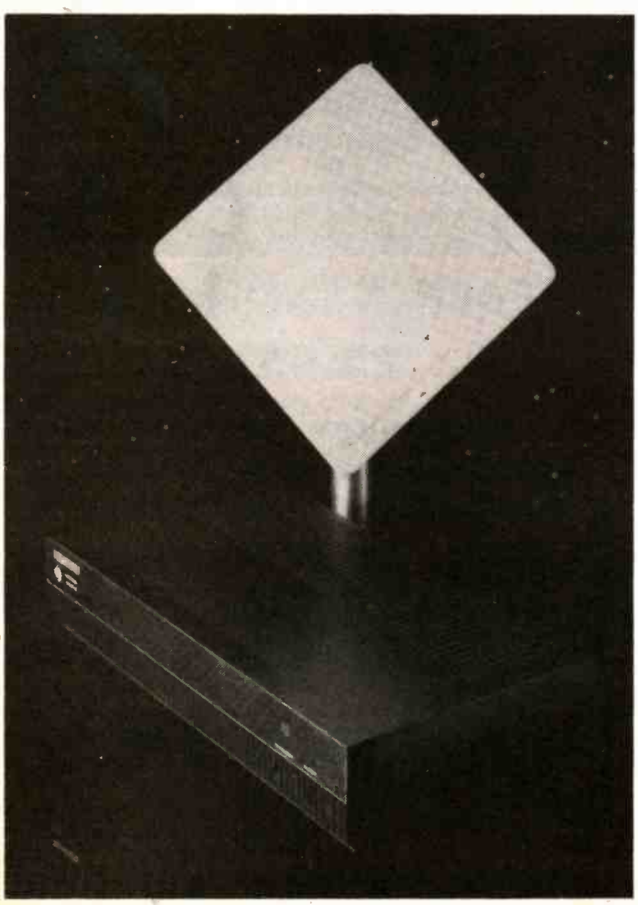
BSB demonstrated a comparison of PAL and D-MAC. PAL is the broadcasting system used by all terrestrial TV stations and until the end of the year all the satellite stations too. D-MAC is a new broadcasting system that will be used by BSB when its three channels begin broadcasting this autumn (with two additional channels due to start in January/February of next year). As soon as D-MAC receivers are available in sufficient quantities, some of Astra's channels will change over to it too.

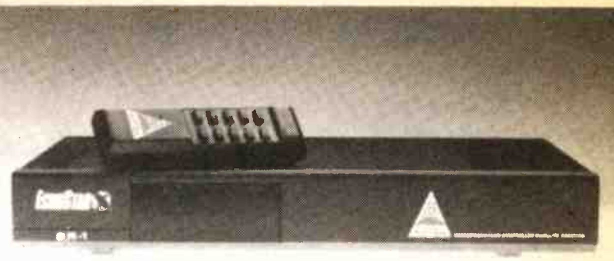
Sky Television has committed itself to sticking with PAL. In BSB's comparative demonstration, the D-MAC pictures were undoubtedly clearer, sharper and interference-free compared to the PAL picture of the same image. Whether or not the same striking improvement in picture quality will be obtained in the home using a PAL television set has been the subject of debate, sometimes acrimonious, between interested parties.

THE PROGRAMME MAKERS

However appealing the technology is, it isn't worth a row of beans if the programmes beamed down from the satellites aren't worth watching. The programme makers and providers were represented in strength to convince showgoers of their value. The ground floor of Olympia's National Hall was dominated by the Sky Television and BSB stands.

Ferguson's SBP1 receiver and the Squarial flat plate antenna should be available in time for broadcasts from the BSB satellite in September.





One of the new Astra receivers from the American company, Echosphere—the Echostar SR-1.

Sky Television is now offering six channels from Astra—Sky Channel, Sky News, Sky Movies, Eurosport, Sky Arts and The Disney Channel. All channels can be seen free at the moment, but in the autumn, Sky Movies and The Disney Channel will be scrambled. To unscramble them, a decoder will be necessary and a subscription of £12 per month will be charged for access to the two channels.

At Cable & Satellite '89, The Children's Channel announced that it would begin broadcasts from Astra on April 1st. The channel, which started in 1984, is currently available to over one million cable TV viewers in Europe and Scandinavia. These low-power broadcasts via Intelsat will continue alongside the direct-to-home Astra service.

MTV (Music Television) was born in the USA in 1981. There, it now reaches 40 million homes. MTV Europe was launched in 1987 via a low power Intelsat satellite to a cable TV audience of 1.6 million households. At Cable & Satellite '89, they announced that by January this year that had grown to five million.

In February, MTV Europe began broadcasting by Astra—24-hour music, pop-star interviews, news, video releases and programmes covering contemporary music tastes from Hip-Hop to Heavy Metal. The channel is a big hit with the youth audience and with the advertisers who want to sell to them.

During the summer, W. H. Smith Television will begin broadcasting two channels in PAL via Astra—Lifestyle (Europe's first women's channel) and Screensport. But at the end of the year, they plan to abandon PAL and switch over to D-MAC. Then, both channels will be encrypted.

BSB will kick off with three channels—The Movie Channel, Galaxy (family entertainment) and Now (news and current affairs). In January or February 1990, two more will be added—The Sports Channel and The Power Station (pop and style). All BSB's channels will be encrypted and The Movie Channel will charge an additional subscription.

REFORM

The Government seems determined to reform British broadcasting for good or ill. In the more competitive environment that will inevitably come, there will be more broadcasters, more cable television companies, more satellite channels . . . more of everything televisual. But expertise in broadcasting doesn't come overnight.

To meet the needs of a de-regulated Britain, Philips Consumer Electronics has set up a new Videocommunications Group to offer a range of professional cable and satellite systems, equipment and training. With 30 years in the broadcast television business, Philips is well-placed to provide this sort of service to the UK cable and satellite industry.

Cable & Satellite '89 provided an interesting window on the satellite television industry. The number of manufacturers introducing products and providing services gives the industry an air of solidity and credibility. A visit provided reassuring evidence that there is more to satellite TV than Rupert Murdoch's Sky Television and Alan Sugar's Amstrad, despite the national press's fascination with these two personalities and their companies. This relatively new branch of the entertainment industry appears to be growing and gathering momentum. □

TEACH-IN SERIES

TWO SPECIAL PUBLICATIONS

FROM EVERYDAY ELECTRONICS

THE FIRST "TEACH-IN" BOOK

ONLY £1.95 plus P & P

By Michael Tooley BA and David Whitfield MA MSc CEng MIEE

A comprehensive background to modern electronics including test gear projects. This 104 page, A4 size book forms 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.

This book is an excellent companion for anyone interested in electronics and will be invaluable for those taking G.C.S.E. or B.T.E.C. electronics courses. ***ORDER CODE: EE/T-I***

TEACH-IN 88/89 BOOK

£2.45 plus P & P

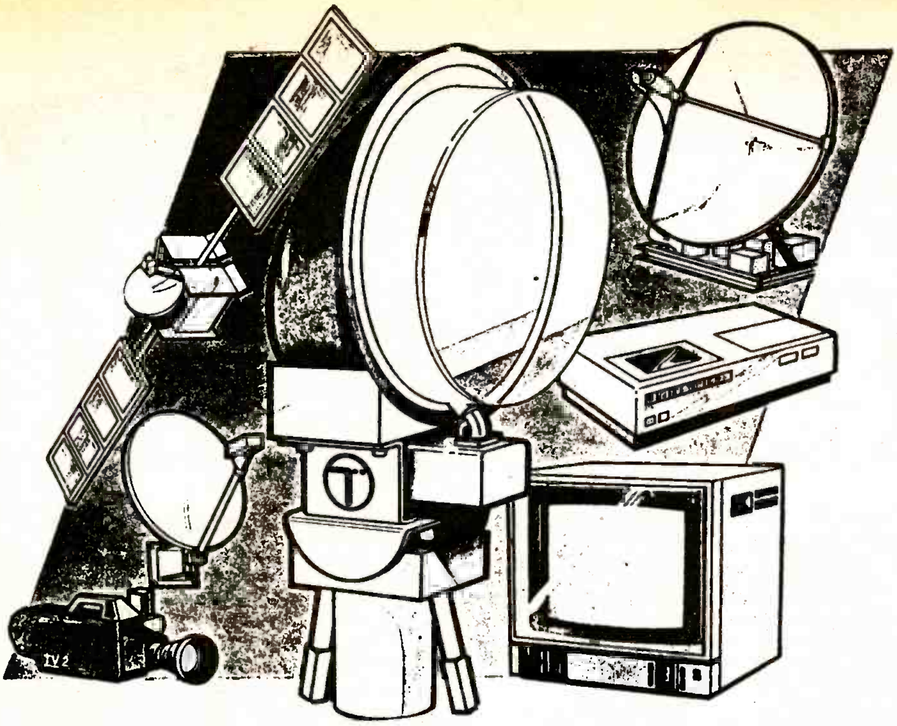
A complete City and Guilds Certificate Course for 726/303 Introductory Microprocessors

Written by Mike Tooley BA this course can lead successful readers to a City and Guilds Certificate. Everything you need to know is included—even pre-test papers, etc.

From Terminology, Integrated Circuits and Logic Families in Part One, the course progresses in easy stages up to High- and Low-level Languages, Flow Charts and Assembly Language. Also featured is a range of eight Data Pages giving information on popular microprocessor chips. A comprehensive index is included, making this a valuable reference manual.

ORDER CODE: TI 88/89

SEE *DIRECT BOOK SERVICE* pages—for full ordering details



Millimetre-wave Multichannel Multipoint Video Distribution Service

By George Hylton

IN THE little Suffolk township of Saxmundham, chimney stacks are sprouting poles carrying 15-centimetre aerial dishes. These are directed, not towards some space satellite, but to the roof of the local telephone exchange. There, a number of tiny transmitters relay television programmes—one transmitter for each channel.

This is an experiment in local TV distribution by microwave relays. It's called a Millimetre-wave Multichannel Multipoint Video Distribution Service, or M³VDS for short. This inelegant title masks some neat engineering by British Telecom, who are installing the Saxmundham project as a demonstration and field test of a TV distribution system which could carry 25 channels, is relatively cheap and is ideal for small towns.

The idea is to collect TV programmes from a number of sources (satellites, local BBC and commercial stations, cable links, video recorders, local studios), convert them to micro-wave on about 30GHz and distribute them by means of low-power (100mW) transmitters with a range of a mile or two. The customer would get high-quality pictures and Telecom would rent the distribution facilities.

FREQUENCY

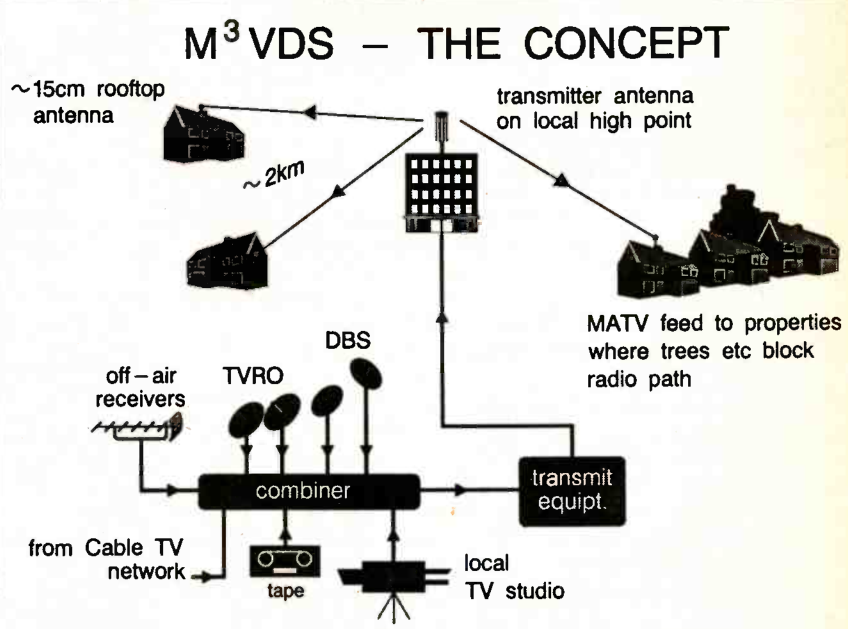
The novel feature of this system is the choice of frequency. Most proposals for microwave TV systems (and some working systems abroad) use frequencies of a few GHz (wavelengths of a few centimetres). Telecom's choice of 30GHz (wavelength 10 millimetres) is based on the belief that only by going to this band will it be possible to find enough channel space for a national system.

The essential engineering need is to avoid co-channel interference from transmitters in the next town. With (ultimately) hundreds of local systems in simultaneous use this means keeping frequencies used in an area well separated. Only at 30GHz and above is there enough available bandwidth to achieve adequate frequency separation and so avoid co-channel interference.

COST

Millimetric radio is expensive. The higher the frequency the higher the cost. Telecom research laboratories (at Martlesham near Ipswich) have made great strides towards getting the costs down. They have designed integrated circuits (using gallium arsenide as a substrate) which carry out the functions required to down-convert the millimetric frequencies to what can be handled by a domestic TV fitted with a translator for transforming the f.m. used for distribution into a conventional TV signal. (Translators will be mass-produced for satellite TV reception so should be inexpensive.)

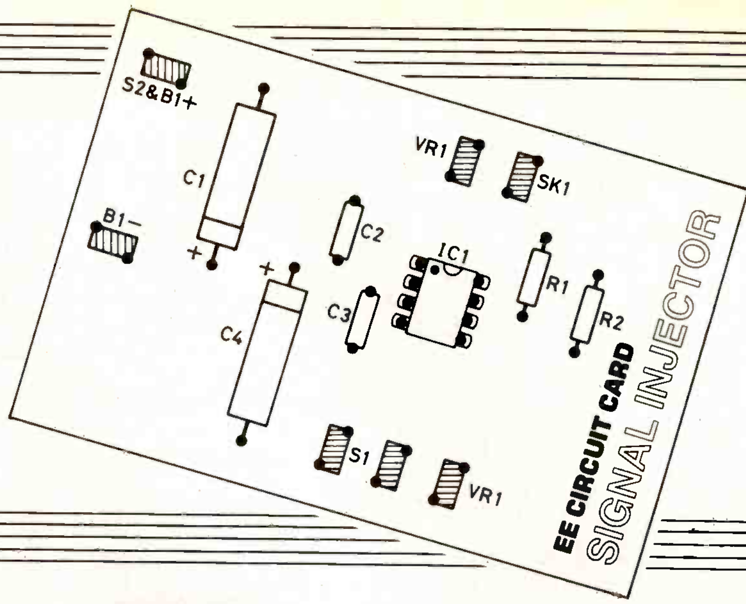
At present, Telecom is using several GaAs i.c.s at each receiving point, but it is hoped to coalesce these into just one or two. The estimated cost of a domestic user's extra equipment is about the same as for satellite TV reception, but of course the potential number of channels is larger.



M³VDS. A test system has been established by British Telecom Research Laboratories to demonstrate feasibility, practicability and the readiness of economic MMWIC (monolithic millimeter-wave integrated circuit) technology.

Circuit Card Project

SIGNAL INJECTOR



ROBERT PENFOLD

An easy to build, inexpensive item of test gear that could prove itself invaluable to any reader.

MOST electronic testing takes the form of initial checks to narrow down the area of the fault to one particular stage, followed by more detailed checks to determine exactly which component is faulty. A signal injector is a very useful device that is primarily used for the narrowing down process, but which can sometimes be used for more precise checks. Basically all it does is to generate an audio frequency signal that can be coupled into various stages of audio frequency equipment.

Most signal injectors, including the present design, produce strong harmonics (multiples) of the fundamental audio frequency. These extend well into the radio frequency spectrum, and enable the unit to be used for checks on some kinds of radio receiver (including long and medium wave broadcast sets).

FAULT-FINDING BASICS

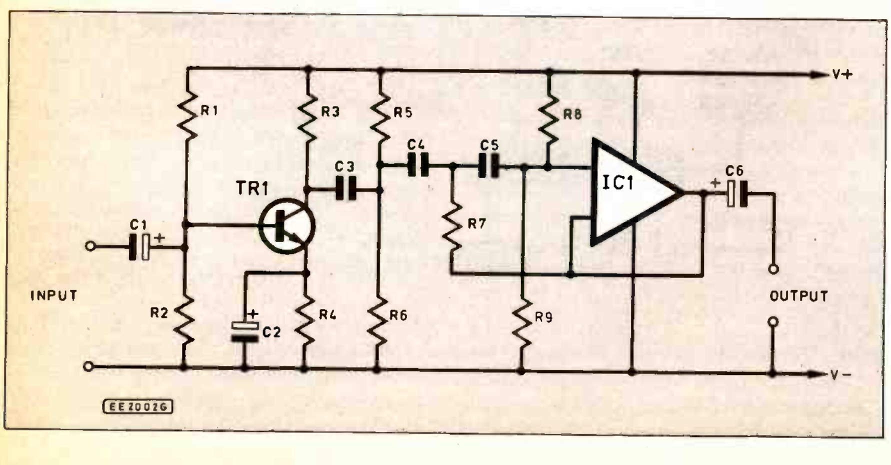
A signal injector is used to test a piece of equipment that has a series of amplifiers or other signal processing stages (tone controls, etc.) The general idea is to inject the signal at the output first, and then gradually work forwards towards the input, injecting the signal at strategic points.

Each test should produce an output from the loudspeaker, headphones, or whatever is being used to monitor the output signal. However, if there is a fault in the unit, at some point the signal will be injected and no signal (or perhaps an inadequate signal) will be forthcoming from the loudspeaker. The fault then lies somewhere in the region of this last test and the previous one.

In fact you can work the other way round, starting at the input and working towards the output of the unit under test. It is then a matter of injecting the signal at various points until a proper signal is obtained from the loudspeaker. Again, the fault will lie somewhere in the region of the ultimate and penultimate test points.

There is a body of opinion in favour of making the initial test point somewhere in the middle of the signal chain, with subsequent checks being ahead of or after this point, depending on the result of this initial check. Whichever of these three methods you adopt, or if you adopt a random approach to selecting the test points, the basic idea is still to find successful and unsuccessful test points close together in the signal chain.

Fig. 1. Typical circuit which can be tested with the Signal Injector.



EXAMPLE

A circuit of the type that can be checked using a signal injector is shown in Fig. 1. This is a common emitter amplifier based on TR1 and a two stage highpass filter having IC1 as the buffer amplifier. Feeding even a weak signal to the input should produce a strong output due to the high gain of the amplifier. Assuming that this test fails to give a suitable output and that the circuit is faulty, the next injection point would be at the base of TR1. If this gives a proper output from the circuit, then C1 is clearly not coupling the signal through to TR1, and has presumably gone open circuit (or perhaps it is connected via a "dry" joint).

If this check is successful, the next test point is at the collector of TR1. When using a signal injector you need to bear in mind that connecting the output of the injector to the output of a stage in the test circuit is not necessarily a good idea. It could conceivably result in damage to the injector or the circuit being tested. This is unlikely, but it is quite probable that the output will heavily load the output of the injector so that only a low output level is obtained.

In this case the output impedance of TR1 is relatively high, and the injector should have no difficulty in inserting a fairly high signal level here. It should also have no difficulty in injecting a signal into the subsequent test points at the junctions of C3/C4, C4/C5, and C5/R8.

The output of IC1 is a different proposition, and operational amplifiers (and most other integrated circuit amplifiers for that matter) have a very low output impedance. It would not be advisable to inject a signal into the output of IC1. A much better approach would be to disconnect the positive terminal of C6 from the circuit board, and to inject the signal into this lead.

If a circuit has a lot of stages with low output impedances it might be better to adopt an alternative method of fault finding, such as using a signal tracer (as described elsewhere in this issue).

CONCLUSIONS

With any electronic testing you should try not to jump to conclusions. There is a very big difference between jumping to conclusions and reaching reasoned conclusions. For example, if applying a signal to the right hand end of C5 produces an output signal, but injecting the signal at the left hand end does not, a fault in C5 is the obvious conclusion. There is another possibility

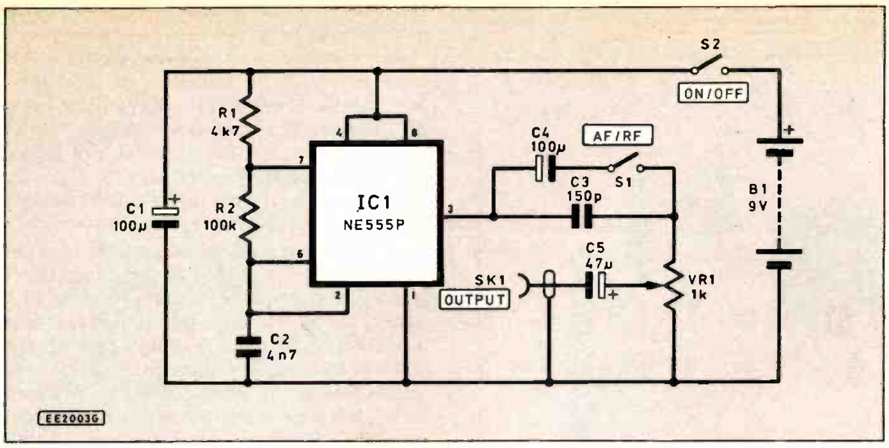


Fig. 2. Circuit of the Signal Injector.

though, which is that R7 has gone short circuit, and is therefore short circuiting this test point to the output of IC1.

Signal injecting will often only indicate the general area of the fault, and some further testing may be needed in order to locate it precisely. In this example one end of R7 could be disconnected. If this restores the output signal, then it is R7 that is faulty. If not, then the defective component is indeed C5. Alternatively, a multimeter could be used to check the resistance of R7.

THE CIRCUIT

The circuit diagram of the Signal Injector is shown in Fig. 2. This is little more than a 555 timer integrated circuit used in the standard astable configuration. There is some advantage in using the TLC555CP low power version of the 555 as this gives somewhat lower current consumption and stronger radio frequency harmonics on the output. The circuit will work quite well with the standard 555 though. Timing components R1, R2, and C2 give a roughly squarewave output at a middle audio frequency of approximately 1kHz.

With S1 in the "RF" position the output signal is coupled via C3 to the output level potentiometer (VR1). The small value of C3 results in the audio frequency content on the output signal being severely attenuated. In theory the audio frequency content of the signal should be irrelevant when the signal is injected into the r.f. or i.f. stages of a radio receiver. In practice a strong audio frequency signal can break through to the output and give misleading results.

When S1 is closed, C4 is switched in parallel with C3, and it then provides full coupling of the output signal through to VR1. C5 provides d.c. blocking at the output so that connecting the unit to a test circuit will not upset the biasing of that circuit. The unit can provide quite a strong output signal, and it is suitable for testing loudspeakers and headphones.

COMPONENTS

Shop Talk see page 398

Resistors
R1 4k7
R2 100k
0.25 watt 5% carbon

Potentiometer
VR1 1k lin.

Capacitors
C1, C4 100µ axial elect. 10V (2 off)
C2 4n7 polyester 7.5mm pitch
C3 150p ceramic plate
C5 47µ axial elect. 10V

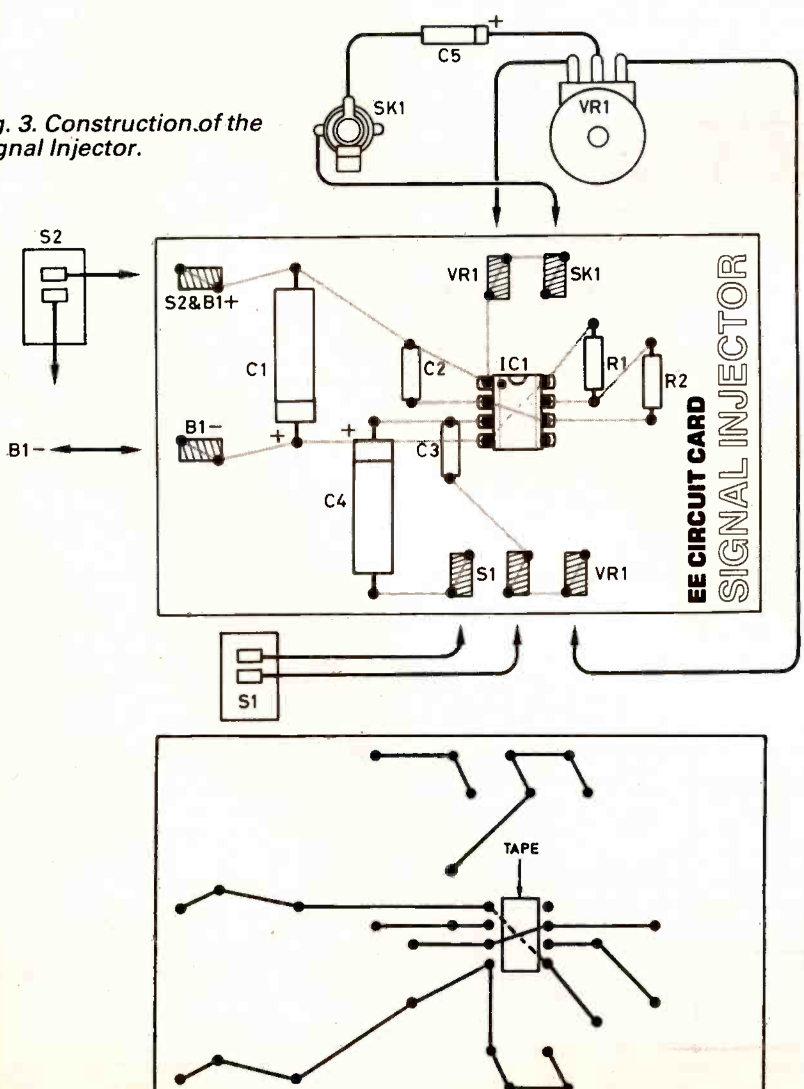
Semiconductor
IC1 NE555P or TL555P timer

S1, S2 s.p.s.t. sub-min toggle switch (2 off)
B1 9 volt (PP3 size) battery
SK1 3.5mm jack socket (see text)

Battery connector; 8 pin d.i.l. i.c. holder; case; Free *EE Circuit Card* or Easiwire board; control knob; wire; etc.

Approx. cost Guidance only £3 plus case.

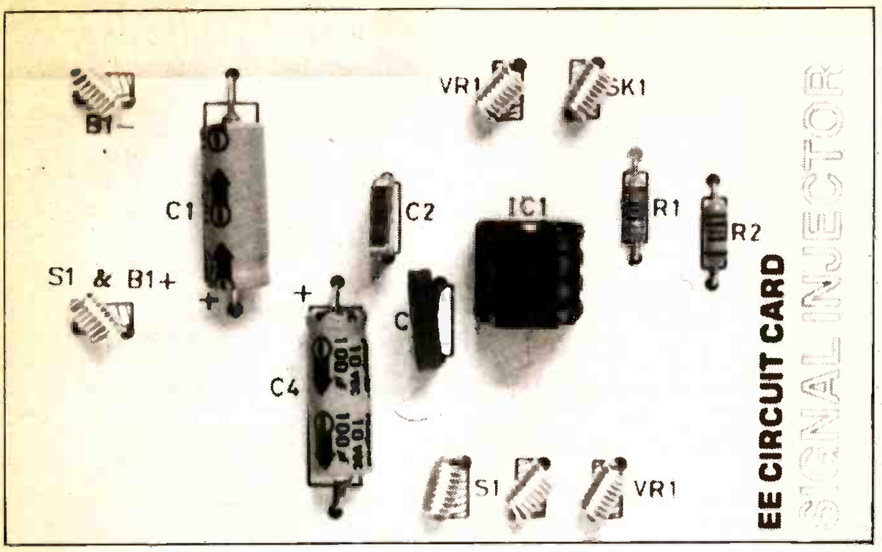
Fig. 3. Construction of the Signal Injector.



CONSTRUCTION

Details of the circuit board and wiring are provided in Fig. 3. Please read the *Using Your Circuit Cards* item before going ahead with circuit assembly. Construction of the board is fairly straightforward, but be careful to get the orientations of C1, C4, and IC1 correct. There is a crossover connection on the underside of the board between IC1's two rows of pins. Put in one of these wires and then cover it over with insulation tape at the appropriate place so that it is insulated from the wire that is taken over the top of it.

In places there are several wires running close together. It is important to keep these wires quite taut so that there is no risk of them accidentally short circuiting to one another.



The components should fit into virtually any small plastic case. The controls and SK1 are mounted on the front panel, with the circuit board mounted on the base panel. I used a 3.5 millimetre jack socket for SK1, but virtually any two-way socket can be used here. Two single-way sockets such as 2 millimetre types are also suitable. They might be less fiddly to wire up.

The board can be mounted on stand-offs, or it can be fixed in place using M3 or 6BA bolts. If it is bolted in place you must include short spacers over the mounting bolts. Without these, the components will be forced from the circuit board as the mounting nuts are tightened!

The point to point wiring is not too difficult. The connections to the board are made via the Easiwire plugs which are "crimped" onto the leads. The other ends of the leads are bound to the component tags using the Easiwire "pen". Note that C5 is mounted off-board, and is wired direct to SK1 and VR1. Take care to connect it the right way round as it is a polarised type.

TESTING

With the unit switched on and connected to a loudspeaker, headphones, or earpiece you should hear the audio output tone. Adjustment of VR1 should control the volume. With S1 switched to the "RF" position the tone will probably still be audible. However, it should sound very "thin" with most of the fundamental and lower harmonics being filtered out. It may be barely audible if the output is fed to a low impedance loudspeaker.

A more useful check is to connect a set of test leads to the output of the unit, and to place the non-earthy lead very close to a radio receiver tuned to the long or medium wavebands. The radio should pick up the harmonics and produce the audio tone regardless of the setting of the tuning control (except that strong transmissions might operate the receiver's automatic gain control circuit and leave the tone barely audible).

USE

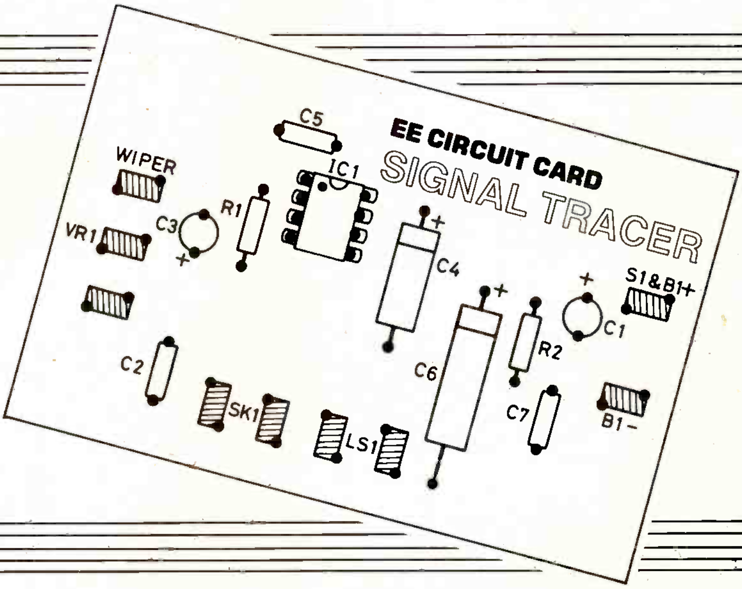
In use the earthy test lead connects to the chassis of the piece of equipment being checked, and the other test lead is applied to the test points. It is best to keep VR1 well backed off and to only advance it when applying a signal to a part of a circuit that really requires a high signal level. Otherwise there is a risk of the signal breaking through to the output and giving misleading results.

One final but important point is that **only those who are suitably experienced should service mains powered equipment. Using this device to test mains powered equipment that does not incorporate an isolation transformer could prove lethal.** □

Circuit Card Project

SIGNAL TRACER

ROBERT PENFOLD



The last of our Easiwire Free Circuit Card projects, but not the least. This useful device will find many applications.

A SIGNAL tracer is used in much the same way as a signal injector (as described elsewhere in this issue), but I suppose could be regarded as the inverse of an injector. Rather than generating a signal, it takes a signal from the test circuit, amplifies it, and feeds it to a loudspeaker. In other words, it is just a reasonably sensitive audio power amplifier and a loudspeaker. It could be regarded as the electronic equivalent of a stethoscope.

Apart from use as a signal tracer, this unit is one of those general purpose items of equipment that no electronics hobbyist should be without. A device of this type proves to be indispensible on numerous occasions when testing projects or just dabbling with circuits. It can save hours of time being held up by what turns out to be a simple problem with a broken socket, short circuited plug, etc., as well as sorting out more difficult problems.

TRACING TECHNIQUE

As when using a signal injector, the basic idea of signal tracing is to find a break in the signal chain. It is used for testing the same types of equipment, which means linear circuits having a series of amplifiers or other signal processing stages.

If a signal tracer was used to check the test circuit in the *Signal Injector* article (Fig. 1 of that article), the first requirement would be that a suitable signal should be applied to the input of the circuit. A signal tracer must have a signal to trace! This signal could be provided by a signal injector or generator, but where possible I prefer to

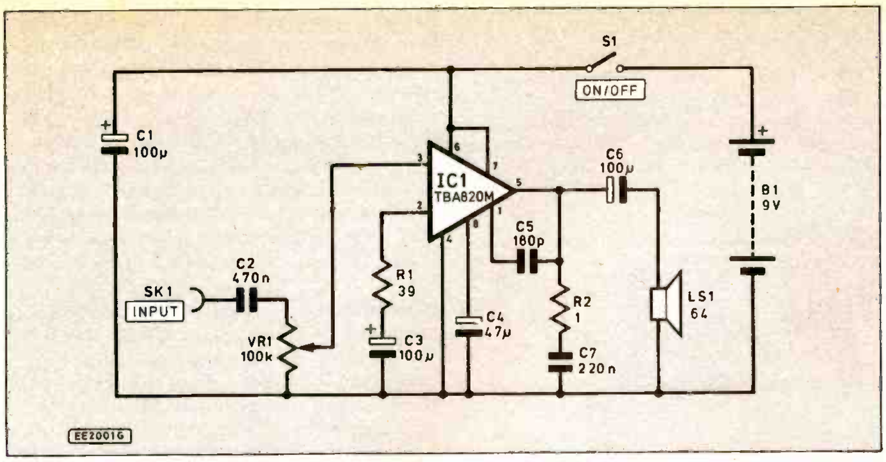


Fig. 1. Circuit diagram of the Signal Tracer.

use the normal signal source for equipment. One advantage is that this automatically provides the equipment with an input of the correct amplitude. Also, you will not always be searching for a complete break in the signal path. The problem might be one of distortion, and any distortion will probably be more noticeable on a speech or music signal than on a simple test signal.

In common with signal injection testing, you can start at the input, the output, or in the middle. For this example we will assume that the starting in the middle technique is to be adopted. An acceptable first test point would therefore be at the junction of C3 and C4 (Fig. 1, *Signal Injector* article). If a suitable signal is detected here, then the fault lies at some later point in the circuit. If no signal is present at the test point, then the fault is here, or at some earlier point in the circuit.

This test point is at the output of a high gain amplifier, and it would be reasonable to expect a reasonably high signal level here. If the volume control of the amplifier needs to be advanced more than a few degrees from its minimum setting, this would tend to indicate a fault in TR1 and its associated components.

For the sake of this example we will assume that the signal is either not detected, or is at a grossly inadequate level. We must therefore try earlier points in the signal path in an attempt to find one that does provide a signal. If (say) the signal is present at both sides of C1, but appears at the collector of TR1 and in subsequent stages at only about the same level, this would suggest that TR1 is failing to amplify the signal properly and is faulty.

The problem could be due to a fault in one of the other components in this part of the circuit though. C2 going open circuit or not being connected properly would result in low gain through TR1. It is easy to test for this using the signal tracer, and it is just a matter of checking for a signal at the emitter of TR1. The decoupling effect of C2 should result in no significant signal here.

If the signal level at TR1's emitter is much the same as the signal level at its base, this would suggest that C2 is not having any effect on the circuit. A signal tracer is just as useful for detecting signals where there should be none present, as it is for finding signals that are "absent without leave"!

CIRCUIT

There are a number of small audio power amplifier integrated circuits which could be used as the basis for a unit of this type. I chose the TBA820M as it is readily available, has quite a good specification, and is well suited to battery operation. It will work on supply voltages as low as three volts, and it has a low quiescent current consumption of only about four milliamps. The full circuit diagram for the Signal Tracer appears in Fig. 1.

The input signal is coupled via d.c. blocking capacitor C2 to volume control VR1. From here the signal is coupled straight into the non-inverting input of IC1. No d.c. blocking capacitor is needed here. In fact VR1 acts as the input bias resistor for IC1, and so it is essential that no input coupling capacitor should be used.

Capacitor C5 provides a small amount of high frequency attenuation which aids the stability of the circuit. This does not significantly affect the unit's audio frequency response. C4 is a decoupling capacitor that helps to avoid problems with instability due to feedback through the supply rails (as does the main supply decoupling capacitor, C1)

GAIN

The voltage gain of the circuit is controlled by an internal feedback resistor, and discrete feedback components R1 and C3. The specified value for R1 gives a voltage gain approaching 200 times, and an input of only about ten millivolts r.m.s. will drive the amplifier to full output power.

In this application there is an advantage in high sensitivity and high input impedance as this enables very weak signals to be detected. The gain and input impedance could be made higher by raising the value of VR1 and reducing the value of R1. The specified values probably represent the best compromise for these components, since boosting the gain and input impedance would risk instability due to stray feedback, and would reduce the output quality. The sensitivity is quite good anyway. Remember that 10 millivolts is needed for full output power, but inputs of well under a millivolt will produce a clearly audible output.

Capacitor C6 couples the output signal to a high impedance loudspeaker (LS1). The maximum output power into a high impedance speaker is not very high, and is less than 100 milliwatts r.m.s. This should be sufficient for the present application, but an eight ohm impedance loudspeaker can be used if a higher output power is requred (at the expense of current consumption and therefore battery life). R2 and C7 are needed in order to prevent high frequency instability.

Although the quiescent current consumption of the circuit is typically only four milliamps, the current drain rises significantly at high volume levels. Using a high impedance loudspeaker the average current consumption is still only likely to be about 10 milliamps or so, and a PP3 size battery should be adequate. I would recommend a higher capacity type (such as six HP7 size cells in a holder) if an eight ohm impedance loudspeaker is used.

CONSTRUCTION

The circuit and wiring are shown in Fig. 2—please read the *Using Your Circuit Cards* piece before going ahead with construction. Assembly of the board presents few problems, but be careful to get IC1 and the electrolytic capacitors fitted to the board the right way round.

There are no cross-overs in the underside wiring, but the wire that goes between IC1's two rows of pins comes quite close to one of the pins to which it does not (and must not) connect. It is advisable to curve it slightly so that it is kept well clear of this pin (pin 6). It is not necessary to completely cover the circuit card with Easiwire double-sided adhesive backing material—a small piece between IC1's rows of pins should suffice. In fact a small piece of insulation tape placed over this wire is probably the easiest way of holding it in position.

COMPONENTS

Shop Talk see page 398

Resistors
R1 39
R2 1
0.25 watt 5% carbon

Potentiometer
VR1 100k log. carbon

Capacitors

C1, C3	100µ radial elect. 10V (2 off)
C2	470n polyester 7.5mm pitch
C4	47µ axial elect. 10V
C5	180p ceramic plate
C6	100µ axial elect. 10V
C7	220n polyester 7.5mm pitch

Semiconductor
IC1 TBA820M

Miscellaneous

SK1	Standard jack socket (see text)
LS1	64 ohm impedance loudspeaker, about 50-80mm diameter
B1	9 volt battery (PP3 size)
S1	s.p.s.t. sub-min toggle switch

Battery connector; 8 pin d.i.l. i.c. holder; case; Free *EE Circuit Card* or Easiwire board; control knob; wire; etc.

Approx. cost Guidance only £6 plus case

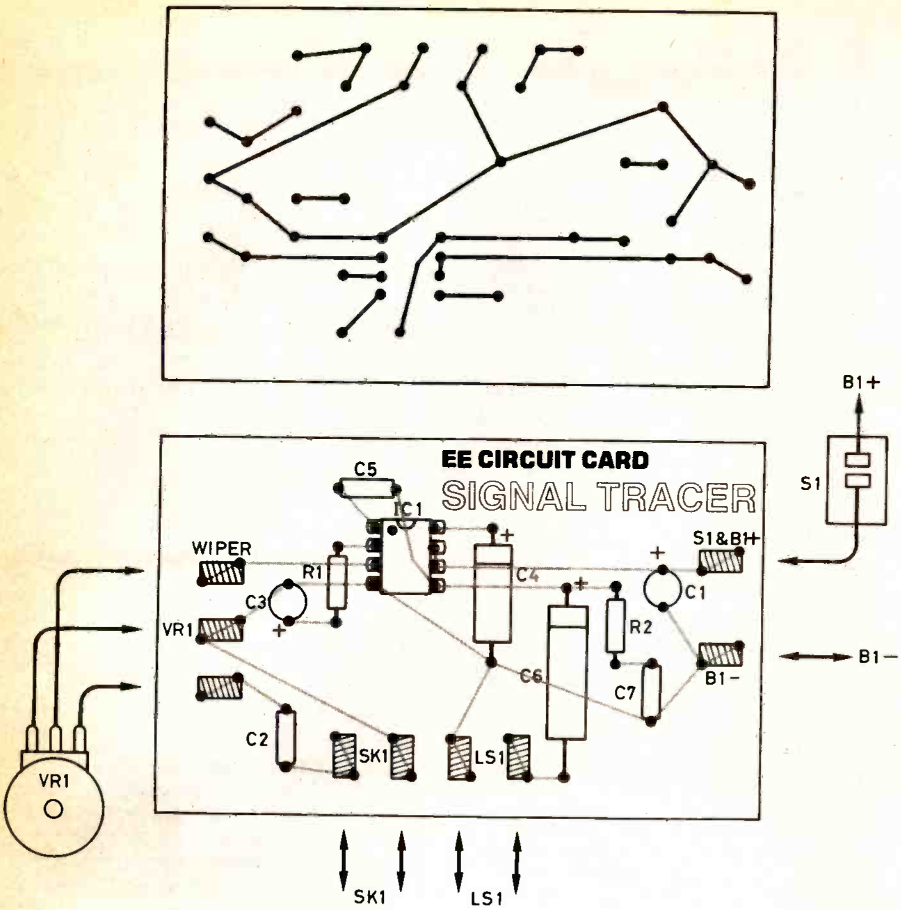
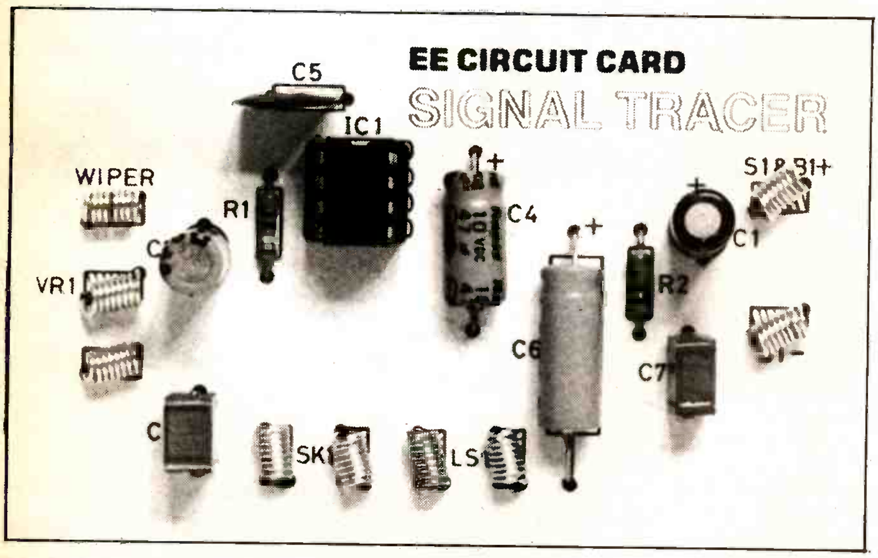


Fig. 2. Construction of the Signal Tracer.



Note that the negative supply rail cannot be handled by a single length of wire. However, there is no difficulty in fitting the main wire and then adding the branch wire which carries the earth connection to LS1.

The unit should fit into most small plastic cases, but be careful to choose one that will provide sufficient space for the loudspeaker. A grille for the loudspeaker must be made in the case. The easiest way of doing this is to drill a matrix of small holes (about five millimetres in diameter will suffice). Take care to position the holes accurately, as it easy to make a slightly sloppy job of this.

Miniature loudspeakers rarely have provision for screw fixing. Consequently, it will almost certainly have to be glued in place using a good quality general purpose adhesive. Avoid smearing any adhesive onto the diaphragm as this could seriously impair the audio output.

Try to arrange the layout so that the wiring to VR1 and SK1 is not intermingled with that to the loudspeaker. This would encourage stray feedback and instability. The input wiring should be kept as short as possible in order to discourage stray feedback and the pick up of mains "hum" or other interference. I used a standard jack for SK1, but any audio connector should suffice. You could even just drill an entrance hole for the test leads in the case and connect them direct to the circuit board.

IN USE

Ideally the test lead should be a screened type, such as those used with oscilloscopes. Ready-made test leads of this type can be quite expensive though, and two ordinary (multimeter type) test leads are a lower cost solution. With these there will inevitably be a certain amount of background "hum" and other pick up, especially when the leads are not connected to a signal source, or are connected to a weak high source impedance signal. With a little ingenuity you will probably be able to make up your own screened test leads.

Connect the earth test lead to the chassis of the equipment under test, and connect the other lead to the various test points. Unless you have the necessary experience and are sure you know what you are doing, **do not try fault finding on mains powered equipment. To do so is potentially fatal.**

Although the unit cannot be used to measure signal levels and calculate voltage gains, you will probably find that after some experience using it you will be able to roughly gauge whether or not test circuits have the correct signal levels. Remember that the more VR1 has to be backed off in order to prevent overloading, the stronger the signal at the test point. □

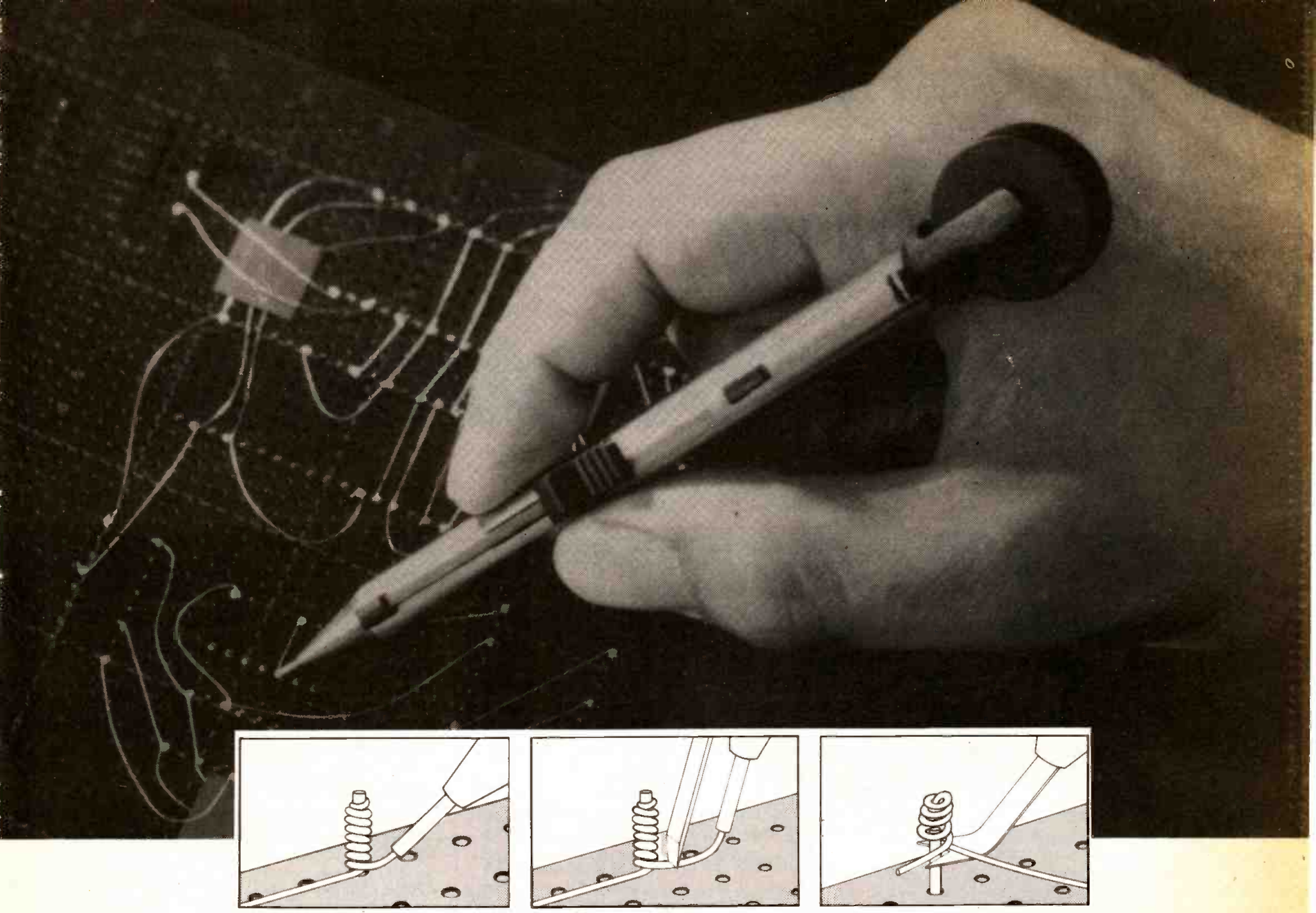
USING YOUR CIRCUIT CARDS

THE CIRCUIT CARDS attached to the front cover of this issue have been specially designed for easy, solderless construction of projects using the BICC-Vero Easiwire system.

HOLE PUNCHING

Carefully remove your Circuit Cards from the cover taking care not to damage them, then cut them in half along the centre line. Next, using the pointed end of the Easiwire unwrap tool, make holes through the board for the component leads. This is best done by placing the Circuit Card, component side up on a piece of thick cardboard or a pad of scrap paper then push the point through the Circuit Card at all the points marked with a "●".

Once all the holes are made you can use the Circuit Card, as described in the special articles in this issue, to build your projects. If you do not have a BICC-Vero Easiwire kit see the special offer on page 441.



EASIWIRE

Circuit construction the easy way.

Solderless, quick and easy to learn. That's Circuigraph Easiwire from BICC-VERO. From now on you'll wonder why you ever used solder to construct your electronic circuits!

Consider the benefits Easiwire offers:

- You need no solder, no chemicals
- You simply wind the circuit wire around the pins
- You can re-use components
- It's easy to change
- The cost is low

What's more, Easiwire is ideal for circuit repairs.

In kit form, Easiwire comes complete with everything you need to construct circuits. That includes a wiring pen with integral cutter, two reels of wire, a component positioning and removal tool – and an instruction book. Of course kit items are available separately too.

VERO
BICC ELECTRONICS

Take advantage of the special offer price now. Complete the coupon below and send it to:

BICC-VERO Electronics Limited,
Flanders Road,
Hedge End,
Southampton, SO3 3LG.

or phone 0489 788774 now with your credit card number (24-hour answering service)

Access VISA

Please rush me................................Easiwire kits.
Special offer price £15. – (includes p & p and VAT).

I enclose cheque/postal order for ....
made payable to BICC-VERO Electronics Limited.

Card number ....

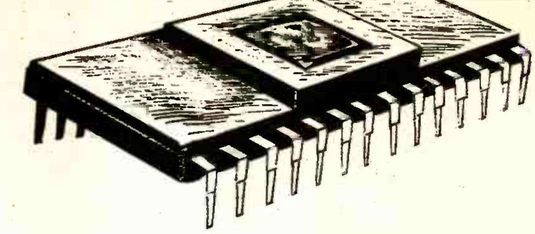
Expiry date ....

Name ....

Address ....

...............................Postcode ....

Signature.......................................Date ....



SPECTRUM EPROM PROGRAMMER

KEN TAYLOR

Construct your own add on EPROM Programmer for your Spectrum. Will program 2716 to 27128's with the exception of 2732.

AS THE uses for EPROMs increase and the prices come down many serious computer users find a justification for a programmer. But the commercial ones aren't cheap so why not construct an add-on unit for your Spectrum? Before we start what do you know of the currently available UV eraseable EPROMs? Perhaps a run through the main features would be useful.

HISTORY

In the dim past, when most memories required three voltages, the 2708 was born. It's only claim to fame was its first two numbers–27. Since then there have been a profusion of EPROMs almost all starting with these two numbers–with the rest of the type number providing information on the size and type of the EPROM.

The next memory to appear was the universally popular 2716. This was double the capacity, having 2 kilobytes of 8 bit words. Now you see what I mean about the ending numbers indicating the size. The sequence has gone on until the present with 27512 and the more recent CMOS type 27C1024. Although this last EPROM is organised as a 64k × 16 bit memory so it does start a change in the rules.

The next bit of standardization was the pin-out. Fig. 1. illustrates the range from 2716 to 27128 and you can see that although they have changed from 24 to 28 pins the output signals on the pins have remained almost unchanged. This amazing consistency of both type identification and pin-out has applied to almost all of the many manufacturers. However before we start to celebrate an electronic "first" there is one feature which has seen changes. This is the programming system.

PROGRAMMING SYSTEM

An EPROM memory unit is a transistor device with an isolated control gate. During programming the gate acquires electrons attracted by the "high" V_{pp} voltage and this inhibits the output when the cell is being read. Thus the programmed cell indicates a zero and the unprogrammed cell a one.

It is immaterial whether the electron charge is built up slowly or acquired in one burst as long as the cell is fully charged. So the original system of giving one 50mS pulse has now changed in favour of a number of short pulses with a monitor check between each to see if the bit has taken. When it has, a few extra pulses are given to fully charge the gate.

Changes have also taken place in the value of the programming voltage V_{pp}. The 2716 EPROM required 25 volts on the V_{pp} pin but as the chip density increased, cell dimensions decreased and to avoid damaging the cell junction, the voltage has been reduced first to 21 volts and latterly to 12.5 volts. This is a critical voltage and **under no circumstances must the maximum rating be exceeded.**

In fact most manufacturers' data sheets emphasise that even spikes on the V_{pp} line must be eliminated. Which is fine if you know the EPROM V_{pp} voltage but this is one parameter not included in the type number. Yet even this is being improved, for while there is still a problem deciding which are which between the 25 and 21 volt EPROMs, the 12.5 volt ones are being marked with the voltage.

One last change in the programming operation. The 12.5 volt EPROMs require that the normal memory supply voltage V_{cc} is increased during programming from 5 to 6 volts. Thus adding one more requirement in the design of the programmer.

To sum up then, we need to be able to program EPROMs from 2716 to 27128 in either normal NMOS or CMOS. The 2716 must be included because there are so many in service but in the interest of rationalisation we can leave out the 2732 which would involve a further problem switching V_{PP}. Three V_{pp} voltages 12.5, 21 and 25 volts will be required and the program should be able to provide either one shot or fast programming pulses. So let's see what the circuitry required for such a programmer looks like.

CIRCUIT OPERATION

The programmer has two main operations; read and program. The read process is simply a case of applying an address and enabling the EPROM output; but the programming as we have already seen is more complex. First the programming voltage V_{PP} (and mabye V_{CC}) has to be set up, then the address and data has to be latched in and finally the program pulse has to be output. This has to be in the correct sense i.e. low high low for 2716 types high low high for 2764 and 27128.

The address and data lines must remain latched for the duration of the pulse or the programming will fail. But as we need to verify the data, the address should stay latched at least until the EPROM has been

27C128 27128	27C64 2764	27C32 2732	27C16 2716	28 PIN	24 PIN		28 PIN	27C16 2716	27C32 2732	27C64 2764	27C128 27128
V_{pp}	V_{pp}	—	—	1			28	—	—	V_{cc}	V_{cc}
A12	A12	—	—	2			27	—	—	PGM	PGM
A7	A7	A7	A7	3	1	24	26	V_{cc}	V_{cc}	NC	A13
A6	A6	A6	A6	4	2	23	25	A8	A8	A8	A8
A5	A5	A5	A5	5	3	22	24	A9	A9	A9	A9
A4	A4	A4	A4	6	4	21	23	V_{pp}	A11	A11	A11
A3	A3	A3	A3	7	5	20	22	OE	OE/V_{pp}	OE	OE
A2	A2	A2	A2	8	6	19	21	A10	A10	A10	A10
A1	A1	A1	A1	9	7	18	20	CE/PGM	CE	CE	CE
A0	A0	A0	A0	10	8	17	19	D7	D7	D7	D7
D0	D0	D0	D0	11	9	16	18	D6	D6	D6	D6
D1	D1	D1	D1	12	10	15	17	D5	D5	D5	D5
D2	B2	D2	D2	13	11	14	16	D4	D4	D4	D4
GND	GND	GND	GND	14	12	13	15	D3	D3	D3	D3

Fig. 1. Comparison of EPROM Pin-Outs.

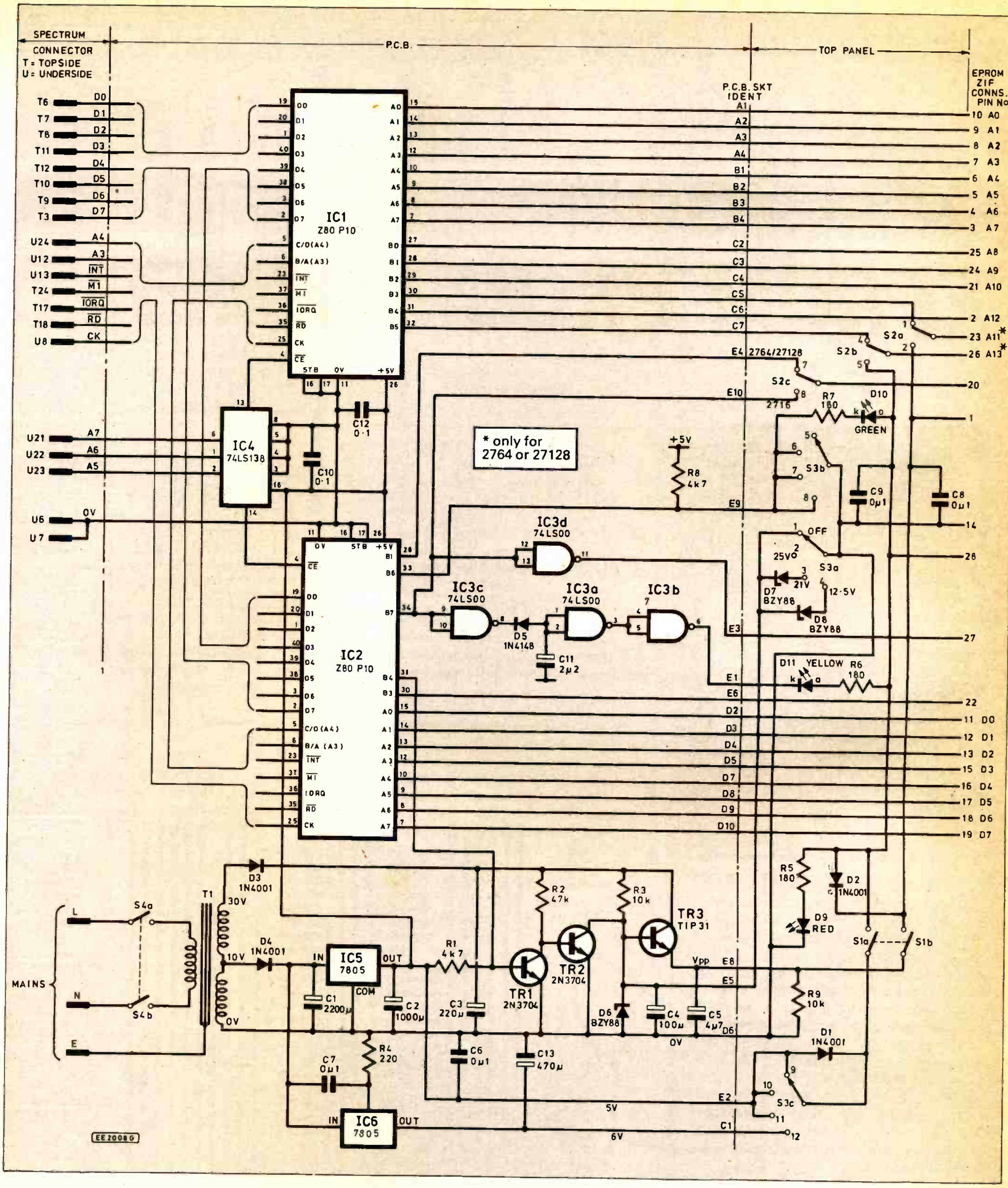


Fig. 2. Circuit diagram of the Spectrum EPROM Programmer.

read and verified. If the data is correct the system moves to the next address, or carries out the extra pulses if in the fast program mode.

SUPPLIES

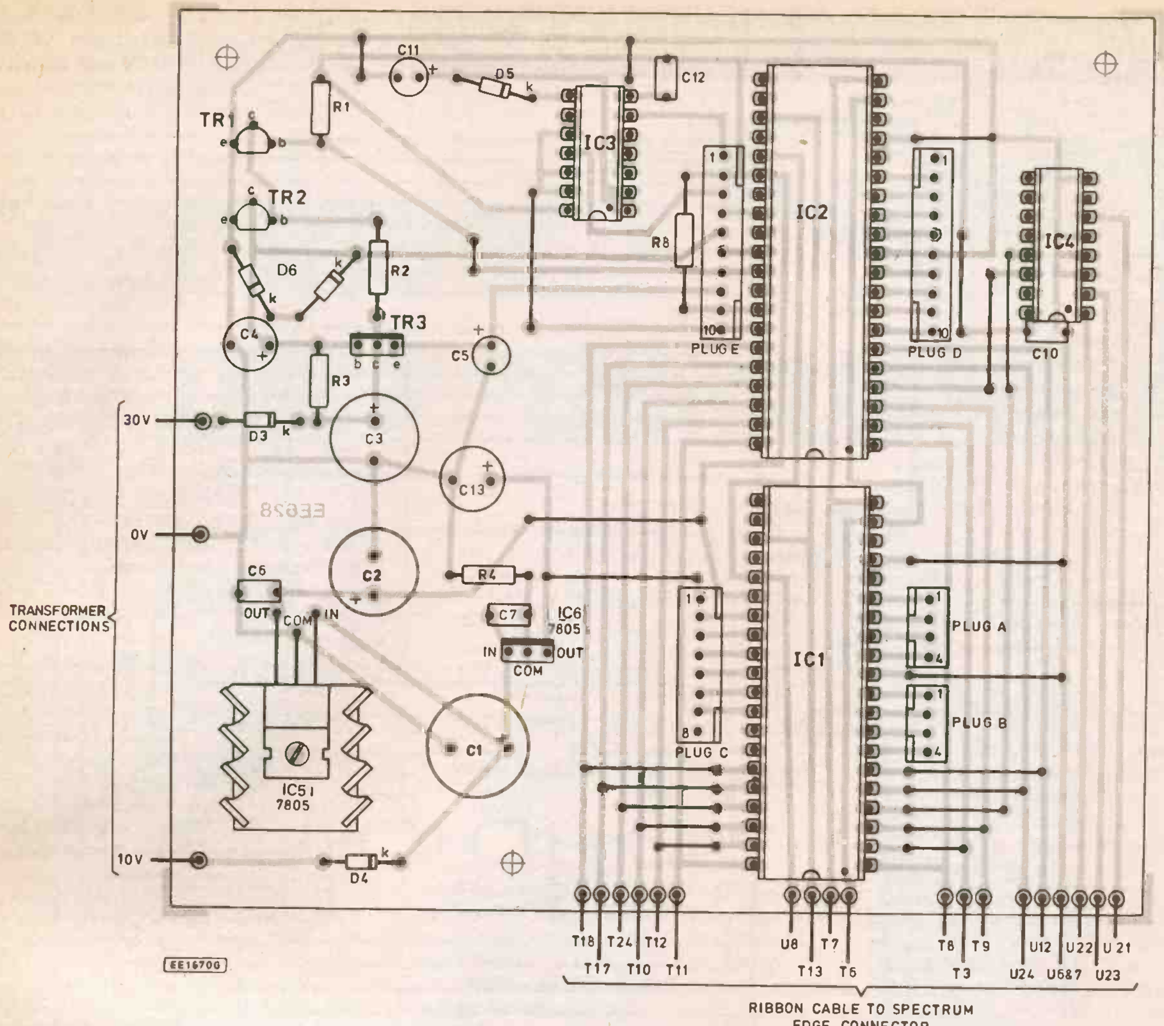
The circuit to operate this sequence is shown in Fig. 2. It connects to the Spectrum expansion port with the connector leads on the left and has its own power supply. This includes regulated 5 volt and 6 volt supplies and a V_{PP} supply which can be set to any of the three standard voltages. This V_{PP} voltage is set by switch S3 but is controlled by the computer program via IC2 pin 31.

A high (5 volts) on this line turns on TR1 which pulls down its collector and the base of TR2 thus turning TR2's output off and allowing the TR3 base voltage to be governed by the setting of S3a. The use of the computer and manual control in this way ensures that V_{PP} is never in excess of 5 volts unless programming is in progress. When the voltage is increased it is brought up slowly by the presence of C4 which prevents the overshoot that otherwise might take place.

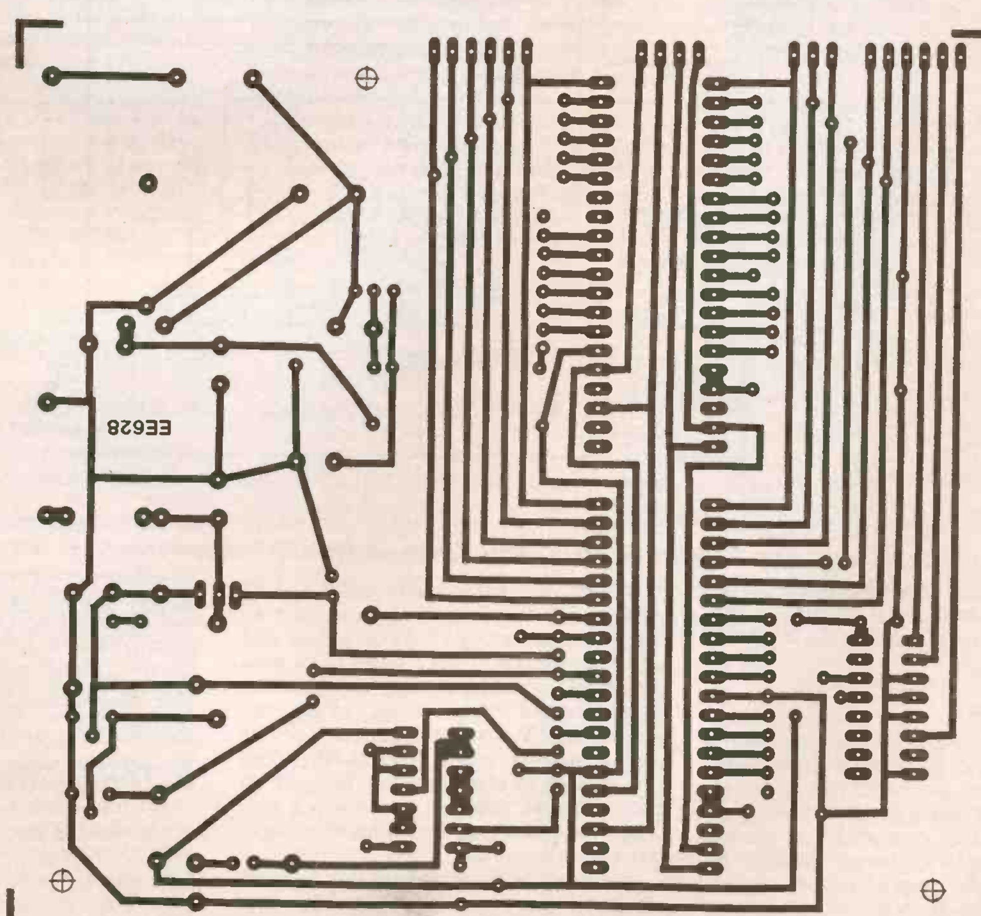
It's worth mentioning here that to avoid any possibility of the V_{PP} voltage being present without V_{CC}, the EPROM must never be removed unless all the voltages are switched off by S1. Switch S3 has the further function of switching the EPROM V_{CC} line from 5 to 6 volts (S3c) when V_{PP} is set to 12.5 volts. The 6 volt supply is developed from IC6 which is a standard 5 volt regulator increased by having R4 in its common line.

INTERFACING

All the computer interfacing including the latching of the address and data lines is carried out by the two Z80 PIOs. These—in case you aren't familiar with them—each have two 8 pin ports which can be set to either input or output under the control of the computer program. Each PIO is



Fog. 3. P.C.B. lay-out and wiring shown full size.



COMPONENTS

Approx. cost guidance only **£45** plus case

Resistors

R1, R8	4k7 (2 off)
R2	47k
R3 R9	10k (2 off)
R4	220
R5, R6, R7	180 (3 off)

All ¼ watt ±5%

Capacitors

C1	2200μ elect. 16V
C2	1000μ elect. 16V
C3	220μ elect. 63V
C4	100μ elect. 25V
C5	4μ7 elect. 63V
C6, C7, C9 C10, C12	100n 16V disc ceramic (5 off)
C8	100n 40V ceramic
C11	2μ2 elect. 100V
C13	470μ elect. 16V

Semiconductors

D1, D2, D3, D4	1N4001 diode (4 off)
D5	1N4148 diode
D6	BZY88 C22 and C3.6*
D7	BZY88 C18 and C3.6*
D8	BZY88 C9.1 and C3.6*

*Zener diodes, see text

D9	5mm red l.e.d.
D10	5mm green l.e.d.
D11	5mm yellow l.e.d.
TR1, TR2	2N3704 transistors (2 off)
TR3	TIP31 transistor
IC1, IC2	Z80 PIO parallel interface (2 off)
IC3	74LS00 quad NAND gate
IC4	74LS138 decoder
IC5, IC6	7805 5V 1A voltage regulator (2 off)

Switches

S1	d.p.d.t. toggle
S2	4-pole 3-way rotary stop set for 2-way
S3	3-pole 4-way rotary
S4	d.p.d.t. toggle 240V a.c. rating

Shop Talk

See page 398

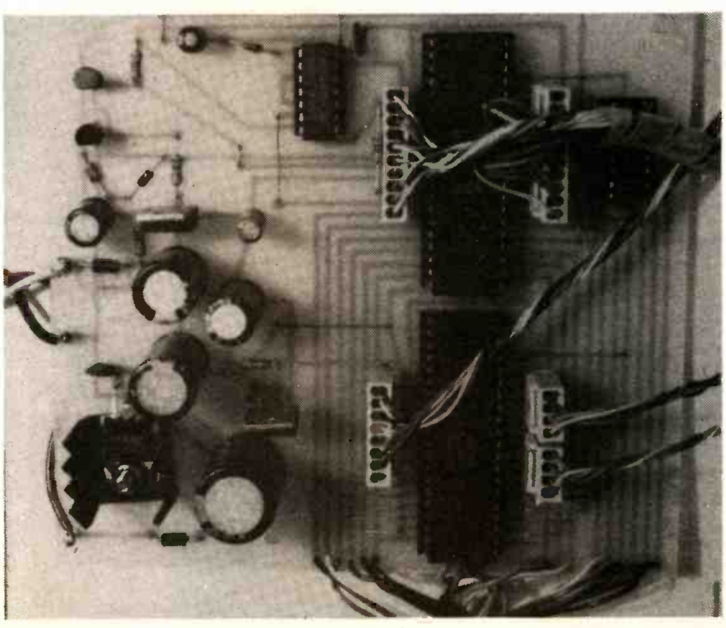
Plugs and sockets

28 pin zero insertion force (ZIF) socket; 14 pin i.c. socket; 16 pin i.c. socket; 40 pin i.c. socket (2 off); 10 pin p.c.b. plugs* (2 off); 8 pin p.c.b. plug*; 4 pin p.c.b. plugs * (2 off); 10 pin cable sockets* (2 off); 8 pin cable socket*; 4 pin cable sockets* (2 off); double sided 2×28 way edge connector; pin extension p.c.b *0.1 pitch plugs and sockets "Minicon" or similar.

Miscellaneous

T1 Multitapped transformer, providing a minimum of 30 volts a.c. at 1A with a tapping at about 10 volts.

Heatsink, size 22×19×19mm high; pointer knobs (2 off); ribbon cable; l.e.d. clips; board pins; small piece of Veroboard for mounting ZIF socket (see text); plastic box minimum internal dimensions 210×130×70mm high (see text)–recommended box is type M8007 desk console 237×182×55/88mm high; printed circuit board available from *EE PCB Service*, Code EE628; software program tape, see Shop Talk.



uniquely addressed using the Spectrum adress lines A3 to A7. Lines A5, A6 and A7 are decoded by IC4 and switch either IC1 or IC2. The other two address lines select the A or B port and set it to send or receive data.

Outputs from IC1 go to the 13 EPROM address lines using both of its ports but each of the ports of IC2 has a different function. Port A is connected to the EPROM data lines and is used to program the EPROM or read the contents of the stores while port B carries out all the control operations.

The port is set so that lines B1, B3, B4 and B7 are in the output mode and B6 is input. B1 outputs the Chip Enable (CE) signal and B3 the Output Enable (OE) signal. B4 operates the V_{pp} voltage while B7 controls the program pulse. The B6 line is pulled high by R8 and switch S3b returns this to 0 volts whenever a V_{pp} voltage is selected. The computer monitors this line to check the switch status.

The layout of the switches, indicators and zero insertion force (ZIF) socket on the top panel of the unit is shown in the photographs. The upper switch S2 selects the two different connection patterns for the EPROMs. As Fig. 1 showed, only pins 20, 23 and 26 require switching because the 2716 EPROMs do not occupy the upper socket positions and the lower pins are common to all the EPROMs.

The lower switch S3, is the V_{PP} voltage selector. In the off position it shorts TR3's base to 0 volts effectively switching the transistor off but in the other positions, one of the Zener diodes sets the base voltage and therefore the V_{pp} voltage. S3 is mounted between the two indicators D10 and D11. These are used to indicate "V_{PP} ON" and "Programming in progress" respectively. The ZIF switch S1 isolates the EPROM socket by turning off both the V_{CC} and V_{PP} supplies. The ZIF indicator (D9) acting as a second reminder to switch off before releasing the ZIF socket lever.

CONSTRUCTION

The main components are assembled on the p.c.b. shown in Fig. 3. This is obtainable from the EE PCB Service, order code EE628. The component layout of the board and the links are shown. Sockets are recommended for all the i.c.'s and the top panel wires should be connected to the board with Minicon or similar plugs and sockets (A to E).

The heatsink shown can be replaced with a simple aluminium channel if you experience any difficulty in obtaining it. Details of the Zener diode values are given in the next section.

If cost is a prime consideration the unit can be built in an MB6 plastic box although you must check that the transformer used will fit. It will almost certainly have to be fastened on its side, to the side of the box. The recommended case is the larger sized "Desk Console" which is only a few pounds extra and, with a sloping top panel, has a very professional appearance. However the top panel is metal and the only way to secure the ZIF socket is by soldering the pins. So if you use this type of box, solder the ZIF to a piece of Veroboard suitably spot faced and fasten the Veroboard over a large clearance hole cut in the panel.

The transformer used is a multitapped one. There are a number available with tappings at various voltages. A minimum of 30 volts is required for the V_{pp} supply and a tapping at about 10 volts for V_{cc}. One amp is more than sufficient current for both.

CONNECTOR

The Spectrum edge connector is wired to one side of the p.c.b. and the ribbon cables brought out through the side of the box. Although it may not look quite as neat it is better to cut the hole in the box wide enough to pass the connector through. However if you use the recommended desk console box you will find the base is removable which greatly simplifies the problem. The slot for the cables can be made just deep enough to trap them and prevent loads on the soldered joints.

The connector on the prototype has a pin extension p.c.b. fitted. This enables an additional unit such as the printer interface described in the January 1989 copy of EE to be connected to the Spectrum. It also facilitates the fitting and removal of the connector to the Spectrum as it is otherwise very difficult to avoid pulling the wires. It is sensible therefore to solder either the extension p.c.b. or a small piece of Veroboard to the connector pins and fasten it securely to the connector with a small fillet of epoxy resin added sparingly between the pins (Fig. 4). The pins and wires can best be insulated with a silicon bath or sink sealer. This sealer is easy to obtain and it is readily removable if a soldered connection has to be remade.

The top panel connections are shown in Fig. 5. Layout is not critical but if the box you are using is restricted in height make sure the switches aren't going to foul components on the board or the transformer. When connecting to the l.e.d.s remember the longest leg is the anode. Take care when mating the plugs and sockets and remember that the A and B, and D and E have the same number of pins. Mixing A and B will only give wrong addresses but mixing D and E could destroy IC2. Pins D1 and E7 aren't used so you could make the plugs non-interchangeable if you wish.

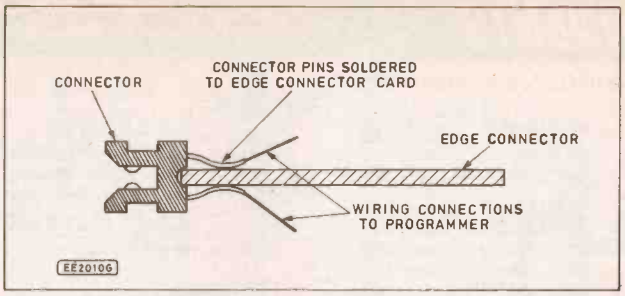


Fig. 4. Connection of an edge connector to the main connector plug.

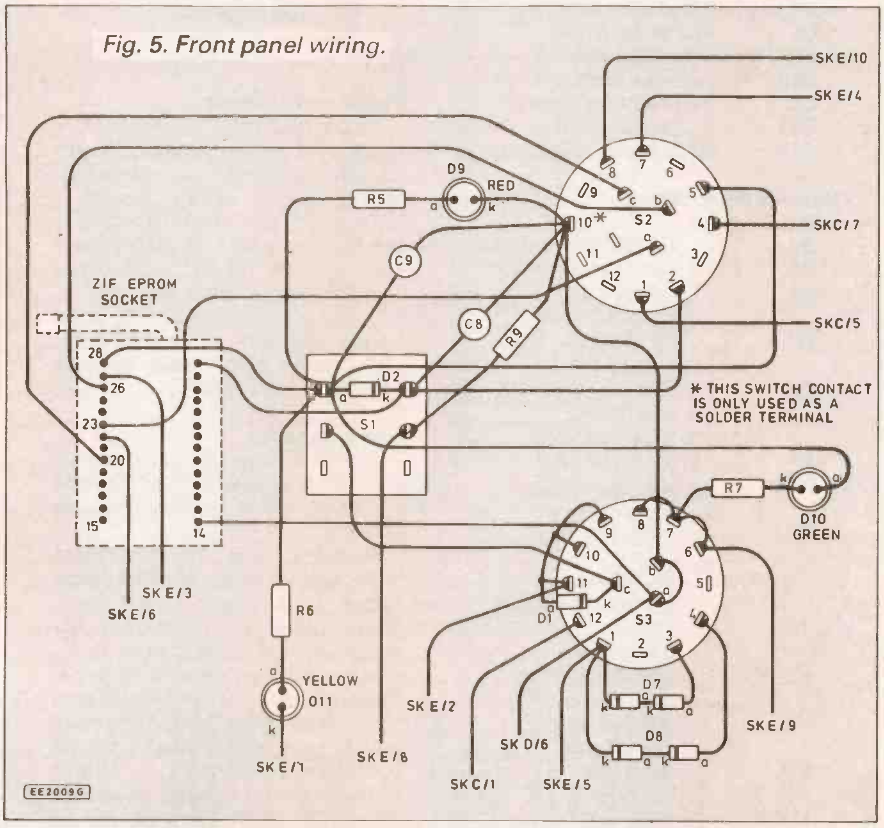
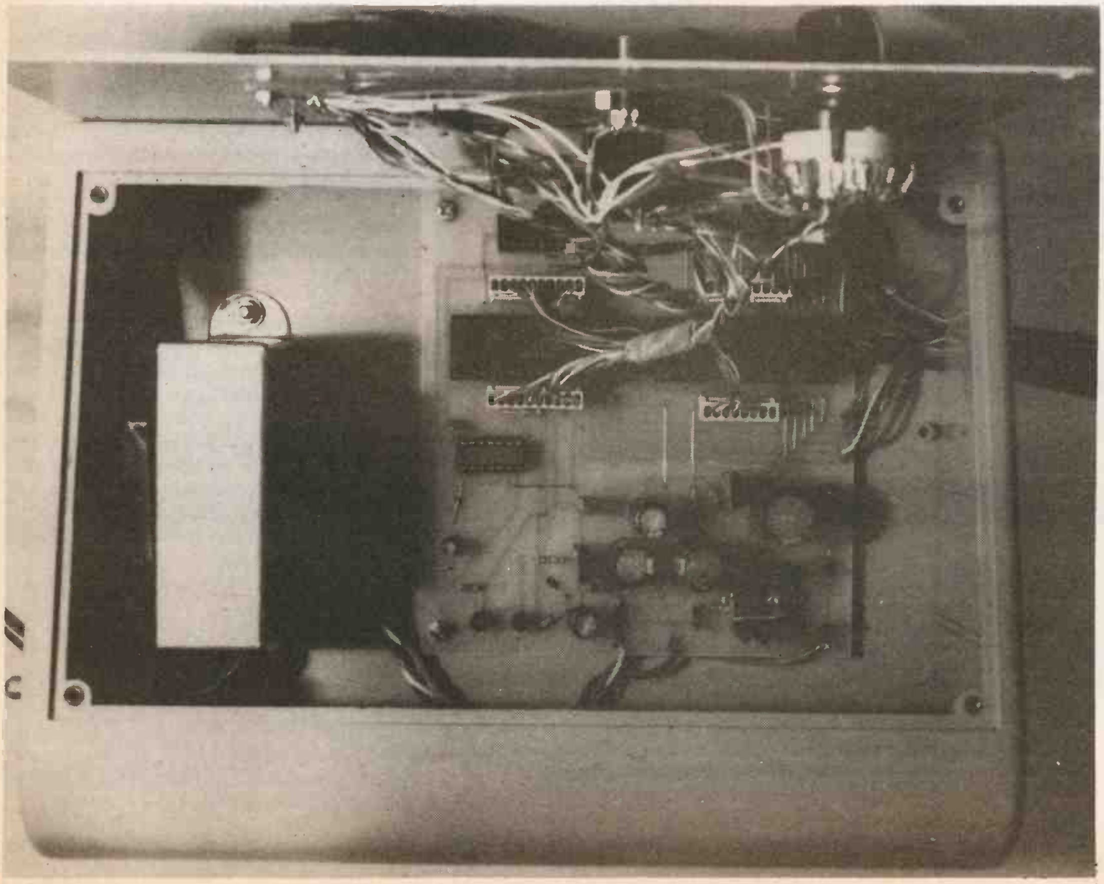


Fig. 5. Front panel wiring.



REMAINING EPROM SOCKET CONNECTIONS

ZIF PIN	CONNECTS TO SOCKET
2	C/6
3	B/4
4	B/3
5	B/2
6	B/1
7	A/4
8	A/3
9	A/2
10	A/1
11	D/2
12	D/3
13	D/4
15	D/5
16	D/7
17	D/8
18	D/9
19	D/10
21	C/4
24	C/3
25	C/2

FINAL ASSEMBLY and TESTING

Connecting the top cover to the p.c.b. and, before fitting the i.c.s, check the complete system, edge connector to i.c. sockets and i.c. sockets to ZIF socket. Then connect the transformer and with the V_{PP} switch set to OFF check the 5 and 6 volt supplies and make sure that the V_{PP} supply is at least 28 volts at TR3 collector. With IC2 removed TR3 can be turned on by the V_{PP} switch allowing you to monitor the V_{PP} voltages at pin 1 of the ZIF socket. The recommended voltages are $12.5V\pm0.5V$, $21V\pm0.5V$ and $25V\pm1V$.

Unfortunately Zener diodes are made in standard voltages and they vary considerably depending on their current so the best way to get these voltages is by trial and error with two Zeners in each position. Use a 9.1, 18 and 22 volt with a 3.6V in series in each case and check the output voltage—at 30mA if you can. Use a couple of other values e.g. 3.3 volt and 3.9 volt to adjust the output if necessary. Finally fit the four i.c.s and the unit should be operational.

OPERATION

The Spectrum program for this unit is over 15 kilobytes long and is being made available on tape—see Shop Talk. However, for those of you who wish to write your own, data is provided at the end of the article to assist. For the rest here is a simple system to check out the unit without blowing up any EPROMs.

Make up a 28 pin header to fit the ZIF socket, with eight resistors of any value 1k to 22k. Common one end of all the resistors and join the other ends to the Data pins i.e. 11, 12, 13, 15, 16, 17, 18 and 19. Now if you join the common to pin 28 (V_{cc}) all the pins will be high and will indicate 255, or if joined to pin 14 (GND) they will all be low and equal to zero. If you use an 8 way d.i.l. switch you can set up any value.

Enter the program given in the software section and you will be able to check the PIO operation albeit in a simple form. Used with the software tape this device will enable most of the Main Menu options to be checked even "Program EPROM".

SOFTWARE TAPE OPERATION

The software consists of a Basic program operating the menu and the slower manual commands and a machine code program to carry out the operations requiring high speed. The two programs effectively occupy the Spectrum memory up to address 40000. Storage of the EPROM contents starts at this address and allows plenty of room for the 16 kilobytes without interfering with the space required for the disassembler.

The machine code consists of a number of related programs each one devoted to a specific task. Addresses or data entered in response to requests in the Basic program are loaded into storage addresses for use in these machine code programs. Similarly information is returned to the Basic program to provide the results of the machine code operation.

To operate the programmer with the taped software first connect the programmer to the Spectrum and switch it on. Then switch on the Spectrum and Load the program. It checks that the V_{PP} switch is OFF and requests the EPROM type being used. Then it presents the main menu shown in Fig. 6b and the following is an explanation of the options:

A. Entering here produces a further option **"S"** Screen display or **"A"** Alter. Fig. 6a. illustrates the former and the data can be selected ineither decimal or hex. **"P"** will provide a print-out—more later—and ENTER produces the next block of data. Alter displays the selected address and requests the new data which is then entered.

B. This is an alternative method of loading data into consecutive addresses.

C. A further **"C"** will display the EPROM contents in a similar form to that of the memory (Fig. 6a.). An **"E"** will verify that the EPROM is fully erased or will quote the first failure address.

D. The program is compatible with the Hisoft disassembler "Mons" and this command transfers to it.

H. This provides hex to decimal or decimal to hex conversion.

L. Loads the tape into the memory addresses specified.

P. The programming command. Single addresses or a block of 16K can be loaded. A 50mS or "Fast Program" sequence can be chosen and if the latter, any pulse length can be selected in 1mS increments and the number of pulses at each address can be set.

S. Saves the selected memory addresses onto tape.

T. The EPROM contents are read and transferred into the computer memory providing a very fast method of duplicating EPROMs. The 2K bytes of a 2716 can be transferred in about two seconds.

The program is user friendly, having default addresses needing only ENTER to select and there is a quick return sequence if the program should crash to Spectrum Basic.

The program is written for the parallel printer interface and program previously articled in *EE*. If a serial printer is used operating from the RS 232 port of Interface 1 the following mods must be made to the program:

Change line 9993 to read: **FORMAT "t";b: OPEN #3;"t"** where **b** is the baud rate of your printer. The printer auto line feed should be OFF.

Note: Microdrives must be disconnected before connecting the unit.

PROGRAMMING THE UNIT

Although a comprehensive suite of machine code programs is required to efficiently operate the unit it is possible to carry out many operations with a few simple commands. The most essential subroutine is the one used to initiate the system. It must be called whenever the unit is switched on **BEFORE** an EPROM is fitted. It sets the PIO's in a "read" state ready to receive further commands. It is given below along with a Basic program which reads and prints a block of EPROM addresses.

The "initiate" program is in machine code but as it is only 23 bytes long it isn't worth providing a code loader. It should be poked into memory starting at address 39168.

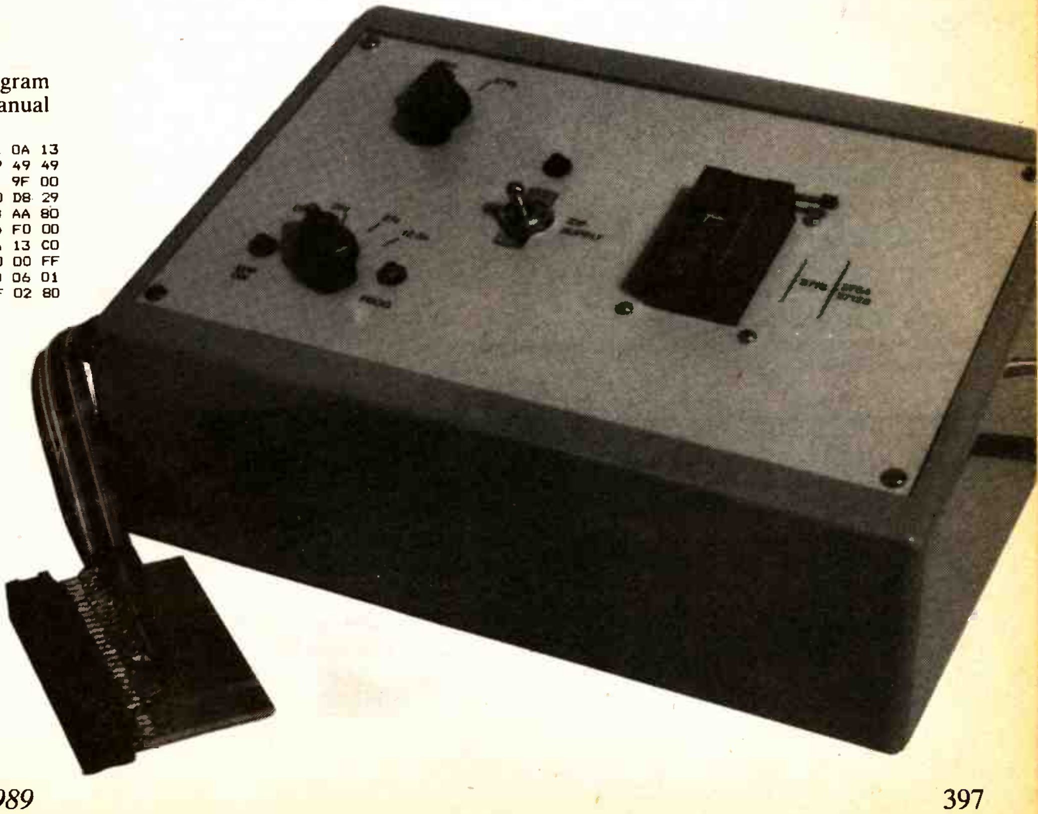
40000 (#9C40)	09	29	A0	00	0E	6E	0A	13
40008 (#9C48)	40	83	4F	29	9C	49	49	49
40016 (#9C50)	BC	1B	01	BA	74	4F	9F	00
40024 (#9C58)	29	9C	08	00	01	00	D8	29
40032 (#9C60)	9E	08	00	00	CC	68	AA	80
40040 (#9C68)	29	9E	08	40	85	C4	F0	00
40048 (#9C70)	28	87	00	3F	00	AA	13	C0
40056 (#9C78)	80	80	80	FF	00	80	00	FF
40064 (#9C80)	02	4F	80	FF	00	00	06	01
40072 (#9C88)	57	30	54	68	AA	6F	02	80

Fig. 6a. Memory contents.

ALTER / CHECK MEMORY STORE	A
LOAD MEMORY STORE from BASIC	B
CHECK CONTENTS of EPROM	C
CALL DISASSEMBLER	D
HEX to/from DECIMAL	H
LOAD TAPE into MEMORY	L
PROGRAM EPROM	P
SAVE MEMORY to TAPE	S
TRANSFER EPROM into MEMORY	T

^ Enter Code for Item required ^

Fig. 6b. Menu.



The code is as follows:
62, 63, 211, 183, 211, 191, 62, 255, 211, 223, 62, 101, 211, 223, 62, 127, 211, 215, 62, 0, 211, 207 & 201.

The Basic program is:

```
10 RANDOMIZE USR 39168
20 FOR n=0 TO 255
30 OUT 167,n
40 PRINT n;" ";IN 199
50 NEXT n
```

This program reads the first 256 addresses. For simplicity I have cheated a bit because I have only called the "A" port of IC1 and relied on all the other address lines being zero. For the next 256 addresses you would have to increment the "B" port thus:

OUT 175,1

and of course both ports should be called every time.

For those of you who want to do your own programming here is a list of the PIO addresses and commands.

IC1			
Port A	Control	183	Set to Output 63
	Data	167	——
Port B	Control	191	Set to Output 63
	Data	175	——
IC2			
Port A	Control	215	Set to Output 63 or Input 127
	Data	199	——
Port B	Control	223	Set to Mode 3 255
	Control	101	This 2nd Control word sets:- B0, B2, B5 and B6 to Input B1, B3, B4 and B7 to Output.
	Data	207	——

Both Port A and Port B of IC1 are always output because they are sending the addresses to the EPROM but the ports of IC2 both alternate. Port A sends and receives the EPROM data and Port B line 6 Inputs the V_{pp} switch signal. Line B4 controls V_{PP} (output "1"=on), B1 and B3 output the CE and OE signals respectively (both active low) and B7 outputs and sets the duration of the PGM program pulse which is always low-high-low.

USING THE PROGRAMMER

One of the greatest difficulties is determining the programming requirements of a strange EPROM. Here is my recommended procedure.

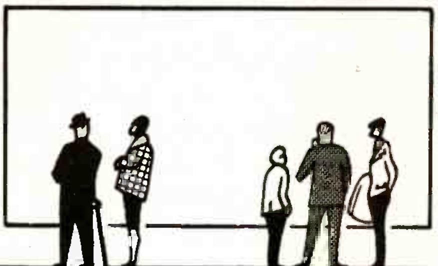
1. Set V_{PP} to 12.5 volts and try programming 00 into a few individual addresses with first 1mS for 10 pulses and if that fails 10mS for 5 pulses.
2. If the above fails repeat with 21 volts and then 25 volts.

You could also try a 50mS pulse at the 21 and 25 volt step. If all this fails, the EPROM is probably faulty.

INTERFACE 1 AND MICRODRIVES

Interface 1 can be used with the unit but due to a clash of addresses any Microdrive must be completely disconnected before the unit is fitted. □

SHOP TALK



BY DAVID BARRINGTON

Design Package

Last month we mentioned the excellent p.c.b design kit from **Kemsoft**, this month comes news that **Number One Systems** of Huntingdon have won a British Design Award for their EASY-PC printed circuit board design package. The EASY-PC is a computer-aided design program that enables preparation of p.c.b. masters and also circuit diagrams to be produced "on screen" before committing to a final printout.

Aimed at the hobbyist user, they have now produced son of EASY-PC. Called TINY-PC it operates at about one tenth the speed of "big brother" and has half its capacity in terms of number of tracks, pads, symbols etc. per board.

For further information and prices of both packages contact: **Number One Systems, Dept. EE, Harding Way, Somersham Road, St. Ives, Huntingdon, Cambs, PE17 4WR. ☎ *0480 61778*.**

Capacitor Tester

We do not expect readers to experience any component buying problems for the *Capacitor Tester* project.

The 10 megohm resistors are listed in most component catalogues and can certainly be found in the one per cent "metal film" range. To make up the 100 megohm resistor R2, which is not available as a single unit, you should, of course, follow the authors guide lines and wire up ten 10 megohm resistors in *series* to obtain the required value.

The CMOS low power op. amp type ICL7611 may prove a little troublesome to locate locally, but it is currently listed by **Cricklewood** and **Omni Electronics.**

Spectrum EPROM Programmer

Most of our advertisers now carry the Parallel Interface (PIO) chips required for the *Spectrum EPROM Programmer* and this should not cause local sourcing problems. This also applies to the various connectors and ribbon cables, although the "zero insertion force" socket is quite an expensive device.

The main printed circuit board for the programmer is available from the *EE PCB Service*, code EE628 (see page 409). The small extension printed circuit board may be purchased from **Maplin** and should be ordered as part code GB81C.

Special arrangements have been made with the designer to supply the software tape at a reasonable price direct. The cost of this tape is £2 (please enclose a sturdy 6in.×4in. stamped (34p) addressed envelope) and orders should be sent to **Mr. K. Taylor, 15 Lindsay Road, Horfield, Bristol, BS7 9NP.** Overseas readers should add 50p to cover additional postage.

Bat Detector

The dual-balanced mixer i.c., type SL1640C, used in the *Bat Detector* is really intended for applications in radio communications and is likely to prove quite troublesome in locating a source of supply. The one used in our prototype model was purchased from **Cirkit** (☎ *0992 444111)* and should be ordered as stock number 61-01640.

The 40kHz ultrasonic transducer is usually sold as part of a pair and some advertisers may be persuaded to part with single items. However, if readers do experience difficulties we understand that **Magenta** are prepared to sell this device separately.

The printed circuit board for the Bat Detector is available through our *PCB Service*, code EE647 (see page 409).

Signal Injector/Tracer

We cannot foresee any component buying problems for readers undertaking the two Circuit Card projects, *Signal Injector* and *Signal Tracer*. All components are standard "off-the-shelf" items and the circuit cards are attached to the front cover of this issue.

The BICC-Vero "Easiwire" kit is stocked by many of our advertisers and details of a £1 off *Special Offer* appear on page 411.

ACTUALLY DOING IT!

by Robert Penfold

I THINK that it is true to say that computer projects are nowhere near as popular as they were a few years ago when home computing was at the peak of its popularity. Nevertheless, there are still plenty of computer projects being constructed, and this remains a popular aspect of the hobby. There have been several bargain computers on sale over the last two years or so, and these have provided many constructors with a low cost means of entering the world of computer add-ons.

I suppose that on the face of it there is no difference between a computer project and any other type. This is something that really depends on the project concerned, but there are terms and components which are much used in computing but are virtually unused in any other field of electronics construction. In this month's *Actually Doing It* article we will consider the building of computer add-ons, paying particular attention to the unusual components and construction techniques which are often used in these projects.

CONNECTORS

One initial point that is well worth making is that a project which connects direct to the buses of a computer (which generally means one that connects to the main expansion bus) is less than ideal for a beginner. It is possible to do considerable (and very expensive) damage to a computer if a mistake is made with this type of project.

In fact modern computer components are quite tolerant to such things as short circuits to one or other of the supply rails. Even so, a complete beginner to electronics construction would probably be well advised not to start with a project of this type. One that connects to something like a printer, serial, or user port is a much safer starting point.

One problem with computer projects is getting the right connectors. When I first started on computer projects I soon accumulated a number of connectors where I had mistakenly ordered the wrong type, or thought I had ordered the wrong thing but had actually been sent the wrong type of connector by the supplier.

Fortunately, the connector terminology now seems a little more standardised and matters are not quite so hit and miss. On the other hand, there seems to be almost as many types of computer connector as there are different computers, and you still need to be a bit careful when ordering.

EDGE CONNECTOR

Probably the most common type of connector for home computers is the so-called "edge connector". The male connector is the one which is normally at the computer end of the system, and this is just some fingers of copper at the edge and on *both* sides of the board. There are actually such things as single-sided edge connectors, but I must admit that I have never encountered one. Some popular home computers which use this type of connector for their expansion buses are the Electron (2×25-way), Amstrad CPC series (2×25-way), Spectrum series (2×28-way) and ZX81 (2×23-way).

Note that a connector having (say) two rows of 25 connectors is normally referred to as a 2×25-way type rather than a 50-way connector. The latter would be a single-sided 50-way connector.

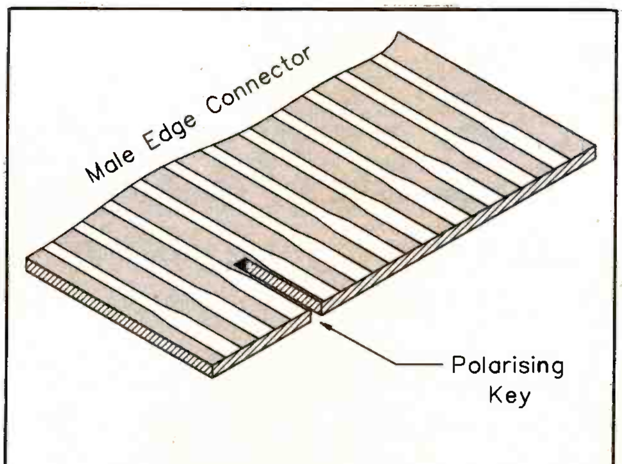


Fig. 1. Male edge connector.

PITCH AND POLARISING

When ordering connectors there are a few pitfalls to avoid. One of these is that there are various pitches for edge connectors. Most computer projects seem to use the 0.1 inch (2.54 millimetre) type, but there are also 0.156 inch and 2 millimetre types (although the 2mm variety do not seem to be listed in any of the electronic component catalogues). As far as I am aware, the only home computer which uses the 0.156 inch type is the Commodore VIC-20, and these are now a rarity in catalogues.

Most computer edge connectors are designed to take sockets that are fitted with a polarising key. This arrangement is pretty basic, and just consists of a slit cut into the male connector (Fig. 1) plus a metal rod fitted into the female connector. The rod and slot match up correctly and permit the two connectors to fit together, but as they are offset from centre, this is only the case if the female connector is fitted the right way up.

Since making the connections to an expansion bus the wrong way round could be decidedly dangerous for the computer or the add-on project (or both), the use of a connector with the correct polarising key has a lot to recommend it. It is essential to have a polarising key only where one is called for, and then to have one in the right position. Otherwise the key will "lock-out" the connector. Where possible it is advisable to buy an edge connector that is specifically advertised for use with the appropriate port of your computer.

Do not make the classic mistake of reversing all the connections so that although the edge connector is fitted to the computer the right way up, it is effectively up-side-down! All wiring should be carefully checked before any finished project is switched on and tested, but this is especially important with computer projects. If you have to use an edge connector which does not have a polarising key, clearly mark the top and bottom edges of the connector.

MAKING CONNECTIONS

Most ordinary connectors are made for soldered connection of leads to their tags. There are alternatives with computer connectors though, and these are designed to make life easier with what is very often a very large number of interconnections. These alternatives are not invariable used, and there are plenty of computer plugs and sockets which have ordinary soldertags. These are connected to the printed circuit board of the project via a piece of ribbon cable. As its name implies, this is a flat, ribbon-like cable, which is in effect a number of multi-strand insulated wires laid side-by-side and joined with an overall plastic sheath.

You may require something like a 28-way cable, but only be able to obtain 26- or 30-way cable. The answer to this problem is to obtain the 30-way type and strip off two wires from this in order to give the required 28-way type. Ribbon cable usually pulls apart without too much difficulty, and there should be no bother at all in trimming a piece down to the required number of ways.

When making the connections to a computer plug or socket the usual rules apply. Strip the insulation from the ends of all the leads and tin them with solder. Then tin all the tags of the connector with solder, and only then start making the connections.

This is inevitably going to be a slightly awkward job as there are likely to be dozens of connections to make to pins that are only about 2.5 millimetres apart. The spacing between rows is not usually very great either.

The solder needs to be used sparingly in order to avoid solder-blobs short circuiting adjacent tags, but obviously it needs to be used in sufficient quantity to produce a good joint. If a short circuit should occur, clear away all the solder from both tags and start again.

PROBLEMS

When wiring up edge connectors I have encountered two main problems. One of these is simply getting wires crossed over. This is where the multi-coloured "rainbow" ribbon cable is very much better than the monochrome variety. It is easy to identify each wire and spot any mistakes that are made. The "rainbow" ribbon cable is usually a little more expensive, but it is probably well worth the extra money for this type of application.

Problem number two is that of getting to the end of wiring up a connector only to find that you are a wire short! What can easily happen is that when connecting one lead you also inadvertently connect the one next to it to the same tag. From there on you are connecting the wrong lead to each tag. The only remedy if this should happen is to disconnect everything back to the point where the mistake was made, and to start again from there.

ON BOARD

Some edge connectors are intended for direct connection to the printed circuit board of the add-on project. These connectors come in the straight and right-angled varieties, as shown in Fig. 2. With this type of connector the project plugs straight onto the back of the computer. This is very neat, but it is a method of construction I tend to avoid.

Having the project attached to the rear of the computer does not necessarily place it where it is convenient in use. Perhaps of greater importance, reliability is not always all it could be. Slight movement of the computer can tend to crash the system! Some very popular computers and add-ons have had severe problems of this type.

There should be no great difficulty in fitting a right angle edge connector to a printed circuit board. It is very much like fitting a large integrated circuit or other multi-pinned component. As with any component which has many closely spaced pins, take due care not to produce any solder bridges. Carefully check for and remove any accidental short circuits that are produced.

An important point to watch is that the connector is pushed right down onto the board before you start soldering it into place. As pointed out in several previous *Actually Doing It* articles, it is important that any component is properly pushed down onto the board prior to being soldered into position. The physical strength of construction is dependent on it. With a gap between the body of the component and the board, any downwards force on the connector tends to rip the copper pads and tracks away from the board.

The large number of pins of an average computer connector aids physical strength, but this is offset by the considerable force that is likely to be exerted on some of the pins each time the project is fitted to the computer or removed from it.

The straight pinned connectors are a bit more tricky. The pins on these are often quite long, and may in fact be too long for the particular printed circuit board you are using. The pins are easily trimmed back using wire clippers though. As a point of interest, trimming the pins back very short will produce a connector with what are effectively simple soldertags, and which can be connected to a piece of ribbon cable without too much difficulty.

For maximum strength the board should be pushed right up to the connector. The pins will almost certainly need to be bent upwards/downwards slightly in order to bring them very close to the surface of the board. Use plenty of solder when connecting each pin, and make sure that the connector is correctly positioned and aligned when making the first few connections.

place with the shaft of a large screwdriver will normally suffice.

I have only once encountered tough ribbon cable that proved to be difficult to fit to an IDC socket. This needed a small hammer to press it down into the teeth, but this type of thing is usually unnecessary. When fitting a cable to an IDC connector make sure that the cable does not slip sideways one lead out of position. This would leave one lead and one tooth unconnected, and is easily done. If a mistake should be made it is not difficult to pull the cable away from the connector and then try again.

Note that it is only the proper (0.05 inch pitch) IDC ribbon cable that is suitable for use with this type of connector. There is a larger type which is not suitable (but which is excellent for the point to point wiring of projects). IDC connectors are often available ready fitted with a piece of ribbon cable, and I always obtain them in this form whenever possible.

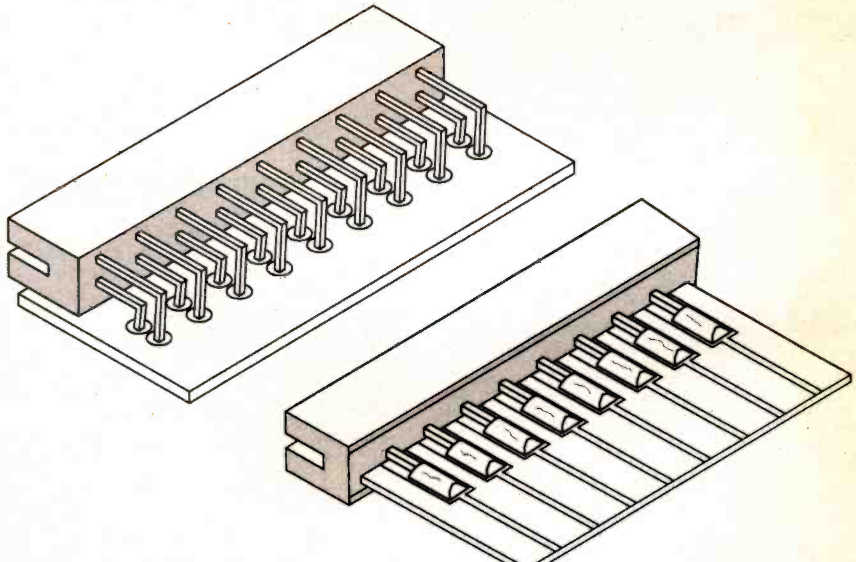


Fig. 2. Right angled and straight type connectors.

IDC

When dealing with computer connectors you will often encounter the term "IDC". This stands for "Insulation Displacement Connector". It is a slightly vague term in that there is a range of connectors which go by the name "IDC" connectors (as used on the BBC and Oric computers for example). It is also a general term which can be applied to any connector which uses this method of connection to the cable. It is a form of solderless connector.

There are rows of small teeth with U shaped cutouts on the rear face of the component. The spacing of the teeth is such that it matches up with the lead spacing on the appropriate type of ribbon cable.

Fitting the cable to an IDC connector is just a matter of pressing one end of the cable down onto the teeth and then fitting a simple clip mechanism which holds the cable in position. The teeth cut through the insulation and make reliable connections to the leads in the cable. The cable can be pressed into place using special tools, but a small vice or even just pressing the cable into

THE REST

There are several computer connectors other than the edge and IDC types, but these mostly come in the same three forms (solder tags, straight or right angled printed circuit mounting, and IDC). Probably the most common of these are the "D" type connectors. Amongst other things, these are used for Atari/Commodore style games ports, the BBC computer's analogue port, and serial/parallel ports on many computers.

A less common type is the DIN41612 96-way connector (as used on the Sinclair QL's expansion bus). These can be a bit confusing as most connectors of this type have less than the full 96-ways. It is a 0.1 inch pitch connector which has three rows of 32 terminals.

However, many types only have one or two rows, giving 32 or 64-ways. The rows are named "A", "B", and "C", and a 64-way type can have either wide row spacing (an "AC" type) or narrow row spacing ("AB" type). Obviously you need to know what you need and what you are buying when obtaining a 64-way DIN41612 connector.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

DEMONSTRATION STATIONS

A number of museums around the country have demonstration amateur radio stations, some using modern equipment and some using older historic sets. Usually run by volunteers, these stations offer visitors an opportunity to see and hear various aspects of amateur radio "in action", while their operators are more than willing to answer any questions.

If you have occasion to visit the Science Museum in London, for instance, make a point of visiting station GB2SM which has an impressive layout. The Chalk Pits Museum in West Sussex has station, GB2CPM, together with historic amateur radio displays. In the Isle of Wight, the National Wireless Museum at Newport has the call BG3WM; the Imperial War Musuem at Duxford Airfield has GB21WM and HMS Belfast near the Tower of London has GB2NR.

If you are holidaying in Scotland this year look out for the Scottish Tourist Board Radio Amateur Expedition Group. This group sets up amateur radio stations with world wide capabilities at historic, scenic, cultural or other sites of interest (e.g. famous distilleries!) throughout Scotland.

Operating on behalf of the National Trust for Scotland, the Scottish Tourist Board, Historic Buildings and Monuments, and other organisations, they aim to make the public more aware of the hobby of amateur radio. They operate with speech, radio teletype (RTTY), Morse (CW), and this year hope to demonstrate packet radio as well. They set up special explanatory displays for visitors and offer special awards to other amateur stations who contact them over the air.

They have a very full itinerary mapped out for the coming year. Look out for GB2RB (Robert Burns) at Burns House Museum, Mauchlin, May 27/28. GB2RBC (Royal Balmoral Castle) operating, with royal permission, from the castle's stable block, June 24/25.

An ambitious event will be a Five Nations National Trust weekend, with stations operating July 29/30 from National Trust properties in Scotland, Northern Ireland, Wales, England and Eire. On August 26/27, the group will be at Edradour Distillery, Pitlochry, with the call GB2SSD (Scotland's Smallest Distillery) and they are in the process of arranging a station to operate at Dumfries and Galloway Aviation Museum on September 23/24/25.

If you come across any of these demonstration stations, don't hesitate to ask the operators or stewards about what's going on.

ANTENNA DEFINED

It occurred to me recently that although, like most other experimenters, I had some knowledge of antenna theory which certainly helps when I construct and try out a new antenna, I didn't have any formal definition of what exactly a transmitting antenna is.

I dug deep into my textbooks to find the following: "It is basically an electrical circuit. In ordinary circuits the dimensions of the components are small compared with the wavelength corresponding to the frequency in use. Most of the electro-magnetic energy remains in the circuit to perform some specific task, or is converted to heat.

In a transmitting antenna, the dimensions of the wiring or the components become significant in terms of wavelength and some of the energy escapes in the form of radiated electromagnetic waves. Efficient antennas are designed to ensure that the major part of the energy in the circuit escapes and is radiated in this manner."

Conventional theory has been much the same for many years, with the ideal antenna physically dimensioned to match the frequency to be used and located high in the air (at least half a wavelength high) and clear of surrounding objects. This means, for instance, that an antenna for use on the 80 metre band should, ideally, be about 40 metres (i.e. half-wavelength) long and the same distance in height.

Because of these large dimensions there has always been an interest in reducing size without losing too much in performance and any number of "specials" have emerged over the years. I have mentioned some of these in previous columns. In all cases however, reduction brings some loss or disadvantage compared to a full-size, full height, antenna. In some cases, though, a properly designed small-size antenna can provide satisfactory performance where space is limited.

MAGNETIC LOOP

There has been a lot of interest recently in a type of small antenna called a *"magnetic loop"*. This is widely used in professional and military communications but has only recently been seriously considered for use by amateurs, although individuals have been experimenting with and writing about various versions over the last 20 years.

The amazing thing about this antenna is its size. A loop of approximately 750mm diameter will cover all amateur bands 20 metres to 10 metres, without a normal antenna tuning unit (ATU), and needs to be mounted just 2.5m above ground. By comparison, a standard antenna for 20 metres is about 10m long and the same distance above ground.

A loop covering the 80, 40, and 30 metre bands is about 1.2m diameter, again 2.5m above ground. As mentioned, the comparable standard length and height dimension for the 80m band is about 40 metres.

Conventional theory indicates that such miniaturisation will result in an antenna which is extremely difficult to "load up", enabling it to radiate radio waves without reflecting r.f. energy back to the transmitter via the feed line, in the form of "standing waves". Such waves can destroy the output stages of solid-state transmitters, yet with the magnetic loop properly used this does not occur.

The loop is claimed to have a radiation efficiency not far short of a half-wave dipole half a wavelength above ground, and a better performance than such a dipole less than a half wavelength high. It is little affected by nearby objects so it can be used indoors, and on receive there is a significant reduction in electrical interference or from strong transmissions on nearby frequencies.

It does have some disadvantages. Being so small it has a very high *Q*, the characteristic that ensures such good interference rejection, but this also means that the antenna has to be retuned every time the transmitting frequency is changed more than a few kHz. Additionally, a very high r.f. voltage develops across the antenna with a risk of r.f. burns so caution needs to be observed when using the antenna indoors with high power.

NOT SO EASY TO MAKE

As can be imagined, this antenna is not as simple to make as a classic dipole, which can be just a length of wire suspended in the air with an electrical break in the centre to form a feed point. The loop is constructed of metal tubing about 25mm diameter, and requires workshop facilities for satisfactory construction. The loop is tuned to the required frequency by a high-quality tuning capacitor linked to a d.c. motor, with reduction gear, all mounted on the antenna and remotely controlled from a control box at the transmitter.

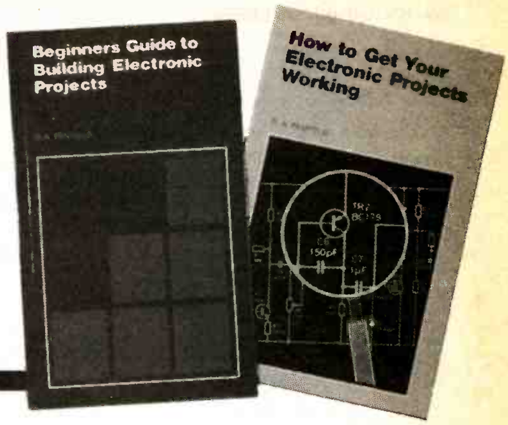
These loops can be obtained commercially from Cap. Co Electronics Ltd, Unit 6, Peel Road Industrial Centre, Peel Road, West Pimbo, Skelmersdale, WN8 9PT, but they are expensive. The smaller 20 to 10 metres version, for example, costs about £300, but I believe there is a "receive only" model for less than £100 for the serious short-wave listeners.

Whether there will be wide-spread use of the magnetic loop by amateurs remains to be seen. It certainly seems to offer a performance never achieved before with such small dimensions, and it could be the answer to the problems of limited space. I imagine that as time goes on there will be other cheaper versions put on the market, perhaps as d.i.y. kits.

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 details are given on the last book page.

For another selection of books see next month's issue.



MORE BOOKS NEXT MONTH—MORE BOOKS NEXT MONTH

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
96 pages **Order code BP110** **£2.50**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£2.50**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.
112 pages **Order code No. 227** **£2.25**

ELECTRONIC SCIENCE PROJECTS
O. Bishop
These projects range in complexity from a simple colour temperature meter to an infra-red laser. There are novelties such as an electronic clock regulated by a resonating spring, and an oscilloscope with solid-state display. There are scientific measuring instruments such as a pH meter and an electro-cardiometer. All projects have a strong scientific flavour. The way they work, and how to build and use them are fully explained.
144 pages **Order code BP104** **£2.95**

CIRCUITS & DESIGN

PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 1
PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 2

R. A. Penfold
These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.

BOOK 1 contains: Oscillators—sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers—simple monostable circuits using i.c.s, the 555 and 7555 devices, etc. Miscellaneous—noise generators, rectifiers, comparators and triggers, etc.

BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.

BOOK 1 *128 pages* **Order code BP117** **£1.95**
BOOK 2 *112 pages* **Order code BP118** **£1.95**

ELECTRONIC ALARM CIRCUITS MANUAL
R. M. Marston
One hundred and forty useful alarm circuits, of a variety of types, are shown in this volume. The operating principle of each one is explained in concise but comprehensive terms, and brief construction notes are given where necessary.
Aimed at the practical design engineer, technician and experimenter, as well as the electronics student and amateur.
124 pages **Order code NE11** **£9.95**

DESIGNING DC POWER SUPPLIES
G. C. Loveday C.Eng MIERE
Covers all aspects of the design of regulated power units, using discretes, i.c. regulators and switched units. It also covers protection circuits and reference supplies. Many design examples and exercises all with fully worked solutions are given.
131 pages **Order code BM2** **£6.95**

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**

DIGITAL LOGIC GATES AND FLIP-FLOPS
Ian R. Sinclair
This book, intended for enthusiasts, students and technicians, seeks to establish a firm foundation in digital electronics by treating the topics of gates and flip-flops thoroughly and from the beginning. This is not a constructor's book in the sense of presenting circuits to build and use, it is for the user who wants to design and troubleshoot digital circuitry with considerably more understanding of principles.
Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used extensively, and more attention is paid to the subject of synchronous counters than to the simple but less important ripple counters.
No background other than a basic knowledge of electronics is assumed, and the more theoretical topics are explained from the beginning, as also are many working practices. The book concludes with an explanation of microprocessor techniques as applied to digital logic.
200 pages **Order code PC106** **£8.95**

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**

MICRO INTERFACING CIRCUITS–BOOK 1
MICRO INTERFACING CIRCUITS–BOOK 2
R. A. Penfold
Both books include practical circuits together with details of the circuit operation and useful background information. Any special constructional points are covered but p.c.b. layouts and other detailed constructional information are not included.
Book 1 is mainly concerned with getting signals in and out of the computer;. Book 2 deals primarily with circuits for practical applications.
Book 1 *112 pages* **Order code BP130** **£2.25**
Book 2 *112 pages* **Order code BP131** **£2.75**

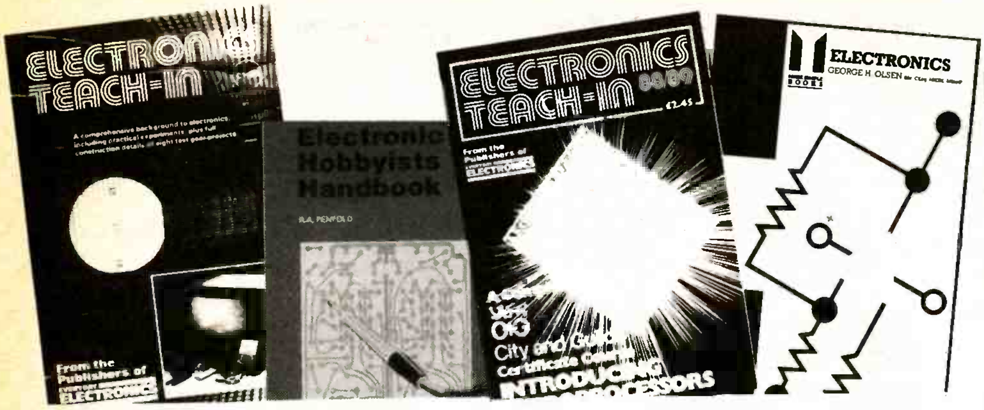
SENSORS AND TRANSDUCERS
Keith Brindley
There are a considerable number of transducers. Look through any electronic components catalogue and you'll find a wide variety of types, and each type has many versions. It's not easy to choose a transducer correctly for a particular function. In many specifications, terms and procedures are referred to which might deter you from using one that is, in fact, the best for the job. Yet, opting to use a transducer merely because it is easier to interface into the measuring system is not the answer. A greater knowledge of all types of transducers capable of doing the task is the ideal, and only then can a totally satisfactory decision be made to use one in particular.
176 pages **Order code NE17** **£12.95**

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**

50 SIMPLE LED CIRCUITS
R. N. Soar
Contains 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components—the light-emitting diode (LED). Also includes circuits for the 707 common anode display
64 pages **Order Code BP42** **£1.95**
BOOK 2 50 more l.e.d. circuits **Order code BP87** **£1.35**

ELECTRONICS SIMPLIFIED —CRYSTAL SET CONSTRUCTION
F. A. Wilson, C.G.I.A., C.Eng., F.I.E.E., F.I.E.R.E., F.B.I.M.
Especially written for those who wish to participate in the intricacies of electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day one can read intelligently and handle simple tools.
80 pages **Order Code BP92** **£1.75**

TEACH-IN, THEORY, AND REFERENCE



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**

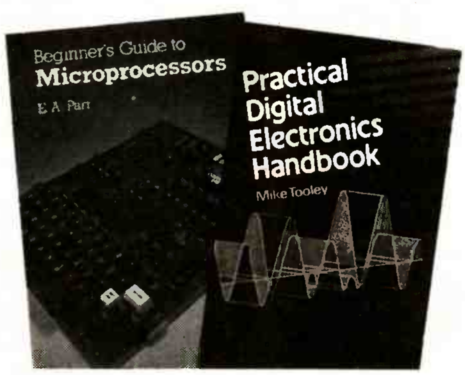
ELECTRONICS TEACH-IN
Michael Tooley BA and David Whitfield MA MSc CEng MIEE (published by *Everyday Electronics*)
This value for money *EE* book provides a comprehensive background to modern electronics including test gear projects. A complete course in basic electronics; designed for the complete newcomer 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***

FROM ATOMS TO AMPERES
F. A. Wilson
Explains in crystal clear terms the absolute fundamentals behind electricity and electronics. Really helps you to discover and understand the subject, perhaps for the first time ever.
Have you ever: Wondered about the true link between electricity and magnetism? Felt you could never understand the work of Einstein, Newton, Boltzmann, Planck and other early scientists? Just accepted that an electron is like a little black ball? Got mixed up with e.m.f. and p.d.? Thought the idea of holes in semiconductors is a bit much?
Then help is at hand with this inexpensive book, in as simple a way as possible and without too much complex mathematics and formulae.
244 pages **Order code BP254** **£3.50**

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** **£5.95**

ELECTRONICS TEACH-IN 88/89—INTRODUCING MICROPROCESSORS
Mike Tooley BA (published by *Everyday Electronics*)
A complete course that can lead successful readers to the award of a City and Guilds Certificate in Introductory Microprocessors (726/303). The book contains everything you need to know including full details on registering for assessment, etc.
80 pages (A4 size) **Order code TI-88/89** **£2.45**

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** **£9.95**



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**

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**

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**

COMPUTING

NEWNES COMPUTER ENGINEER'S POCKETBOOK
Michael Tooley
An invaluable compendium of facts, figures, circuits and data, indispensable to the designer, student, service engineer and all those interested in computer and microcomputer systems. It will appeal equally to the hardware or software specialist and to the new band of "software engineers". This first edition covers a vast range of subjects at a practical level, with the necessary explanatory text. The data is presented in a succinct and rapidly accessible form so that the book can become part of an everyday toolkit.
205 pages (hard cover) **Order code NE01** **£8.95**

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**

AN INTRODUCTION TO Z80 MACHINE CODE
R. A. & J. W. Penfold
Takes the reader through the basics of microprocessors and machine code programming with no previous knowledge of these being assumed. The Z80 is used in many popular home computers and simple programming examples are given for Z80-based machines including the Sinclair ZX-81 and Spectrum, Memotech and the Amstrad CPC 464. Also applicable to the Amstrad CPC 664 and 6128.
144 pages **Order code BP152** **£2.75**

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**

AN INTRODUCTION TO PROGRAMMING THE SINCLAIR QL
R. A. & J. W. Penfold
Helps the reader to make best use of the fantastic Sinclair QL's almost unlimited range of features. Designed to complement the manufacturer's handbook.
112 pages **Order code BP150** **£1.95**

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**

A CONCISE INTRODUCTION TO MS-DOS
N. Kantaris
This guide is writen with the non-expert, busy person in mind and, as such, it has an underlying structure based on "what you need to know first, appears first". Nonetheless, the guide is also designed to be circular, which means that you don't have to start at the beginning and go to the end. The more experienced user can start from any section.
The guide covers versions 3.0, 3.1 and 3.2 of both PC-DOS and MS-DOS as implemented by IBM and other manufacturers of "compatible" microcomputers, including the AMSTRAD PC's. It covers both floppy disc-based systems and hard disc-based systems.
64 pages **Order code BP232** **£2.95**

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**

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** **£5.95**

AN INTRODUCTION TO LOUDSPEAKERS AND ENCLOSURE DESIGN
V. Capel
This book explores the various features, good points and snags of speaker designs. It examines the whys and wherefores so that the reader can understand the principles involved and so make an informed choice of design, or even design loudspeaker enclosures for him or herself. Crossover units are also explained, the various types, how they work, the distortions they produce and how to avoid them. Finally, there is a step-by-step description of the construction of the *Kapellmeister* loudspeaker enclosure.
148 pages **Order Code BP256** **£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**

MORE BOOKS NEXT MONTH

DATA & COMPONENT IDENTIFICATION

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**

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**

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 **Temporarily out of print**

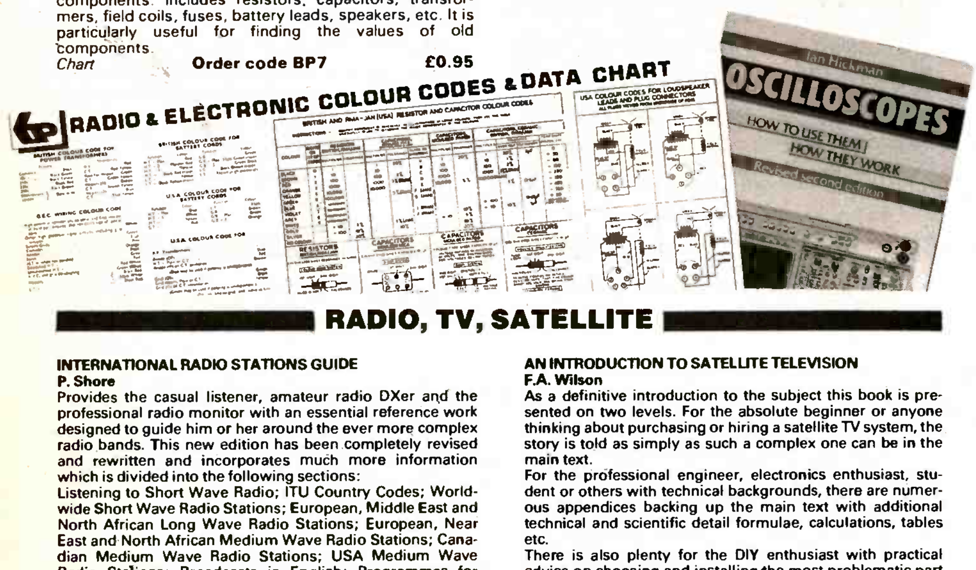
RADIO AND ELECTRONIC COLOUR CODES AND DATA CHART
B. B. Babani
Although this chart was first published in 1971 it provides basic information on many colour codes in use throughout the world, for most radio and electronic components. Includes resistors, capacitors, transformers, field coils, fuses, battery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

MUSICAL APPLICATIONS OF THE ATARI ST's
R. A. Penfold
The Atari ST's are now firmly established as *the* computers to use for electronic music applications. The range and sophistication of these applications are much greater than most people may realise, but there are still a lot of misconceptions about just what can and cannot be achieved. This book will help you sort out the fact from the fallacy and to get the most musically from the ST's.
A wide selection of topics are covered, including the internal sound chip; MIDI; applications programs such as sequencing and score writing, etc; simple but useful add-on projects and MIDI programming.
90 pages **Order code BP246** **£5.95**

TESTING & TEST GEAR

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**

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** **£6.95**



RADIO, TV, SATELLITE

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

AERIAL PROJECTS
R. A. Penfold
The subject of aerials is vast but in this book the author has considered practical aerial designs, including active, loop and ferrite aerials which give good performances and are relatively simple and inexpensive to build. The complex theory and mathematics of aerial design have been avoided.
Also included are constructional details of a number of aerial accessories including a pre-selector, attenuator, filters and tuning unit.
96 pages **Order code BP105** **£2.50**

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 BP195** **£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**

DIRECT BOOK SERVICE
(A Division of Wimborne Publishing Ltd.)

TO ORDER

Please state the title and order code clearly, print your name and address and *add the required postage* to the total order.

Add 75p *to your total order* for postage and packing (overseas readers **add £1.50** for countries in Europe, or **add £2.00** for all countries outside Europe, surface mail postage) and send a PO, cheque or international money order (£ sterling only) made **payable to *Direct Book Service* quoting your name and address,** the order code and quantities required to **DIRECT BOOK SERVICE, 33 GRAVEL HILL, MERLEY, WIMBORNE, DORSET, BH21 1RW** (mail order only).

See next month's issue for another three page selection of books.

Although books are normally sent within seven days of receipt of your order, please allow a maximum of 28 days for delivery. Overseas readers allow extra time for surface mail post.

Please check price and availability (see latest issue of Everyday Electronics) before ordering from old lists.

Note—our postage charge is the same for one book or one hundred books!

MORE BOOKS NEXT MONTH

SO FAR in this series of articles the 1MHz Bus has received relatively little attention. We will now rectify matters with an in-depth look at this port, and its possibilities for user add-ons. As we will see, these possibilities are substantial.

The 1MHz Bus certainly offers much greater expansion potential than user and analogue ports. In theory at any rate, dozens of add-ons could be simultaneously connected to and operated from this port.

The Buses

Connection details for the 1MHz Bus have been provided in a couple of previous *Beeb Micro* articles, including the last one, and so this diagram will not be provided again here. This is a list of the 1MHz Bus pin functions:

PIN	FUNCTION	PIN	FUNCTION
1	GND	18	D0
2	R/W	19	D1
3	GND	20	D2
4	1MHz Clock	21	D3
5	GND	22	D4
6	NNMI	23	D5
7	GND	24	D6
8	NIRQ	25	D7
9	GND	26	GND
10	NPGFC	27	A0
11	GND	28	A1
12	NPGFD	29	A2
13	GND	30	A3
14	NRST	31	A4
15	GND	32	A5
16	AUDIO IN	33	A6
17	GND	34	A7

The 1MHz Bus provides most of the lines you would expect to find on the expansion port of a 6502 based computer. One of these is the 1MHz clock signal. This could be useful for add-ons that require an accurate clock signal which can be derived from the 1MHz signal. This signal is also needed by many standard 65** and 68** series peripheral devices.

Although the 6502 in the BBC computers operates with 2MHz a clock signal, some internal circuitry reduces the clock speed to 1MHz when input/output devices are accessed. This enables standard 1MHz 65** and 68** peripherals to be used within the computer. This includes the 6522 VIA which provides the user port lines, and the 1MHz Bus is also run at the lower rate (from which its name is derived).

The eight bit data bus is available, and this is obtained from the microprocessor bus via a bidirectional tristate buffer. This provides the port with plenty of drive, and ensures that it does not heavily load any input devices connected to it.

Another important point in favour of this buffering is that it reduces the risk of any serious internal damage to the computer in the event of a fault in any add-on connected to the 1MHz Bus, or if a device is connected incorrectly. Many of the other lines are also buffered incidentally.

There are the usual control and interrupt lines available. NRST provides a negative reset pulse at switch-on, and when the BREAK key is pressed. The usual read/write and two interrupt lines are included, but the latter are really only something for experienced users. There is a useful audio input, or "analogue" input as it is sometimes confusingly called in Acorn literature.

Addressing

Only the eight least significant address lines are available, but these are all that are needed as the upper eight address lines are decoded by internal circuits of the computer. The decoded outputs are NPGFC and NPGFD, which pulse low when any address in pages &FC and &FD (respectively) are accessed. This gives two pages of 256 addresses for expansion purposes, which should be considerably more than enough to satisfy even the most ambitious BBC add-on builder.

On the BBC model B both of these lines tend to suffer from spurious pulses which can result in unreliable results with most add-ons. This problem can be overcome by adding a simple clean-up circuit (which was provided in the previous *Beeb Micro* article). Note that this circuit is not needed with the Master 128 computer.

In order to make use of all 512 available addresses a considerable amount of address decoding would have to be applied to NPGFC, NPGFD, and A0 to A7. In most cases only one or two decoded outputs will be needed, and it is then quite in order to use NPGFC and NPGFD without any decoding of the eight available address lines.

Acorn have divided up pages &FC and &FD into areas which are given over to specific purposes, but this is not to say that you have to keep within their guidelines. You should certainly do so if you wish to connect commercial add-ons to the 1MHz Bus, and to also have your own circuits connected to this port at the same time.

Probably most users will not wish to do this, and will only fit their own circuits to this port, or will only have commercial add-ons or their circuits connected to it at any one time. Anyway, details of how this address range has been divided up are provided below:

ADDRESS	ASSIGNMENT
&FC00-&FC0F	Test Hardware
&FC10-&FC13	Teletext
&FC14-&FC1F	Prestel
&FC20-&FC27	IEEE488
&FC30-&FC3F	Cambridge Ring
&FC80-&FC8F	Test Hardware
&FCC0-&FCFE	User Add-ons
&FCFF	Extended Page Register
&FD00-&FDFF	Extended Page Memory

At first sight this may seem to be a bit restrictive, since out of some 512 addresses only 63 are available for user add-ons. If you should decide to keep within these guidelines, then I think it is unlikely that this would really prove to be a serious limitation. After all, this is sufficient address space for up to three 6522 VIAs, with sufficient spare address range for a few 6821s and 6850s. The main problem if you adhere to this system is that it will necessitate the use of some additional address decoding.

Paging Jim

For reasons best known to themselves, Acorn decided that page &FC should be called "Fred", and page &FD should be called "Jim". While Fred is intended for

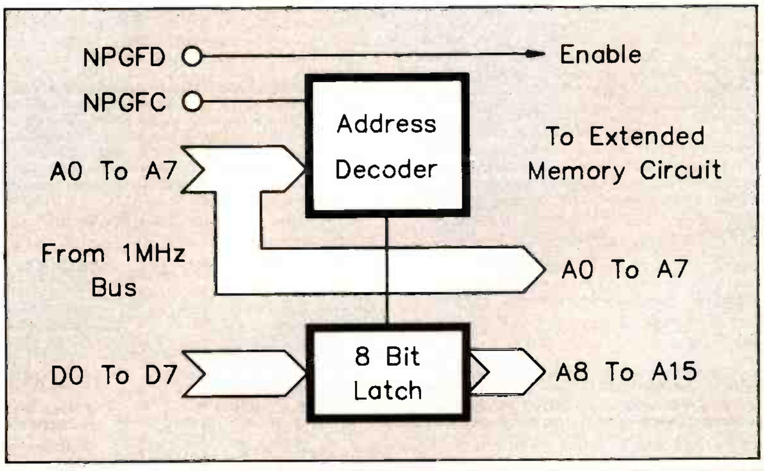


Fig. 1. The basic method of using the 1MHz Bus to provide 64K of extended memory.

use with a number of add-on devices, Jim is intended to provide 256 pages of extended memory. An extra 64k of memory in other words.

It does this in conjunction with the uppermost address (&FCFF) in Fred. Jim on its own only provides 256 addresses, but the idea is to switch between various banks (or pages) of 256 addresses using the extended page register (address &FCFF).

In other words, you have an arrangement like Fig. 1, where an address decoder and latch provide an 8-bit output from address &FCFF. This is used as the upper eight address lines for the extended memory. You write to ?&FCFF the value for the eight most significant address lines, and then read/write at addresses in Jim (?&FD00 to ?&FDFF).

The eight least significant address lines act as such for the extended memory, with NPGFD being used to activate this memory when the appropriate address range is accessed. The bottom 32k of this extended memory is reserved for system use, but the upper 32k is free for user applications.

Like all forms of memory which extend the limits of the microprocessor, this system is relatively slow. It is not aided by the fact that each block of extended RAM is just 256 bytes. Most other systems operate with a block size of something more like 16k, like the BBC computer's sideways RAM. In practice you are unlikely to bother with this form of extended memory, and page &FD is then available for other purposes, as is address &FCFF.

Various other recommendations about devices connected to the 1MHz Bus are made by Acorn. One of these is that each device should load the bus by no more than LS TTL input. Also, devices which connect to this port should have their own mains power supply unit.

This explains the lack of any power supply output on the 1MHz Bus. The recommended connecting lead length is 600 millimetres, and add-ons should have a standard 1MHz Bus socket so that a series of devices can be strung together using the "chain" (series) method of connection.

It is obviously important for producers of commercial add-ons to adhere to the Acorn recommendations, to ensure that their units are, as far as reasonably possible, compatible with other 1MHz Bus add-ons. The home constructor is free to decide for his or herself whether or not to follow these recommendations.

If you have lots of add-ons on other ports, including disk drives powered from the power port, trying to power 1MHz Bus add-ons from the computer would probably be a bit risky. On the other hand, if you only have a couple of small add-ons connected to the user and analogue power ports, plus self-powered disk drives or a cassette based system, it is perfectly acceptable to power 1MHz Bus add-ons from the computer.

Tapping off power from one of the other ports should not prove to be difficult. Similarly, there would seem to be no point in providing a 1MHz Bus for other peripherals if you only intend to use a single device on this port.

Expansion

This is something you have to weigh-up and decide for yourself. The 1MHz Bus not only has tremendous expansion potential, but it is easy to use if you take a few short cuts such as minimal address decoding.

As an example, standard chips in the 65**and 68** series of peripherals can be interfaced to this port with little or no extra circuitry being required. Basically you just connect each terminal of the peripheral chip to the corresponding line on the 1MHz Bus.

Either NPGFC or NPGFD should be used to drive a negative chip select input of the peripheral chip, or a positive chip select input should be driven from one of these lines via an inverter. Any other chip select inputs should be wired to their active logic levels.

In this way it is possible to connect two peripheral devices to the 1MHz Bus without the need for any additional address decoding. One device occupies page &FC while the other occupies page &FD. Of course, with the BBC model B computer, clean-up circuits are needed for both the decoded page-select outputs of the port, but this requires nothing more than a couple of quad gate integrated circuits costing a few pence each.

Peripheral chips not intended for use with the 6502 microprocessor might not be so easily interfaced to this port. Where possible it is probably best to use 68** or 65** series peripheral chips rather than those for (say) the 8080 series of microprocessors.

However, most computer peripherals can be interfaced to the 1MHz Bus, including such things as UARTs, analogue to digital converters, and digital to analogue converters. Like any general purpose computer expansion bus, you can interface practically anything to it.

Next Month: We will take a detailed look at ways of connecting a range of peripheral devices to this port, and using them in practice.

Robot Roundup

NIGEL CLARK

FORGOTTEN DREAMS

THE short history of the small robot is littered with the bright hopes and dreams of investors and inventors which have come to nothing. Colne Robotics with the Armdroid, L. W. Staines and their Ogres and IGR's Zero are only a few examples of products which briefly shone before they were eclipsed.

Armdroid was more a "now-you-see-me-now-you-don't" as a variety of companies attempted to keep it on the market. It is in a "you-don't" phase at the moment but that is not to say that it will not reappear in the near future.

Even some of those robots which have survived have had a far from easy time. Valiant Research had to become Valiant Technology in order for the turtle to continue.

"RETURN"

Now, after disappearing for a number of years Remcon's Teach Robot has returned to the scene. The basic hardware is much the same but this time it is being offered completely built instead of as a kit and it is linking its fortunes to the various versions of the IBM PC.

Another change is that it is being offered this time as part of a package, the other components comprising an interface and control software.

Geoff Chapman of Remcon said that he thought the time was now right for another effort at making the machine a success. He emphasised that the Teach Robot had not disappeared in the intervening period. Sales, though not at the level of its first year, had been steady to various parts of the world.

It had been decided to give it an extra push when the IBM software and interface had become available. At a price of about £1,000, the West German-built arm has five axes plus gripper. The feature which sets this arm apart from the rest is that four axes are driven by linear rams. The rams are driven by lead screws but Remcon says that they are representative of hydraulic or pneumatic rams as used in full-size industrial machines.

The rams, which work on the waist, shoulder, arm and wrist up and down, are powered by d.c. motors with optical shaft encoders to provide feedback. Waist rotation and gripper movements are driven by worm and worm wheel. All axes have limit switches and ramping facilities to prevent damage and provide smooth movement.

Movement can be limited by the use of the rams and the shoulder, arm and wrist up and down can move through only 90 degrees. The waist on the original machines also only had 90 degrees of movement but this has been increased to 270 degrees. The wrist can also turn through 270 degrees and the gripper can open 180 degrees. It can carry a maximum load of 200 gms.

INTERFACE

When the robot first appeared about five years ago it was offered with a general interface and a limited amount of software, centred on the Spectrum. It could also be controlled by a keypad.

Chapman said that there had been an attempt to get BBC software so as to be able to enter the education market but the German software house did not show much interest as the BBC did not have a large market outside Britain.

He thought that the decision to link the arm to IBM and IBM XT and AT compatibles would make it much more appealing. There are also plans for creating a work cell—the conveyor is ready but other items are still at the design stage. It is hoped that there might be something to show at the CDT exhibition in the autumn.

Remcon claims the software has been developed to give a simple and user friendly system. To enable inexperienced users to get an idea of how the system works the sotware contains a short "demo" program showing simultaneous and single step operation.

A double-sided interface card plugs into any of the free ports of the computer. They do not interfere with the working of the computer allowing it to be used for other purposes while the card is plugged in.

Chapman said that software was being developed to allow eight arms to be controlled at the same time. That would require eight cards to be plugged into the port.

As usual programs can be saved, edited and downloaded to and from the disc storage. The system provides for a screen display of the programs stored, the display being in three sections, one across the top of the screen with two columns beneath.

The left-hand column shows the program being run, with a cursor indicating the part of the program in operation. The top section gives the state of the six motors, both the called for position and the actual position. The rest supplies information on the various key functions. Remcom says that knowledgeable users should be able to change this section so as to show their own required information.

ATARI/ROBOKIT

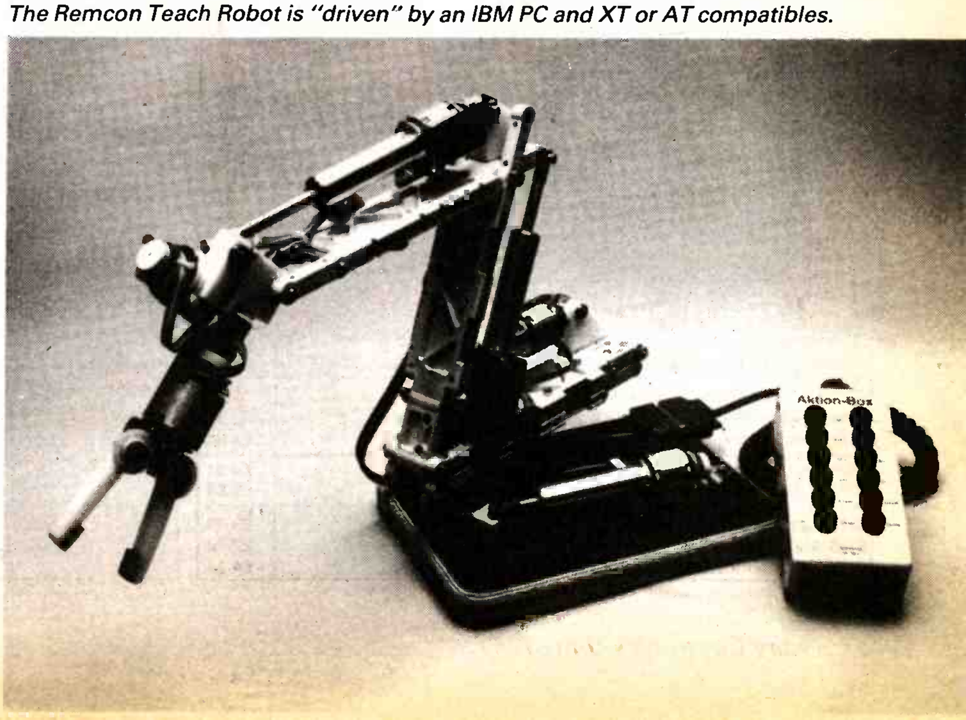
As mentioned by Richard Pawson in his interview (EE September 1988) the Atari version of his company's—Personal Robots Ltd—Robokit robotic development and teaching system is now available from Atari, or its distributors, at a cost of about £80.

For that users, and it is said to be ideal for secondary schools, get an interface for the ST range, 520 and 1020, to drive d.c. motors, lights and solenoids, plus eight inputs for microswitches or simple sensors and two inputs for microswitches or simple sensors and two outputs for Lego Technic shaft encoders, a manual and software. The manual contains instructions for building five projects from Lego Technic.

The company says that it is the software which really sets the system apart from the rest. It is based on the larger, more complex version which has been developed over four years at a cost of £1.2m. Making use of the Gem interface it starts with a picture of the model on screen, control is effected by adding control icons and assigning messages to them. From there it is possible to move onto building sequences of messages and developing event-driven applications.

During the next two years a number of add-on packages are planned including a vision processing system. A more complex version, Professional Robokit, is being prepared and, at a cost of about £2,000 for the software, is expected to go on sale in 1990. As might be expected from the price it is thought to be most suitable for universities and commercial development laboratories.

The Remcon Teach Robot is "driven" by an IBM PC and XT or AT compatibles.



PCB SERVICE

Printed circuit boards for certain constructional projects (up to two years old) are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: The PCB Service, *Everyday Electronics* Editorial Offices, 6 Church Street, Wimborne, Dorset BH21 1JH. Cheques should be crossed and made payable to *Everyday Electronics (Payment in £ sterling only.)*

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: *Boards for older projects–not listed here–can often be obtained from Magenta Electronics, 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST. Tel: 0283 65435 or Lake Electronics, 7 Middleton Close, Nuthall, Nottingham NG16 1BX. Tel: 0602 382509.*

NOTE: please allow 28 days for delivery. We can only supply boards listed in the latest issue. Boards can only be supplied by mail order and on a payment with order basis.

PROJECT TITLE	Order Code	Cost
Light Rider–Lapel Badge - OCT '86 -	540 & 541	£2.97
–Disco Lights	542	£5.12
–Chaser Light	546	£4.04
Modem Tone Decoder – NOV '86 -	547	£3.46
200MHz Digital Frequency Meter	548	£5.14
Dual Reading Thermometer - DEC '86 -	549	£7.34
Automatic Car Alarm	550	£2.93
BBC 16K Sideways RAM	551	£2.97
(Software Cassette)	551S	£3.88
Random Light Unit – JAN '87 -	552	£5.88
Car Voltage Monitor – FEB '87 -	553	£2.48
Mini Amp	554 & 555	£5.68
Video Guard	556	£3.80
Spectrum I/O	557	£4.35
Spectrum Speech Synthesiser	558	£4.86
Computer Buffer/Interface - MAR – '87	560	£3.32
Infra Red Alarm : Sensor Head	561	£4.19
PSU/Relay Driver	562	£4.50
Alarm Thermometer – APR '87 -	559	£2.60
Experimental Speech Recognition	563	£4.75
Bulb Life Extender	564	£2.48
Fridge Alarm – MAY '87 -	565	£2.40
EE Equaliser–Ioniser	566	£4.10
Mini Disco Light – JUNE '87 -	567	£2.93
Visual Guitar/Instrument Tuner	568	£3.97
Fermostat – JULY '87 -	569	£3.34
EE Buccaneer Metal Detector	570	£4.10
Monomix	571	£4.75
-AUG '87 -		
Super Sound Adaptor Main Board	572	£4.21
PSU Board	573	£3.32
Simple Shortwave Radio, Tuner	575	£3.15
Amplifier	576	£2.84
Noise Gate – SEPT '87 -	577	£4.41
Burst Fire Mains Controller	578	£3.31
Electronic Analogue/Digital Multimeter	579	£6.40
Transtest – OCT '87 -	580	£3.32
Video Controller	581	£4.83
Accented Metronome – NOV '87 -	582	£3.77
Acoustic Probe	584	£2.78
BBC Sideways RAM/ROM	585	£4.10
Pseudo Echo Unit – DEC '87 -	586	£4.60
Dual Mains Light Flasher	587	£3.66
Twinkling Star	588	£2.61
Audio Sine Wave Generator	589	£3.03
Capacitance Meter – JAN '88 -	590	£4.10
Bench Amplifier	591	£5.51
Transistor Curve Tracer	592	£2.84
Bench Power Supply Unit - FEB '88 -	593	£4.01
Game Timer	583	£3.55
Semiconductor Tester – MAR '88 -	594	£3.19
SOS Alert	595	£2.78
Guitar/Keyboard Envelope Shaper	596	£4.23
Stereo Noise Gate – APR '88 -	597	£6.65
Pipe & Cable Locator	598	£2.72
Inductive Proximity Detector	574	£2.97
Multi-Channel Remote Light Dimmer - MAY '88 -		
Transmitter	599	£2.78
Receiver	600	£3.07
Door Sentinel	605	£2.60
Function Generator–Main Board	606	£5.91
Function Generator–Power Supply	607	£4.19
Super Sound Effects Generator	608	£4.78
Multi-Channel Remote Light Dimmer - JUNE '88 -		
Relay/Decoder	601	£4.86
Dimmer Board	602	£3.07
Power Supply	603	£2.72
Mother Board	604	£7.76
Headlight Reminder	611	£2.78
Video Wiper – JULY '88 -	612	£6.75
Isolink	613	£4.21
Tea Tune – AUG '88 -	609	£2.56
Time Switch	614	£4.84
Suntan Timer	610	£3.07
Car Alarm	615	£3.12
Doorbell Delay – SEPT '88 -	616	£3.55
Breaking Glass Alarm	617	£4.27
Amstrad PIO	618	£6.77
Eprom Eraser - OCT '88 -	620	£4.07
Doorbell Delay - NOV '88 -	616	£3.56
Micro Alarm	621	£3.12
Infra-Red Object Counter		
Transmitter (£9.28 if bought as a set)	622	£4.61
Receiver (£9.28 if bought as a set)	623	£3.23
Display (£9.28 if bought as a set)	624	£3.05
Seashell Sea Synthesiser	625	£4.84
Reaction Timer - DEC '88 -		
Main Board	626	£3.46
Display board	627	£2.67
Downbeat Metronome	629	£4.84
EPROM Programmer (On Spec)	630	£8.29
Phasor	631	£5.64
Monkey/Hunter Game — JAN '89 —	634	£3.36
Continuity Tester —FEB '89—	619	£2.67
4-Channel Light Dimmer	635	£7.67
Mini PSU	636	£3.23
Sound-to-Light Interface -MAR '89-	637	£6.24
Midi Pedal	639	£7.00
Midi Merge	640	£2.78
Audio Lead Tester	641	£5.77
Light Sentinel -APR '89-		
Main Control Board	632	£9.20
Remote Interface (4 boards)	633	£4.59
Electron User Port	638	£6.64
4-Channel Auto-Fader Interface	642	£6.80
Pet Scarer -MAY '89-	644	£2.84
Electron A/D Interface	645	£4.84
Spectrum EPROM Programmer	628	£7.87
Bat Detector -JUNE '89-	647	£4.95

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps. **Do not send any other correspondence with your order.**

EE PRINTED CIRCUIT BOARD SERVICE
Please send me the following p.c.b.s.
Make cheques/PO payable to: **Everyday Electronics (payment in £ sterling only)**

Order Code Project Quantity Price

....

....

....

I enclose cheque/PO for £ ....

Name...

Address...

....

BLOCK CAPITALS PLEASE

Please allow 28 days for delivery

DOWN TO EARTH

BY GEORGE HYLTON

LINEARIZING RECTIFIERS

MULTIMETERS often have special scales for their lowest a.c. voltage ranges. The scale markings are not evenly spaced, but become progressively closer towards the zero end. (See Fig. 1). The explanation lies in the behaviour of the built-in rectifier which changes a.c. to the d.c. required to give a meter reading.

The semiconductor diodes used for this job have voltage/current characteristics of the general shape indicated. If a very low d.c. voltage is applied with the polarity which tends to make the diode conduct (often called a *forward* voltage, as opposed to the *reverse* or *inverse* voltage which inhibit conduction) nothing happens.

As the forward voltage is increased, current begins to flow. Further increases produce even more current.

If the straight portion of the curve is extended downwards it cuts the voltage axis at a particular forward voltage, called the forward Zener voltage. This varies with the material and fabrication method used for the diode.

For a normal silicon junction diode at room temperature it's about 700mV. For a silicon Schottky diode it's about half this, for a germanium junction about 240mV and for an old-fashioned copper oxide rectifier about 100mV. Point-contact diodes give more rounded curves with a much less pronounced "knee".

RECTIFICATION

When a.c. voltages are applied (as shown below the graph) very small voltages have no perceptible effect. At intermediate voltages there is some conduction near the positive peaks, where the voltage begins to get into the knee region. At high voltages there is conduction over most of each positive half cycle.

This explains the meter scale. Suppose the voltage range is 10V full-scale. Large inputs (say over 3V) produce conduction over most of the positive half cycles and the current is controlled by the range-setting resistance R1.

With small inputs such as 1V conduction occurs only near the peaks and the pointer deflection is less than it would be with a perfect rectifier. (A perfect diode, in this sense, would offer no resistance to forward voltages, however small, and infinite resistance to reverse voltages, large or small.)

On high-voltage ranges (such as 100V full scale) virtually all readable voltages are large enough to clear the knee and the scale markings are most regular. In fact, for high voltages the same markings are often used for both a.c. and d.c.

The diagram Fig. 1 shows sine wave inputs. For other waveforms the response is different but the effect of the knee is always present to some extent. Asymmetrical waves, where the positive half cycles have a different shape from the negative may give different meter readings when the meter leads are reversed (if the rectifier is half-wave as shown). There's something to be said for measuring both ways then averaging the result.

BIASING

One way to improve matters is to apply a small d.c. forward bias to the diode. Suppose this sets the working point to *P*. Then a small a.c. signal can produce a significant current. Of course, the meter shows a small deflection when there's no input but this can be tolerated.

A problem is that diodes are strongly affected by temperature. A bias voltage that is right at 20°C will give too much current at 30°C and not enough at 10°C.

So biasing isn't the complete answer. One possibility is to use a transformer to step up low a.c. voltages so that they become high enough to lie in the linear part of the characteristic.

This works, but the effect of the transformer is to reduce the impedance of the meter to the input signal. This may lead to low readings when the meter is used on a high impedance circuit. A good transformer is also expensive.

AUTOMATIC BIAS

The effect of these considerations on design is that the lowest a.c. voltage range on the cheaper sort of meter is around 10V full-scale, and a specially calibrated scale is used for this 10V range. In electronics, however, it is often desirable to measure a.c. voltages down to a few millivolts.

Some sort of automatic bias system which adjusts itself precisely to the signal level and gives perfect compensation for the knee of the diode curve would be very handy. This is a tall order for a simple passive multimeter but as soon as the meter is made active, by incorporating an amplifier, the problem is greatly eased.

With an amplifier small voltages can be boosted into large ones without the sort of penalties incurred by using transformers. Also, there is a circuit trick which has much the same effect as the wished-for automatic biassing.

In Fig. 2, back-to-back diodes are connected as the negative feedback path of a difference amplifier such as an op. amp. When a diode is non-conductive its high resistance blocks the feedback path. With no negative feedback the amplifier gives its full normal gain.

When a large signal is applied the diodes conduct, closing the negative feedback loop and since feedback is

Fig. 1. Diode characteristics. Small forward voltages are not sufficient to cause conduction. When a sine wave is applied current flows over a portion of the positive half cycles which increases with signal amplitude. This explains why a.c. meter scales are cramped at the low voltage end.

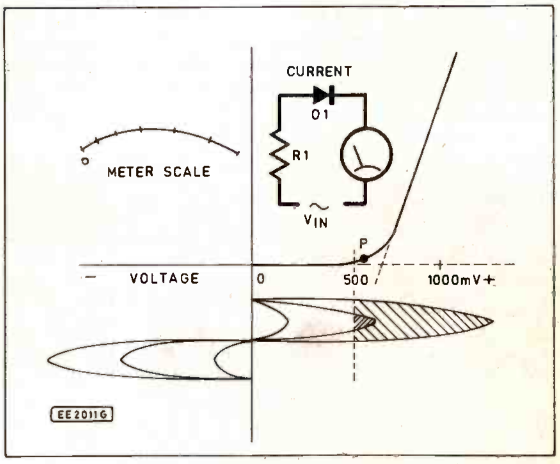
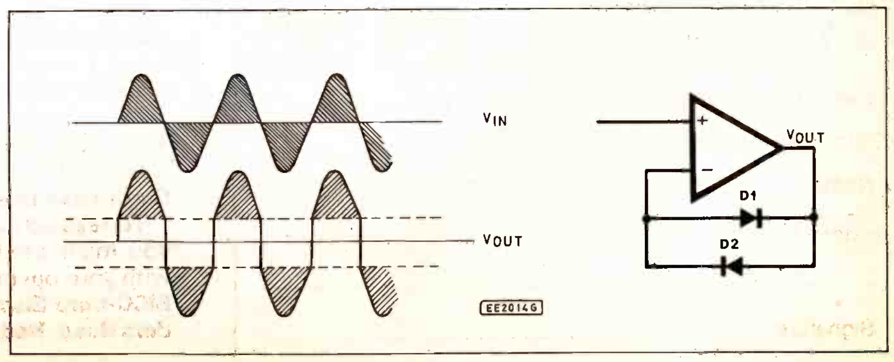


Fig. 2. Diodes as feedback controllers. The amplifier gives normal gain until the output signal overcomes the diode "knee" voltage and D1 or D2 conducts. The feedback path is then completed and gain falls to 1. The effect is to place each half-cycle of output on a pedestal equal to the knee voltage, if this output is rectified by other diodes it gives an almost exact measure of the signal amplitude.



now 100 per cent reducing the gain to 1. The effect of the diodes is to permit normal gain until the knee voltage is reached then reduce gain to 1.

Suppose the signal is 100mV peak and the amplifier gain is 100, and the knee voltage is 500mV. As the signal wave rises from the zero line full gain is then obtained until the output reaches 500mV, when gain falls to 1.

With our values, an input of 5mV gives 500mV output. So the first 5mV of our 100mV signal is fully amplified and the other 95mV is not, appearing at the output as a replica of the input wave. The effect of all this is to produce an output wave in which each half cycle of the input stands on a pedestal equal to the knee voltage.

If this output is now applied to diodes identical with D1 and D2 the voltage pedestals overcome the knee almost instantaneously and conduction then follows a replica of the input wave. In other words, the diode feedback arrangement creates something very like the automatic bias we've been looking for.

PRACTICAL CIRCUITS

In describing the principal I have as usual made some simplifying assumptions. One is that the knee is abrupt, when in practice of course it is gradual.

In practice, however, the Fig. 2 type of circuit works very much as described. The important thing is that in effect the knee voltage is reduced by the gain of the amplifier. A number of practical circuits exist in which this is made use of to make rectifiers give a more faithful response to a.c. signals.

One very convenient arrangement is shown in Fig. 3. This is just a familiar class-B complementary output stage driven by an op. amp. Negative feedback is taken from the load R_L to the inverting input. To get there the feedback has to have passed through the base-emitter junctions of the output pair TR1 and TR2.

These junctions are of course diodes and so the circuit behaves like Fig. 2 as far as feedback is concerned and large signals are subject to a gain of 1. The load current is V_{out}/R_L, and this is the same as V_{in}/R_L when gain is 1.

The complementary output stage is unbiassed so there is no standing current through the transistors. The meter in the collector of TR2 reads zero.

When a signal large enough to overcome the knee voltage arrives, TR1 and TR2 conduct on alternate half cycles. Each transistor thus acts as a half wave rectifier. The meter reads half the load current.

As before, only a tiny portion of a large signal is lost in overcoming the knee voltage. Once overcome, the amplifier is gain stabilized by the negative feedback and this evens out the frequency response.

So long as the amplifier has enough gain the rectification is linearized. In practice this means that with an ordinary op. amp performance just begins to fall off towards the upper frequency limit of the audio band.

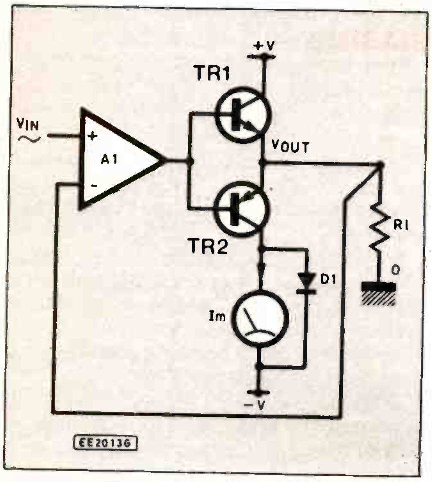


Fig. 3. Practical active rectifier, negative feedback stabilizes the gain and linearizes the transistor base–emitter characteristic.

RANGE SETTING

The op. amp acts as a buffer with a fairly high input impedance. Range setting can be carried out with a voltage divider at the input, giving a constant input resistance on all ranges.

The current in R1 is the input/output voltage divided by R1. Since TR2, which supplies the meter current, carries only alternative half cycles the meter current is half the load current. It can be set to whatever the meter needs (within reason) by selecting or adjusting R1.

Suppose the input voltage at full scale is to be 1V and the meter takes 1mA at full scale. Then the load must carry 2mA.

At first sight this seems to call for a load resistance of 500 ohms. However, this is true only for square wave signals. For sine waves load current is less than 2mA away from the peaks and the value of R1 has to be reduced to about 0.9 times the apparent resistance to allow for this.

The diode D1 across the meter is not for rectifying but for meter protection. If the voltage across the meter coil resistance exceeds the knee voltage D1 conducts and bypasses the meter. With some meters it will pay to increase the coil resistance by adding a series resistance so that D1 comes on earlier. With others, D1 may conduct too soon and to avoid this two diodes in series may be needed.

EVERYDAY ELECTRONICS

CLASSIFIED

Reach effectively and economically today's enthusiasts anxious to know of your products and services through our semi-display and classified pages. The prepaid rate for semi-display spaces is £8.00 (plus VAT) per single column centimetre (minimum 2.5 cm). The prepaid rate for classified advertisements is 30 pence (plus VAT) per word (minimum 12 words).
All cheques, postal orders, etc., to be made payable to Everyday Electronics. **VAT must be added.** Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: (0202) 881749.

Electronic Components

A & G ELECTRONICS LTD.

If you are buying Electronic Components elsewhere you are almost certainly paying too much! Write to us for a free 1989 catalogue and start saving money. (Please send two 19p stamps towards postage.)

100 Park Avenue, London E6 2SR
Tel 01-552 2386

WALTONS OF WOLVERHAMPTON

Established since 1947 – offering a complete range – I.C.s, transformers, switches, pots, capacitors, resistors, kits, speakers, test equipment, books and lots, lots more!

COME AND SEE US AT: MON-SAT 9-6.00 pm
55A WORCESTER STREET, WOLVERHAMPTON TEL: 0902 22039

ELECTRONIC COMPONENTS

EVERYTHING FOR YOUR NEXT PROJECT

THE BIGGEST DISPLAY IN THE SOUTH IS AT

FRASER ELECTRONICS

42 ELM GROVE ★ SOUTHSEA ★ HANTS

Telephone 0705-815584

RCS VARIABLE VOLTAGE D.C. BENCH POWER SUPPLY

1 to 24 volts up to ½ amp. 1 to 20 volts up to 1 amp. 1 to 16 volts up to 1½ amps A.C. Fully stabilised. Twin panel meters for instant voltage and current readings. Overload protection.

Fully variable. Operates from 240V AC. Compact Unit. size 9 x 5½ x 3in.

£39 inc. VAT +Post £2

RADIO COMPONENT SPECIALISTS

337 WHITEHORSE ROAD, CROYDON SURREY, U.K. Tel: 01-684 1665

List, Large SAE. Delivery 7 days. Callers welcome. Closed Wednesday

CAMBRIDGE COMPUTER SCIENCE LIMITED

5.25" Disc Drives, 80Tk, DSDD	£34.00	each
3" Disk Drives, 40 Tk, SSDD	£28.00	each
5.25" Disks, DSDD, 48tpi, boxed in 10s	£3.00	box
	£27.00	/10
Dual Disk Drive Power Supply	£20.00	each
Lead to connect one drive to psu	£2.00	each
Single Data lead (BBC Micro to Disk Drive)	£2.00	each
Dual Data lead (BBC Micro to 2 Disk Drives)	£4.00	each
Power lead (BBC Micro to Disk Drive)	£1.00	each
Dual leads (BBC Micro to 2 Disk Drives)	£2.00	each
20 pin dil low profile IC sockets	£0.50	/10
	£4.00	/100
40 pin dil low profile IC sockets	£0.60	/10
	£5.00	/100
QWERTY keyboard with cursor keys, function keys & numeric pad	£6.00	each
Hitachi 640 * 200 dot matrix LCD display	£40.00	each
Toroidal transformer, mains in, 12V @4A, 12V @0.4A, 12-0-12 @0.1A, 12-0-12 @0.2A & 9-0-9 @ 0.2A	£4.00	each
	£6.00	/2
	£8.00	/3

All items new and boxed. Add 15% VAT to all prices
Prices include postage. Add 50p to orders below £5.00.
Dept EE, 374 Milton Road, Cambridge CB4 1SU
Tel: 0223 327602

*****RESISTOR PACKS*****

¼W 5% CARBON FILM
E12 range 10R to 10M
1p each+25p P&P

10 OF EACH VALUE
Total 730 resistors
£6.95

RMOS P.O. BOX 3
USK GWENT NP5 2YF

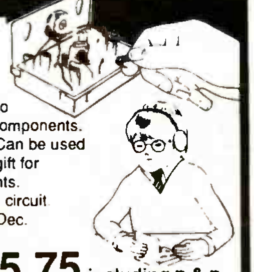
*****EPROMS*****

2764 (250ns) **70p** 3 for **£2.00** pp
Discount for 10/100
Also:—
8085; 8155; 8257; 2732 all at **75p** ea pp
(All IC's Ex Equipment)

A. W. Ferneyhaugh,
30 Bedford Drive, Sutton Coldfield, West Midlands B75 6AU

LEARN
ELECTRONICS WITHOUT SOLDER

Build electronic circuits without solder on a S-Dec.
This has built-in contacts and holes into which you plug your components.
Suitable for all ages. Can be used time after time. Ideal gift for students or experiments.
Full instructions and 2 circuit diagram with each S-Dec.



Send Cheque or P.O. to:
Vistaplan, Dep EE
High March, Daventry,
Northants. NN11 4QE

£5.75 including p & p

STATE OF THE ART SEAS LOUDSPEAKERS

8" 100 WATT BASS **£39.45** inc. p&p
1" 100 WATT TWEETER **£17** inc. p&p
CROSSOVERS **£19.98** per pair inc. p&p
FULL INFORMATION IN OUR LATEST ILLUSTRATED CATALOGUE
of quality electronic and electrical Spares and accessories
SEND 75p TODAY FOR YOUR COPY
Fast by-return service

STRACHAN ELECTRONICS (EES)
9 Croall Place Edinburgh EH7 4LT

KIA SPRINGTIME FREEBIE!! Transistors . . . Giftpack . . . *npn-pnp* assortment . . . Diodepack+Datapack!! Enclose advertisement/£1 coin (p&p). 8 Cunliffe Road, Ilkley LS29 9EA.

Miscellaneous

TRANSMITTER CIRCUIT DIAGRAMS—f.m., medium, shortwave, C.B., some crystal controlled, minimum 17 circuits. Includes price list for kits. Cheques/P.O.s, £4.25 to D. Davies, 33 Gwaelodygarth, Merthyr Tydfil CF47 8YU.

TECHNICAL INFO SERVICES (EE)
76 Church St., Larkhall, Lanarkshire ML9 1HE
Phone 0698-884585 Mon-Fri, 9-5,
any other time 0698-883334, FOR FAST QUOTES

WORLD'S LARGEST COLLECTION SERVICE MANUALS—Most unobtainable elsewhere. Prices range from only £4.50—large s.a.e. any quotation, no obligation to buy.

WORLD'S SOLE Suppliers of TV & Video Repair manuals, etc. from TV TECHNIC, also such publishers as Heinemann, Newnes, TV Technic, Thorn etc. Every published service sheet in stock, supplied full size, not bits & pieces. CTV's or any combination £3.50 plus Lsae; any other single item £2.50 plus Lsae. Complete Circuit Sets for most Videorecorders only £7 set (no serv shts made).

LSAE for QUOTATIONS plus GIANT CATALOGUE—NEWSLETTERS—BARGAINS—FREE S/Sht as available.

Comprehensive TV Repair Manual £9.50. Complete Radio Service and Repair Course £9.50. Complete Repair & Service Manuals—Mono TV £12.50; CTV £17.00; Video £19.50. Complete Repair Data with circuit—Mono TV £9.50; CTV £12.50; Video £10.50.

£3.00 plus LSAE BRINGS THE ONLY COMPREHENSIVE SERVICE SHEETS & MANUALS, CATALOGUES plus FREE CHASSIS GUIDE and £4.00 OF VOUCHERS

F.M. MICRO TRANSMITTER kit 20mm × 28mm. Long range, £3.99 inc. P&P. Cheques/P.O. to Minral, 39 Parkside, Orrell, Wigan WN5 8LU.

PROFITS FROM CAMERA REPAIRS. Our comprehensive training manual explains how to repair all types of cameras. Our step by step guide shows all the trade secrets. Get started today. Full manual and training notes £17.50 inc p&p. Camrep Publications, Dept EE, 3 Alnwick Drive, Bury BL9 8BZ.

NEW VHF MICROTRANSMITTER KIT

Tuneable 88-115 MHz, 500 metre range, sensitive electret microphone, high quality p.c.b. **SPECIAL OFFER** complete kit **ONLY £5 POST FREE.** Access orders telephone 021-411 1821 (24 hrs).

Cheques/P.O.s payable to:

QUANTEK ELECTRONICS LTD
(Dept. EE), 45a Station Road
Northfield, Birmingham B31 3TE

PROTOTYPE PRINTED CIRCUIT BOARDS, one offs and quantities, for details send s.a.e. to Mr B. M. Ansbro, 38 Poynings Drive, Sussex BN3 8GR, or phone Brighton 720203.

TRANSMITTERS—tuneable—70:150—p.c.b. TX1 £5.00—FM5 £9.95—FM100 £16.95 3 miles, s.s.a.e. other details. Gemtronics, 40 Baker, Crawley, Sussex RH10 6HA.

G.C.S.E. ELECTRONICS KIT. 10 diferent £10.50 (+70p p&p) or s.a.e. for details. SIR-KIT Electronics, 70 Oxford Road, Clacton-on-Sea, Essex CO15 3TE.

KITS, MICROTRANSMITTER, v.h.f./f.m., 25×15mm, £3.95. We also stock telephone transmitters/recording switches, bleepers, radio transmitting alarms, circuit diagrams, etc. Kits and built available. S.a.e. to A.C.E., 99 Greenheath, Hednesford, Staffs.

2×8" MPE DISK DRIVES 1.2 Meg, double sided. Brand new, abandoned project. Cash offers? Tel. (0732) 354311 evenings.

USE THIS SPACE TO SELL YOUR PRODUCTS
IT ONLY COSTS £20+VAT
(see above for details)

NATIONAL COMPONENT CLUB

SPECIAL OFFERS * SPECIAL OFFERS

SCANNER KIT(T)

A complete, six channel LED chaser kit for less than a fiver! The kit comes complete with all components, including PCB and instructions simple enough for even a complete novice. Works from 6-15vdc.

Only £4

MAINS POWER SUPPLY FOR ABOVE £1

*** SPECIAL OFFER PACKS ***

100	ASSORTED CAPACITORS	£1
30	ASSORTED TRANSISTORS	£1
25	ELECTROLYTIC CAPACITORS	£1
12	LED's (5mm red or green)	£1
5	555 TIMER IC's	£1
5	741 OP-AMPS	£1

FREE MYSTERY PACK WITH ALL ORDERS OVER £6

Please add £1 P&P, but do not add VAT.

P.O. or cheque to: NATIONAL COMPONENT CLUB, DEPT EE, BAILEY HILL, CASTLE CARY, SOMERSET BA7 7AD

We now accept Access - phone (0963) 51171

✲ FREE CLUB MEMBERSHIP ✲

Just phone above number or write for details

SURVEILLANCE

PROFESSIONAL QUALITY KITS

A range of high quality kits as supplied to leading UK security companies, all in-house designed and produced, not to be confused with cheap imports. All kits come fully documented with concise assembly and setting-up details, fibreglass PCB and all components. All transmitters are fully tuneable and can be monitored on a normal VHF radio or tuned higher for greater security. All units available ready built if required.

MTX. Micro-miniature audio transmitter. 17mm×17mm. 9V operation. 1000m range **£10.95**

VT500. Hi-power audio transmitter. 250mW output. 20mm×40mm 9-12V operation. 2-3000m range **£12.95**

VOX75. Voice activated transmitter. Variable sensitivity. 30mm×40mm. 9V operation. 1000m range **£15.95**

CTX900. Sub-carrier scrambled audio transmitter. Cannot be monitored without decoder fitted to radio. 30mm×40mm. 9V operation. 1000m range **£18.95**

DSX900. Sub-carrier decoder unit for monitoring CTX900. Connects to radio earphone socket. Provides output for headphones. 35mm×50mm. 9-12V operation **£17.95**

HVX400. Mains powered audio transmitter. Connects directly to 240V AC supply. 30mm×35mm. 500m range **£15.95**

XT89. Crystal controlled audio transmitter. High performance. 100mW output. Supplied with xtal for 108MHz. Others available to 116MHz. 85mm×28mm. 9V operation. 2-3000m range **£29.95**

TKX900. Tracker/Bleeper transmitter. Transmits continuous stream of audio pulses. Variable tone and rate. Powerful 200mW output. 63mm×25mm. 9V operation. 2-3000m range **£18.95**

ATR2. Micro size telephone recording interface. Connects between telephone line (anywhere) and cassette recorder. Tape switches automatically with use of phone. All conversations recorded. Powered from line 10mm×35mm .. **£10.95**

TLX700. Micro miniature telephone transmitter. Connects to line (anywhere) switches on and off with phone use. All conversations transmitted. 20mm×20mm. Powered from line 1000m range **£10.95**

XML900. RF bug detector. Variable sensitivity. Triggers LED and bleeper when in presence of RF field. Detects MTX 15-20 feet. 55mm×55mm. 9V operation **£21.95**

XL7000. Professional bug detector/locator. Variable sensitivity. Twin mode ten segment LED readout of signal strength with variable rate bleeper. Second mode AUDIO CONFIRM distinguishes between localised bug transmission and normal legitimate signal such as pagers, cellular etc. 70mm×100mm. 9V operation **£49.95**

UK customers please send cheques, PO's or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send sterling bank draft or Eurocheque and add £5.00 per order for shipment. Credit card orders accepted on 0827 714476. Full catalogue available on receipt of 28p stamp. Trade enquiries welcome.

SUMA DESIGNS

The Workshops, 95 Main Rd
Baxterley, Nr. Atherstone
Warks CV9 2LE

VISA · AMERICAN EXPRESS

0827 714476

Carbon Film resistors ¼W 5% E24 series 0.51R to 10MO	1p
100 off per value—75p, even hundreds per value totalling 1000	£6.00p
Metal Film resistors ¼W 10R to 1MO 5% E12 series—2p, 1% E24 series	3p
Mixed metal/carbon film resistors ½W E24 series 1RO to 10MO	1½p
1 watt mixed metal/Carbon Film 5% E12 series 4R7 to 10 Megohms	5p
Linear Carbon pre-sets 100mW and ¼W 100R to 4M7 E6 series	7p
Miniature polyester capacitors 250V working for vertical mounting	
.015, .022, .033, .047, .068-4p. 0.1-5p. 0.12, 0.15, 0.22-6p. 0.47-8p. 0.68-8p. 1.0-12p	
Mylar (polyester) capacitors 100V working E12 series vertical mounting	
1000p to 8200p - 3p. .01 to .068 - 4p. 0.1 - 5p. 0.12, 0.15, 0.22-6p. 0.47/50V-8p	
Submin ceramic plate capacitors 100V wkg vertical mountings. E12 series	
2% 1.8pf to 47pf - 3p. 2% 56 pf to 330pf - 4p. 10% 390p - 4700p	4p
Disc/plate ceramics 50V E12 series 1PO to 1000P, E6 Series 1500P to 47000P	2p
Polystyrene capacitors 63V working E12 series long axial wires	
10pf to 820pf - 3p. 1000 pf to 10,000pf - 4p. 12,000 pf	5p
741 Op Amp - 20p. 555 Timer	22p
cmos 4001 - 20p. 4011 - 22p. 4017	40p
ALUMINIUM ELECTROLYTICS (Mfds/Volts)	
1/50, 2.2/50, 4.7/50, 10/25, 10/50	5p
22/16, 22/25, 22/50, 47/16, 47/25, 47/50	6p
100/16,100/25 7p; 100/50 12p; 100/100	14p
220/16 8p; 220/25, 220/50 10p; 470/16, 470/25	11p
1000/25 25p; 1000/35, 2200/25 35p; 4700/25	70p
Submin, tantalum bead electrolytics (Mfds/Volts)	
0.1/35, 0.22/35, 0.47/35, 1.0/35, 3.3/16, 4.7/16	14p
2.2/35, 4.7/25, 4.7/35, 6.8/16 15p; 10/16, 22/6	20p
33/10, 47/6, 22/16 30p; 47/10 35p; 47/16 60p; 47/35	80p
VOLTAGE REGULATORS	
1A + or – 5V, 8V, 12V, 15V, 18V & 24V	55p
DIODES (piv/amps)	
75/25mA 1N4148 2p. 800/1A 1N4006 6p. 400/3A 1N5404 14p. 115/15mA OA91	6p
100/1A 1N4002 4p. 1000/1A 1N4007 7p. 60/1.5A S1M1 5p. 100/1A bridge	25p
400/1A 1N 4004 5p. 1250/1A BY127 10p. 30/.15A OA47	8p
Zener diodes E24 series 3V3 to 33V 400 mW - 8p. 1 watt	12p
Battery snaps for PP3 - 6p for PP9	12p
L.E.D.'s 3mm. & 5mm. Red, Green, Yellow - 10p. Grommets 3mm - 2p, 5mm	2p
Red flashing L.E.D.'s require 5V supply only	50p
Mains indicator neons with 220k resistor	10p
20mm fuses 100mA to 5A Q/blow 5p. A/surge 8p. Holders pc or chassis	5p
High speed pc drill 0.8, 1.0, 1.3, 1.5, 2.0m - 30p. Machines 12V dc	£7.00
HELPING HANDS 6 ball joints and 2 croc clips to hold awkward jobs	£3.50p
AA/HP7 Nicad rechargeable cells 80p each. Universal charger unit	£6.50p
Glass reed switches with single pole make contacts - 8p. Magnets	12p

TRANSISTORS

BC547/8/9-8p, BC557/8/9-8p, BC182L/4L-10p, BC183, 183L-10p, BC212,212L-10p, BC337,337L-12p, BC727/737-12p, BD135/6/7/8/9-25p, BCY70-16p, BFY50,52-20p, BFX88-15p, 2N3055-50p, TIP31,32-30p, TIP41,42-40p, BU208A-£1.20, BF195,197-12p

All prices are inclusive of VAT. Postage 25p (free over £5). Lists Free.

THE CR SUPPLY CO

127 Chesterfield Rd, Sheffield S8 0RN

Return posting

OMNI ELECTRONICS

174 Dalkeith Road, Edinburgh EH16 5DX · 031 667 2611

Have you sent for your copy of our catalogue yet?

If not, simply send 2×19p stamps for a copy by return.

A COMPREHENSIVE RANGE WITH SERVICE SECOND TO NONE

Open: Monday-Friday 9.00-6.00
Saturday 9.00-5.00

VISA

MAKE YOUR INTERESTS PAY!

More than 8 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 90 years experience in home-study courses and is the largest correspondence school in the world. You learn at your own pace. When and where you want, under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for your **FREE INFORMATION PACK** on the course of your choice.

GCSE/GCE/SCE
ELECTRONICS
BASIC ELECTRONIC ENGINEERING (City & Guilds)
ELECTRICAL ENGINEERING
ELECTRICAL CONTRACTING/INSTALLATION

CAR MECHANICS
COMPUTER PROGRAMMING
TV, VIDEO & HI-FI SERVICING
RADIO AMATEUR LICENCE EXAM (City & Guilds)

Course of Interest ....

Name: ....

Address: .... P.Code ....

ICS

International Correspondence Schools, Dept. ECS69. 13/314 High Street, Sutton, Surrey SM1 1PR. Tel: 01-643 9568 or 041-221 2926 (24 hrs)

PRODUCE YOUR PRINTED CIRCUITS AT HOME -

on positive light sensitive coated fibre glass board (FR4).

Full instructions provided.

Coated Stock

Approx Size	Price
200 x 220	£4.20
100 x 160	£1.68

Prices are per panel, and include VAT.

Charges for post and packing:	order value up to £5.00 - please add £1.00
	over £5.00 & up to £20.00 - please add £2.50
	over £20.00 - please add £5.00

Settlement terms: cheque with order

SEND FOR CATALOGUE DETAILING FULL PRODUCT RANGE FOR HOBBYISTS.

ADVANCED CIRCUITS LIMITED

Clarendon Road, Blackburn, Lancashire BB1 9SS

(Tel 0254 680156)

Marconi Pattern Generator and SLMS TF2802/Z combined Digital Pattern Generator and selective level measuring set.	P.O.A.
Philips PM5324 HF Generator 100kHz-110MHz.	120.00p
Centronics type C036E 36 Way Data Interface Plug, complete with shielded metal cover and rubber cable gland.	3.25p
Clairtronics Encapsulated Transformer 9421, rated at 0.75mA 15V+0.75mA 15V PCB Mounting.	3.50p
Spectrol HEL-05-B05 10 turn wirewound potentiometer.	6.25p
5 way miniature DIP switch SPST PCB mounting.	.60p
5mm LEDs red or green standard.	.12p
Varta mempak nic. cad. rechargeable batteries 3.6V 100mA.	1.85p
MC6800P 8 bit micro-processor 1MHz.	3.18p

PRINTER CABLES

DM25-36CENM-6 IBM Printer Cable 6ft.	7.50p
DM25-DM25-6 RS232 Male to Male 6ft.	8.50p
DM25-DM25-6 Male to Female 6ft.	8.50p
Centronic-6 Cable Extender 6ft.	13.50p
25 Pin Modem Cable 9 Conductors — 6ft.	5.50p
25DM-8 Pin-6, Apple Cable Male 6 Conductor 6ft.	4.00p
Apple 6 Conductor 8 Pin Din — 6 ft.	4.00p
RGB Monitor Cable — 6ft.	4.50p
Piezo Sounder round electronic buzzer PCB.	.51p
10 piece VHS Video/Audio Dubbing Kit.	5.95p
URM76 50ohm RF, Uniradio Cable.	.35p per mtr.

CHAFFORD VALLEY PRODUCTS

Chafford Lane, Fordcombe, Kent TN3 0SH. Tel. 089 274 287 Fax. 089 274 216.

MAIL ORDER ONLY. ALL PRICES EXCLUDING VAT. ADD 1.00p P&P UNLESS OTHERWISE STATED. TERMS CASH, CHEQUE OR POSTAL ORDER WITH ORDER. SCHOOL ACCOUNTS AVAILABLE

ADVERTISERS INDEX

BTEC ELECTRONICS TECHNICIAN FULL-TIME TRAINING

2 YEAR
BTEC National Diploma (OND)
ELECTRONIC & COMMUNICATIONS ENGINEERING
(Electronics, Computing, Television, Video, Testing & Fault Diagnosis)

1 YEAR
BTEC National Certificate (ONC)
ELECTRONIC ENGINEERING

1—INFORMATION TECHNOLOGY
(Electronics, Satellite TV, Networks, Telecomms)

2—ELECTRONIC EQUIPMENT SERVICING
(Electronics, Television, Video Cassette Recorders, CCTV, Testing and Fault Diagnosis)

3—SOFTWARE ENGINEERING
(Electronics, Assembler, BASIC, Pascal, CADCAM)

4—COMPUTING TECHNOLOGY
(Electronics, Computing Software/Hardware, Microelectronics)

10 MONTHS
BTEC Higher National Certificate (HNC)
COMPUTING TECHNOLOGY & ROBOTICS
(Microprocessor Based Systems, Control, Robotics)

These courses include a high percentage of college based practical work to enhance future employment prospects
No additional fees for overseas students
Shortened courses of from 3 to 6 months can be arranged for applicants with previous electronics knowledge

THOSE ELIGIBLE CAN APPLY FOR E.T. GRANT SUPPORT AN EQUAL OPPORTUNITIES PROGRAMME

O.N.C. and H.N.C.
Monday 18th September 1989

FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE
(Dept. EE), 20 PENYWERN ROAD
EARLS COURT, LONDON SW5 9SU
Tel: 01-373 8721

QUALITY...

SECURITY SUPPLIES

FOR DIY & TRADE

...AT LOWEST PRICES

CONTROL UNITS
- Automatic
- Modular
- Lighting
- Timer

SENSORS
- Passive Infra-Red
- Ultrasonic
- Infra-Red Beam

ACCESSORIES
- Contacts
- Pressure Pads
- Security Lighting
- Cable Etc. Etc.

CARS & VANS

HOMES & FACTORIES

PRODUCT OF THE MONTH

DP3570 TIMER/SWITCH & POWER SUPPLY

FOR SECURITY, LIGHTING CONTROL AND OTHER APPLICATIONS

★ Adjustable Timing from 10 secs—5mins.
★ 4A Switching Capacity.
★ 12V 250mA Stabilised Output.
★ Separate Switched 240V Output.
★ Timing Start by Make or Break Circuits.

ONLY £13.95+VAT

TELEPHONE OR SEND FOR FREE LITERATURE TODAY

The Security Specialist

RISCOMP LIMITED

Dept. EE6, 51 Poppy Road, Princes Risborough, Bucks. HP17 9DB

Callers by Appointment
Office hours Mon–Fri 9am–5pm

(084 44) 6326

BRIAN PRICE
Böhm ORGAN STUDIOS

389 ASPLEY LANE, NOTTINGHAM NG8 5RR
Telephone/Fax: 0602 296311

32 years' experience in high quality Organ and Keyboard design behind every BOHM product. Equipment for Home and Professional use.

Bohm Musica Futura 520

- Latest from BOHM.
- Portable or Spinet.
- 49 note keyboards. Touch Sensitive.
- 16 Bit Sampled voices.
- Stereo Sounds.
- 22 Sampled Rhythm Instruments.
- 16 Live Rhythms, Fills, Intros,
- Breaks & Endings.
- Tempo Readout.
- User Programmable voices, Rhythms & Accompaniments.
- Soundcard Programming.
- 15000 note Sequencer.
- Full MIDI/IN/OUT/THRU.
- 160W Stereo Hi-Fi Amplifier.

BOHM MUSICA FUTURA 520 Kit form Price **£2330** inc. Stool. **Built Price £2563**
BOHM DOUBLE KEY 520(P) Kit form Price **£2069** inc. Stool. **Built Price £2275**
Loudspeakers extra for Double Key 2×B100 **£474** 100 Watts if required

Supplied in kit form or built by:

THE Böhm SPECIALISTS

Part Exchange welcome. Please write or phone for full illustrated literature and price list.

Published on approximately the first Friday of each month by Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Printed in England by Benham & Co. Limited, Colchester, Essex. Distributed by Seymour, 334 Brixton Road, London SW9 7AG. Sole Agents for Australia and New Zealand – Gordon & Gotch (Asia) Ltd., South Africa – Central News Agency Ltd. Subscriptions INLAND £15.70 and OVERSEAS £19 payable to "Everyday Electronics" Subscription Department, 6 Church Street, Wimborne, Dorset BH21 1JH. EVERYDAY ELECTRONICS is sold subject to the following conditions, namely that it shall not, without the written consent of the Publishers first having been given, be lent, resold, hired out or otherwise disposed of by way of Trade at more than the recommended selling price shown on the cover, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of Trade or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.