EVERYDAY ELECTRONICS

Graham

NOVEMBER 1988

INCORPORATING ELECTRONICS MONTHLY

£1.30

MICRO ALARM

REAR SCREEN ONE-SHOT

SEA SYNTHESISER

I.R. OBJECT COUNTER

City and Guilds

C+G

Introducing DIGITAL ELECTRONICS Part 2

The Magazine for Electronic & Computer Projects

No. 1 LIST BAKERS DOZEN PACKS

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

- BD1 5 13A junction boxes for adding extra points to your ring main circuit.
- BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
- BD7 4 In flex switches with neon on/off lights, saves leaving things switched on.
- BD9 2 6V 1A mains transformers upright mounting with fixed clamps.
- BD11 1 6½in speaker cabinet ideal for extensions, takes our speaker. Ref BD137.
- BD13 12 30 watt reed switches, it's surprising what you can make with these—burglar alarms, secret switches, relay, etc., etc.
- BD22 2 25 watt loudspeaker two unit crossovers.
- BD29 1 B.O.A.C. stereo unit is wonderful value.
- BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
- BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
- BD34 48 2 meter length of connecting wire all colour coded.
- BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
- BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day. original cost £40 each.
- BD49 10 Neon valves, with series resistor, these make good night lights.
- BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
- BD59 2 Flat solenoids—you could make your multi-tester read AC amps with this.
- BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
- BD91 2 Mains operated motors with gearbox. Final speed 16 rpm, 2 watt rated.
- BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
- BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
- BD122 10m Twin screened flex with white pvc cover.
- BD128 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
- BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
- BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
- BD139 6 Microphone inserts—magnetic 400 ohm also act as speakers.
- BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
- BD149 6 Safety cover for 13A sockets—prevent those inquisitive little fingers getting nasty shocks.
- BD180 6 Neon indicators in panel mounting holders with lens.
- BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
- BD196 1 in flex simmerstat—keeps your soldering iron etc. always at the ready.
- BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
- BD201 8 Keyboard switches—made for computers but have many other applications.
- BD210 4 Transistors type 2N3055, probably the most useful power transistor.
- BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
- BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
- BD242 2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
- BD246 2 Tacho generators, generate one volt per 100 revs.
- BD252 1 Panostat, controls output of boiling ring from simmer up boil.
- BD259 50 Leads with push-on ¼in tags—a must for hookups—mains connections etc.
- BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
- BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
- BD275 1 Guitar mic—clip-on type suits most amps.
- BD283 3 Mild steel boxes approx 3in x 3in x 1in deep—standard electrical.
- BD293 50 Mixed silicon diodes.
- BD296 3 Car plugs with lead, fit into lighter socket.
- BD305 1 Tubular dynamic mic with optional table rest.

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

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

OVER 400 GIFTS YOU CAN CHOOSE FROM

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

NEWLY ADVERTISED ITEMS

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

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

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

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

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

TWIN CASSETTE & STEREO RADIO—Covers long, medium and FM bands. Twin cassettes allow copying, editing, recording, playback, etc. A beautifully made portable unit which normally retails at about £60. Our price only £30. plus £3 insured delivery.

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

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

LASER TUBE

Made by Philips Electrical. New and unused. This is helium-neon and has a typical power rating of 1.6mW. It emits random polarised light and is completely safe provided you do not look directly into the beam when eye damage could result. DON'T MISS THIS SPECIAL BARGAIN! Price £29.95 plus £3 insured delivery.
POWER SUPPLY KIT for our laser gives 8kV striking and 1.25 running at 5mA. price £13 (plus £2 post unless ordered with tube).

PAPST AXIAL FAN—MANUFACTURERS REF NO. TYP4580N.
This is mains operated. 15 watt rating and in a metal frame with metal blades so OK in high temperatures. Body size approx. 4¾" square x 1⅝" thick. £6.00 each, plus £1.00 postage. Our ref 6P6.

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

FLIP-OVER DIGITAL CLOCK Quite an eyecatcher, this is mains operated. The figures flip-over per minute and per hour and give a larger than usual visual display. Supplied complete with front and perspex panels to glue together to make its case. £2.00 each. Our ref 2P285

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

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

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

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

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

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

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

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

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

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

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

MINIATURE DRIVER TRANSFORMER—Reference LT44. Impedance ratio 20K ohm to 1K ohm centre tapped. Size approx. 19.5mm. 2 for £1. Order Ref. BD653.

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

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

J & N BULL ELECTRICAL

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

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

POPULAR ITEMS

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

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

3in FDD HITACHI HFD305SXA Shugart compatible interface. 500k on 3in disc. Recommended for many Amstrads but interchangeable with most drives. £29.50 plus £3 insured post.

FDD CASE AND POWER SUPPLY KIT for the 3in or 3½in. £11.00. Ref 11P2 for the Chinon, 11P3 for the Hitachi.

9in MONITOR made for ICL, uses Phillips black and white tube. Brand new and complete but uncased. £16.00 plus £5.00 post.

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

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

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

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

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

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

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

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

METAL PROJECT BOX Ideal size for battery charger, power supply etc.; sprayed grey, size 8in x 4¼in x 4in high, ends are louvred for ventilation other sides are flat and undrilled. Order Ref. 2P191. Price £1.

BIG SMOOTHING CAPACITOR. Sprague powerlytic 39,000uF at 50V. £3. Our ref. 3P41.

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

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

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

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

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

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

20V-0-20V Mains transformers 2½ amp (100 watt) loading, tapped primary. 200-245 upright mountings £4. Order ref. 4P24.

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

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

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

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

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

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

APPLIANCE THERMOSTATS—Spindle adjust type suitable for convector heaters or similar. Price 2 for £1. Ref. BD582.

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

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

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

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

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

500V BRIDGE MEGGER—Made by famous Evershed and Vignoles Company. 500V Meggers are the only reliable instrument for measuring the state of electrical wiring installations, but the Bridge Megger has the additional feature of being able to measure low ohms so can be used for finding and localising faults. The instruments we have are complete in a leather carrying case and they have been re-calibrated and tested and are in perfect order. Price is £50 plus £6 insured delivery.

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

VOL 17 No 11 NOVEMBER '88

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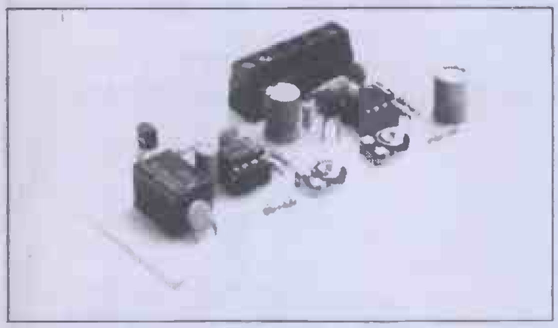
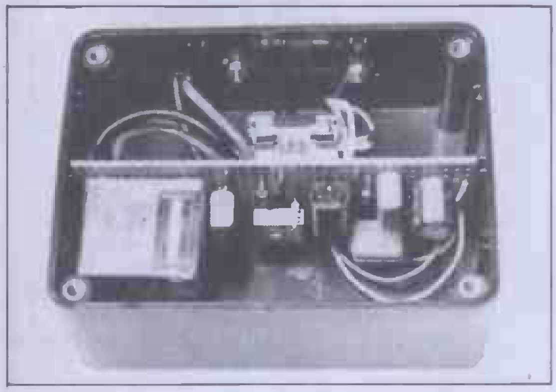
ABC

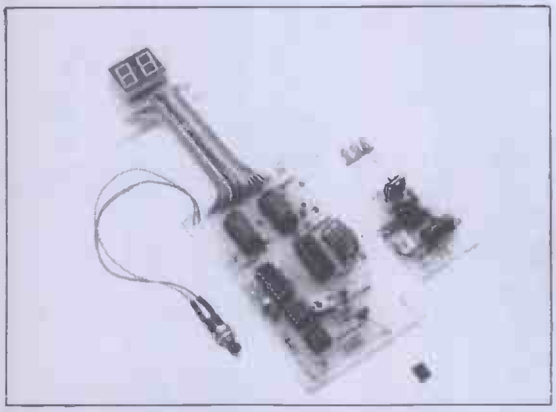
The Magazine for Electronic & Computer Projects

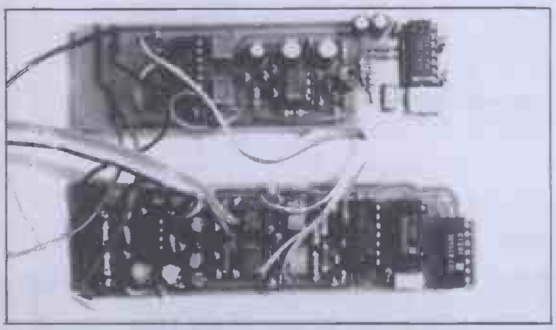
ISSN 0262–3617

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









Projects

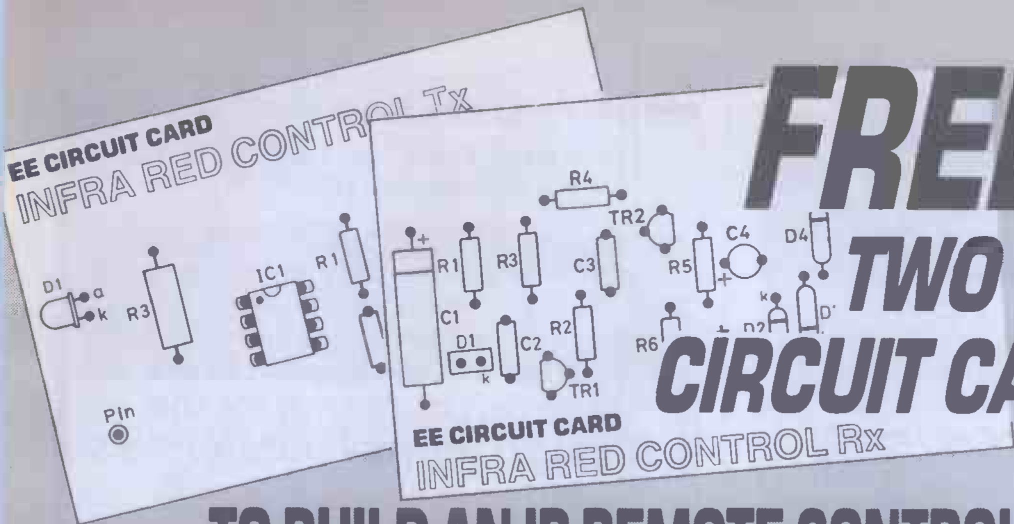
Series

Features

FREE
GREENWELD 100-page COMPONENTS CATALOGUE (banded with magazine)

Our December '88 issue will be published on Friday, 4 November 1988. See page 623 for details.

NEXT MONTH



FREE! TWO CIRCUIT CARDS

TO BUILD AN IR REMOTE CONTROL TRANSMITTER AND RECEIVER

Two circuit cards will be given away free with next month's issue. On them you can build an infra-red Transmitter and a matching Receiver for remote control or infra-red beam systems. Full circuits and constructional details will be given in the issue.

PERSONAL CASSETTE AMPLIFIER

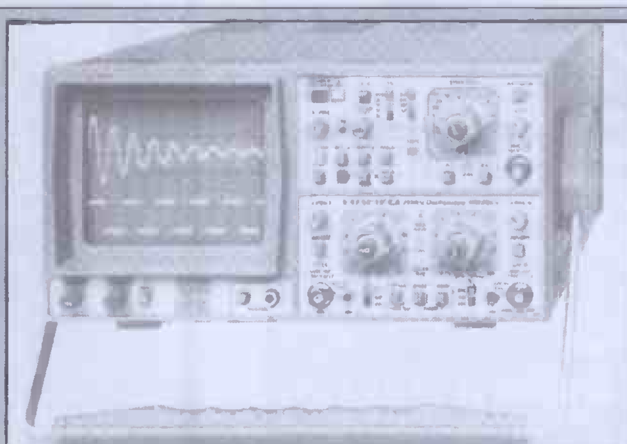
Use your personal cassette player as an in-car stereo system with the addition of this low cost amplifier. Using just twelve components this amp should appeal to both novice and experienced constructors and can be used for a variety of applications.

METRONOME

All budding musicians eventually face a common problem; learning to keep time. A metronome provides a cheap and effective solution to this difficulty. Better still is an "accented" metronome, with a "ping" every few beats to indicate the start of each bar. These are rather expensive to buy, but one may be built very cheaply from readily obtainable components. This one is also pocket-sized, so if your instrument is portable you can take it with you and practice anywhere.

SPECIAL 'SCOPE OFFER

Two oscilloscopes at very special prices for EE readers. The Hameg HM205-2 Digital Storage 'scope and the HM203-6 two channel 20MHz 'scope. Both have built-in component testers. Don't miss this offer.



COMPLETE INDEX FOR '88

EVERYDAY ELECTRONICS

DECEMBER ISSUE ON SALE NOVEMBER 4

Tel (0939) 32763
Telex 35565

MARCO TRADING

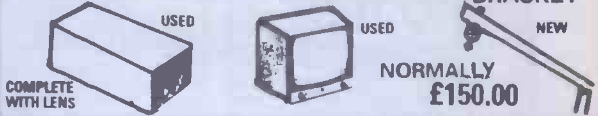
24 HOUR ANSWERING MACHINE

THE MALTINGS, HIGH STREET, WEM,
SHROPSHIRE SY4 5EN
DEPT. EE11

VISA

NOVEMBER SPECIAL OFFER
ONLY £130
"CLOSED-CIRCUIT" TELEVISION SYSTEM

COMPRISING:
1 x CAMERA 1 x MONITOR 1 x CAMERA BRACKET

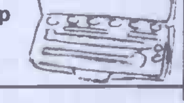


NORMALLY
£150.00

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

PLEASE ADD 85p P&P +15% VAT TO ALL ORDERS unless otherwise stated.

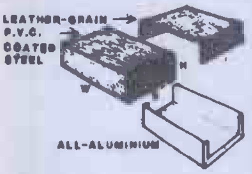
HANDY BOX
A very useful strong aluminium box with hinged lid. Intended as a socket set box but when you remove the plastic socket tray you finish up with a very handy box.
Dimensions: L290 x W 130 x D 45mm.
Quantity available: 320
Order Code 80/050
PRICE 1+75p 6+60p



TV AERIAL ACCESSORIES
Co-Ax cable 75 Ohm 100 metre reel £11.00

	1+	10+
Co-Ax Metal Plug	20p	18p
Co-Ax Line Socket	25p	22p
Co-Ax Line Connector	12p	10p
Co-Ax In-Line Splitter	80p	
TV/Video/Computer Combiner	£3.09	
TV Indoor Amplifier Improves signal 3 times	£13.66	
Second Set Amplifier Improves signal to 2 sets 50%	£12.72	
CB Interference Suppressor Minimises CB interference on TV	£4.45	
TV/FM Diplexer Separates UHF TV signals from FM radio signals	£3.78	

EQUIPMENT CASES



DIMENSIONS

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

SERVICE AIDS

Goldklene Degreasing Solvent	1.78
Switch Cleaner Lubri	1.18
Supa Freeze-it	1.46
Foam Cleanser	1.26
Video/Tape Head Cleaner	1.14
Plastic Seal	1.40
Aero Klene	1.16
Anti Static Spray	1.28
Excel Polish	1.24
Aero Duster	1.55
Super 40	1.94
Rapid Fire extinguisher	3.45
Silicone Grease Tube	1.82
Silicone Grease Spray	1.48
Heat Sink Compound	1.20
Solder Mop Light gauge 0.08mm	0.80
Standard gauge 1.2mm	0.78
Industrial reel 1.2mm	2.96

LOGIC PROBE
PRICE–£7.99

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

RESISTORS—CARBON FILM 5%

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

MAINS SOCKETS

13A single unswitched	1.50
13A Single switched	2.18
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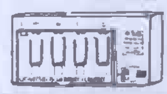

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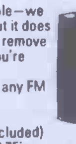

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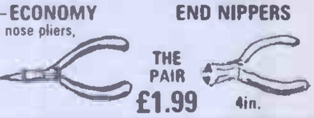

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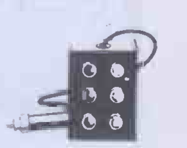

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INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

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MAIL ORDER

AS I write this we are in the middle of a postal strike—hopefully by the time you read it the strike will be over! It does, however, serve to remind us just how much we rely on the post as part of our general lives and also for our hobby/business.

The strike has had a tremendous effect on the mail order companies that supply components—our own p.c.b., back numbers, binders and book service has ground to a halt and we are also unable to get copy to some authors and advertisers for checking. The office FAX is working overtime and so is the 'phone but they do not solve all the problems.

RIGHTS

The mail order supply of almost anything has become a way of life and this method of supply is usually quick and efficient. A recent incident at home made me realise that for younger readers a few pointers might be helpful.

My son had ordered some parts for his skateboard—when they came he was not happy with the quality and felt he had wasted his money. I pointed out that if he sent them back quickly, undamaged, he could get a full refund of his money. He had not realised that he was entitled by law to such a refund if he was not happy with the goods. Your rights as a consumer are well protected by the law in the U.K. and you should have no hesitation in ordering by mail—postmen permitting.

BE PATIENT

The aftermath of a postal strike gives the mail order companies even more problems, with an unprecedented amount of mail being delivered. Following a period of little or even no work they then have more than they can cope with. Please be patient if you are waiting for goods—there is no way of knowing when a particular letter will eventually find its destination and, therefore, how quickly the company can despatch the goods.

Mike Kenward

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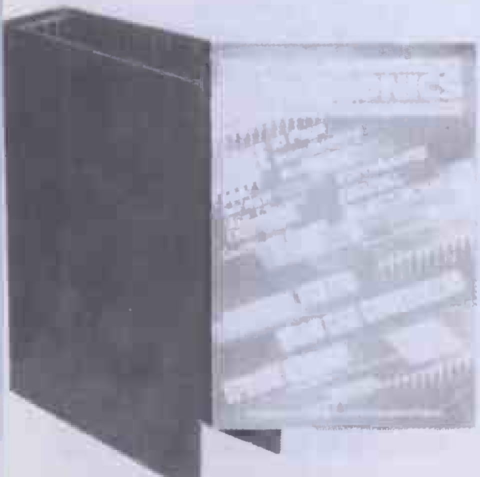

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We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

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

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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.

Constructional Project

DOORBELL DELAY

STEVEN HOLLAND

A simple timer that prevents misuse of the doorbell. Can also be used as a "doorbell" for the deaf.

How many times does somebody ring your doorbell, and while you are on the way to answering, they keep on pressing the bellpush three or four times which can be quite annoying. Sometimes having to shout "I'm coming" to stop them pressing the bellpush even more.

Well, all your problems are over with this little circuit design for a Doorbell Delay that connects to your existing doorbell unit. When the caller rings the bell, it will only ring for "X" seconds and then cancels. The bellpush will remain inoperative for a further "X" mins/secs.

These times can be adjusted by two small presets. The circuit uses two common timer i.c.'s and just a few external components. All the unit needs is a 9V to 12V power supply.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Doorbell Delay is shown in Fig. 1.

The basic operation of this circuit is easy to understand and should pose no problems even to the beginner.

The two 555 timer i.c.s (IC1 and IC2) are designed to operate as "one shot multivibrators" which are linked in series, consequently when the first timer is triggered the second timer also triggers–which in turn operates the relay RLA.

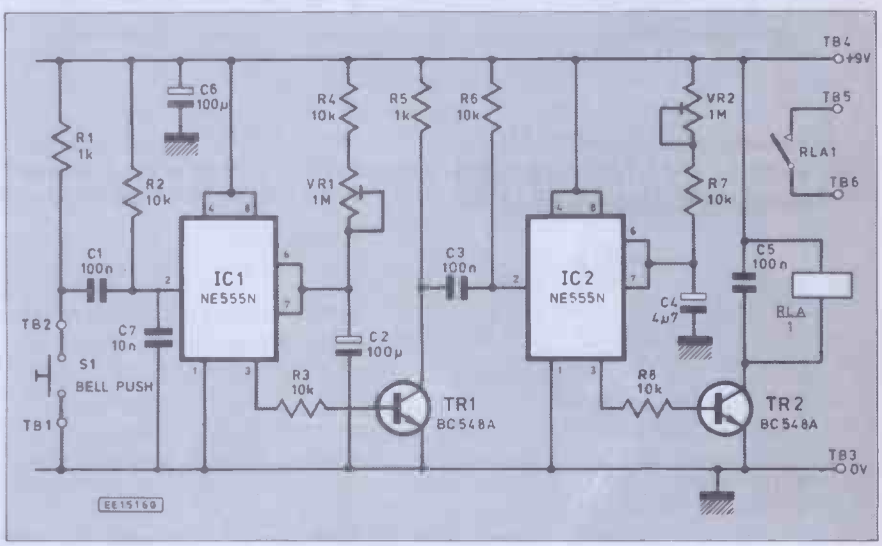


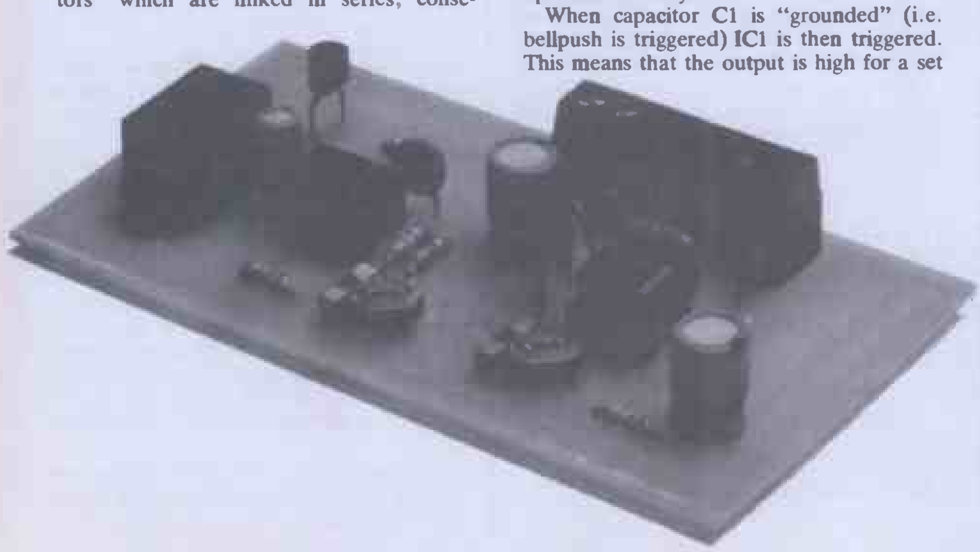
Fig. 1. Circuit for the Doorbell Delay

When capacitor C1 is "grounded" (i.e. bellpush is triggered) IC1 is then triggered. This means that the output is high for a set period. No matter how many times it is triggered during this period the timer will not start again but will finish its time period and then allow another trigger pulse to be received.

Transistor TR1 allows a negative pulse to trigger IC2 and the same operation happens here, but the timing components are different. The time periods are dependent on the timing components, VR1 and C2 for IC1 and VR2 and C4 for IC2.

IC1 sets the time between each successive relay operation and IC2 sets the time for which the relay is energised. Capacitors C5 and C6 provide suitable suppression for the circuit.

Resistors R1, R2, R5 and R6 provide the pull-up voltage required for the change in state voltage at the trigger pins on each i.c. Transistor TR2 is used simply as a switch for the relay RLA.



CONSTRUCTION

The circuit for the *Doorbell Delay* is built

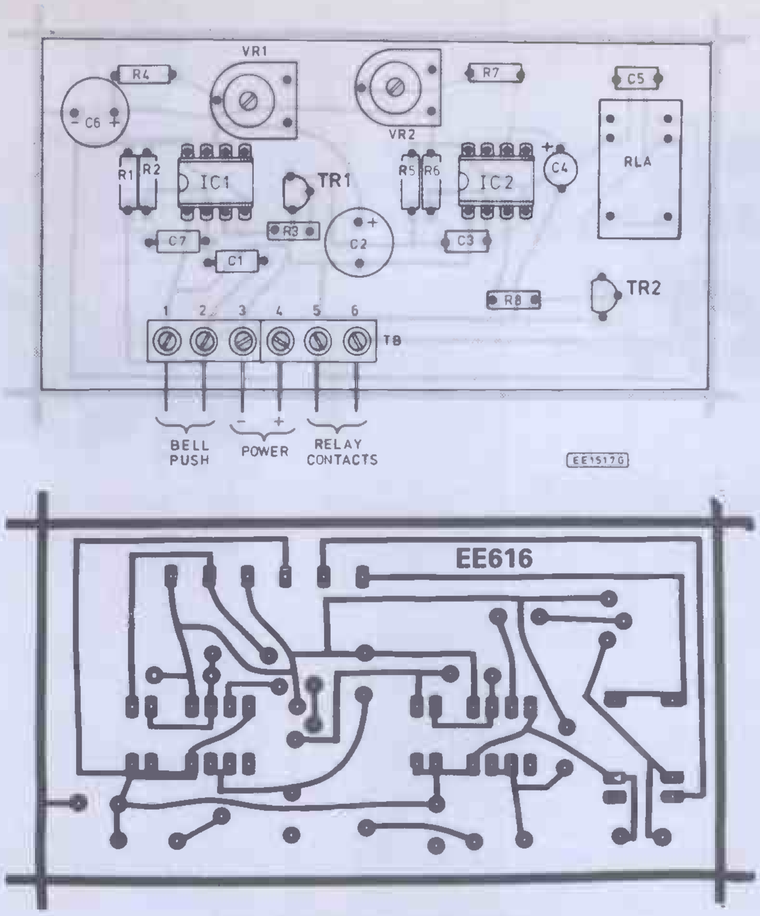


Fig. 2. PCB layout and wiring

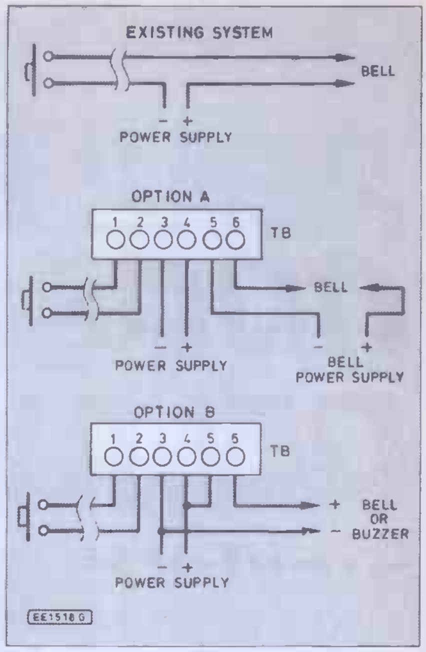


Fig. 3. Connecting to the existing doorbell

COMPONENTS

Shop Talk See page 660

Resistors

R1	1k
R2,R3,R4	10k (3 off)
R5	1k
R6,R7,R8	10k (3 off)

All 0.25W 10% carbon

Potentiometers

VR1,VR2	1M skeleton preset (2off)

Capacitors

C1	100n poly.
C2	100μ radial elec.
C3	100n poly.
C4	4μ7 radial elec.
C5	100n poly.
C6	100μ radial elec.
C7	10n

Semiconductors

IC1,IC2	NE555N timer (2off)
TR1,TR2	BC548A *npn* gen. purpose (2 off)

Miscellaneous

RLA 6V miniature d.i.l. p.c.b. mounting relay; Printed circuit board, available from *EE PCB Service*, code EE616; 3-way screw terminal block (2 off); 8-pin i.c. socket (2 off); connecting wire and solder etc.

Approx. cost Guidance only **£5.50**

on a small printed circuit board and the component layout is shown in Fig. 2. This board is available from the *EE PCB Service*, code EE616.

The construction of this project is not difficult at all, as long as the main guide lines are followed. If you wish to construct this project on stripboard you will have to figure out the component layout for yourself. However, as a guide, it could follow a similar layout as the p.c.b. version with the copper strips running from top to bottom, with breaks in the copper as necessary.

Referring to the printed circuit board, first insert the two 8-pin d.i.l. sockets and solder them in position. Next place and solder the two preset potentiometers in their correct position, don't force them into their holes because they could break, so widen the holes a little to allow for this.

Insert the three electrolytic capacitors, making sure the polarity is correct, and solder in position. Now proceed to solder the two transistors, remaining capacitors and resistors on the board. This should be followed by the p.c.b. terminals and the miniature p.c.b. mounting relay RLA.

Finally, examine the board for any dry joints, illegal solder blobs, joint tracks or indeed any breaks in the copper tracks. When satisfied–insert the two i.c.s and power up.

TESTING AND USING

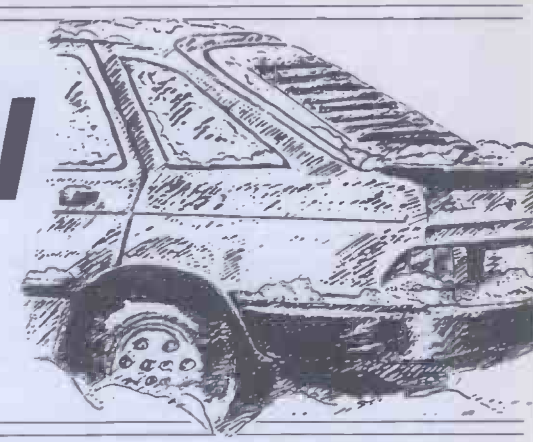
Apply a 9V to 12V power supply to connections 3 and 4 on the terminal block. You should hear the relay click on–then after a few seconds it should click off. Turn both presets VR1 and VR2 anti-clockwise to the minimum setting.

Either with a short wire link or a bellpush connected up, short connections 1 and 2 together. The relay will activate for approx 0.25 seconds. Now increase VR2 setting and repeat the operation. This time the relay will be on for a slightly longer period. With VR2 set to its maximum level the maximum time is approx six seconds with a power supply of 9V.

Set VR2 minimum again and trigger the circuit again. With VR1 set at minimum the relay will be triggered again instantly. But if VR1 is increased the time between each successive relay operation will be increased. The maximum time here is approx 2 mins 30 seconds with a 9V power supply.

The reason for the bell length time being up to six seconds is to prevent any misunderstanding whether the doorbell was heard or not. The method of connecting the unit into the existing doorbell system is shown in Fig. 3.

This module can also double up as a doorbell for the deaf, with the relay used to activate a bulb or some other type of indicator. □



REAR SCREEN ONE-SHOT

T. R. de VAUX-BALBIRNIE

Avoid a flat battery—use timed control

A HEATED rear windscreen is very effective in keeping the glass free from condensation and improving visibility. Unfortunately, it is easy to leave it switched on once it has done its job. In some cases it is even possible to leave the heater on continuously while the ignition is switched on and this imposes an unnecessary and unacceptable load on the vehicle battery.

The heating element of a typical car rear windscreen requires 5A to 8A. On a large car this may exceed 12A. When this is added to the current requirements of headlights, fog lights, windscreen wipers and other accessories being used in the winter, an overall current drain may result.

The battery will then discharge since the current supplied by the generator is less than the total requirement. The problem is alleviated by putting the heated rear windscreen under timed control.

The circuit design presented here is a "one-shot" system. That is, on pressing the Start button for an instant, the windscreen heater operates for a preset time then switches off automatically. Normal operation is also possible (depending on the way in which the circuit is connected to the existing system) so that the heater may be switched on continuously if required.

The Start button may also be pressed at intervals to re-start the timing cycle. The circuit draws no current with the ignition off. With the ignition switched on, it requires 15mA approximately with the windscreen heater off and 120mA with it on. In either case the additional load is negligible.

The circuit is contained in a small plastic box placed out of sight—behind the dashboard, for example. External connections are made to a 5-way terminal block mounted on the side. The Start button is sited at any convenient place on the dashboard.

The Heated Rear Windscreen One-Shot could find applications in putting other 12V appliances in the car or elsewhere under timed control.

CIRCUIT DESCRIPTION

The circuit diagram for the complete Heated Rear Windscreen One-Shot is shown in Fig. 1. IC1 is an integrated circuit timer whose period depends on the values of preset potentiometer VR1 and capacitor C2.

With preset VR1 adjusted for maximum resistance this is approximately 30 minutes and any operating time from 30 seconds up to this figure may be chosen. IC1 is a digital device which counts 4095 charge/discharge cycles of C2 before switching off. This minimises the value of capacitor C2.

With the ignition switched on, the circuit draws current through fuse FS1 and diode, D2. Capacitor C4 smooths the rather "noisy" output from the vehicle generator which could otherwise cause false triggering.

off switch contacts. At the end of the preset timing period, pin 3 reverts to low. Transistor TR1, the relay and the heating element then switch off.

Capacitor C3 provides internal stability for IC1 and resistor R2 increases the nominal timing period by a factor of about two, so reducing the value required for C2 still further. Capacitor C1 prevents possible false triggering due to pin 1 (trigger input) being left unconnected while S1 is not being pressed—this would leave the circuit

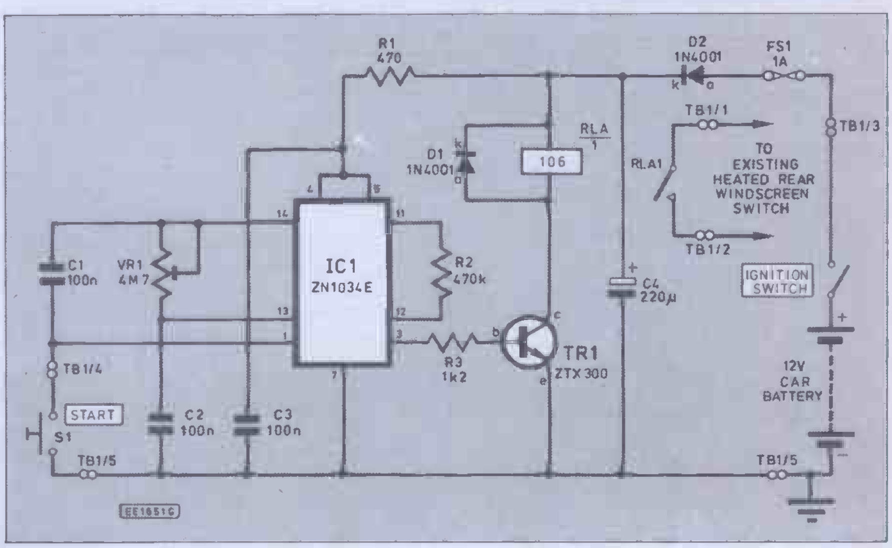


Fig. 1. Circuit diagram of the one-shot timer.

Current flows to IC1 via resistor R1 and voltage stabilisation then takes place on the chip.

The internal timing (counting) of IC1 does not begin until switch S1 (Start) is pressed to make pin 1 low (supply negative voltage) momentarily. This initiates the i.c. and the output, pin 3, changes state from low to high. This supplies current through R3 to transistor TR1 base which, in turn, operates relay, RLA in the collector circuit.

The "make" contacts of the relay direct current to the heated rear windscreen element usually by bypassing the existing on-

vulnerable to stray signal pick-up. The protection diode D1 bypasses the potentially harmful high-voltage pulse which appears when the magnetic field in the relay coil collapses (back e.m.f.).

The specified relay has 16A contacts which are more than sufficient for all heated rear windscreens checked by the author. Sometimes the heater is already operated through a relay to relieve the existing on-off switch contacts of the high current drawn. This is unimportant as far as the present circuit is concerned.

CONSTRUCTION

The component layout of the prototype circuit board is shown in Fig. 2. This uses a piece of 0.1in. matrix stripboard, size 12 strips×37 holes.

Begin construction by cutting the board a little larger than required and filing it to fit the slots in the plastic box. File out the small section at matrix position 13*A* to accommodate the wires passing below the panel later.

Make all underside copper track breaks and solder in the topside inter-strip link wires. This should be followed by all the on-board components, but do not insert IC1 into its socket until the end of construction.

Pay particular attention to the polarities of diodes D1, D2 and capacitor C4. A check should also be made to ensure that no copper tracks have been "bridged" with solder.

Solder 15cm pieces of light-duty stranded connecting wire to copper strips *C*, *D* and *J*, along the left-hand side of the circuit panel as indicated. Solder 15cm pieces of auto-type wire of 7A rating minimum (or as appropriate for the particular windscreen heater) direct to the relay "make" contact terminals—do NOT **connect these wires through the copper tracks.**

Drill two small holes in the case near terminal block TB1 position for the wires to pass through from the circuit panel. Use one hole for the wiring to terminals TB1/1 and TB1/2 and the other for TB1/3, 4 and 5. Drill two small holes in the bottom of the case for mounting it in position later. Drill holes and mount the five-way terminal block and the fuse FS1.

Referring to Fig. 3, complete the internal wiring shortening any wires as necessary but

COMPONENTS

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See page 660

Resistors
R1 470
R2 470k
R3 1k2
All 0.25W 5% carbon

Potentiometer
VR1 4M7 sub-min enclosed preset (horizontal).

Capacitors
C1, C2,
C3 100n (3 off)
C4 220μ radial elec. 16V

Semiconductors
D1, D2 1N4001 1A 50V diodes (2 off)
TR1 ZTX300 *npn* silicon
IC1 ZN1034E precision counter/timer

Miscellaneous
S1 Miniature push-to-make switch

RLA/1 Miniature relay with 12V 106 ohm coil and 16A changeover or "make" contacts.

Plastic case, size 100×76×41mm external; stripboard, 0.1in matrix size 12 strips×37 holes; TB1 15A terminal block—5 sections required; FS1 20mm chassis fuse-holder with 1A fuse to fit; 14-pin d.i.l. i.c. socket; 3A auto-type wire; 7A auto-type wire; auto-type connectors; small fixings; etc.

Approx. cost Guidance only **£12.50**

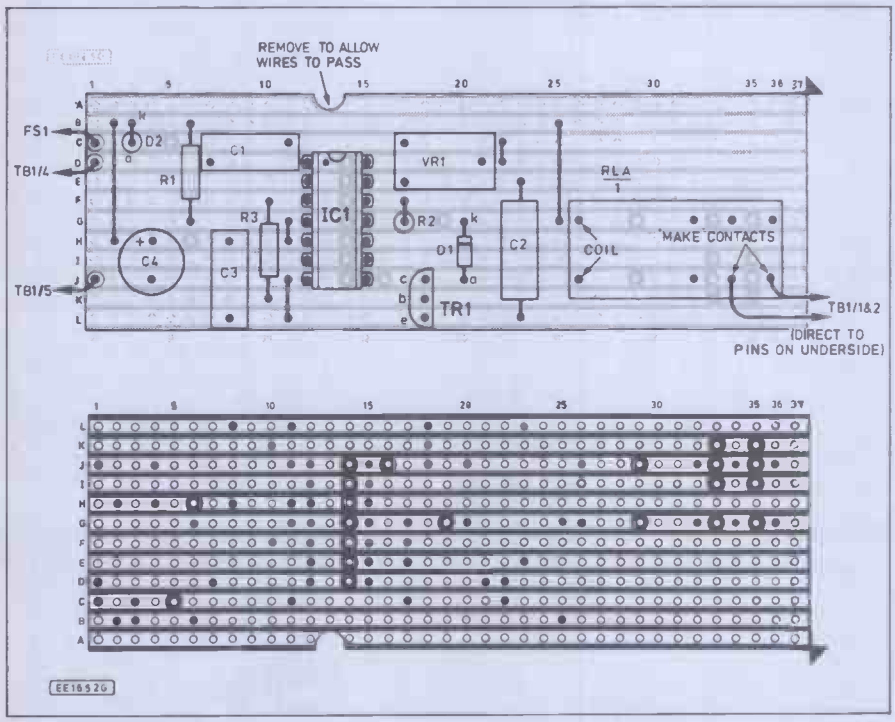


Fig. 2. P.C.B. layout and wiring.

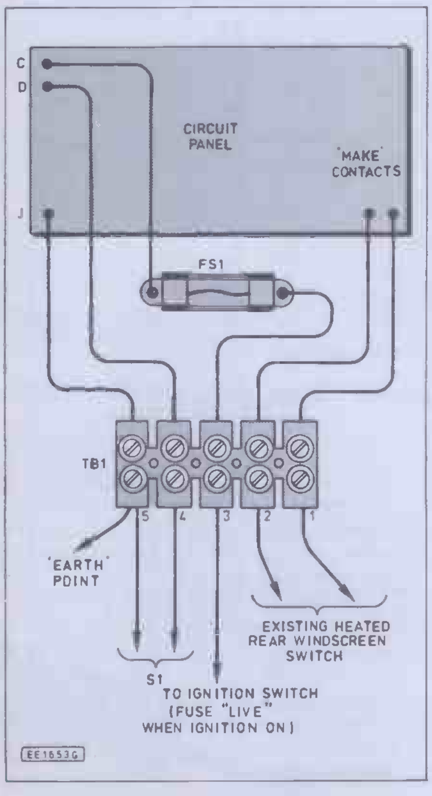
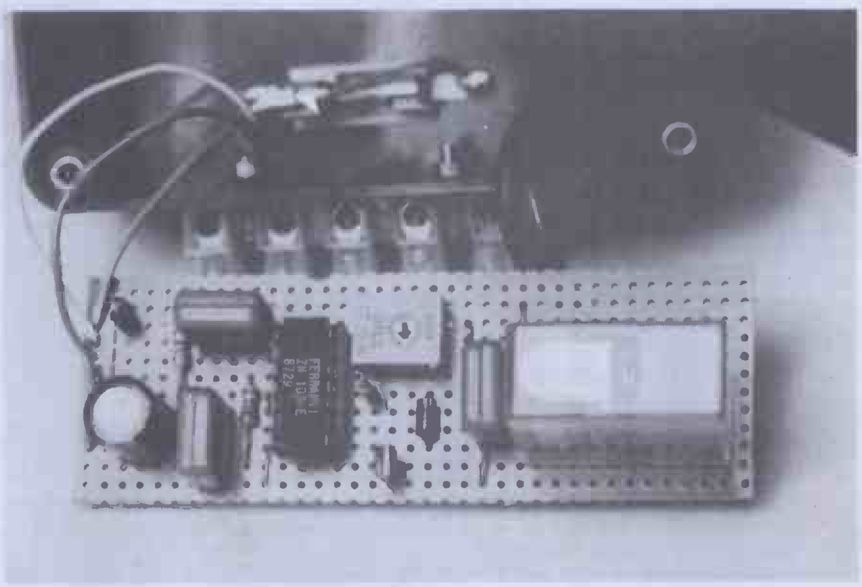
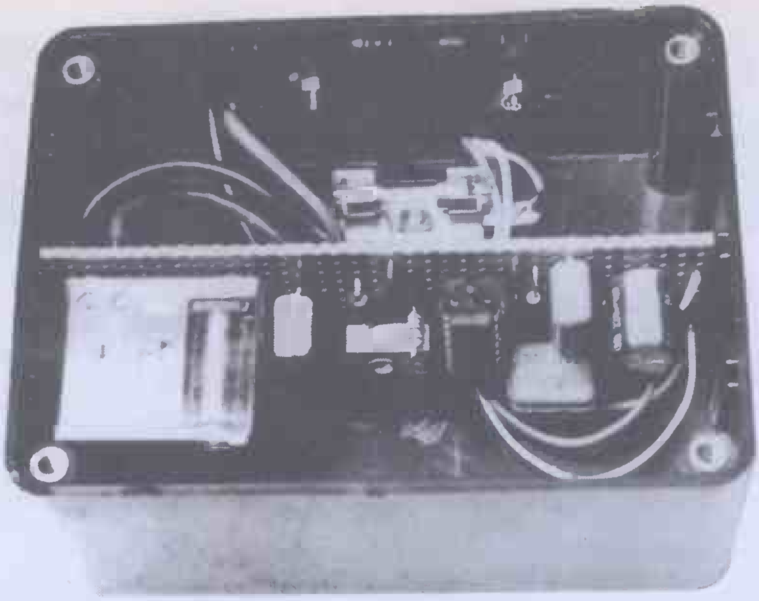


Fig. 3 (left). Internal wiring and car connections.





leaving some slack. Adjust preset VR1 sliding contact fully clockwise then anticlockwise by one sixteenth turn approximately. Insert the fuse. Place IC1 carefully into its socket with the correct orientation and slide the circuit panel into position.

INSTALLATION AND TESTING

Before starting external wiring, remove the car battery positive connection, or safer still disconnect the battery completely. Remember that where a wire passes through a hole in metal, a rubber grommet must be used.

Note that all external wiring to the terminal block TB1 MUST be made with auto-type wire. Also, heavy-duty wire appropriate to the heater MUST be used for TB1/1 and TB1/2 connections but light-duty wire of 3A rating may be used for the others.

There are two ways of proceeding. The first involves connecting terminals TB1/1 and TB1/2 direct (in parallel with) the windscreen heater switch contacts—existing wires being left in position. For automatic use, this switch will be left off. To override the timer, the switch may be used in the usual way.

If the connections to the windscreen heater switch are difficult to reach, there is an alternative way of connecting the unit. This involves breaking into one of the heater feed wires and connecting the free ends to terminals TB1/1 and TB1/2. This can usually be done most easily at the rear of the car with the unit mounted in the boot. Proper insulated auto-type connectors MUST be used for this.

Carefully remove one of the heated rear windscreen "spade" connectors and extend the free wire to reach terminal TB1/1 on the unit. Connect a piece of wire between the now free heater connector and terminal TB1/2 . Using this method means that the existing on-off switch will need to be left on for the unit to work.

Connect terminal TB1/3 to a fuse which is live only when the ignition is switched on. Decide on a position for S1 on the dashboard and connect this to terminals TB1/4 and TB1/5. Terminal TB1/5 should also be connected to a nearby "earth" point on the car metalwork. Mount the unit in position using two self-tapping screws through the holes drilled for the purpose.

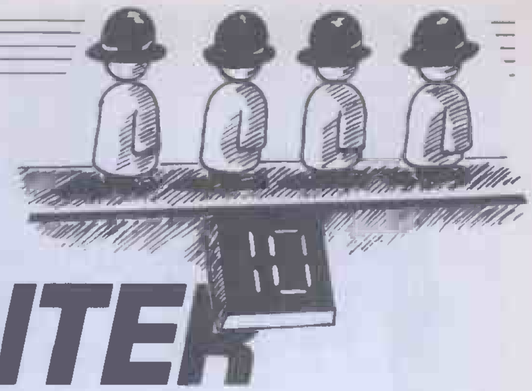
Re-connect the car battery and switch the ignition on. Press S1 (Start) momentarily—relay RLA should be heard to click. After a short while depending on the setting of preset VR1, it should click off again.

If it remains on continuously, it is possible that the preset has been adjusted too far clockwise (near-zero resistance). Under these conditions it latches on and VR1 should be re-adjusted accordingly.

If all is well, the unit may be put into permanent service. Over a trial period, the operating time may be adjusted to best effect by rotating VR1 slider anti clockwise using a small screwdriver. When doing this, the ignition MUST be switched off.

If the heater needs to be switched off before the timing period ends, this may be done by switching off the ignition for an instant. If the unit has been connected in series with the existing wiring, the unit may be cancelled by switching off at the on-off switch. □

Constructional Project



INFRA RED OBJECT COUNTER

ROGER PARSELL

This neat, programmable object counter uses an infra-red beam to sense the passing objects. It can be preset to count "one" for any number of beam interrupts up to 255.

MOST object counters around today implement a mechanical method of counting and those that don't, use some very sophisticated and expensive methods of determining the presence of an object. These may take the form of magnetic induction or single ended optical detection both of which have some major drawbacks.

I required an object counter that could count objects of different size, shape, composition and orientation as they pass the sensor.

I decided that an optical method was best suited to the task. For this reason I used an infra-red transmitter and receiver, this was superior to the mechanical method because there is no physical contact made between the object and the sensor. I also had the problem that the object might break the beam more than once during the pass, e.g. a car has two sets of wheels as seen from the side, if you count the wheels as they pass you will have counted two but only one car has passed. So a programmable divider was included to count once when every (X) number of times the beam was broken, (X being the number the divider is set to divide by), then the numerical value of the objects that have passed the sensor is displayed on a seven segment display.

HOW IT WORKS

As can be seen in the block diagram (Fig. 1) an oscillator generates pulses of infra-red light at a predetermined frequency, in this case 5kHz. This light is then detected by the receiver and amplified. The amplified signal is then fed through a filter that only allows a signal of 5kHz to pass, following this is a pulse shaping circuit which outputs one pulse every time the beam is broken, this is sent to the programmable divider or directly to the counters which ever is required.

The counters are decade counters and directly drive the displays from their decoded outputs, thus eliminating the need for counters, decoders and drivers as they are all on board the chips.

CIRCUIT

The transmitter is based on the NE555 timer i.c. configured in the astable multivibrator mode (Fig. 2). The advantages of using a pulsed beam in preference to a continuous beam are as follows:-

By using the pulsed beam method the beam can be encoded in a way that the receiver can differentiate from any other light source. This allows the system to be used in so called optically noisy environments e.g., environments that are prone to lights being turned on and off or even the transition from day to night. These environmental changes can cause the receiver to trigger a false count.

There is also a power saving when using the encoded system, this is because the output diodes are flashed on and off many times a second so the output is only on for half the time, therefore, only half the power is used.

The timing components VR1, R1, R2, and C1 are selected to produce 5kHz at the output. VR1 is incorporated so that the transmitter can be fine tuned to the optimum for the environment.

The output of the NE555 can only sink loads up to 200mA so transistor TR1 is used

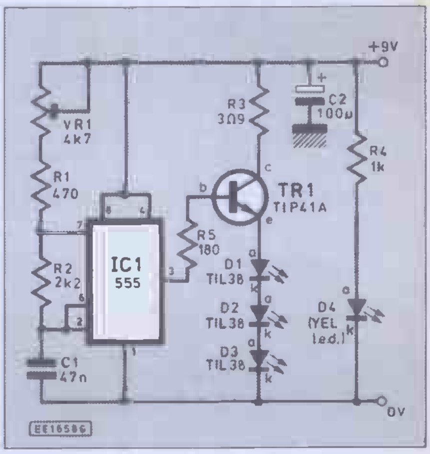
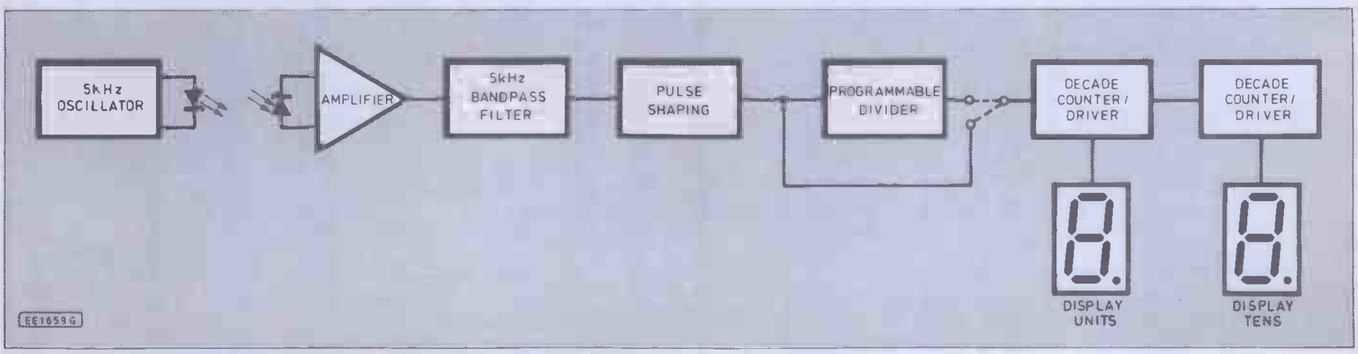


Fig. 2. Transmitter circuit diagram.

Fig. 1. Block diagram of the I.R. Object Counter.



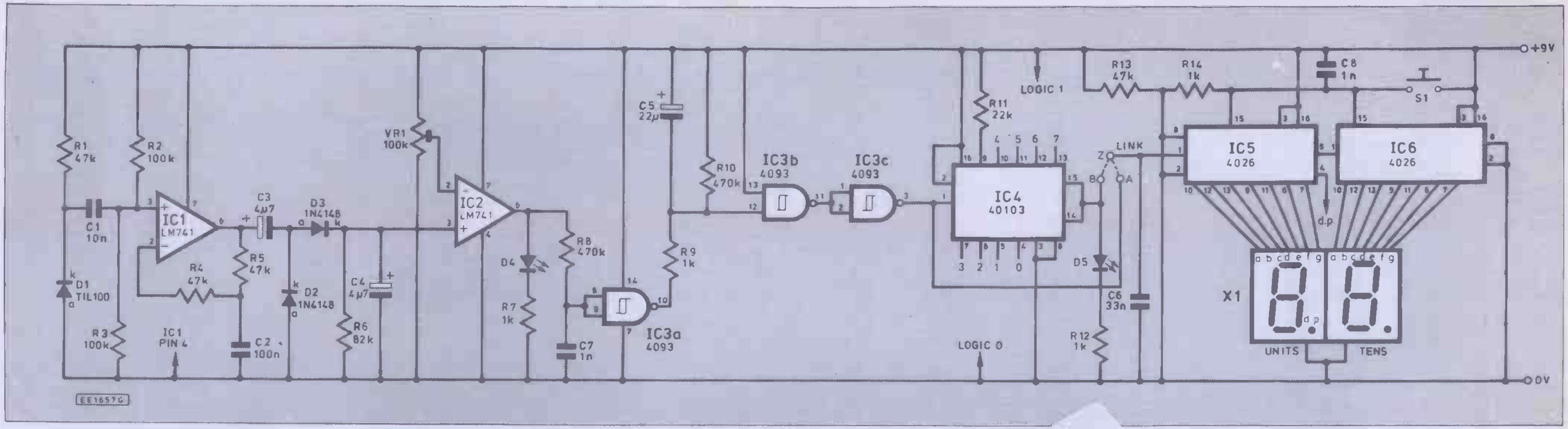
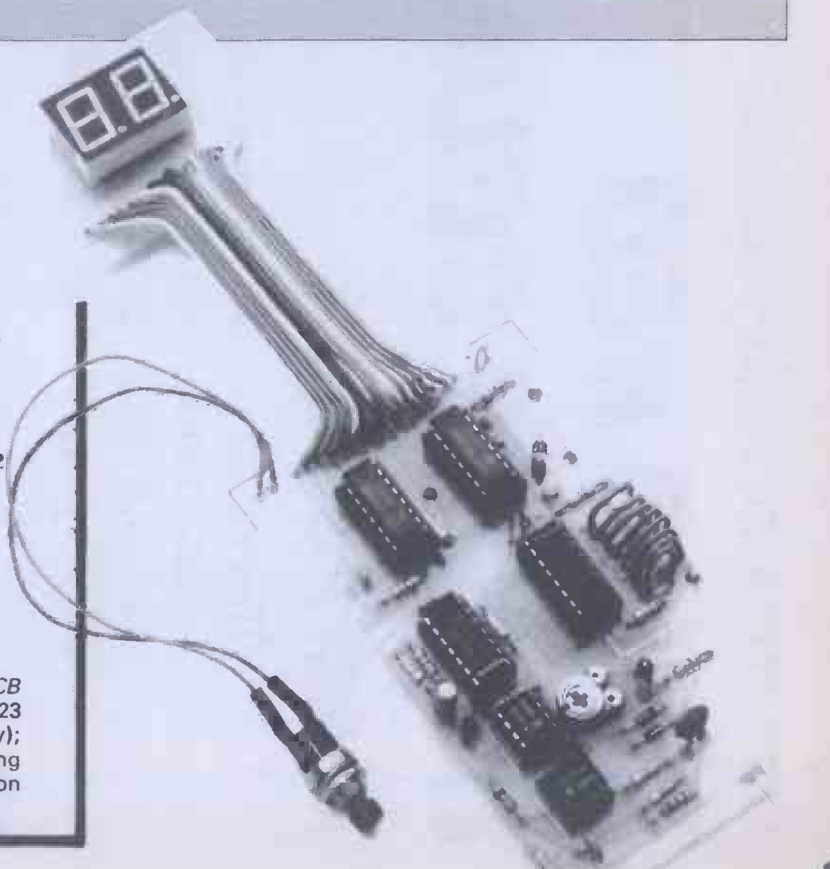


Fig. 3. Receiver and counter circuit.



COMPONENTS £21

Approx. cost Guidance only

TRANSMITTER

Shop Talk
See page 660

Resistors

R1	470
R2	2k2
R3	3Ω9
R4	1k
R5	180

All ¼W± 10% carbon

Potentiometer

VR1 4k7 horizontal preset

Capacitors

C1 47n polyester layer
C2 100µ axial elect. 16V

Semiconductors

IC1	NE555 timer
TR1	TIP41A *npn*
D1, D2, D3	TIL38 infra-red diode (3 off)
D4	3mm. l.e.d.

Miscellaneous

P.C.B. available from the *EE PCB Service*, order code EE622; connecting wire; solder etc.

RECEIVER

Resistors

R1, R4, R5, R13	47k (4 off)
R2, R3	100k (2 off)
R6	82k
R7, R9, R12, R14	1k (4 off)
R8, R10	470k (2 off)
R11	22k

All ¼W± 10% carbon

Potentiometer

VR1 100k horizontal preset

Capacitors

C1	10n ceramic
C2	100n ceramic
C3, C4	4µ7 tant. 16V (2 off)
C5	22µ min. elect. 16V
C6	33n ceramic
C7, C8	1n ceramic (2 off)

Semiconductors

IC1, IC2	LM741 op-amp (2 off)
IC3	4093 quad NAND Schmitt
IC4	40103 programmable divider
IC5, IC6	4026 counter driver (2 off)
D1	TIL100 photo diode
D2, D3	1N4148 (2 off)
D4, D5	3mm l.e.d. (2 off)
X1	Double 7 segment display (commom cathode)

Miscellaneous

P.C.B.s available from the *EE PCB Service*, order codes EE623 (receiver) and EE624 (display); single core insulated connecting wire; short length of 16 way ribbon cable; solder etc.

to drive the output diodes as these diodes take 100mA each.

Resistor R3 should not be replaced by a lower value than 3Ω 9 or this might damage the transistor TR1. R4 and D4 are only incorporated to indicate the connection of power to the transmitter as the output diodes do not emit any visible light.

RECEIVER DRIVER UNIT

The receiver driver unit can be split into four separate parts; these are, Receiver and Filter, Pulse Shaping, Pulse Dividing, and Counter Drivers.

RECEIVER AND FILTER

The device used to receive the infra-red signal is the TIL100 photo diode (Fig. 3.), this diode works best when light in the infra-red spectrum falls upon it. When the light falls upon the sensor the current flowing through it increases. If this diode is connected in reverse bias across the supply through a pull up resistor, we can get a change in potential at the point where they meet which is proportional to the light falling upon the sensor. This potential is also oscillating at the same frequency as the transmitter so we can a.c. couple the signal to the amplifier via C1.

The amplifier is designed so that only a signal of 5kHz can pass easily, this is due to the feedback arrangement of R4, R5 and C2. At low frequency the gain of the amplifier is approximately 1:1, but at 5kHz the impedance of C2 decreases so that the gain of the amplifier increases to several thousand.

The 5kHz frequency at the output of the amplifier is then sent through a voltage doubler circuit D2, D3, and smoothed by R6, C4, it then reaches the pulse shaping stage.

PULSE SHAPING

Pulse shaping is required to shape the smoothed signal into a pulse with fast attack and fast decay, this eliminates the risk of false reading by unwanted noise spikes. Noise spikes can occur by the switching on and off of light switches etc., in the close proximity of the receiver.

The first stage of the pulse shaping is to compare the input pulses with a known potential, this is done by a comparator circuit. A 741 operational amplifier (IC2) is used to compare the potential set at pin two by the potentiometer VR1—this is known as the reference potential. The input signal is connected to pin three and this is then compared with the reference potential. If the signal is greater than the reference then the output goes high. If the signal potential does not reach the reference potential then the output will remain low. By using a comparator all the noise spikes less than the reference potential are eliminated.

The output of the comparator then feeds R7 and D4. This diode then emits light when the beam remains unbroken and stops emitting when the beam is broken.

The next stage is formed by IC3 which consists of four 2-input NAND gates, which can be used as Schmitt triggers, this simplifies the task of pulse shaping. (As the Schmitt trigger is a dedicated pulse shaping device it is an obvious choice). The input pulse is fed into the first two gates for shaping and the third is incorporated as an inverter to invert the output of IC3b ready to be fed through the dividing circuit.

PULSE DIVIDING

As described previously the pulse divider was incorporated to enable the use of the system in applications where the beam might be broken more than once by the object. By calculating how many times the beam will be broken by the object, this number can then be programmed into the divider so the output will only pulse once for every predetermined number of times the beam is broken, or once every time the object passes.

The programmable divider is virtually self contained as IC4. The input pulse is fed to pin one of IC4, from there it is divided by the value set by the programme inputs.

The programming inputs are pins, 4, 5, 6, 7, 10, 11, 12, 13. As can be seen there are 8 inputs and these must be programmed in binary, with a binary 1 equal to +ve and binary 0 equal to 0V, this combination of 1's and 0's is connected to the programming inputs of IC4 to give the numnber to be divided by.

Resistor R12 and D5 indicate the output pulses from IC4. IC4 can divide the input pulses from 2 to 256, if a 1:1 count is required then the link should be made to bypass the counter, otherwise connect a link from divider to counters. The link should never go from the output of the divider to the bypass as the Schmitt triggers cannot drive the l.e.d. and IC3 would be destroyed.

COUNTER DRIVING

Again in the counter driver section most of the circuits are self contained in the chips and very few external connections are necessary. IC5 and IC6 are both decade counter drivers, this means that they can only count from 0 to 9 and reset to 0, also contained on the chips are seven segment decoders and drivers, allowing seven segment displays to be driven directly from the decoded outputs.

The few components that are associated with these i.c.s consist of capacitor C8 and switch S1. These are both connected to the reset pin 15. When this pin is connected to the +ve supply via S1 the counters will reset. The capacitor C8 holds pin 15 high at switch on for a short while in order to reset the counters to zero each time the unit is turned on.

CONSTRUCTION

The circuits are constructed on the p.c.b.s as shown in Figs. 4, 5 and 6. It is advisable to use the p.c.b. method of construction, rather than Veroboard, as this would not be easy even for the experienced constructor. It would also be possible to severely damage or totally destroy one of the chips with an incorrect connection.

Before commencing construction take a careful look at the photographs of the prototypes and diagrams. On the receiver driver board (Fig. 4) the wire links on the top of the

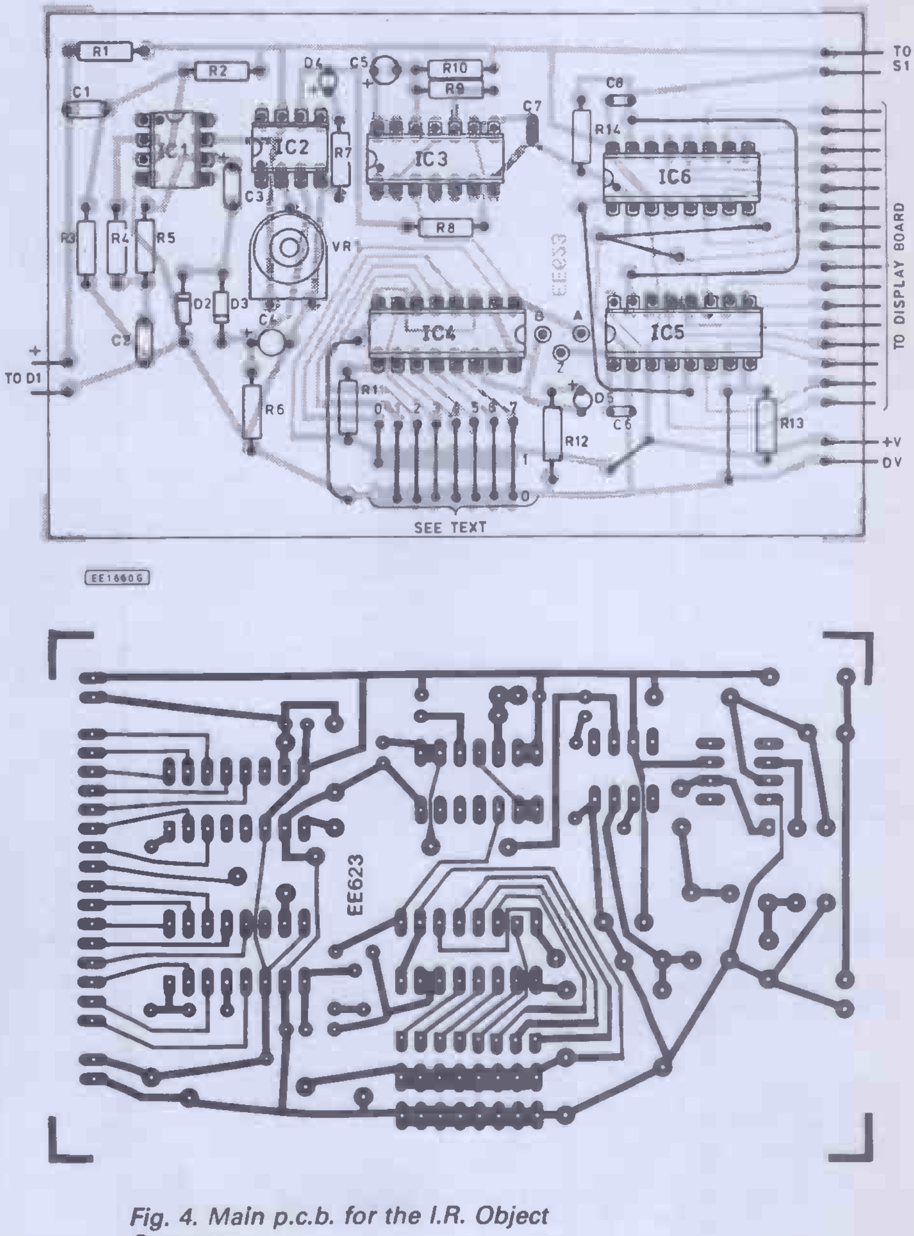


Fig. 4. Main p.c.b. for the I.R. Object Counter.

board should be connected first using insulated connecting wire (these replace the double sided p.c.b. used in the prototype). Then all resistors should be connected. The resistors should then be followed by inserting the signal diodes D2, and D3 ensuring the correct orientation. Then connect the remaining capacitors and l.e.d.'s also ensuring the correct orientation.

The i.c.'s should be connected using i.c. sockets as it is very difficult to remove them once they have been soldered in place. Components IC3, IC4, IC5 and IC6 are all CMOS devices and should be handled with all static handling precautions. D1 could be connected to the p.c.b. or connected remotely via two connecting wires, but pay particular attention to the orientation of this device. The long lead should be connected to the positive and the short lead connected to the 0V line.

The transmitter board (Fig. 6) is assembled in much the same way with the resistors and capacitors connected in place first. This should then be followed by D1, D2, D3 and D4 connected in forward bias with the long lead to the positive. Finally IC1 and TR1 should be connected in, observing the right orientation. The display board should cause no problem in construction but make sure that the display is the correct way around.

SETTING UP

Before testing the board the programmable divider should be set up using solder links. All eight programming presets or IC4 must be connected to either positive for logic 1 or the 0V rail for logic 0. Any count can be made between 1 and 255 and is set in binary using solder links to the supply rails as shown in the connection diagram. Having worked out the number of times the object will break the beam, the number can be set up as an eight bit binary code.

Each preset input of IC4 corresponds to a single bit of an eight bit binary number as follows:-

0	1	2	3	4	5	6	7
1	2	4	8	16	32	64	128

Thus any number can be programmed up to 255 by connecting the appropriate input to either positive input or ground. For example, if you require one count for every 122 times the beam was broken.

$$122=0\times128+1\times64+1\times32$$
$$+1\times16+1\times8+0\times4+1\times2+0\times1$$

Which is 01111010 in binary, this number is set by connecting the programming inputs in the following way.

Preset 7 goes to 0V
Preset 6 goes to +ve
Preset 5 goes to +ve
Preset 4 goes to +ve
Preset 3 goes to +ve
Preset 2 goes to 0V
Preset 1 goes to +ve
Preset 0 goes to 0V

A word of caution: the preset inputs 0–7 do not correspond to the i.c. pin numbers (see Fig. 3), so do check before you start.

TESTING

The transmitter may be powered by any voltage source of eight or nine volts. When powered up you will not be able to see anything being emitted as infra-red is invisible to the human eye, however, checking pin three of the NE555, with either a high impedance earphone or an oscilloscope should confirm the presence of high frequency oscillation.

The receiver is best checked by powering up, and then bringing the transmitter close to D1 of the receiver at which point the l.e.d. D4 should light. If it does not do this then try rotating VR1, a result should be obtained when it is set to a central position. If the diode still stays unlit then check that photo diode D1 is connected the right way around, also check that C3, D2, D3, are the right way around.

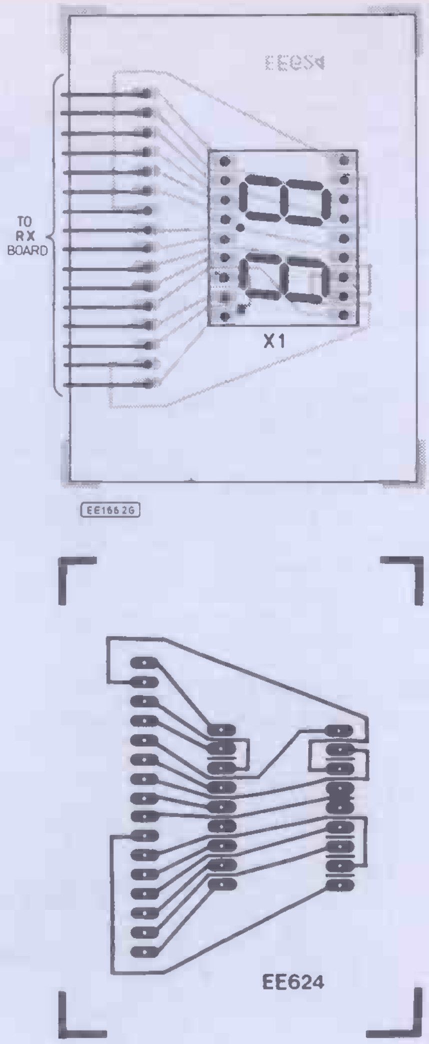


Fig. 5. Display p.c.b.

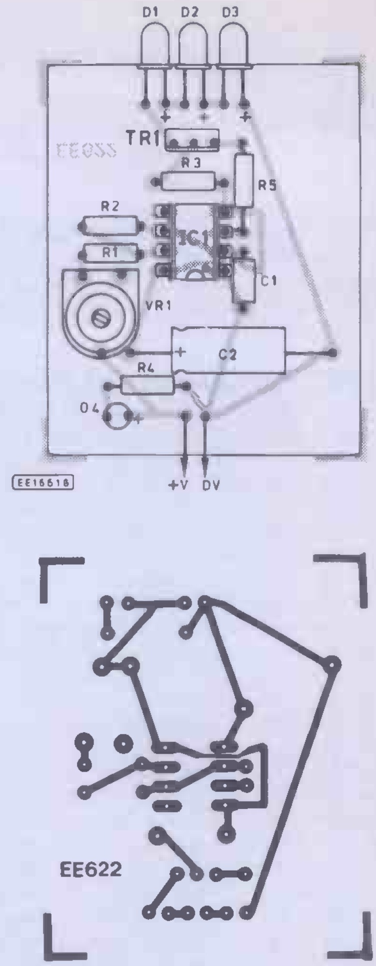
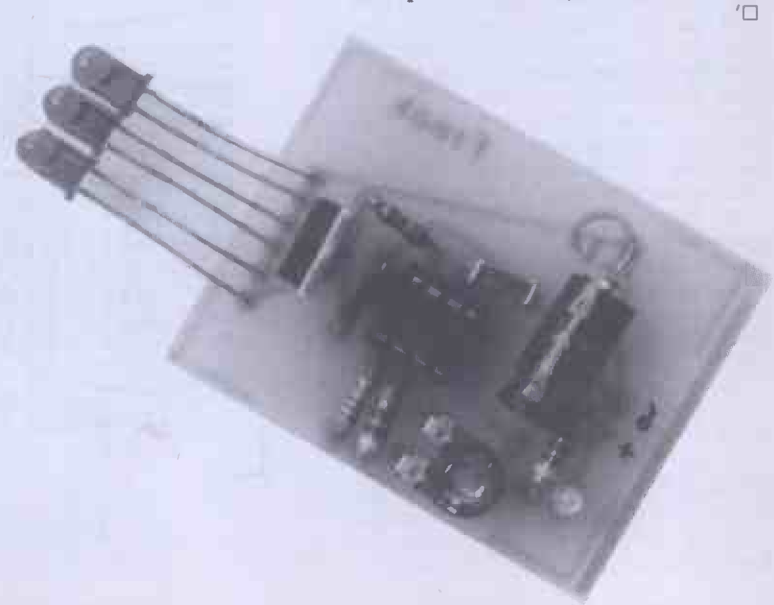


Fig. 6. Transmitter p.c.b. for the I.R. Object Counter.

In use the receiving diode should be covered by a light guide, thus making it more directional and less sensitive to stray pickup. A small piece of rubber sleeving is ideal for this.

An operational range of up to 3.5m is possible, the only adjustment required is to alter VR1 on the transmitter and VR1 on the receiver for optimum operation. It is also necessary to set the programming of the divider and the link to count pulses or count the output of the divider, as described earlier. □



City and Guilds

Certificate Course

Introducing DIGITAL ELECTRONICS

Part 2: Component Identification and Coding

By Michael J. Cockcroft
Training Manager, Peterborough ITeC

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

WE will cover the following City and Guilds objectives in this part:

1.1 Components

1.1.1 Identify at least ten commonly available components (selected from Appendix A of the City and Guilds "Introductory Electronics Modules Resource Document") and determine costs and component reference numbers from suppliers catalogues.

1.1.2 State and apply the pin numbering convention associated with common integrated circuit packages including 8-pin, 14-pin, and 16-pin d.i.l.

1.1.3 State and apply standard colour coding to identify resistor values and tolerances (Appendix J of the Resource Document).

1.1.4 State and apply standard colour coding to identify capacitor values, tolerances, and working voltages (Appendix K of the Resource Document).

1.1.5 State and apply commonly used alternative methods employed for marking capacitor and resistor values (Appendix J and K of the Resource Document).

1.1.6 Identify the correct orientation of polarised components including selected capacitors and diodes.

Circuit Building

Electronic components are the variables that are combined with voltage sources and conductive paths (e.g. wires) to produce electronic systems, they help us manipulate electrons in any way we like to produce useful functions. We have already used a few electronic components in our experiment with the "torch", in Part 1: first, using a battery as a voltage source and wires as a path for electrons, we directed an electric current through a bulb to illuminate it; then we added a switch to the circuit to provide control over when the bulb was on or off.

Rarely, though, are electronic systems quite as simple as this torch circuit, and the method by which it was assembled is far from typical. Most electronic components are designed to be **printed circuit board** mounted. Printed circuit boards (p.c.b.'s) are thin boards made from insulating material (usually glass reinforced plastic like the one in Fig. 2.1) with metal conductive paths, representing wires, printed onto the surface. The components are usually connected to the metal paths by soldering.

Mostly, as in the examples of Fig. 2.2, holes are drilled into the board to accommodate components; but more and more, these days, a recent development called **surface mount technology** is being adopted by electronic equipment manufacturers. This technology requires special components called **surface mount devices** (SMD's) as shown in Fig. 2.3.

Stripboard

Both of these types of p.c.b. are used for large scale production, for the purpose of this course the **stripboard** form of p.c.b. of Fig. 2.4 and conventional components (i.e. not SMDs) are what we will be using. Stripboard is intended only for the assembly of prototype (trial model) circuits and very small scale production. It has uniform strips of copper on one side and many holes so that the user may place components to any layout. If many components are to be mounted in a small area it may be necessary to make breaks in the copper strips to isolate components from each other: this is easily done by twisting an ordinary drill bit (about ¼ inch) by hand in one of the holes until the copper strip separates.

Polarity

When constructing a circuit the physical parts of the components need to be tallied with their symbolic representations in circuit diagrams; a

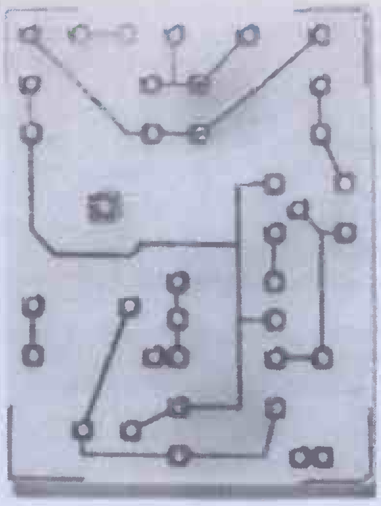
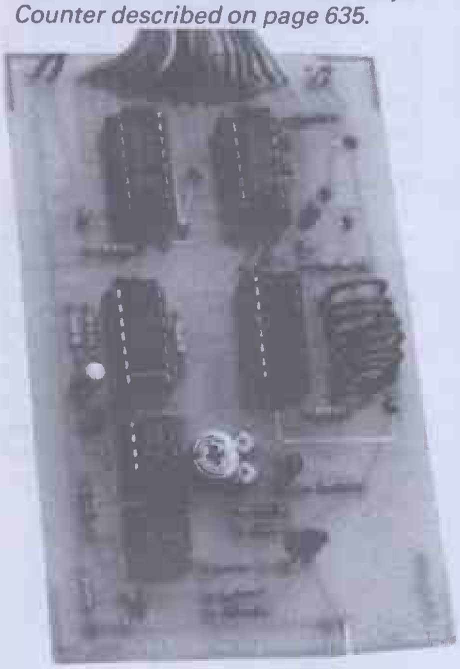


Fig. 2.1 (above). The underside of a p.c.b. before the components are inserted.

Fig. 2.2 (below). A completed p.c.b. This one is for the Infra-Red Object Counter described on page 635.



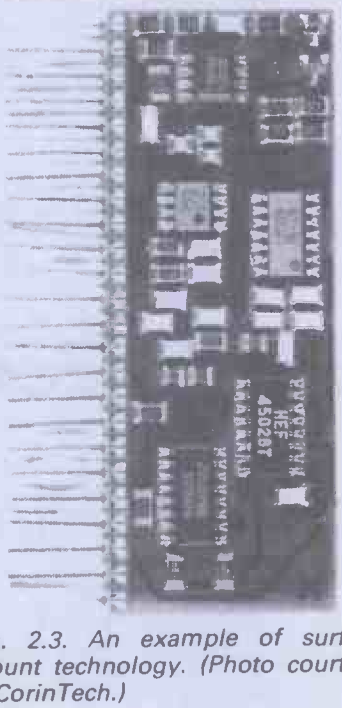


Fig. 2.3. An example of surface mount technology. (Photo courtesy of CorinTech.)

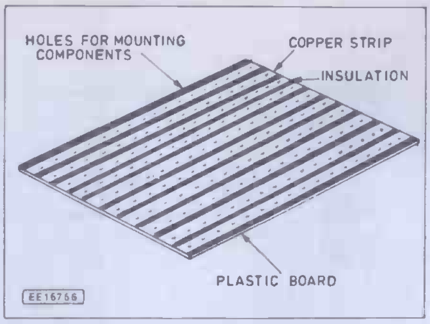


Fig. 2.4. Stripboard form of p.c.b.

light emitting diode, for instance, has two parts and we need to be able to distinguish which is which from both the circuit diagram and from the physical device itself if we are to build a physical system; Fig. 2.5a, for example, shows how the circuit symbol for the light emitting diode (LED) relates to the physical component in Fig. 2.5b so that one may interpret the circuit diagram of Fig. 2.5c to construct the physical system on stripboard as shown in Fig. 2.5d. The other component in the circuit is a resistor and it is not polarised, therefore, it may be connected either way round on the stripboard.

An important point to note about this example is that the power supply (battery) is not actually mounted on the p.c.b. nor is it included on the circuit diagram. This is typical of the way in which it is usually done: power supplies (particularly battery supplies) are almost always physically separate from the p.c.b.s and only included on circuit diagrams as a straight line marked with the appropriate voltage.

Components

Components are the building blocks of electronic systems and in order to be able to start building we need to know a number of things about them: what do they look like?, how do we determine their values?, how are they connected within a circuit?, and how are they symbolically represented in circuit diagrams? We are not concerned, at this point, how the components work; we leave that for later issues. For the present, we need to know how to use them in our experiments and exercises.

Although there are many, many electronic components, the following are some of the most important and are the subject of this part of the course:

(a) Resistors
(b) Capacitors
(c) Diodes
(d) Transistors
(e) Integrated Circuits

Resistors

Resistors are probably the most common electronic component and almost every circuit will contain at least one of them. Each resistor has a resistance value and a power rating; when connecting them into a circuit it is important to ensure that both values correspond with what is specified on the circuit diagram. If a resistor of the wrong resistance is placed in a circuit, the circuit will not function properly; if the resistor's power rating is too low it will overheat and eventually fail (perhaps burning to a cinder in the process!).

Resistors are simply pieces of conducting material with leads or legs which allow them to be soldered or otherwise connected into a circuit. They are made from a variety of conductors (poor conductors, of course, otherwise the component would require excessive material for the job) using a variety of manufacturing processes depending on the application for which they are intended.

Some resistors are of fixed resistance value—a number of these are shown in Fig. 2.6a—and others are manufactured so that their value can be manually adjusted with the fingers or a special tool, like a screwdriver, called a pot' trimmer. Variable resistors are called potentiometers (often shortened to pots) and a few of the available types are depicted in Fig. 2.6b. Fig 2.6c shows the circuit symbols for both fixed and variable resistors.

Resistor Colour Coding

Since resistors are never manufactured to be *exactly* the marked value, there are two things to consider

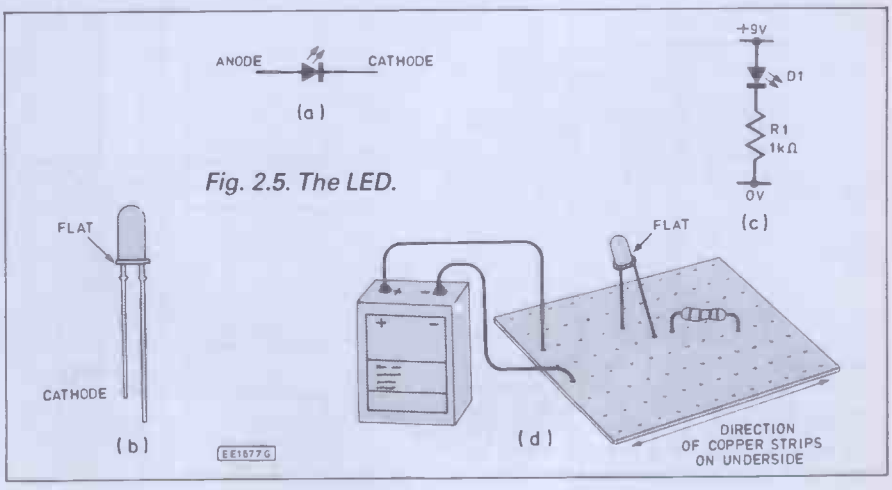


Fig. 2.5. The LED.

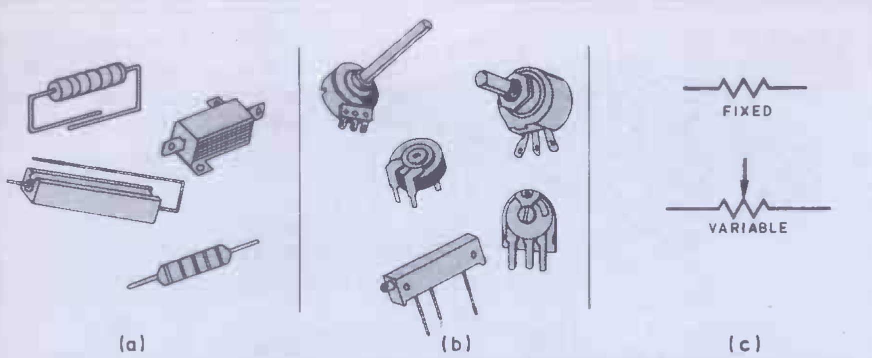


Fig. 2.6. Fixed and variable resistors.

when selecting one for use: the actual resistance value in **ohms** (symbol Ω) and the **tolerance** rating which is the guaranteed degree of accuracy to which the resistor is manufactured.

Some resistors have their value of resistance and tolerance (as a percentage of the value) printed onto the body of the resistor, but most small types use a colour coded representation of the value and tolerance. Resistor coding is given in Table 2.1, but the system may require some explanation as follows:

Each number, zero to nine, is represented by a colour which is printed around the body of the resistor. There are usually four colour bands per resistor (also shown is the less popular five band system). In the four band system three of the bands give the value of the resistor and the fourth gives the tolerance. The position of the bands is given in Table 2.1.

When reading the resistor value, orientate the resistor such that the three "clustered together" bands (1, 2, and 3) are to the left. Read the bands from left to right. (If the bands are equally spaced you can usually identify the gold or silver "tolerance" band—this is the last band.) The first two bands (1 and 2) represent the first two digits in the resistance value, and the third band (3) represents the number of zeros that follow the first two numbers. If, for example, the resistor shown has these colours:

Band 1=Yellow
Band 2=Violet
Band 3=Orange
Band 4=Silver

Yellow makes the first digit 4, violet makes the second digit 7, and orange means that three zeros must be placed after these two digits like this:

yellow violet orange
4 7 000

The resistor has the resistance value of forty seven thousand ohms (47,000Ω), plus or minus the tolerance indicated by the fourth band.

The tolerance is a value indicated by the silver fourth band which, according to Table 2.1, is 10%. The actual value of the resistor, then, can be any value between 42,300 ohms (47,000 less 10%) and 51,700 ohms (47,000 plus 10%).

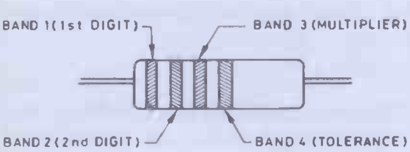
These large numbers are cumbersome (and much larger numbers are common in electronics) and it is conventional to substitute zeros in multiples of three for letters of the alphabet, as shown in Table 2.2. So, in place of three zeros we can put k, six zeros M, nine zeros G, and twelve zeros T. The value for our resistor becomes 47k. This is easier to say and it is also less to write—the Ω sign is not normally written.

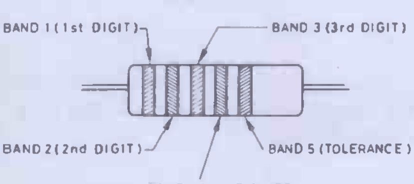
Note that some manufacturers use the silver and gold bands in both value and tolerance coding. This is expressed in Table 2.1 as a division by ten for gold and a division by one hundred for silver, look at Table 2.3 for examples of this using both colour and letter coding.

Power Rating

There is also an unmarked rating which must be considered when selecting a resistor for a job—the power rating. This rating relates to the highest amount of current that can pass through the resistor without damaging it. The power rating is measured in Watts which is a measure of the amount of energy expended for the amount of current

RESISTOR AND CAPACITOR IDENTIFICATION

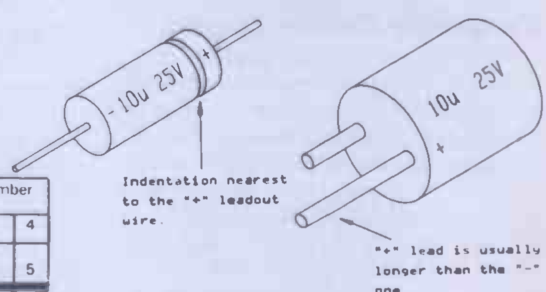


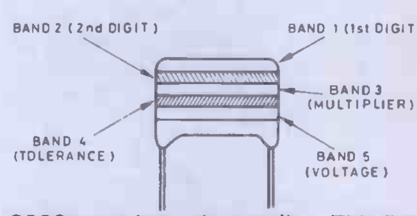


		Band Number				
	4 Band Codes	1	2		3	4
	5 Band Codes	1	2	3	4	5
Colour	Silver				0·01	10%
	Gold				0·1	5%
	Black	0	0	0	1	
	Brown	1	1	1	10	1%
	Red	2	2	2	100	2%
	Orange	3	3	3	1000	
	Yellow	4	4	4	10000	
	Green	5	5	5	100000	
	Blue	6	6	6	1000000	
	Violet	7	7	7		
	Grey	8	8	8		
	White	9	9	9		
	None					20%

TABLE 2.1

Four and five band resistor colour codes. Do not assume that a resistor having a similar code to the one you require will have a similar value. If the "multiplier" is wrong the value will be wrong by a factor of at least ten.





C280 capacitor colour coding. This first three bands gave the value (in pF) using the same system as for the four band resistor coding.

		Band	
		4	5
Colour	Black	20%	
	White	10%	
	Green	5%	
	Orange	2·5%	
	Red	2%	250V
	Brown	1%	
	Yellow		400V

Table 2.2. Resistor Letter Codes

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

passing through the resistor in a given time.

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

Capacitors

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

Capacitor Colour Coding

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

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

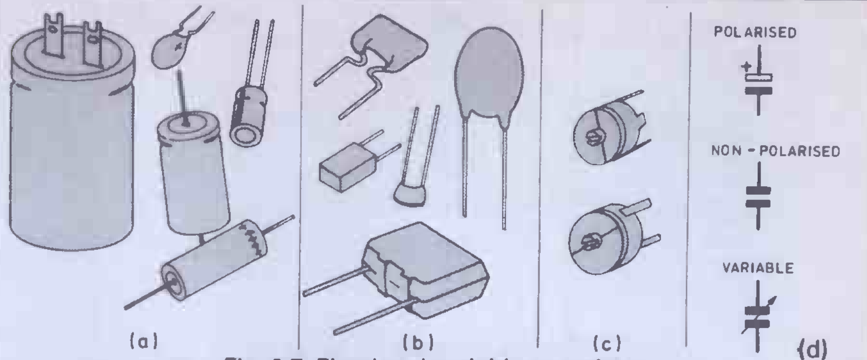


Fig. 2.7. Fixed and variable capacitors.

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

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

Voltage Rating

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

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

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

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

Powers of Ten

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

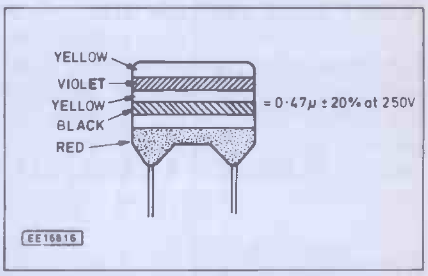


Fig. 2.8. Example of capacitor colour coding.

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

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

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

$1 = 1\times10^0$

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

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

Table 2.3. Examples

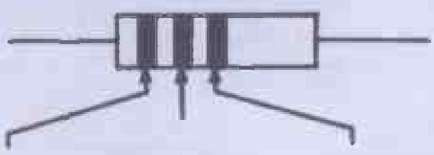
Colour Code			Resistance in ohms	Letter Code
				
Yellow	Violet	Silver	0.47	R47
Yellow	Violet	Gold	4.7	4R7
Yellow	Violet	Black	470	470R
Red	Red	Red	2.2k	2k2
Yellow	Violet	Yellow	470k	470k
Brown	Grey	Green	1.8M	1M8
Brown	Black	Blue	10M	10M

Table 2.4. Multiples and submultiples

Name	Symbol	Multiplying Factor
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}
Hecto		10^{2}
Deca		10^{1}
Deci		10^{-1}
Centi		10^{-2}
Milli		10^{-3}
Micro	u or μ	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto		10^{-15}
Atto		10^{-18}

Electrical Quantities (S.I. Units)

Term	Symbol	Unit	Abbreviation of Unit After Numerical Values
Current	I	Ampere Milliampere Microampere	A mA μA
Difference of Potential	V	Volt Millivolt Kilovolt	V mV kV
Power	W	Watt Kilowatt Megawatt	W kW MW
Resistance	R	Ohm Microhm Megohm	Ω $\mu\Omega$ MΩ

notation. When multiplying numbers in this form we simply *add* the powers; for example, 10000×100 as powers of ten is $10^4 \times 10^2$.
$10^4 \times 10^2 = 10^6$ (4+2=6).

When dividing the same two powers of ten we *subtract* the second power from the first:
$10^4 \div 10^2 = 10^2$ (4−2=2).

Scientific Notation

It is possible to express any number in a form such that this easy method of multiplying and dividing can be applied: any number can be written as a number between one and ten multiplied by a power of ten; for example:

$$1500 = 1.5 \times 10^3$$
$$325 = 3.25 \times 10^2$$
$$6.2 = 6.2 \times 10^0$$
$$0.47 = 4.7 \times 10^{-1}$$

This form of representing numbers is called scientific notation. Any decimal number can be converted to scientific notation by:

(a) Shifting the decimal point until all the zeros plus one non-zero digit are to one side of it (e.g. 0.000526 becomes 00005.26, in fact 5.26).
(b) Counting how many places the decimal point was shifted (in the above case it was 4⟶ 0.0005.26). This gives the "power" of the number.
(c) Observing as to whether the decimal point needed to be shifted left or shifted right to get all the zeros and a non-zero digit to one side of it.
(d) Compiling the number in scientific notation: write down the number obtained from the first operation (a), above, followed by "×10" and a small superscripted digit representing the power of the number (the count obtained from (b)). If the decimal point was shifted right (c) the superscripted number must be preceded by a minus sign; for example:
0.0005.26=5.26×10^{-4}

To convert the numbers back from scientific notation, shift the decimal point the number of times indicated by the power. If the power is positive—shift right, if the power is negative shift left, thus:

$$5.26 \times 10^{-4} = 0.000526$$
and $18 \times 10^6 = 18000000$

For addition and subtraction of numbers in scientific notation, convert all numbers to the same power of ten by shifting the decimal point, the result will then be to the same power of ten.

Numbers in scientific notation can be used in formulae, but component values should be written using the mega, kilo, micro, pico etc. prefixes shown in Table 2.4.

Diodes

We have already met one particular type of diode, the l.e.d. As we progress through the course it will become apparent that diodes are named according to their particular application; for the time-being, we only consider l.e.d.s (LEDs), Zener diodes, and general purpose diodes.

Diodes are packaged in many ways, as can be seen from Fig. 2.9a, but the most common types are those which look like resistors with a single colour band. They are polarised devices and the band indicates the connecting terminal called the cathode. The unmarked side of the diode is called the anode. Fig. 2.9b identifies the cathodes of the various types of diode with regard to the symbol.

Some example diode identification numbers are 1N4002, OA90, BY127, and UF4001.

Transistors

There are literally hundreds of varieties of transistor, a number of which are depicted in Fig. 2.10a. Like diodes, transistors are identified by code numbers; some examples are BC182, 2N5447, BD377, and ZTX107. The transistors of interest to us are **bipolar** which are of two general types: *n-p-n* and *p-n-p* whose circuit symbols are given in Fig. 2.10b.

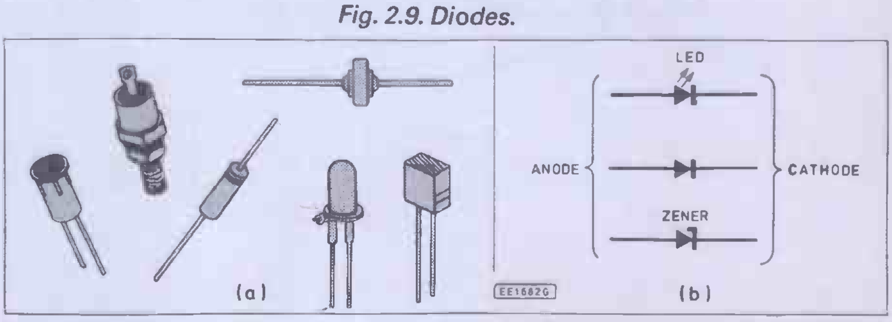
There are three parts to the transistor, hence the three connecting leads. The three leads are known as **base, collector** and **emitter** and are marked b, c, and e, on the symbols. The only difference in the two symbols is the direction of the arrow on the emitter of each type. Fig. 2.11 shows examples of the position of these leads in some different packages, but it is important to realise that the lead positions for a particular transistor cannot be known simply by looking at the transistor.

So how does one learn the pin-out of a particular transistor? Component manufacturers and distributors supply hand-books or catalogues containing look-up charts and tables similar to the one in Fig. 2.12. We simply look up the package number for the transistor indexed by the designated transistor code; for example, if the catalogue states that a BC108 transistor has a package (sometimes called the case rather than package) number TO18, we find the lead designation picture for that package (this is ringed in the figure).

Integrated Circuit Pin-Outs

An integrated circuit (i.c.) is a com-

Fig. 2.9. Diodes.



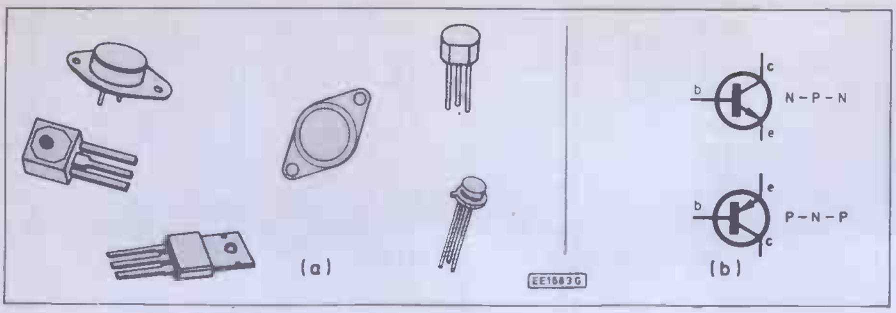


Fig. 2.10. Transistors.

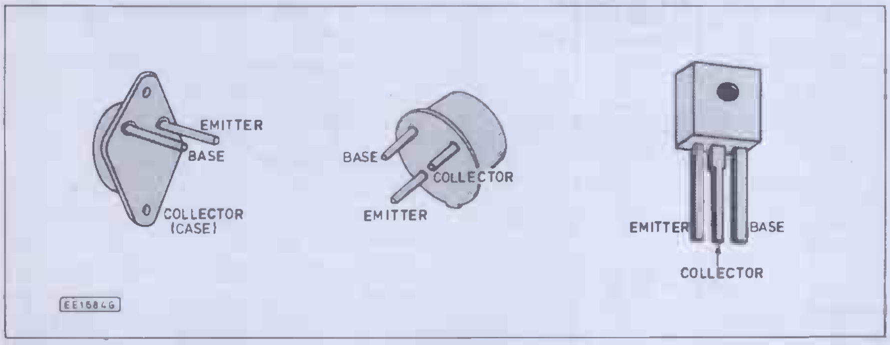


Fig. 2.11. Typical transistor leadouts.

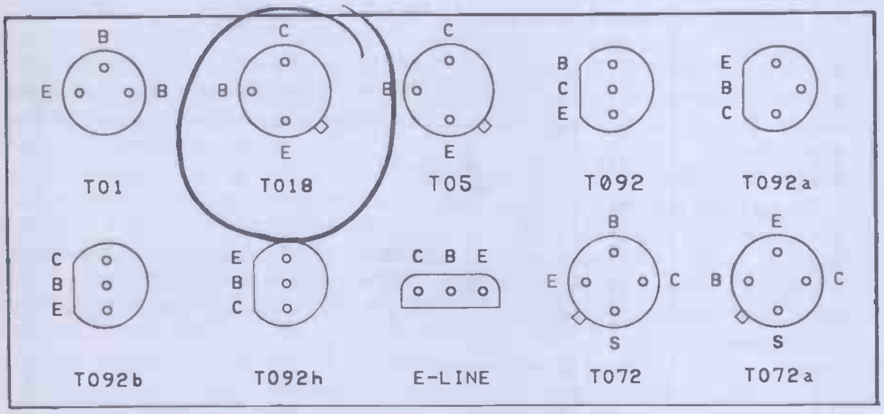


Fig. 2.12. Example of transistor base identification chart.
(Diagram taken from *Electronic Hobbyists Handbook* published by Babani)

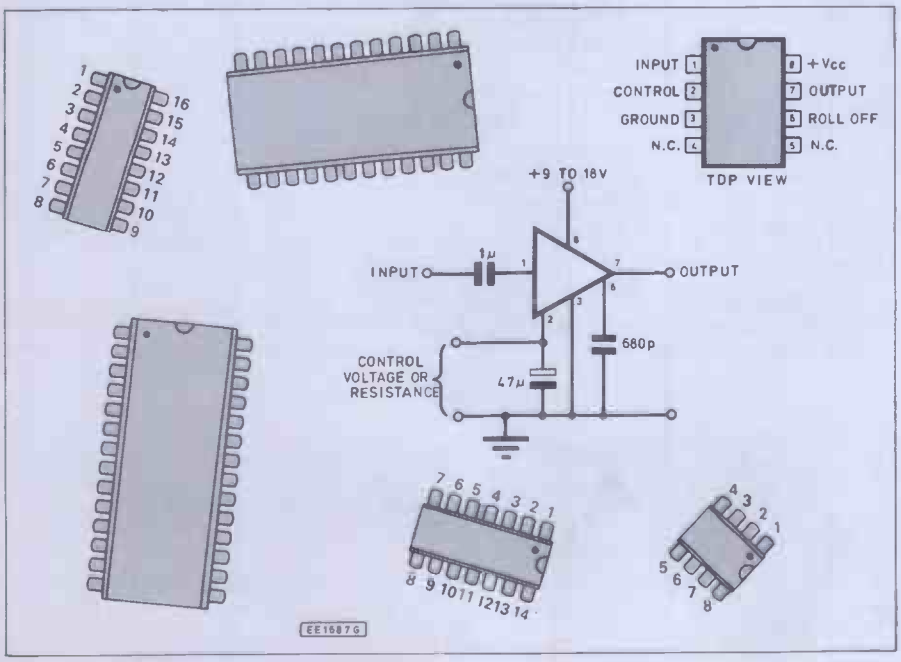


Fig. 2.13. Integrated circuits.

plete circuit containing transistors and, perhaps, diodes, resistors and capacitors all contained within a single package (see Fig. 2.13). I.C.s (often called chips) are available in many sizes with varying numbers of connecting pins (or legs), the most common of which are 8-pin, 14-pin, and 16-pin devices.

Manufacturers of integrated circuits apply standard conventions for packaging (encasing) their devices. Device "packaging" specifies the physical construction and pin numbering arrangement as well as the amount of connecting pins. Fig 2.13 shows the physical shape and pin numbering arrangement for 8, 14 and 16 pin d.i.l. (dual-in-line) packages. Notice that, on the diagram, the notch and the dot indicate the position of pin 1 and the last pin of the device, depending on the size of the package. The same arrangement applies to all d.i.l. chips.

Table 2.5 is a complete listing of the components and materials in appendix A of the Resource Document, it gives the following information about all of these components:

(a) The physical appearance of some types of each component.
(b) The symbolic representations used in circuit diagrams.
(c) Names given to some typical variations of each component.
(d) The number of connections required for many of the components and their respective names (e.g. a diode has two connections, the anode and the cathode).
(e) Whether a particular component is polarised or not.
(f) Each component's electrical unit of measure and corresponding symbol (e.g. the electrical unit of resistance is the ohm and its symbol is Ω).

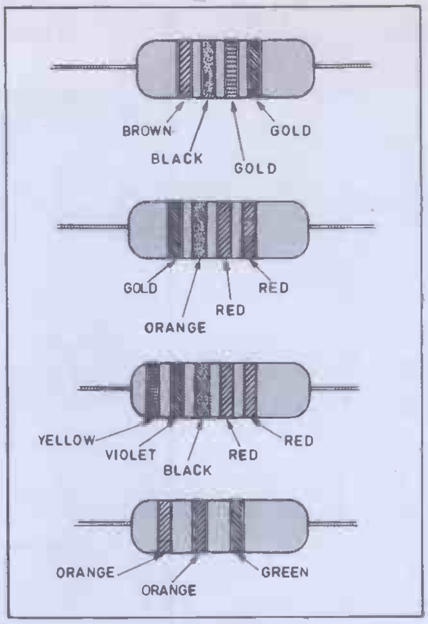
Take some time to look up each component in suppliers catalogues making sure that you can identify each one and discover the basic specification i.e. value or type number, rating etc.

This table serves as a convenient reference for this, and future parts of the series.

Questions

1. What is the tolerance of a resistor baring a fourth colour band of gold?
2. With the aid of a component suppliers catalogue or a data book, state the integrated circuit package and pin numbering convention of a 7400 i.c.
3. Is an electrolytic capacitor polarised?
4. A resistor is colour coded: band one blue; band two grey; band three orange; band four silver. What is the value and tolerance?

5. A ceramic capacitor has a value of 56pF; tolerance of 20%; and a working voltage of 400V. State the colour coding.
6. What is the working voltage of a polyester capacitor with a fifth band of red?
7. Wirewound resitors are not usually colour coded, how would its value be marked?
8. Convert 100mA into Amperes.
9. Draw the circuit symbols for the components listed below.
   1. l.e.d. 5. Zener diode
   2. switch 6. bulb
   3. capacitor 7. diode
   4. transistor 8. resistor
10. A p—— is a variable resistor.
11. A tantalum capacitor is marked:
    4.7
    35
    +
    What do these numbers and the symbol represent?



12. What is the value and tolerance of the resistors on the left?
13. For what is d.i.l. an abbreviation (in terms of i.c. packages)?
14. Identify the i.c. pin number to which the arrow in the diagram below points.
15. Convert 47,000pF to nanoFarads.

ANSWERS, PLUS "MATERIALS AND TOOLS", NEXT MONTH.

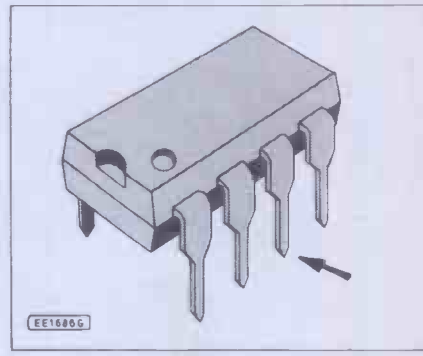
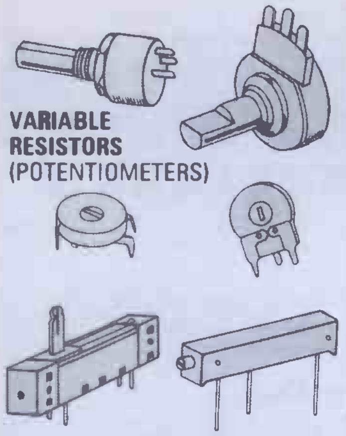
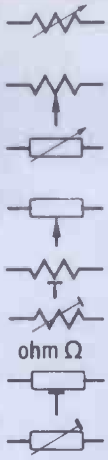
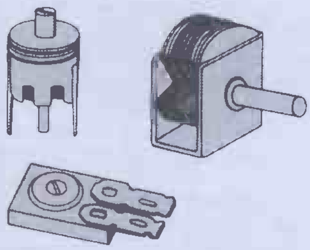
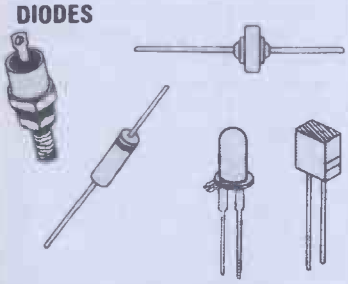
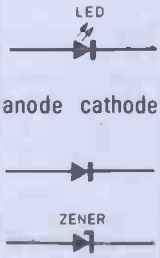
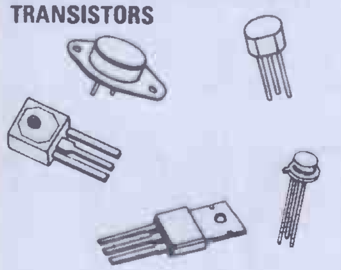
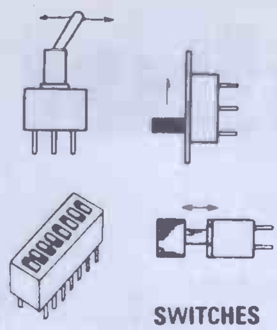
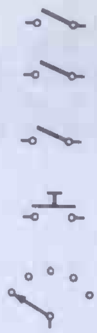
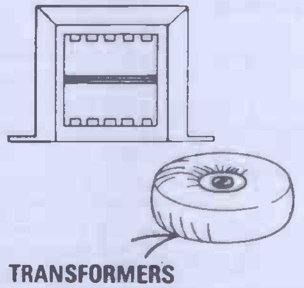
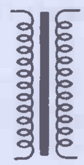
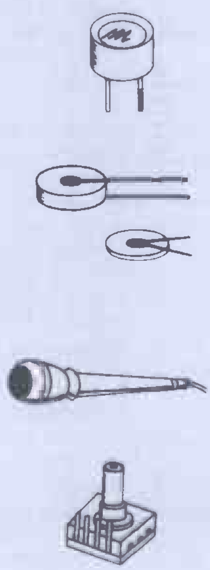
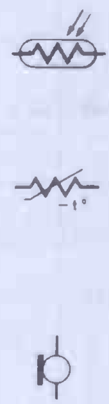


TABLE 2.5

COMPONENT	SYMBOL	TYPES POLARISED?
BATTERIES	Volt V	Zinc Alkaline Nicad Yes
BULB HOLDERS		MES LES MBC
BULBS		No
CAPACITORS	Farad F	Polystyrene Polyester Polycarbonate Ceramic Silver Mica No Tantalum Electrolytic Yes
REED SWITCH		Open Encapsulated No
REED RELAYS		DIL SIL

COMPONENT	SYMBOL	TYPES POLARISED?
FUSES		Anti-surge Quick Blow No
INTEGRATED CIRCUITS	Various	Various
LOUDSPEAKERS		Not polarised but marked for phase
PRINTED CIRCUIT BOARDS		Various
RESISTORS	ohm Ω	Carbon Wirewound Metal-Oxide No

COMPONENT	SYMBOL	TYPES POLARISED?
VARIABLE RESISTORS (POTENTIOMETERS) 		Carbon Wirewound LOG LIN Preset Multiturn Slider No
VARIABLE CAPACITORS 		Ceramic Airspaced Preset No
DIODES 		Various Yes
TRANSISTORS 		Various
SWITCHES 		Toggle Rocker Slide Pushbutton DIL Rotary PCB Mounting No
TRANSFORMERS 		Various
SENSORS 		Light Dependent Resistor Light Activated Switch Thermistor Thermocouple Dynamic Microphone Piezo Resistive Transducer

NOTE: The phone number given in the booklet for Mansfield Information technology Centre should have been 0623 650263.

RECOMMENDED BOOKS

Rather than provide a long list of recommended books at this stage (which readers may be tempted to rush out and buy!), we will simply suggest titles for background reading as the course progresses. To start the series off we would suggest the following title (which covers the whole range of electronics): **Electronics** by G. H. Olsen, £4.95 (one of the Heinemann "Made Simple" books). This book is available from the Direct Book Service —for full details on ordering see page 674.

COMPONENTS

The following is a list of components required for the first six parts of the *Introducing Digital Electronics* course. These components are all readily available from companies advertising in the pages of *Everyday Electronics*. Readers will find that by obtaining a number of catalogues from various companies they will be able to fulfil their requirements for electronic components by mail order fairly easily. Most catalogues also carry illustrations of various components and other helpful data—they are in this way very useful for newcomers to electronics.

Resistors
10 ohm 0.5W 1 off
100 ohm 0.5W 1 off
1 kilohm 0.5W 1 off
10 kilohm 0.5W 1 off

Switches
Single pole single throw push to make button, 1 off.
Single pole single throw toggle switch, 1 off.

Semiconductors
2N3053 transistor 1 off
ORP 12 light dependent resistor 1 off
Light emitting diode (l.e.d.) 1 off

Miscellaneous
9 volt to 12 volt single pole changeover relay with low resistance (100ohm to 500ohm) coil 1 off
9 volt PP3 battery 1 off
12 volt MES bulb 1 off
MES bulb holder with screw terminals 1 off
Solderless breadboard—single plug-in, Vero or similar type
Veroboard, 0.1 inch matrix 36 strips by 50 holes
Crocodile clips, standard insulated, 6 off
Insulated single core copper wire (1/0.6mm)—approx. 5 metres, various colours
PP3 "press-stud" battery clip with red and black wires attached
Solder—22 s.w.g. cored type, 10m

Robot Roundup

NIGEL CLARK

ANY robot which can answer the perennial question: "What can it do?" has an immediate advantage over the competition. This realisation has lead to a number of responses including specialist software and interfaces for the popular micros and large amounts of back-up documentation.

With robot arms the most visible form this has taken has been the development of the work-cell, giving the robot an environment in which it can show off its skills.

The usual cell includes a method of presenting objects to the arm—such as a gravity feeder, a conveyor, a method for testing the objects—for example for size—and a rotary table with bins in which the sorted objects can be placed. Variations include some way of working the objects, usually by a computer numerically controlled (CNC) lathe or drill.

Such cells have become increasingly popular and recent developments have left very few arms without a cell of some description. The latest additions include the EMU, Alfred, Teachmover and Scorbot. Meanwhile moving in the opposite direction is the Armtech which has been shorne of its companion peripherals.

FLEXIBLE MANUFACTURING

The EMU from LJ Electronics now forms part of the IRO 2 package, selling at about £850, which also includes two conveyor belts. The 4-axis EMU, under control from an IBM PC, moves parts between the two conveyors.

The company also plans to include the EMU in a flexible manufacturing system (FMS). Again controlled by the IBM PC the system will have a CNC drill and should be launched at the beginning of next year.

Research Development Associates is developing the Alfred work cell in response to an order from the States. The system allows three Alfreds to work together with usual work cell components.

The whole cell is again controlled by the IMB PC by way of RDA's Octopus intelligent controller. The price to the US will be about £2,500. Dave Doughty said that the price in the UK should be about the same and although orders were being taken it would not be possible to satisfy them immediately until the US order had been met.

Teachmover, the 5-axis articulated arm, has a work cell which includes a CNC lathe, and sells for a little more than £3,000. Scorbot, at about the same price, is now able to work with a variety of devices. Both Teachmover and Scorbot can also be used with vision systems.

NEW COMPANIES

The machines are now being supplied by a new company called Morgan Automation, having taken over from Syke Instrumentation, following the sale by Syke of its industrial machines.

Morgan is run by Vaughan Clark, a former Syke director. He felt there was a market in education for the Teachmover, which has been imported from the US for some time, and the Israeli Scorbot which has been available in the UK for about two years.

The decision by Shestotech to limit its output to the Armtech, its Armdroid look-a-like, followed slow sales. Richard Shestopal said that the company was concentrating on the basic 5-axis arm with toothed belt drive and seeing how sales went.

The work cell, with the usual items, was supplied with the more powerful 2000 Plus version.

Meanwhile Chris Magee, who bought the rights to the Colne Robotics products, is no longer supplying the up-dated Armdroid arm and the vision systems. His Cardiff-based company, Concorde Robotique has been closed and he has moved to Farnborough in Hampshire and set up a new company, MQ Electronics.

He blamed distributors for the problems at Concorde and added that he would not be considering returning to the robotics market until the problems had been sorted out.

EXPANDED WALLI

Back on the work cells Cybernetic Applications has expanded its Walli control program so that up to eight of its varied collection of arms can work together with the other items in the cell. The arms include the latest gantry device which has been named the Kestrel, and which is now available. The only limitation from the user's point of view is that the controlling computer needs 512K of memory.

Full specifications for the Kestrel reveal that it has four axes plus a gripper working in the X and Y directions, in the same way as a plotter, with the limb to which the gripper is attached being raised and lowered.

It is driven by stepper motors and with its gripper, which can be either two-fingered pneumatic type or vacuum, and can lift up to 2kg. It can move 50cm in the X direction, 35cm in the Y and 15cm in the Z with a further 15cm on the Z which can be preset in increments of 5cm.

The wrist can turn through 360 degrees.

Programming can be by push button and by the direct entry of the cartesian co-ordinates. All that for a little less than £4,000.

IMPROVEMENTS

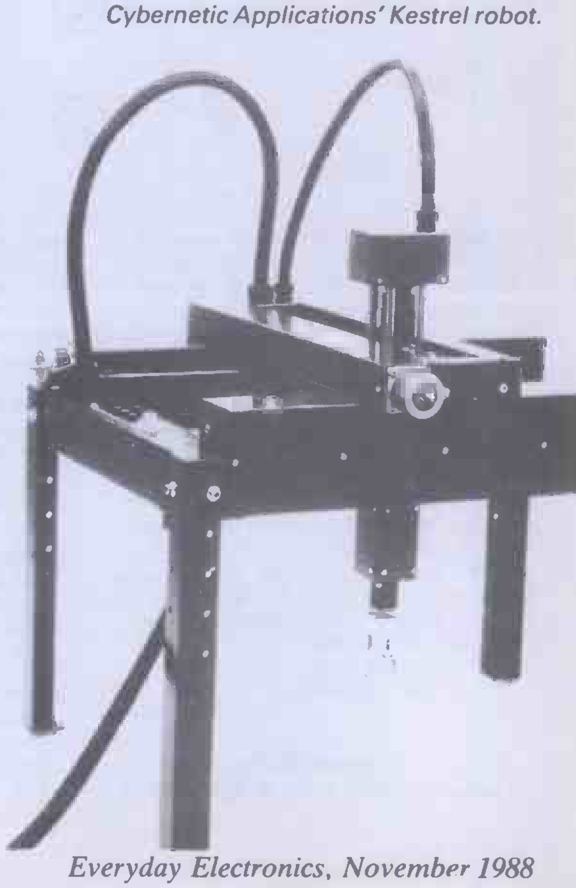
Other manufacturers have also been making improvements to their ranges. LJ's Atlas can now be controlled by the IBM PC. An interface can be obtained for about £350. LJ is also looking to update its unusual X–Y plotter arm, the Placer.

UMI has made the vertical movement of its RTX Scara arm faster and more accurate. The company is offering to upgrade existing machines for about £750.

The plans it had for a smaller, simpler arm, based on the RTX technology have been dropped. Not sufficient interest was shown in the device, a prototype of which was shown at the Barbican show earlier this year. UMI is, therefore, concentrating on the main arm which, the company says, has attracted a lot of interest and sales in education and health care.

The Trekker buggy can now be controlled using Logotron Logo in addition to the built-in Basic commands. For £10, a chip will be supplied allowing the language to be used. Clwyd Technics, which makes the Trekker, is also looking to provide a version, with the necessary support material, to be used in primary schools. □

Cybernetic Applications' Kestrel robot.



FOR YOUR ENTERTAINMENT

BY BARRY FOX

Satellite D-Day

The UK satellite scene is finally "shaking down". British Satellite Broadcasting (BSB), the consortium licensed by the Independent Broadcasting Authority to provide a three channel TV service, will be using a Hughes satellite broadcasting at 110W per channel.

This is scheduled for launch by a McDonnell Douglas rocket around August 10th 1989 from Cape Kennedy in Florida. So the service should be well under way by Christmas 1989. Even if BSB launched earlier, there would be no MAC reception equipment available and no de-encryption modules.

BSB is committed, by UK government policy, to using the D-MAC system, with eight digital sounds channels. And BSB will encrypt all three channels using a system called EuroCipher developed by General Instruments in the US.

De-encryption of two channels to UK viewers will be free. This limits the copyright fees payable by BSB to the software companies.

Pay-to-View

The free channels will be supported by advertising. The third channel will be available only by subscription. In the future there may be pay-per-view, either on impulse or by prior arrangement.

BSB's rival is *Astra*, due to be launched early next month by a Luxembourg consortium with government backing. This will use existing TV technology and 45 watt transmitters, without any encryption, to broadcast up to 16 channels of entertainment, including four *Sky Channels* from Rupert Murdoch. Amstrad will offer a bare-minimum reception system, comprising TV tuner and dish aerial for about £199, and a system with infra-red remote controlled tuner for around £259.

Three companies, Ferguson (owned by Thomson of France), Salora (owned by Nokia of Finland) and Tatung (of Taiwan) have signed agreements with BSB to make remote-controlled systems available for BSB reception at approximately £250. BSB says it will not subsidise manufacture. Trade estimates are that £400-£500 would be a more realistic price.

Squarial

The BSB system will also inlcude a "squarial" instead of a conventional dish. The squarial is a flat, 25cm diamond shaped satellite plate aerial.

The squarial unveiled at BSB's press conference in early August was just a wooden dummy. Not even Ferguson, Salora or Tatung had tested it. BSB would not answer technical questions on it or put enquirers in touch with inventor John Fortel's company address. It was c/o a firm of solicitors in Cupar, Fife in Scotland.

BSB said the ERA labs of Leatherhead had "verified" the squarial. In fact they can only extrapolate from similar designs of different sizes, made of aluminium.

The novelty of the Fortel idea is that the plate will be moulded from plastics instead of formed from metal. This will keep the cost down. But will it pick up enough signal? And will it work after years of exposure to the elements?

Only time will tell. But ERA confirms that there is nothing magic about the squarial design. It is a passive circuit and passive flat aerials have no more gain, and usually less, than dishes of the same area. They usually cost more too.

Until proved otherwise, the squarial looks like another of BSB's publicity gimmicks. The company needs gimmicks to keep city investors confident.

I finally got to speak with John Collins of Fortel, thanks to ERA and no thanks to BSB. Collins admits that he has not yet made a 25cm plastics squarial as promised by BSB, but he has made different sizes, from metal, and feels confident that the idea will work.

Engineers have their doubts. Small plates have a wider beam width than a dish (four or five degrees instead of one degree), and are thus easier to align. But they have nasty side lobes, picking up unwanted signals from other satellites.

BSB admits it has not yet found anyone to make squarials, and at a price which fits inside the £250 bracket. BSB is thus making the age-old mistake of promising to sell something before it has been engineered.

The full system price target has already quietly climbed from £200 to £250. I'll bet it climbs next to £299 (which is still under £300) and from there to £399 in time for the launch in a year's time.

If there is a launch. More likely investors will pull the plug next spring if the *Astra* launch goes well.

"The best thing BSB can do" says Robin Crossley and Marcus Bicknell, who run the *Astra* operation in Luxembourg *"is book three channels on our satellite"*.

Technical K.O.

Even if you have no interest in sport, spare a thought for this. It is TV and video technology which has made sports stars into rich superstars. And in the future it could cost more to see a "live" telecast than a live event.

I was in New York when world heavyweight boxing champion Mike "Iron Man" Tyson fought challenger Micheal Spinks in Atlantic City. Tyson knocked Spinks out in just 91 seconds. Together the two boxers earned $35 million. Without TV and video technology they would have earned only a hundredth or even a thousandth of that.

Because the fight was not televised live, blood-lusting fans all across America paid outrageous prices to watch it on closed circuit television. In Madison Square Garden, where live title fights used to take place in the days of Joe Louis, 18,000 fight fans paid up to $60 each to sit in the arena and watch four large television screens erected in a boxing ring.

I was there and can bear witness to the fact that they screamed and cheered just as if the video images were real people. Restaurants all across the city screened the fight for customers as part of an all-in menu costing up to $200 a head.

In Atlantic City fight fans paid touts up to $5000 each for ringside seats. Like Spinks they never knew what hit them.

We are all so used to seeing slow motion replay on TV that when something happens fast and live in a sports event we feel lost without the chance to see it repeated and analysed. In Madison Square Garden the knockout was re-run half a dozen times. So we at least got a little extra value for our money. In Atlantic City there was only brief reality.

Gloving-Up

Before the fight there had been long delays while managers squabbled over how the boxer's gloves had been laced. In Madison Square Garden we saw shots of the backstage dispute and heard a commentator over the house PA system explain what was going on. In Atlantic City the crowd had no idea what was happening.

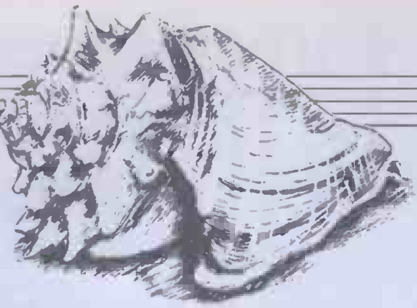
We also heard the commentator explain an oddity which was visible only from video cameras very close to the ring. At Atlantic City it's likely no-one saw or noticed the significance of what the Madison Square Garden audiences could see on a big screen.

As usual each boxer had seconds in his corner, ready to treat any cuts and swab blood between rounds. But this time the seconds at Atlanta City were wearing rubber gloves. They worry about catching AIDS.

The US Cable network Home Box Office had bought the rights to release the fight on home video. HBO was left trying to fill a 60 minute tape with one and a half minutes of action, and justifying the $20 price tag they set in advance.

The last I heard, HBO was planning to include the fight several times over, but each shot from a different angle with different cameras. But that still leaves at least 55 minutes to fill. Somehow I don't think the Tyson-spinks tape will be a best seller.

Constructional Project



SEASHELL SEA SYNTHESISER

ANDY FLIND

Why pay out hundreds of thousands of pounds for the latest marine dwelling? Now you can bring the relaxing sounds of the sea into your own living room for a fraction of the cost.

FROM time to time, most of us wish we lived near the sea. That is, with the exception of those fortunates who actually do! For the rest, the glorious pounding of surf on the beach is just a distant, fading holiday memory.

Imagine actually hearing the waves from your workshop . . . the therapeutic properties could work wonders in a stress-filled life and might even inspire real creativity.

As children, we were sometimes exhorted to take sea-shells home and listen to the "sea sound" that might be heard in them, but these were always a disappointing substitute for the real thing. The memories quickly fade and for those with jobs, families and the usual financial obligations, actually moving to the coast is an impossible dream. Those waves had to remain just a distant memory.

Until now! This project will re-create that sound, either through headphones (try the effect during a stressful day at the office!) or through a hi-fi, where judicious use of tone controls will simulate anything from actual presence on the beach to the muffled roar as heard from a distance. The realism is quite incredible; after a few minutes one tends to forget it's a simulation, the sound is unconsciously accepted as the real thing, with all the accompanying sensations of relaxation and timelessness.

DESIGN OBJECTIVES

The design objectives for this project were simple. The sound should be as realistic as possible, in stereo, with appropriate tone and volume changes plus apparently random variations.

There would be absolutely no compromise in sound quality. Also, if possible it was to be pocket-sized, portable and capable of driving Walkman-type headphones.

In practice this meant low-current operation for prolonged use from a single PP3 battery. Unfortunately the first objective led to a fairly complex circuit, which raised difficulties with the second, but eventually a successful design was arrived at.

Although the circuit is rather complex, all the components are fairly cheap so it is inexpensive to build. The complexity stems mainly from there being two of almost everything; if only one channel were needed it would be much simpler. However, the stereo sound produced is incredibly realistic; constructors will probably agree that the final result is well justified.

WHITE NOISE

The first problem was generation of suitable "white noise". Considering the effort sometimes needed to minimise electronic noise, it's amazing how difficult it is to find some when it's wanted!

Most recognised sources are not, in fact, very noisy; they only cause problems where high gain levels are used. The usual "noise generators" found in projects are Zeners and reverse-biased diode or transistor junctions.

Most Zeners and diodes produce less than a millivolt and, of transistors tried, fewer than one in five proved suitable. The quality of sound also varied widely between devices.

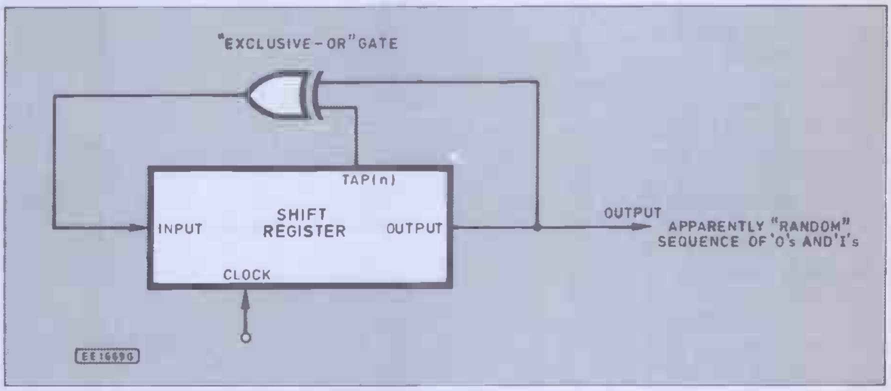


Fig. 1. Simplified digital noise generator using a shift register.

A prototype of this project used special "noise diodes" which were very effective, but subsequently these were withdrawn by the manufacturers and no suitable substitute could be found. Eventually, the circuit was redesigned with a digital noise source, based on IC4, IC5 and IC6 (see Fig. 2). The principle is shown in simplified form in Fig. 1, where a shift register has its output exclusive-OR'd with the output from a tap at stage "*n*" and returned to the input.

If the shift register is clocked at a suitable frequency, the output will be a "pseudo-random" series of 1's and 0's which will take a considerable time to repeat. Just how long depends on the number of stages and the tap position; choice of tap for the longest possible sequence requires involved calculation and is best left to experts, but the arrangement used in this design has a 33-stage register with a tap at stage 14 and when clocked at 1MHz takes over two hours to repeat!

CIRCUIT DESCRIPTION

In the full circuit diagram for the Seashell shown in Fig. 2, the clock consists of IC4a and IC4b, running at approximately 1MHz and driving a 33-stage register made up from IC5 and IC6. The register output, from IC6 pin 9, is EX-OR'd with the output from the tap, IC6 pin 13, by IC4c for return to the input, IC5 pin 1.

It is possible for the circuit to get into a state where all the circulating bits are "0's". This would result in an input of 0, so the output would appear to be continuously low. This condition is avoided by the inclusion of capacitor C12 and resistor R27, which will rapidly inject a "1" to break the sequence should it occur.

Two apparently independent noise sources are required by this project. If a stereo amplifier is switched to "mono" and turned up until the background hiss is audible, the effect of switching to stereo will immediately be apparent. From being a mere irritant, the noise will acquire "depth", suggestive of wind and wide open spaces, and this is the type of sound needed for processing into "waves".

Instead of building two separate sources (with six chips!) the register input is EX-OR'd with another tapping point by the remaining gate IC4d to become a second output. A pair of two-stage low-pass filters convert the digital outputs into audio analogue signals, and attenuation by resistors R32 and R33 reduce them to a suitable level, about 35mV r.m.s., for the following stages. The two sources look sufficiently unrelated for the intended purpose on a 'scope, and they certainly sound "right".

Volume and tone are controlled by diodes. Taking the channel following capacitor C17, the signal passes through diodes D5 and D7 to appear across resistor R40. The diodes act rather like variable resistors whose resistance falls as the d.c. current flowing through them is increased. The current needed is just a few microamps, supplied mainly from resistor R36. From here the signal passes through C21 and R44, which with capacitor C23 provides "top cut" tone control varying with the current, from resistor R42, passing through diode D9.

The full control network includes diode D3, resistors R8, R11, R38, and capacitors C19, and C25, and with the values given produces a realistic "crashing wave" sound when supplied with a positive pulse lasting about two seconds. The tone change lags slightly behind the volume, so the "wave" crashes initially at high pitch, shifts rapidly to a deep roar, then as it dies away the pitch gradually rises again for a realistic "backwash" effect.

Volume control VR1a lets the user adjust the level before amplifier IC7a, which can produce an output of about 200mV r.m.s. maximum. IC7 is a 1458, the dual version of the trusty old 741. Tests proved this to be capable of directly driving Walkman-type headphones for portable use.

Switch S1b offers two levels of overall tone control if required. The tone positions could well, in fact, be labelled "near", "far" and "furthest"! The second channel, following capacitor C18, works in exactly the same way.

COMPONENTS

Approx. cost Guidance only **£22**

Resistors

R1, R3	10M (2 off)
R2	5M6
R4, R5, R23, R24, R25	100k (5 off)
R6, R7, R34, R35	4M7 (4 off)
R8, R9, R50, R51	220k (4 off)
R10, R38, R39	47k (3 off)
R11, R12, R44, R45	22k (4 off)
R13, R14	330k (2 off)
R15, R16, R17, R18, R21, R22, R28, R29, R30, R31, R40, R41, R46, R47	10k (14 off)
R19	120k
R20	150k
R26	27k
R27, R36, R37	1M (3 off)
R32, R33	1k (2 off)
R42, R43	560k (2 off)
R48, R49	3k9 (2 off)
R52, R53	22 (2 off)

All 0.6W 1% metal film

Shop Talk

See page 660

Potentiometer

VR1	100k dual rotary carbon, log.

Capacitors

C1	1μ polyester layer
C2, C12, C21, C22	100n poly. layer (4 off)
C3, C4	22μ single-ended elec. 16V (2 off)
C5, C6, C17, C18	470n poly. layer (4 off)
C7, C8, C36, C37	100μ single-ended elec. 10V (4 off)
C9, C10, C19, C20, C25, C26, C31, C32, C33	10μ single-ended elec. 50V (9 off)
C11	10p ceramic plate
C13, C14	1n poly. layer (2 off)
C15, C16, C23, C24, C27, C28	4n7 poly. layer (6 off)
C29, C30	10n poly. layer (2 off)
C34, C35	220p ceramic plate (2 off)
C38	470μ axial lead elec. 10V

Semiconductors

D1, D2, D3, D4, D5, D6, D7, D8, D9, D10	1N4148 signal diode (10 off)
IC1	4011B CMOS quad NAND gate
IC2	4093B CMOS quad Schmitt NAND gate
IC3	LM358N Dual op-amp
IC4	4070B CMOS quad EX-OR gate
IC5, IC6	4006B CMOS shift register (2 off)
IC7	1458C Dual op-amp

Miscellaneous

S1	3-pole 4-way rotary switch
JK1	3.5mm stereo jack socket

Printed circuit board available from *EE PCB Service*, code EE625; case (ABS plastic box 120mm×65mm×40mm), with p.c.b. runner guides; knobs (2 off); 8-pin d.i.l. sockets (2 off); 14-pin d.i.l. sockets (5 off); PP3 battery and connector; wire, solder; etc.

SOUND WAVES

The rest of the circuit is concerned with providing suitable pulses to control the sounds. IC1a and IC1b form a simple clock, cycling about once every ten seconds. The output is differentiated by capacitator C2 and resistor R3, so the coupled outputs of IC1c and IC1d are normally high, but go low for about one second with each clock cycle.

Each output pulse discharges capacitators C3 and C4 through resistors R4 and R5, taking about four seconds to reach half supply voltage where IC2c and IC2d each go high for about two seconds.

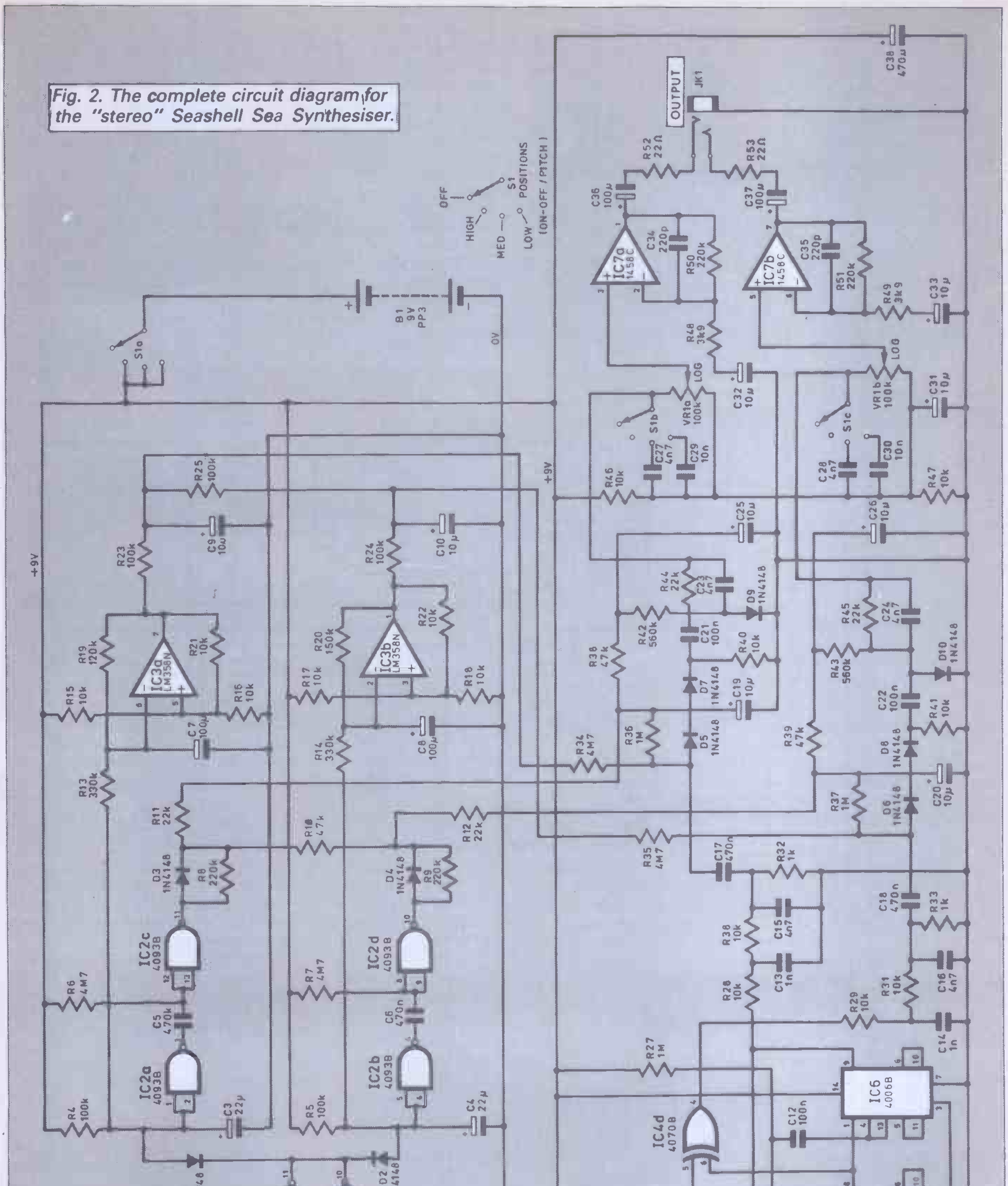
These positive (high) pulses are fed to the "wave" generators by D3, R11 and D4, R12. When the outputs go low again they provide the discharge paths for slow sound decay through resistors R8 and R9.

If the "waves" simply crashed regularly and in unison they would sound boring and unrealistic (though less control circuitry would be required!), so IC3 introduces a little "randomising". The two amplifiers in this chip are configured as very slow running astable oscillators, with slightly different rates set by resistors R19 and R20.

The signals found on capacitators C7 and C8 are very slow triangle waves (approximately), of which small proportions are fed to capacitators C3 and C4 by resistors R13 and R14 respectively. This alters the times taken by these capacitators to charge to half-supply, slightly varying the switching times of the following gates.

The apparent effect is that the waves occasionally crash initially a little to one side. A little crosstalk introduced by resistor R10 improves the realism. Two further signals taken from IC3 are fed directly into the amplitude controlling stages by resistors R34 and R35. The high value of these resistors keeps the effect small, but it results in the "backwash" effect after each wave varying in volume and apparently swinging around. Again a little crosstalk, this time through resistor R25, improves the effect.

Fig. 2. The complete circuit diagram for the "stereo" Seashell Sea Synthesiser.



CONSTRUCTION

All components except the Volume control VR1, Tone (or Presence) switch S1 and the Headphone socket JK1 are accommodated on a printed circuit board. The component layout (assuming the board has not been cut) and copper foil master pattern is shown in Fig.3. This board is available from the *EE PCB Service*, order code 625.

There can be few projects where intending constructors are advised to begin by sawing the circuit board in half! This isn't necessary, of course, if it is to be housed in a case that will accept it in one piece. However, if pocket-size is required this is the first step.

The cutting line is marked by a dotted track, along the centre of the copper side of the board which should be carefully sawn with a fine-toothed hacksaw. The two halves should then fit lengthwise into the moulded slots of the recommended case and the lid should fit; they can be trimmed with a file if necessary. Their edges can be smoothed with emery paper when cutting is complete.

As the components are quite densely packed together a fine-tipped iron is essential for construction. The components should be of the correct type, otherwise they may not fit. In particular, all the non-electrolytic capacitors, save C39 and C40, are miniature polyester layer types, not the larger polyester film variety.

All the electrolytics save capacitor C11 are the single-ended p.c.b. mounting type. Their dimensions are 11mm (high)×5mm (dia.) for 10μF and 22μF and 11mm×6.3mm for 100μF. The height is important as space between the boards is limited.

The layout of all components is shown in the overlay drawing, Fig.3. Care should be taken over the polarity of the diodes; Fig. 4 provides additional guidance for their installation. If they are bent and placed as shown their polarities will be correct.

The electrolytic capacitors normally have their negative leads identified with a broad stripe and all except capacitors C36 and C37 are fitted with positive sides uppermost. They must be fitted close against the board to minimise overall height. DIL sockets should be used for all the i.c.s, which should NOT be plugged in at this stage.

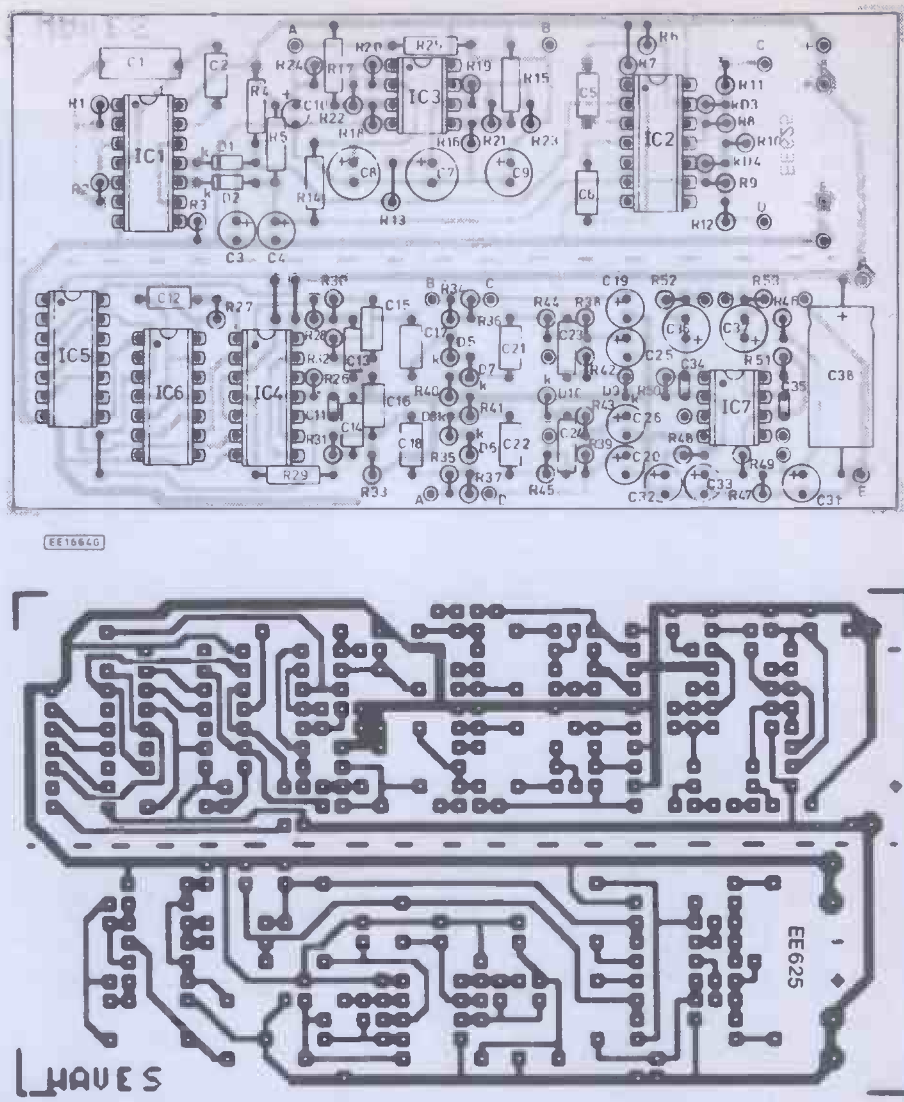
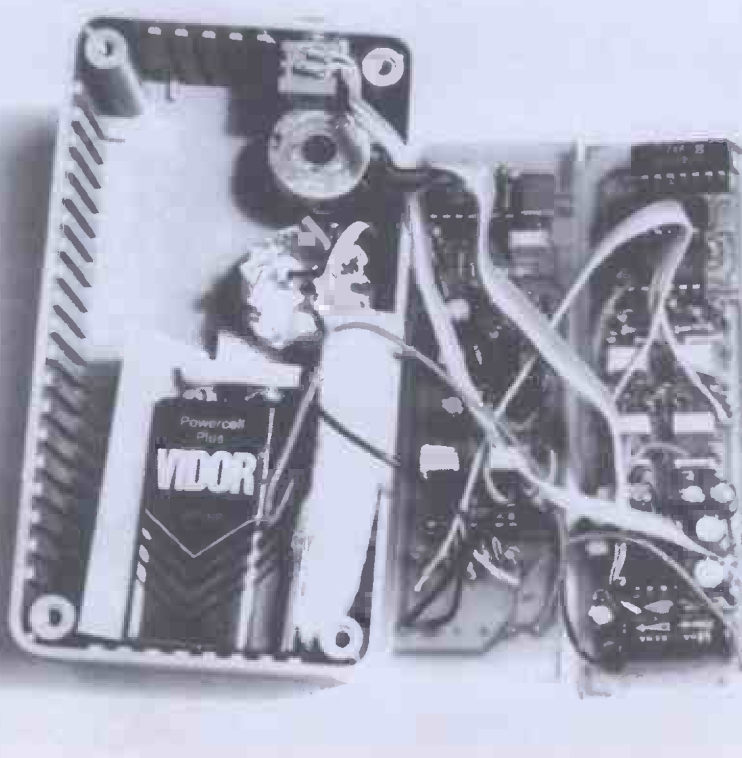


Fig. 3. printed circuit board component layout and full size copper foil master pattern. This board is cut in half to form two boards, if using the case specified.

It is always preferable where possible to test a new project in stages, to minimise chances of catastrophic damage and simplify location of any faults which may be present. Before starting to test this project, all connections between the boards and controls should be completed, temporarily if preferred, except those to the rotary switch S1 which should be added afterwards.

The use of coloured ribbon cable, though not essential, makes for a neater job and reduces risk of error. The interwiring connections are shown in Fig. 5. Note the lead between the "common" point on VR1 and its case, to reduce hum pick-up. If the board is not cut, the power rails will be unnecessary. None of the i.c.s should be plugged in yet.



TESTING

If a 9V supply is connected to the project with a milliammeter in series the drain, following a brief initial surge, should be around 1.3mA to 1.4mA. Any obvious deviations from this figure should be investigated before progressing further.

If all seems well, IC7 can be fitted and power reapplied. This will raise the consumption to about 3.5mA. The voltage on pins 1 and 7 of this i.c. should be half the supply, or about 4.5V.

If the headphones are plugged in a fair amount of hum will probably be heard, especially if volume control VR1 is turned up. Touching the top ends of the volume control sections should produce loud hums on the corresponding headphone. Following this test, the volume should be turned right down.

The next stage is to fit IC4, IC5 and IC6.

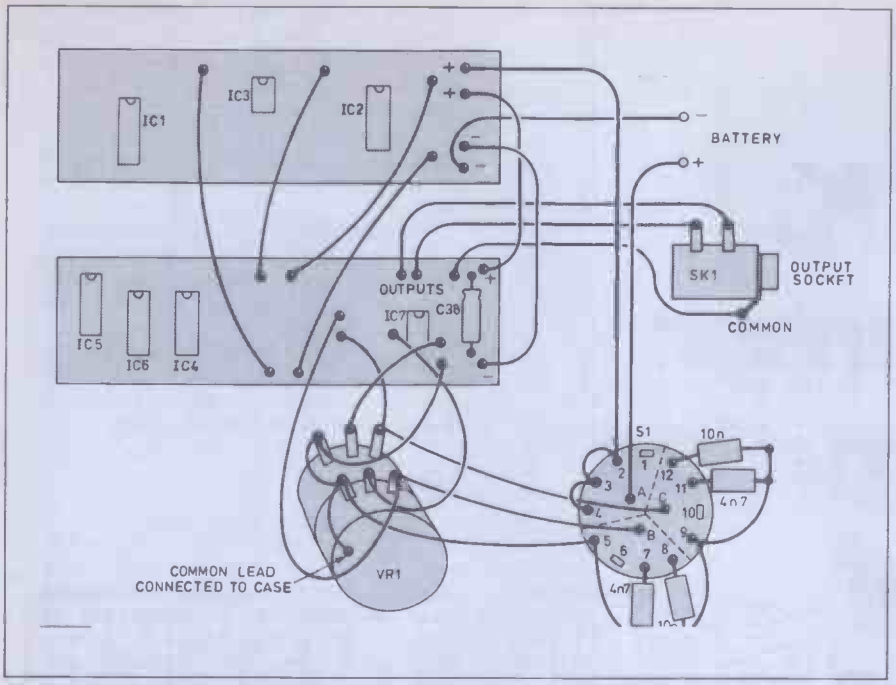


Fig. 5. Interwiring to the boards, VR1, JK1 and switch S1.

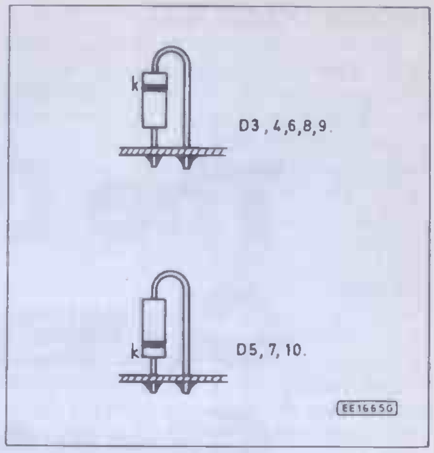
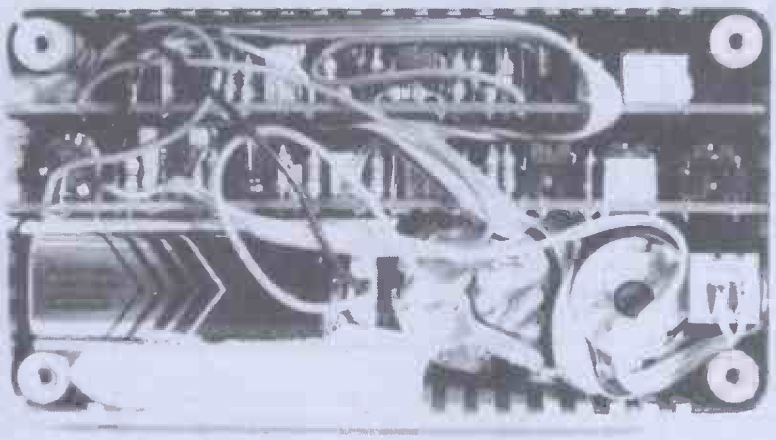


Fig. 4. Polarity guide for mounting the diodes on the p.c.b.



Close "packing" of components inside the case. Note that the volume control should be mounted and wired before mounting the output socket.

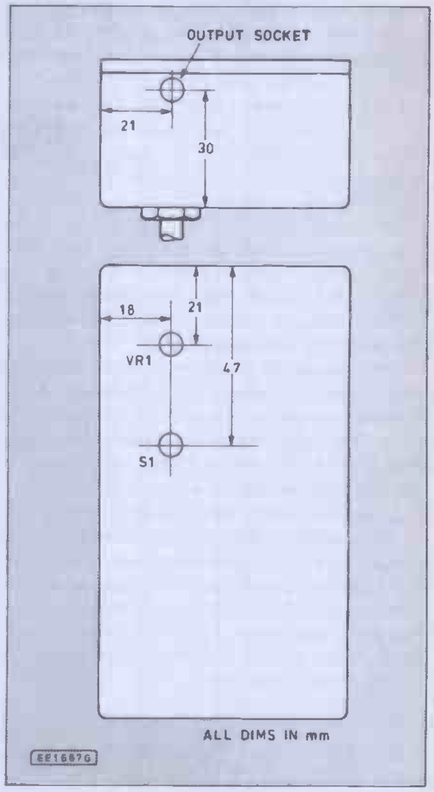


Fig. 6. Case drilling details.

This will raise the drain to about 7mA. IC4 pin 4 and IC6 pin 9 should, if tested for d.c. voltage, show about half the supply. These are the outputs and if they are operating correctly this will be their average level. If there appears to be a problem, a check on IC4 pin 10 should show about half the supply voltage, indicating that the clock oscillator is running.

Fitting IC3 will increase the current to 7.7mA. IC3 pins 1 and 7 should be switching from 0.5V to 7.5V and back very slowly, about every 20 to 30 seconds. These provide a small amount of drive to the diode attenuator circuits, so if the volume is turned up a little the output sounds should be heard whilst they are positive.

If IC1 is now plugged in the current taken will start to vary slightly with oscillator action. Pin 4 of IC1 should be clocking up and down at about 10 seconds per cycle, whilst pin 10 and pin 11 will be normally high, pulsing low about once every 10 seconds as pin 4 goes high.

IC1 on its own will not affect the audio output. Fitting IC2 should, however, result in the full "wave" sounds appearing.

If testing is needed here, pin 3 and pin 4 of IC2 should be normally low but go high for about three to five seconds in every 10 seconds, whilst pins 10 and 11 should also be normally low, going high for about two seconds in every 10 and triggering "waves" as they do so.

The total drain of the complete circuit depends on the output volume, point on the clock cycles etc., but should be around 8mA to 12mA. With an operating current of around 10mA this circuit will operate for long periods from a single PP3 battery.

FINAL WIRING

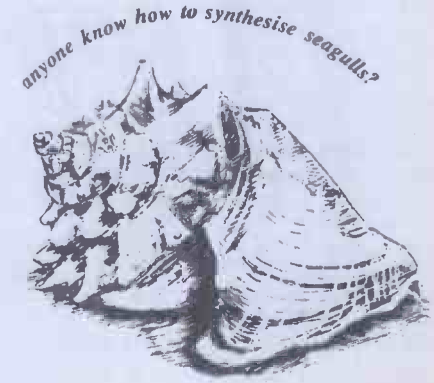
Following satisfactory results of these tests the tone switch S1 can now be wired up. The capacitators C27 to C30 are mounted directly onto the tags of this switch as shown in Fig. 5, with a piece of heavy gauge wire attached to tags 5 and 9 forming their common connection. Three wires connect S1 to VR1.

The drilling details for mounting the volume control, function switch and output stereo jack socket in the case are shown in Fig. 6. The project can now be assembled into the case following the photograph above. The output jack socket should be fitted after the volume control, which in turn will have to be connected before installation.

In the prototype the battery is held by a plastic clip cut from a 35mm photographic slide box and glued into place, with a piece of foam plastic to prevent rattling. The small clearance between parts of this project means there is some risk of parts touching, so check carefully and use small bits of plastic to insulate adjacent items if necessary. On the prototype the presence of the wiring between the boards keeps them apart satisfactorily.

Applications are limited only by the ingenuity of the individual; for stress reduction after (or during) a hard day, as a background for meditation or yoga classes, sound effects for amateur dramatic productions or musical compositions, or simply (with a little imagination) to return to that beach during a winter's evening. Only one thing appears to be lacking . . .

□



The U.K. Consumer Electronics Market

Ian Graham

LAST year, British consumers spent £3,700 million on television, video and audio products. This highly lucrative market is also highly competitive. Manufacturers vie with each other to bring out the cheapest, biggest, smallest, best quality or most stylish products to catch our eye and make us reach for our cheque books. In a market subject to the twin devils of rapidly advancing technology and the whims of fashion, manufacturers and retailers have to react very quickly to what the consumer wants and what current technology can deliver at an acceptable price, while also keeping an eye on what their rivals are doing.

Ferguson, which manufactures products in all three sectors of the market (television, video and audio), has just published its first *UK Consumer Electronics Market* report. The slim Spring 1988 volume (only 10 pages long) is packed with pie charts, bar graphs and figures analysing the market.

It reveals that the greater popularity of television and video rental in the UK compared to the rest of Europe has resulted in faster growth in the television and video recorder market here. By regularly introducing television viewers to new television sets and video recorders, rental companies have stimulated demand for these products, but their influence isn't limited to the rental market. Sooner or later, people stop renting and decide to buy a television set or video recorder or both. This energetic consumer demand has in turn created more interest in the UK from Far Eastern manufacturers whose products tend to reach the UK before the rest of Europe and in greater numbers.

Our shops have influenced the market too. We have more chains of electrical retail shops in the UK than in the rest of Europe. Their active promotion of new products has helped considerably in making the buying public aware of new products. The higher volume of sales they have encouraged has made it possible to bring prices down. So, in the UK we have more products, more up-to-date products and more Far Eastern products than the average European would find in his or her shops *and* we pay less for them.

FST

Flat Square Tube (FST) television sets continue to grow in popularity. In 1986 less than 14 per cent of all television sets sold in the UK were FST models. That had risen to almost 30 per cent last year and is expected to reach 44 per cent this year. The most popular screen sizes are now 14-inch and 21-inch, but we tend to go to different shops for each. Most 14-inch and other small-screen television sets are bought in electrical chain stores and department stores. Most televisions with larger screens are bought in independent shops, but the multiples are gaining ground here too. Ferguson, Hitachi and Philips dominate the market, although retailers' "own brands" are increasing in popularity.

TV FUTURE

The report also looks into the near future of television. The introduction of stereo television sound and satellite television, offering 19 television channels in addition to the four channels broadcast now, will create new demands for new products (set-top receivers, decoders, dish aerials, etc).

CD-Video (a compact disc with sound *and* pictures) and Super VHS (a new improved version of the VHS video format) are due to be launched towards the end of this year. Both will help stimulate interest in video products. S-VHS is also expected to help camcorder sales, which have been disappointing in the UK compared to other western countries.

A camcorder is a video camera and recorder combined in a single unit. Only 95,000 camcorders were sold in 1987, compared to over two million video recorders.

AUDIO

Turning to the audio sector—given a choice between tape cassettes, singles, LPs and compact discs, most of us like to hear our music from tape cassettes, with singles a short way behind and LPs trailing a few per cent behind singles. CDs account for only 6 per cent of sales, not surprising when, according to the report, only 8 per cent of British households have a CD player.

An astounding 70 per cent of 15-19 year olds now own personal stereos. As if we haven't enough ways of squeezing music out of tapes and discs, a new CD only eight centimetres across and a new high-quality audio tape format called Digital Audio Tape (DAT) are due to be launched this year. They will undoubtedly spawn new ranges of home-based and portable CD and DAT products.

In addition to the major trends revealed by the report, there are also a few curiosities. For instance, did you know that 20 per cent of us give away our old video recorders when we buy a new one? And even more (22 per cent) of us give away our old television sets. On average, we take no less than nine weeks to buy a television set and 12 weeks to buy a video recorder. Despite the considerable time taken to decide on which model to buy, we don't shop around a great deal. Half of us buy from the first shop we visit without looking any further.

The report isn't furnished with Ferguson figures alone. Information is credited to several organisations and retail associations in addition to Ferguson itself. □

Production of audio products on the Goldstar high technology line in Korea.

b...Beeb...Beeb...Beeb...Be

... Analogue ... ECG Interface ... Digital ...

In last month's article we looked at what was involved in monitoring a human heartbeat via the electrical signals in the body. In this month's article we will consider a simple amplifier and trigger circuit that can detect the electrical activity in the body, and provide both analogue and digital outputs that can be used to drive the BBC computer. In this respect the present design is very much like the optical detector described in a previous *Beeb Micro* article, (September 1988) and it should operate with the same software (which was provided last month).

An important difference is that the present design does involve direct electrical contact with the "patient". As the BBC micro is mains powered, the interface described here must *NOT* be directly connected to the computer. For safety reasons it is absolutely essential to have some form of isolation circuit between the output of the interface and the input of the computer. This is something we will consider in more detail later in this article.

Detector Circuit

The full circuit diagram of the ECG (electrocardiograph) Interface is shown in Fig. 1. This closely follows the general scheme of things described last month.

At the input of the unit there is a simple *C–R* network that prevents d.c. signals from being coupled into the amplifier. Due to the fairly high gain of the input stage this is important, as quite small d.c. input levels could seriously upset the biasing of the circuit.

Apart from the two differential inputs (inputs one and three) there is also an "earth" input (input two). This is apparently needed for some electrode arrangements, but I obtained some quite good results without using this input. Anyway, it is there if it should be needed. The circuit is powered from a single 9V battery, and so the mid-supply earth rail is provided by a potential divider made up of resistors R1, R2 and capacitor C2.

The differential amplifier has separate preamplifiers for each input. These are based on dual operational amplifier IC1, and both stages are non- inverting amplifiers having a voltage gain of a little over 34dB (50 times).

There are a couple of unusual aspects to these stages, one of which is the severe top-cut filtering provided by capacitors C6 and C7. Here we are only interested in very low frequency signals in the so-called "infra-audio" range, and this filtering does not significantly affect the main input signal.

It does, however, strongly attenuate any mains "hum" or other electrical noise picked up in the input wiring or in the body of the patient. There is almost certain to be a large amount of this noise to contend with, and the noise is in fact almost certain to be many times stronger than the main signal!

The other unusual feature is that the negative feedback networks do not have separate resistors going to the earth rail. Instead, there is a single resistor (R7) wired between the two amplifiers.

This again helps to avoid problems with any noise on the input signal. The noise will be in-phase whereas the wanted signal will be out-of-phase at the two inputs.

Resistor R7 acts as part of the negative feedback network with anti-phase input signals, but it has no significant effect with in-phase input signals, giving only about unity voltage gain through the input stages. This ensures good attenuation of noise on the input signal.

IC2 acts as a conventional differential amplifier. It has a voltage gain of about 26dB (20 times) and the inclusion of capacitor C10 provides further lowpass filtering.

The output voltage range of IC2 is too high for the analgoue inputs of the BBC computer, but the preset potentiometer VR1 can be used to attenuate the output signal so that it is brought within the required 0 to 1.8V range. If it is found that the output voltage is always well above 0 volts, even on negative signal peaks, reducing the value of resistor R2 to about 1.5k should effect an improvement.

IC3 acts as a simple trigger circuit having a substantial amount of hysteresis provided by resistor R15. The output of IC3 is used to drive the l.e.d. at the input of the Opto-Isolator Circuit (Fig. 2) by way of current limiting resistor R16.

The current consumption of the circuit is about seven milliamps. Of course, this *MUST*

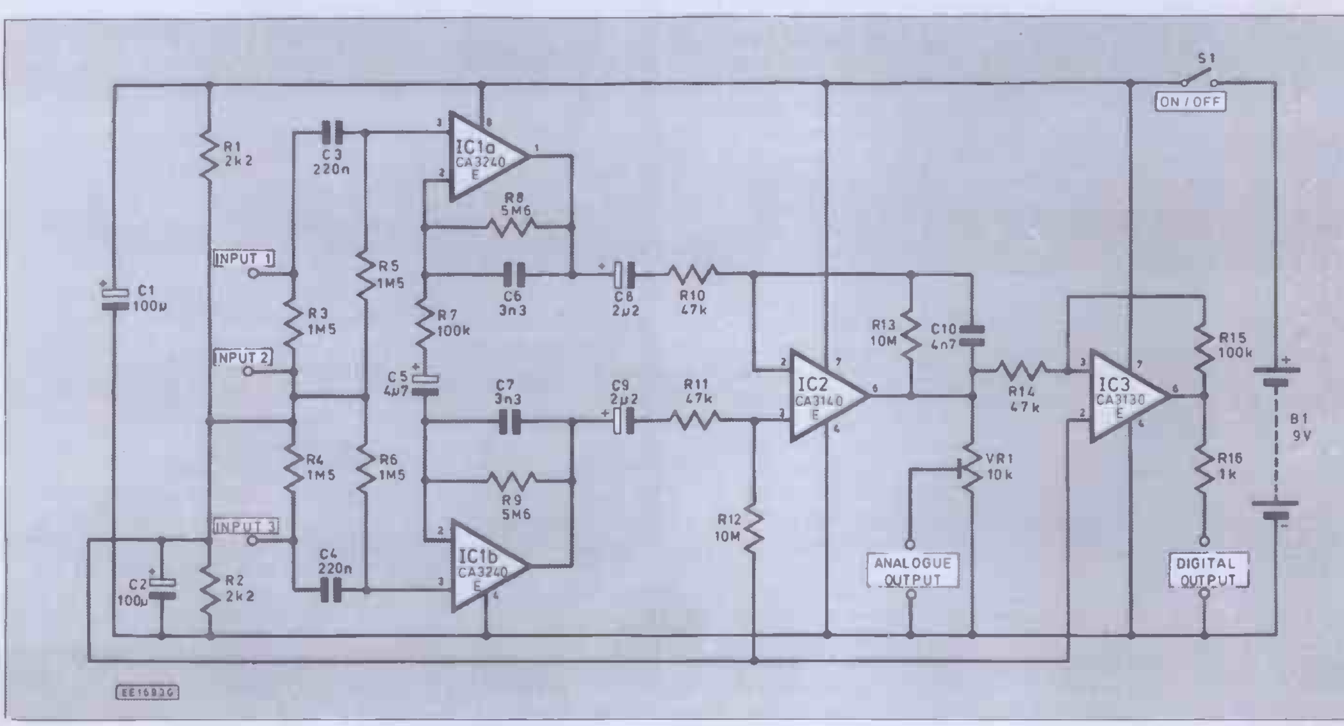


Fig. 1. The circuit diagram for the ECG Interface

COMPONENTS

ECG INTERFACE

Resistors

R1, R2 R3, R4	2k2 (2 off)
R5, R6	1M5 (4 off)
R7, R15	100k (2 off)
R8, R9	5M6 (2 off)
R10, R11, R14	47k (3 off)
R12, R13	10M (2 off)
R16	1k

All 0.6W 1% metal film

Potentiometer

VR1	10k skeleton preset

Capacitors

C1, C2	100μ elec. 16V
C3, C4	220n poly layer
C5	4μ7 elec. 16V
C6, C7	3n3 poly layer
C8, C9	2μ2 elec. 16V
C10	4n7 poly layer

Semiconductors

IC1	CA3240E
IC2	CA3140E
IC3	CA3130E

Miscellaneous

Circuit board, stripboard or p.c.b.; single-pole changeover switch (On/Off); Input/Output sockets to suit; 9V battery and connectors; case; wire, solder and suitable materials for electrodes, see text.

DIGITAL ISOLATION CIRCUIT

Resistors

R17	100
R18	12k
R19	470

All 0.6W 1% metal film

Shop Talk
See page 660

Semiconductors

TR1	BC547 *npn* silicon
IC4	TIL111 opto-isolator

Miscellaneous

Circuit board, stripboard or p.c.b.; connecting wire; solder; etc.

Approx. cost Guidance Only **£14**

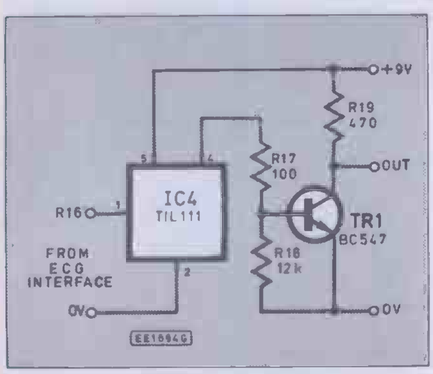


Fig. 2: The Digital Isolation circuit diagram

be provided by a ***battery***, and not from the computer or a mains power supply.

Isolation

Whichever output of the unit you use, it must be connected to the analogue port of the computer via an isolation circuit. If you utilize both outputs, then two different isolation circuits will be required.

In practice this means using some form of opto-isolator based circuit. The digital signal is the one that is most easily dealt with, and the low frequency of the interface's output signal means that there is no need for an expensive high speed device.

Opto-isolation is very simple in principle, and it relies on the light output of (usually) an infra-red l.e.d. being directed towards some form of photo-sensitive device. A variety of photocells are used in opto-isolators, but a photo-transistor is the most common type.

The photo device is shielded from external light sources, and it is, therefore, turned on and off in sympathy with the l.e.d. or other internal light source. I suppose that strictly speaking the device is not turned on, and what is really happening is that it exhibits a very high leakage level. The effect is very much the same as if it was biased into conduction in the normal way though.

This will indeed happen, but non-linearity through the device gives less than ideal results. In fact severe distortion is likely to occur.

There are some quite complex ways around the problem, and these mostly provide a very high degree of linearity. They usually involve some form of modulated pulse signal.

For the present application the very simple method used in the circuit of Fig. 3 will suffice. This relies on the use of negative feedback rather than some form of pulse modulation.

A unity voltage gain buffer amplifier, IC5, is used to drive two opto-isolators (IC6 and IC7). IC6 is included in the feedback loop so that there is unity voltage gain from the input at pin 3 of IC5 to pin 4 of IC6. The feedback takes care of any voltage offsets or non-linearity through IC6 so that there are only very low levels of distortion through the circuit.

There is no isolation between the input of the circuit and IC6 pin 4 though. However, there is isolation between the input of the circuit and pin 4 of IC7. Provided IC6 and IC7 have perfectly matched characteristics there will also be excellent linearity and unity voltage gain from the input to the output of the circuit.

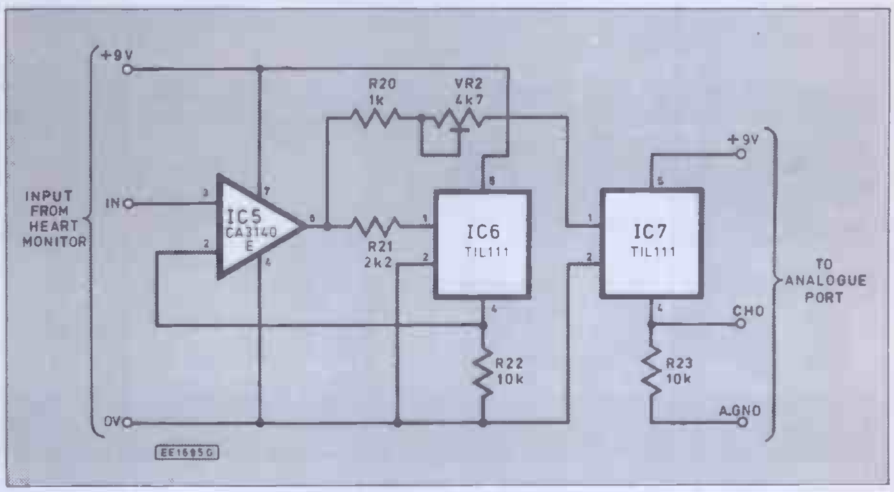


Fig. 3. The Analogue Isolation circuit diagram

Digital Isolator

The circuit for a simple opto-isolator circuit, that can handle the digital output of the ECG Interface, is shown in Fig. 2. IC4 is the opto-isolator, and this is a type which has an infra-red l.e.d. driving a photo-transistor. The efficiency of the TIL111 is not very high, which is something it has in common with other low cost types.

This is not a major drawback though, since an external switching transistor is all that is needed in order to provide a suitably high ratio of input current to output current. This is the purpose of common emitter amplifier TR1. Less than a milliamp is sufficient to reliably operate the circuit.

The output of the unit should be able to drive any digital input, including those on the analogue port of the BBC machines. There is an inversion of the signal through the unit, but this is of no consequence in the current application.

Analogue Isolator

Providing isolation for analogue signals is a bit more difficult. An opto-isolator is not a switching device, and on the face of it a variable signal level on the input side will produce a varying signal on the output side.

COMPONENTS

ANALOGUE ISOLATION CIRCUIT

Resistors

R20	1k
R21	2k2
R22, R23	10k (2 off)

All 0.25W 1% metal film

Potentiometer

VR2	4k7 skeleton preset

Semiconductors

IC5	CA3140E
IC6, IC7	TIL111 opto isolator (2 off)

Miscellaneous

Circuit board, stripboard or p.c.b.; Input/Output sockets to suit; connecting wire; solder; etc.

Approx. cost Guidance only **£5**

In practice it is not possible to obtain perfectly matched opto-isolators. Preset VR2 can be adjusted to compensate for moderate differences in the efficiencies of the two isolators so that approximately unity voltage gain is obtained, but a certain amount of distortion will have to be tolerated.

In the present application the distortion should not be unacceptably high unless the two opto-isolators are very poorly matched. If this should be the case then the best solution is to obtain another TIL111 opto-isolator which should then be a reasonable match for one of the existing components. On trying a number of TIL111's in this circuit I found that any two gave usable results, and it is unlikely that you will obtain two devices that are so poorly matched as to be unusable.

In Use

For initial testing it is probably best to use the simple test circuit provided in the September '88 *BEEB Micro* article, or to use some other method of monitoring the digital output of the unit. At one time suitable electrodes (complete with conductive jelly) were available from one of the larger component retailers, but they would seem to be no longer available from this source.

It seems to be possible to obtain quite good results using improvised electrodes. I cut a sheet of kitchen paper in half, folded up the two halves until they were each about 30 by 50 millimetres, and then soaked them in a strong solution of ordinary table salt. A crocodile clip is an easy way of making an electrical contact to each electrode, and it can also be used to prevent the paper from unfolding itself.

Reasonable results were obtained by simply holding one electrode in each hand. However, a consistent contact with the "patient's" skin is important if noise is to be minimised, and to this end it is better if the electrodes are taped in place (ordinary sticking plaster will suffice).

The electrodes do not have to be placed one on each hand, and anywhere on opposite sides of the body will probably give an input signal, although not necessarily a particularly good one. Try fitting an electrode on each thigh. This should give quite a strong signal.

Do not worry if the number of pulses from the digital output seems to be rather high. The waveform of the input signal can be such that two output pulses are produced per heartbeat.

The unit should work with the software provided in last month's article, provided the unit is connected to the analgue port using the same method that was suggested for the optical sensor. Of course, slight modification will be required to the program if the problem with double output pulses is experienced.

Unlike the optical monitor, this version can be used with the "patient" keeping less than completely still. A consistent contact between the "patient's" skin and the electrodes is important though, and it is essential that the electrodes are securely taped in place. Provided the electrodes are held in place suitably firmly, the unit should work even with the "patient" running on the spot, or something of this nature.

Non-BEEB Owners

Non-BBC computer owners should note that the unit is not only suitable for computer use. The output of IC3 could be used to drive a panel l.e.d. which would flash on and off in sympathy with the "patient's" heartbeat. The analogue output could be used to drive an oscilloscope (but the isolation circuit MUST be included in the likely event that the oscilloscope is mains powered).

The unit has no serious purpose, but it is an extremely interesting circuit to try out, especially in view of its minimal cost. □

SHOP TALK

BY DAVID BARRINGTON

Stock Clearance

We have just received news of a big stock clearance sale which, at first glance, will enable constructors to buy many semiconductor devices at less than half price.

With a no minimum order value, **Omega Electronics** are currently advertising the CMOS 4000 and 7000 series of i.c.s at almost "buy-in" prices. They are also listing voltage regulator, transistors and linear i.c.s at very competitive rates.

For further details see the **Omega** advertisement on page 684 or phone them on **01 965 5748** for a copy of their listing. Stocks are limited and all items are subject to stock availability.

CONSTRUCTIONAL PROJECTS

Doorbell Delay

The only component that may cause constructors concern when building the *Doorbell Delay* is the miniature relay. This is a p.c.b. mounting type and the one used in the prototype was an Omron 5V i.c. type, code G2U-182P-M. Although the circuit only shows one set of contacts, this device has two sets of changeover contacts.

Provided it has a low coil resistance, other relays may be used in this circuit but the pinning arrangement may vary and it may be necessary to "hard wire" it to the circuit board. The rating of the relay contacts will, of course, depend on the final set-up, i.e. audio or visual switching. The small printed circuit board is available from the *EE PCB Service,* code EE616.

Rear Screen One-Shot

It is vitally important that the relay selected for the *Rear Screen One-Shot* be rated as specified, or even greater. Certainly, the switching contacts should be rated at least 16A minimum.

The relay used in the prototype model was a miniature type especially suitable for automobile applications and was purchased from Maplin. It can switch 16A at 12V d.c. and is coded YX99H (12V 16A relay).

It is also important to use only the correctly rated auto-type wires and connectors where specified. Prior to mounting and wiring the "one-shot" in the car the car battery ***MUST*** be disconnected. When installed the final wiring should be double-checked ***BEFORE*** reconnecting the car battery.

Seashell Sea Synthesiser

Althogh the component count for the *Seashell Sea Synthesiser* is fairly large, nearly all the devices are common off-the-shelf items and should not present any buying difficulties.

The one exception could be the dual operational amplifier i.c. type 1458C. Checking through our collection of components catalogues, we found that this device appears in very few and could cause local sourcing problems. Also, it is only listed in the **Marco Trading** and **Electrovalue** current advertisements.

Further investigations have revealed that some advertisers list it under their *LM* range and other component suppliers put it under their *MC* stock listing.

Micro Alarm

The warning device called for in the designer's *Micro Alarm* model is a RS Components type (no. RS249 794) and was purchased through Electromail (☎ 0536 204555), their mail order operation. The circuit arrangement is fairly basic and it is quite likely that practically all the low voltage buzzer/sirens stocked by advertisers will work in this set-up.

The micro connectors and the rest of the components are standard devices and should be readily available from most suppliers. The p.c.b. may be purchased from the *EE PCB Service,* code EE621 (see page 678).

Infra-Red Object Counter

The infra-red diodes and photo diode specified for the *Infra-Red Object Counter* are now stocked by most of our component suppliers. The dual 7-segment, common cathode display is also now widely stocked and should not cause buying problems.

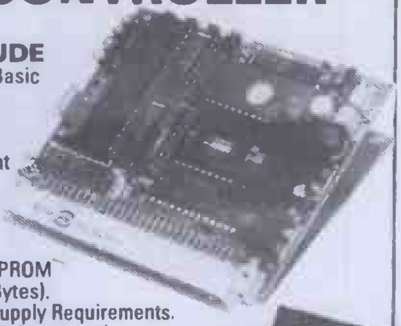
The three printed circuit boards for this project may be purchased seperately or as a set through the *EE PCB Service,* codes EE622, 623, and 624. The set cost £9.28, see page 678 for details.

Introducing Digital Electronics

Last month, in the *Introductory Booklet,* we listed the components required for the first six installments for the *Introducing Digital Electronics* C & G Certificate Course. Several of our advertisers are now making up kits for this important new series and readers are invited to peruse the advertising pages for local suppliers.

We cannot foresee any component buying problems for the simple ECG Monitor Interface—the subject of this months *BBC Micro installment.*

8052-BASIC MICROCONTROLLER



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- **VT500** High power version of the MTX with on-board PA stage providing 250mW of RF. Measures just 20mm x 40mm, power requirements 9-15V. Excellent sensitivity and stability. Fully tuneable over FM band. Ranges over 3000m can be expected £12.95
- **VOX75** Voice-activated transmitter. Variable sensitivity trigger level switches transmitter on when sounds are detected. Stays on for time delay variable between 1-20 sec. Fully tuneable output covers all FM band. Very sensitive and low standby current through CMOS circuitry. 9V operation, range up to 1000m. Measures 30mm x 40mm £15.95
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- **ATR2** Micro size telephone recording unit. Connects onto line at any point and connects into ANY normal cassette recorder, standard or micro having MIC and REM sockets. Requires no batteries. Switches recorder on silently when phone is used for incoming or outgoing calls, switches off when phone replaced. Clearly records both sides of conversations. Undetectable by phone users. Measures 10mm x 35mm £10.95
- **XML900** RF Bug Detector/Locator. Wide band input circuitry detects presence of RF field and triggers flashing LED and piezo bleeper. Variable sensitivity enables source of transmission to be pinpointed to within 6 inches. Max sensitivity will detect MTX or similar transmitter at around 15-20 feet. 9V operation. Measures 55mm x 55mm £21.95

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

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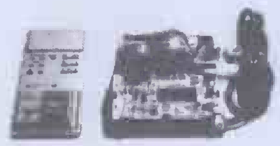

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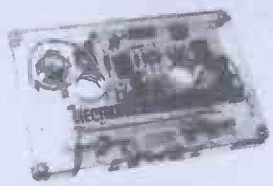

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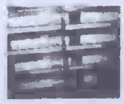

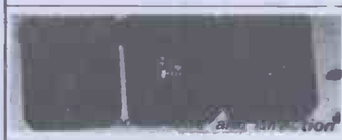

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Constructional Project

MICRO ALARM

JOHN LEWIS

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

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

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

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

CIRCUIT DESCRIPTION

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

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

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

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

COMPONENTS

Shop Talk See page 660

Resistors
R1, R2, R4, R5, R6 — 1M (5 off)
R3 — 10k
All 0.25W carbon ± 10%

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

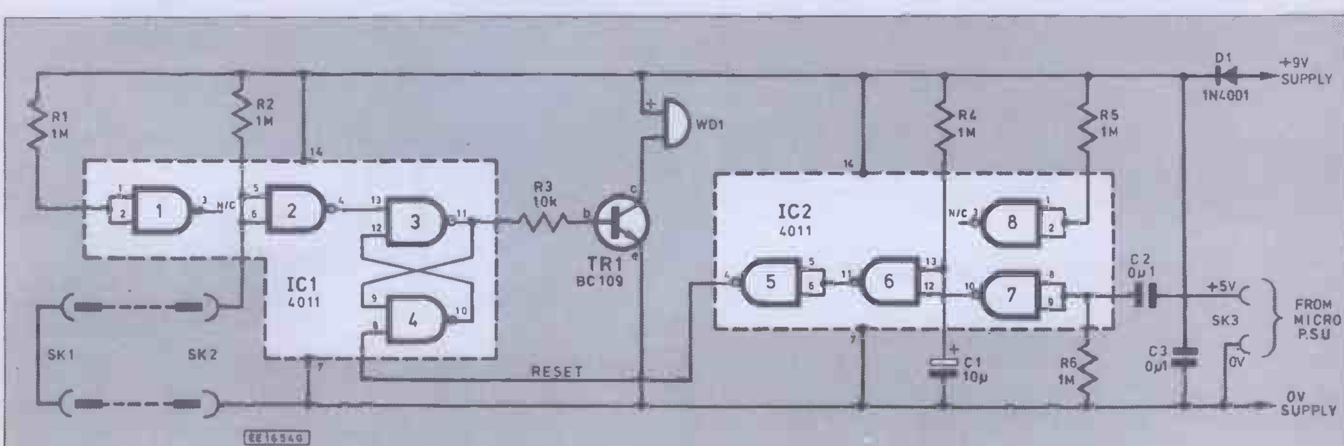
Semiconductors
D1 — 1N4001 silicon diode
TR1 — BC109 *n.p.n.* silicon transistor

IC1, IC2 — 4011 quad 2 input CMOS NAND gate (2 off)

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

Approx. cost Guidance only **£8.50**

Fig. 1. Circuit diagram of the Micro Alarm.



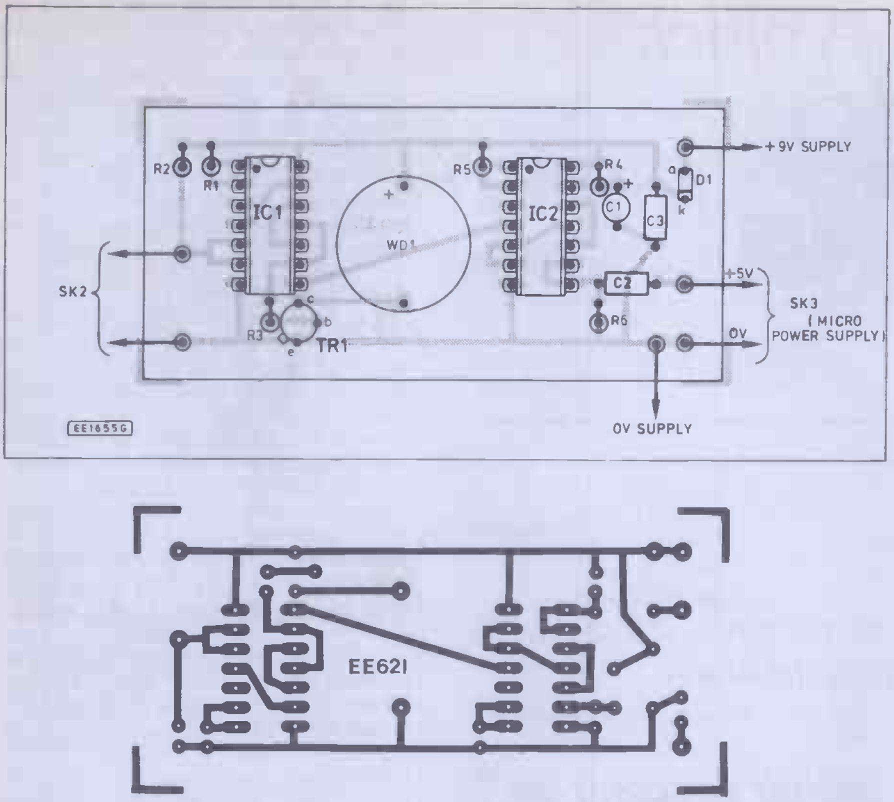


Fig. 2. P.C.B. layout and wiring diagram.

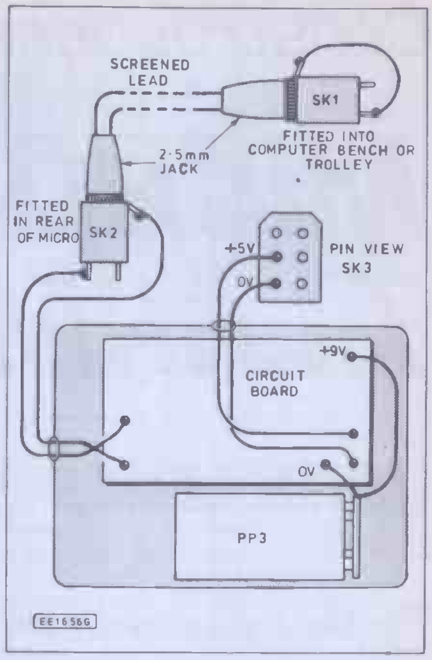


Fig. 3. Interconnections for the Micro Alarm.

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

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

CONSTRUCTION

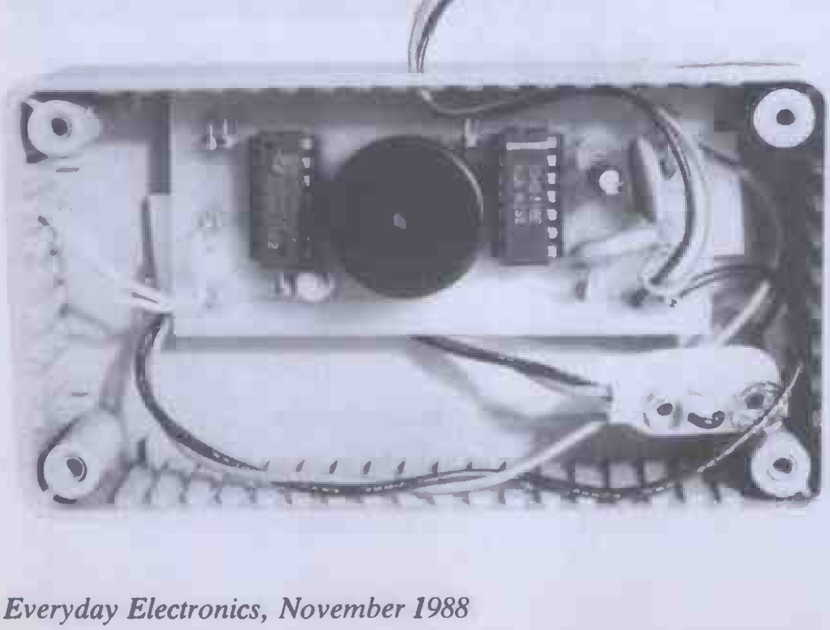
The circuit may be constructed most easily on a printed circuit board, the layout of which is shown in Fig. 2. The resistors may be mounted first on the board followed by the capacitors, diode and transistor. Notice that C1 is an electrolytic type and must be inserted with the correct polarity. The audible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

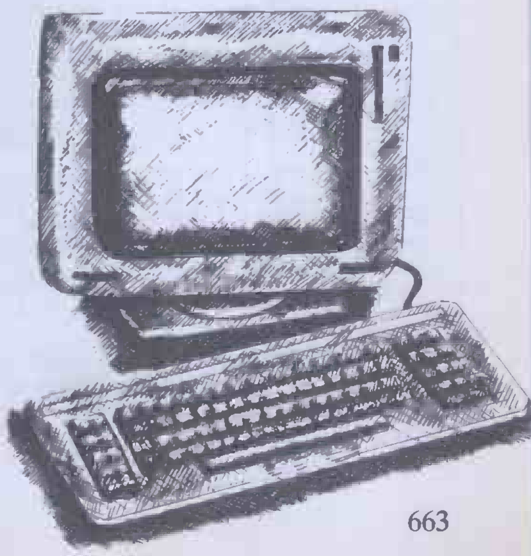
Socket SK1 (Fig. 3) is a short circuited 2.5mm jack socket which must be securely fitted at a suitable location on the computer desk. SK2 should be mounted on the rear of the micro in a convenient position. If you do not fancy the idea of boring a small hole in the rear of your micro then it would be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

CONNECTIONS

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

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





ACTUALLY DOING IT!

by Robert Penfold

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

GENTLY DOES IT

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

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

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

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

LOCATING LUG

On virtually all potentiometers, plus a few other front panel mounting components, you will find a locating lug (Fig. 1). The idea here is to have a hole for this lug

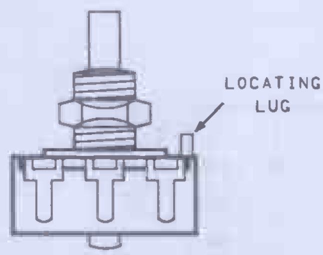


Fig. 1. Locating lug on a potentiometer.

in the panel on which the potentiometer is mounted. This helps to resist any tendency for the component to rotate when its control knob is adjusted, and helps to make construction just that bit tougher and more reliable.

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

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

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

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

DIRECT MOUNTING

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

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

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

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

BUSH SIZES

It is worth pointing out that there are currently two common bush sizes for rotary potentiometers and similar components. Most types now have the metric 10 millimetre diameter threads, but there are still plenty of components which have the old 3/8 inch threads. Mounting nuts for one type will not fit the other (3/8 inch is only about 9.5 millimetres).

With either method of spacing, it is quite possible that the locating lug will be left just short of the front panel, so that it can just be ignored. If it should still reach

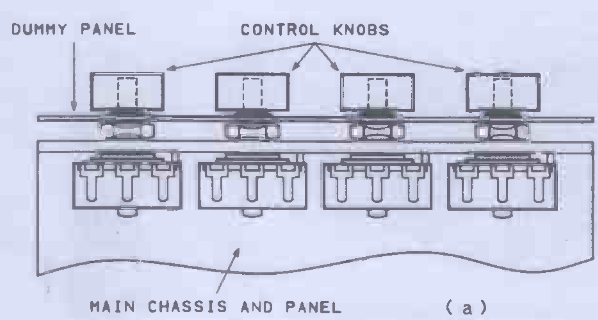


Fig. 2 (left). Dummy front panel to hide the nuts.

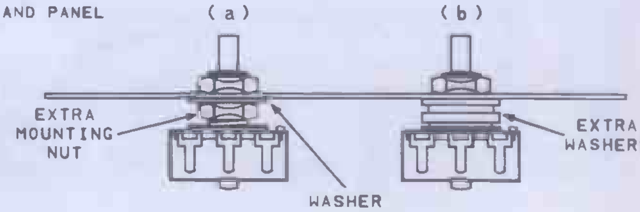


Fig. 3 (right). Using two nuts or extra washers to mount the controls.

the panel, I would not advise making a hole for it in the panel. Unless you are going to use large control knobs, the knobs will fail to cover over the protruding locating lugs, giving a rather unsightly appearance to the finished project.

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

SPINDLE TRIMMING

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

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

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

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

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

CUTTING

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

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

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

FLAT FILING

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

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

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

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

EE CROSSWORD 7

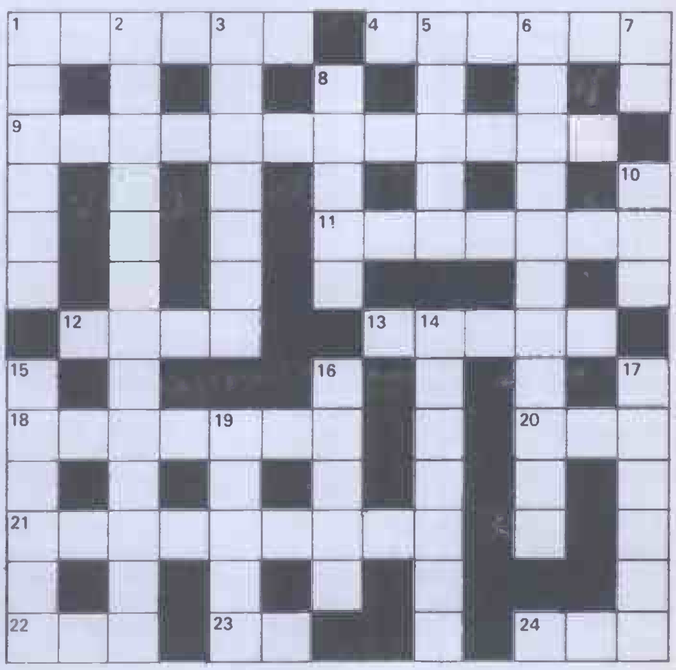
CLUES ACROSS

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

DOWN

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

For fun only—answers on page 673



...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

NEW UK AMATEUR LICENCE

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

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

NOVICE LICENCE

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

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

NEW SYLLABUS

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

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

THE VOICE OF THE ANDES

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

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

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

NEW ANTENNA DESIGN

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

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

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

HAM RADIO TODAY

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

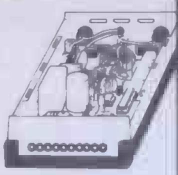
A recent programme I listened to included an amateur radio news bulletin; a discussion on how Morse code signals should be reported over the air; an ongoing series about the propagation of radio waves; an explanation of the NCDXF beacon system on the 20m band; details of amateur radio books available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

ANTENNA LEAFLET

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

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

POWER CONDITIONER



FEATURED IN ETI
JANUARY 1988

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

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

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

PARTS SET £28.50 + VAT

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

KNIGHT RAIDER

FEATURED IN ETI JULY 1987

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

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

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

Lamps not included

PARTS SET £19.90 + VAT

RAINY DAY PROJECTS

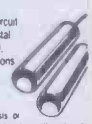
All can be built in an afternoon!

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

FEATURED IN ETI AUGUST 1988

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

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



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

PARTS SET £33.80 + VAT

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

THE DREAM MACHINE

FEATURED IN ETI
DECEMBER 1987

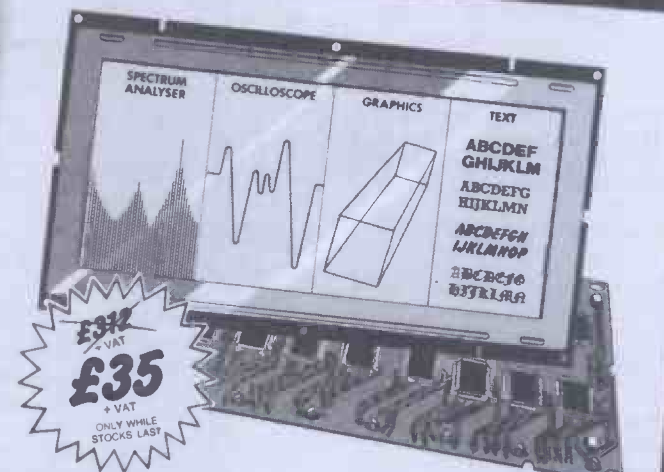
Adjust the controls to suit your mood and let the gentle, relaxing sound drift over you. At first you might hear soft rain, sea surf, or the wind through distant trees. Almost hypnotic, the sound draws you irresistably into a peaceful, refreshing sleep

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

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

PARTS SET £16.50 + VAT

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



GRAPHICS DISPLAY OFFER

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

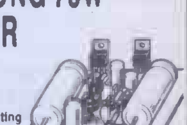
But it's an ill wind that blows nobody any good. Because of their bad management, you now have the chance to own a high grade graphics display module at a tiny fraction of the normal price. Hitachi distributors will charge £312 each for these displays. From us, while stocks last, the price is £35!

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

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

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

ARMSTRONG 75W AMPLIFIER



FEATURED IN PE
JULY 1988

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

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

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

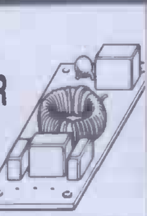
Parts set includes top grade PCB and all components.

SPECIAL INTRODUCTORY PRICE FOR FULLY UPGRADED MODULES.

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

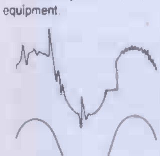
Please send SAE + £1 for data and circuits (free with parts set), including diagrams for matching pre-amp and power supply. This amplifier will not be available from your usual audio supplier – we produce the only designer approved parts set

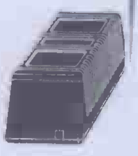
MAINS CONDITIONER



FEATURED IN ETI
SEPTEMBER 1986

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





PARTS SET **£4.90** + VAT

RUGGED PLASTIC CASE **£1.65** + VAT

BIO-FEEDBACK

FEATURED IN ETI
DECEMBER 1986

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

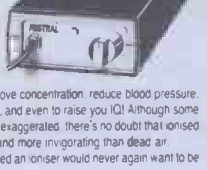
The complete parts set includes case, PCB, all components, leads, electrodes, conductive gel, and full instructions

PARTS SET **£13.95** + VAT

BIO-FEEDBACK BOOK **£3.95** (no VAT)

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

POWERFUL AIR IONISERS



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

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

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

MISTRAL IONISER PARTS SET **£24.80** + VAT

DIRECT-ION PARTS SET (BLACK CASE) **£11.50** + VAT

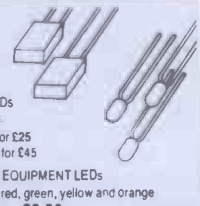
DIRECT-ION PARTS SET (WHITE CASE) **£11.80** + VAT

LM2917 EXPERIMENTER SET

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

LM2917 EXPERIMENTER SET **£5.80** + VAT

LEDs



Green rectangular LEDs for bar-graph displays.

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

DIGITAL AND AUDIO EQUIPMENT LEDs

Assorted 3mm LEDs: red, green, yellow and orange

25 of each (100 LEDs) for **£6.80**

BRAINWAVE MONITOR

FEATURED IN ETI
AUGUST 1987

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

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

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

PARTS SET **£36.90** + VAT ALPHA PLAN BOOK **£2.50**

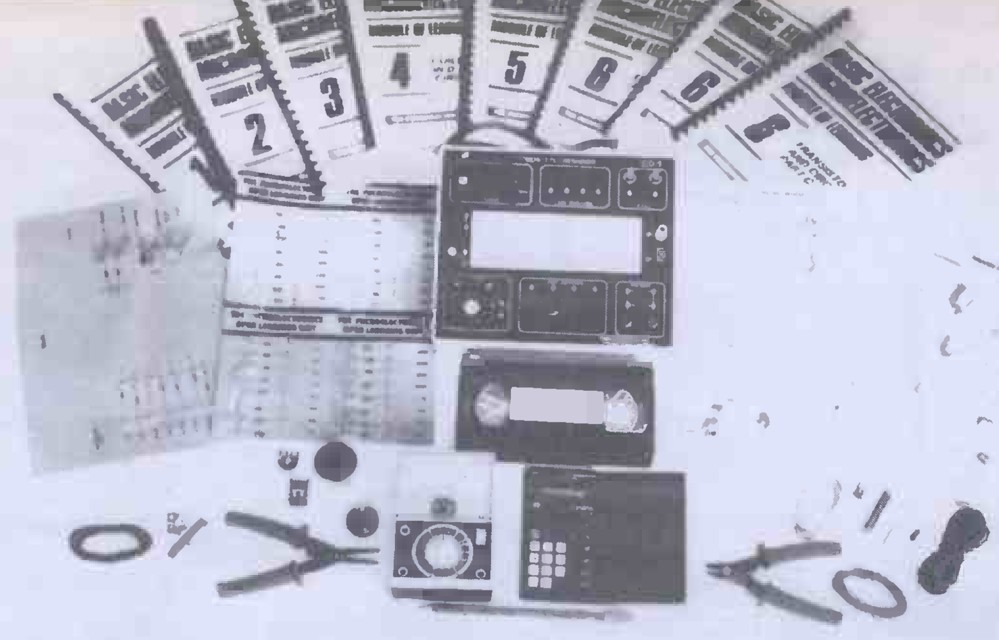
SILVER SOLUTION (for plating electrodes) **£3.60** + VAT

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

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

Specialist SEMICONDUCTORS LIMITED

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



BASIC ELECTRONICS REVIEW

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

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

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

PRACTICAL KIT

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

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

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

MODULES

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

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

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

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

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

MODULE 1

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

MODULE 2

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

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

MODULES 3 to 6

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

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

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

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

VIDEO

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

COST

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

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

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

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

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

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

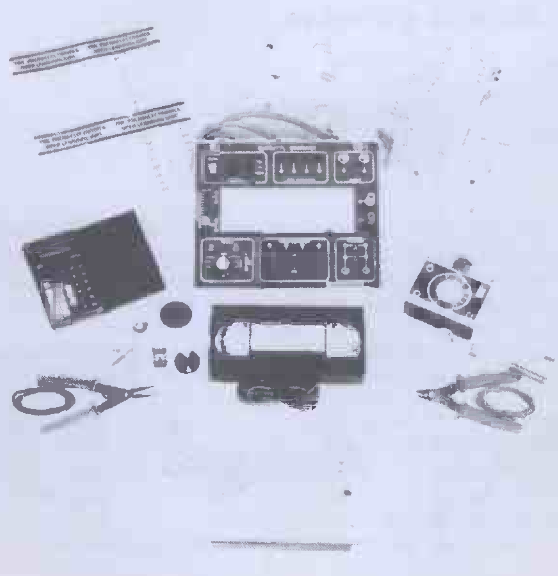
OVERALL REACTIONS

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

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

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

By Mike Tooley



BOOK REVIEWS

OSCILLOSCOPES, HOW TO USE THEM (2nd Edition)

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

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

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

See

DIRECT BOOK SERVICE

Page 674

A TV-DXERS HANDBOOK

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

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

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

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

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

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

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

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

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

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

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

KEY TECHNIQUES FOR CIRCUIT DESIGN

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

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

In his book, *Key Techniques For Circuit Design,* G. C. Loveday shows that you don't have to be a boffin to custom design a circuit. Basic electrical and electronic theory is all that is required. And the first all important factor is a logical approach to the task. For this, the opening sequence is one that would apply in any area of design, not just electronics; namely to define the task, prepare a design specification, list the possible options and choose a method. To get the feel of it, a number of design tasks have been set with solutions provided at the end of the book.

To help those whose theory may be a bit rusty, there are two revision chapters, one dealing with passive components viz. resistors, capacitors and inductors and the other covering the characteristics of the various types of semiconductors. There is even a section dealing with the more complex problem of choosing i.c.s.

All in all, this would seem to be a useful little book and certainly will make those of us who think that circuit design is beyond our capabilities, think again. *Paul Gabriel*

DOWN TO EARTH

BY GEORGE HYLTON

ACTIVE FILTERS

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

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

PRACTICAL CASE

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

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

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

AN UNUSUAL COMPONENT

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

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

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

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

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

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

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

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

PHASE SHIFT OSCILLATOR

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

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

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

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

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

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

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

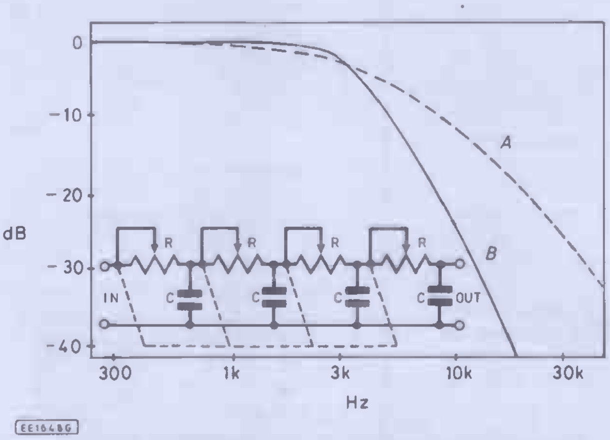
At very high frequencies each section must have a phase shift of nearly 90°, giving a total network phase shift of 360°. The feedback is then negative.

BENCH TEST

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

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

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



EE1648G

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

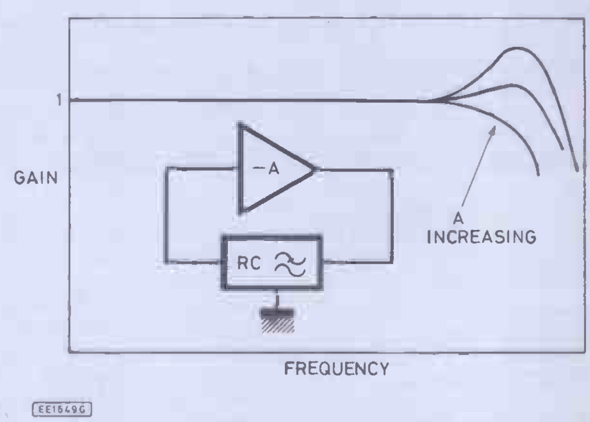


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Fig. 2. When an RC *lowpass with three or more sections is connected as a feedback path in an inverting amplifier the frequency response becomes very dependent on the gain when the phase shift of the network is close to 180°.*

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

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

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

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

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

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

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

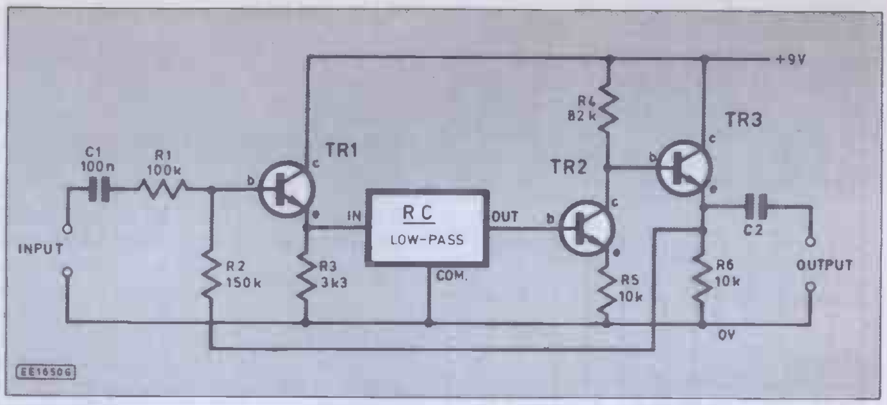

Fig. 3. Circuit diagram for a practical lowpass active filter embodying a four-section RC *network with equal* C *and equal* R.

FIXED FILTERS

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

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

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

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

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

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

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

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

Any high gain audio transistors will do.

MARKET PLACE

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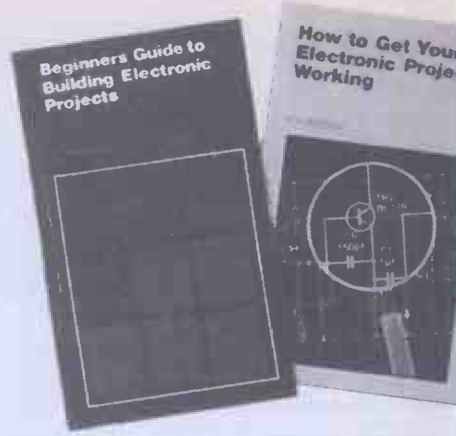
The books listed have been selected as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.



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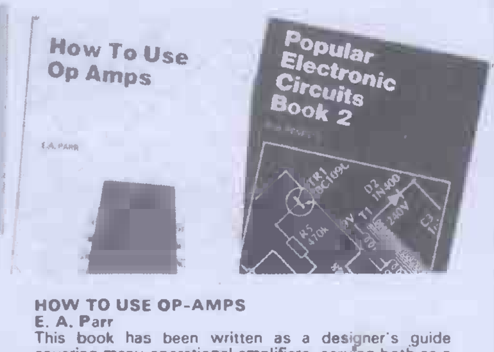

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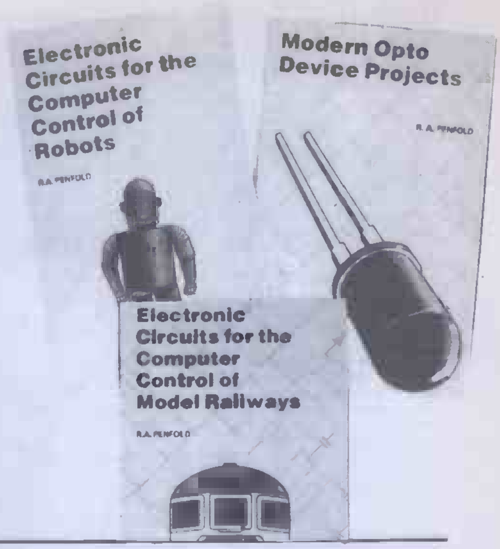
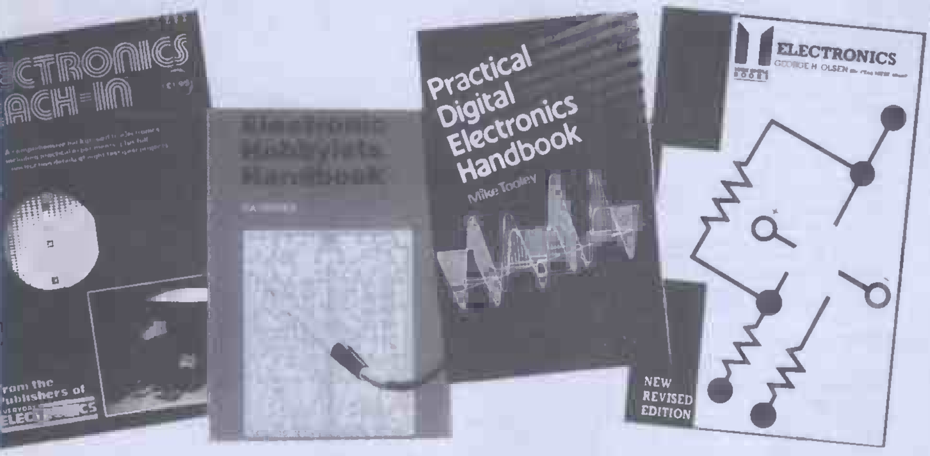
While many of these designs are not in the "dead simple" category, they should be within the capabilities of anyone with a reasonable amount of experience in electronics construction and some of the more simple designs are suitable for beginners.
104 pages **Order code BP194** **£2.95**

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



DATA AND REFERENCE



ELECTRONICS TEACH-IN
Michael Tooley BA and David Whitfield MA MSc CEng MIEE (published by *Everyday Electronics*)
This value for money *EE* book provides a comprehensive background to modern electronics including test gear projects. A complete course in basic electronics; designed for the complete newcomer it will however also be of value to those with some previous experience of electronics. Wherever possible the course is related to "real life" working circuits and each part includes a set of detailed practical assignments. Includes details of eight items of related test gear giving full constructional information and diagrams for each one. They are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator. An excellent companion for anyone interested in electronics and invaluable for those taking G.C.S.E. and BTEC electronics courses.
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Bridges the gap between complicated technical theory, and "cut-and-tried" methods which may bring success in design but leave the experimenter unfulfilled. A strong practical bias—tedious and higher mathematics have been avoided where possible and many tables have been included.
The book is divided into six basic sections: Units and Constants, Direct-current Circuits, Passive Components, Alternating-current Circuits, Networks and Theorems, Measurements.
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R.A. Penfold
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FOR INTRODUCING DIGITAL ELECTRONICS

ELECTRONICS–A "MADE SIMPLE" BOOK
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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.
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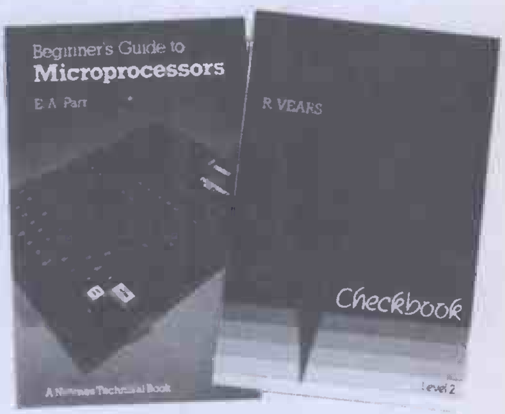

BEGINNERS GUIDE TO MICROPROCESSORS
E.A. Parr
An excellent grounding in microprocessors, this book is broadly relevent to the whole of our Introducing Microprocessors course. It is easy to read and well illustrated.
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MICROELECTRONIC SYSTEMS 2 CHECKBOOK
R. Vears
The aim of this book is to provide a foundation in microcomputer hardware, software and interfacing techniques. Each topic is presented in a way that assumes only an elementary knowledge of microelectronic systems and logic functions. The book concentrates on 6502, Z80 and 6800 microprocessors and contains 60 tested programs, 160 worked problems and 250 further problems.
194 pages **Order code NE04** **£4.95**

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Ian Hickman

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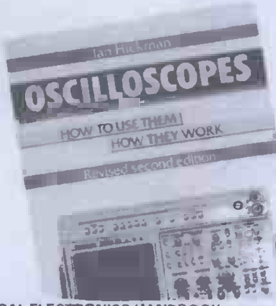

PRACTICAL ELECTRONICS HANDBOOK
Ian Sinclair

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

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

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

BEGINNER'S GUIDE TO HI-FI
Ian Sinclair

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

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

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

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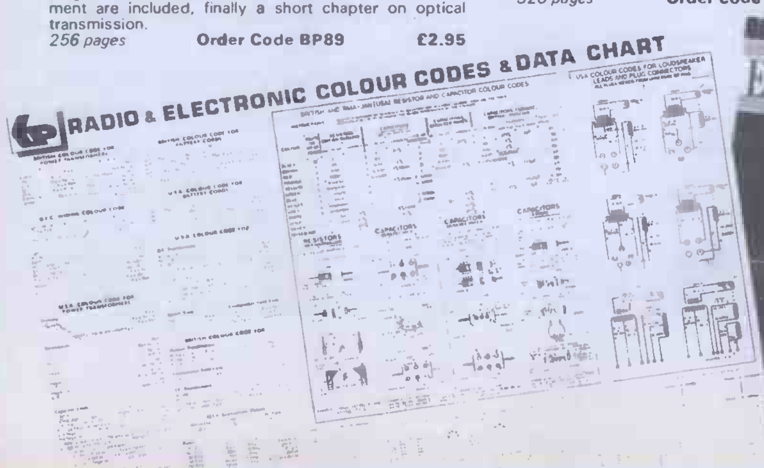

GETTING THE MOST FROM YOUR MULTIMETER
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This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the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

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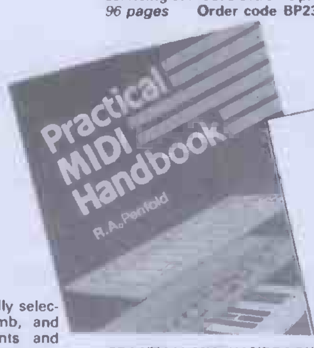

PRACTICAL MIDI HANDBOOK
R.A. Penfold

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.

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Ian Sinclair

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

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

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

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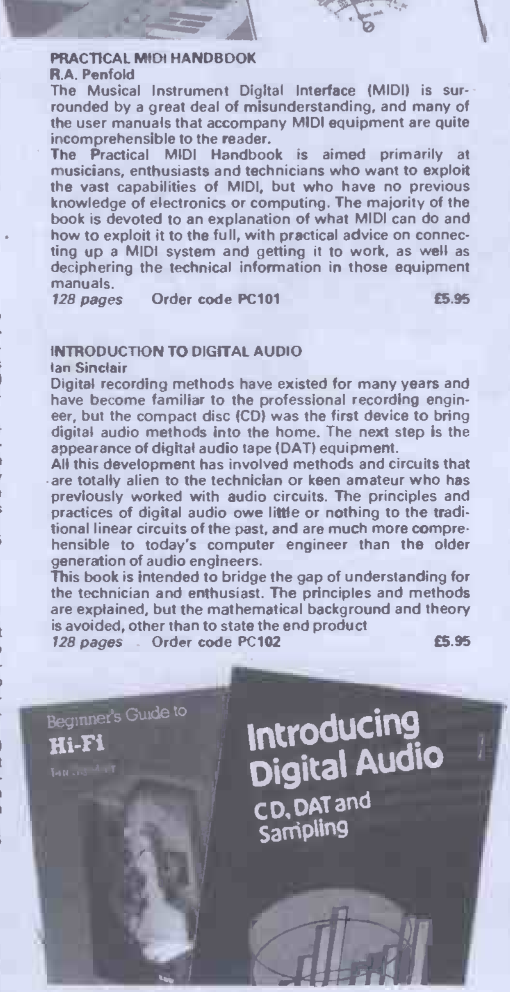

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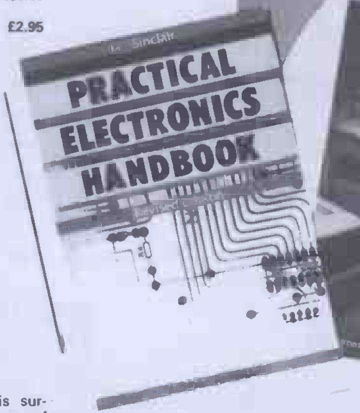

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C. E. Miller

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.

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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.

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E. A. Parr

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

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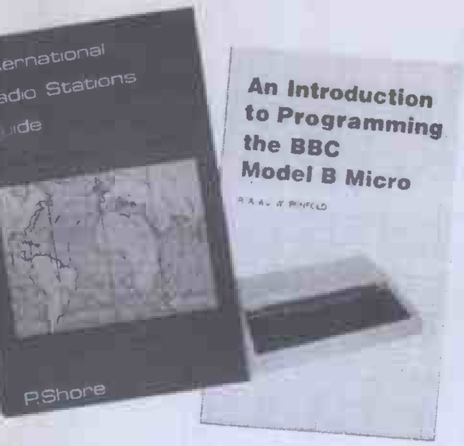
RADIO/TELEVISION



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

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Michael Tooley
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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.*

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ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

A silk purse from a sow's ear?

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

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

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

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

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

Solution

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

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

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

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

Amstrad Board!

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

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

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

Colour Monitor

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

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

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

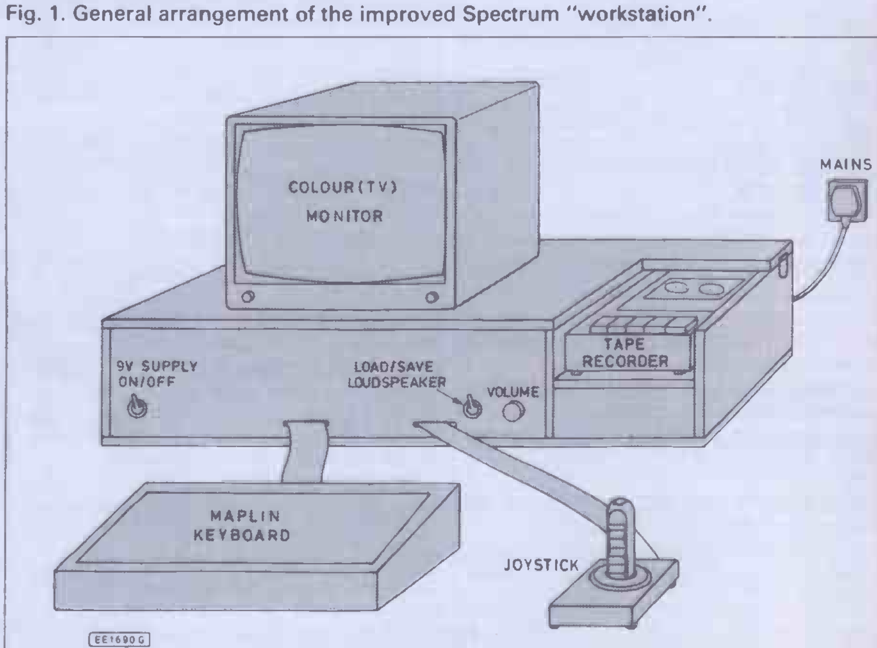
Finally, I completely disconnected the modulator from the video input and its power supply. This further improved the picture quality. (The capacity of the modulator for mischief can perhaps best be illustrated by the fact that I can receive a fuzzy picture of the Sinclair copyright message even when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

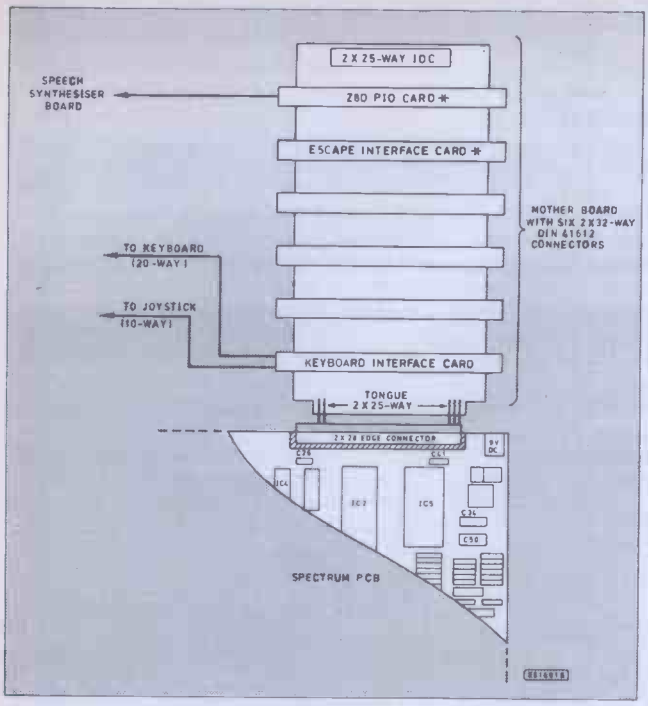
Audio

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

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

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





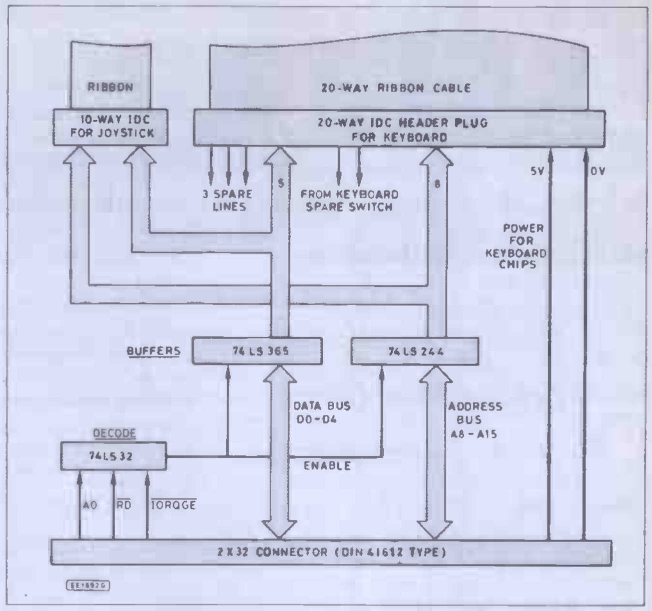


Fig. 3 (above). Details of suggested keyboard interface.

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

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

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

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

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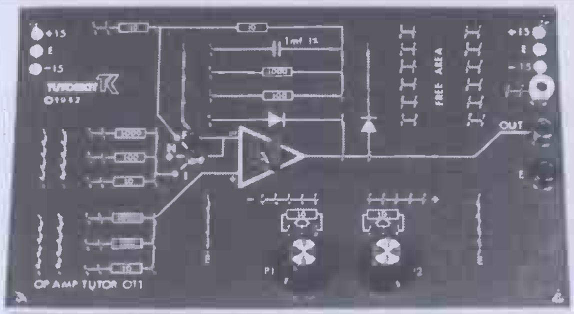

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74HCT367	0.25
74HCT373	0.59
74HCT374	0.38
74HCT390	0.45
74HCT393	0.39
74HCT533	0.43
74HCT541	0.44
74HCT640	0.80
74LS TTL SERIES	
74LS00	0.09
74LS01	0.09
74LS02	0.09
74LS11	0.15
74LS05	0.09
74LS08	0.09
74LS09	0.09
74LS20	0.09
74LS21	0.09
74LS30	0.09
74LS32	0.09
74LS51	0.09
74LS55	0.09
74LS73	0.18
74LS83	0.46

74LS92	0.26
74LS107	0.18
74LS109	0.30
74LS113	0.19
74LS114	0.25
74LS123	0.25
74LS125	0.20
74LS132	0.24
74LS138	0.19
74LS139	0.32
74LS148	0.39
74LS151	0.22
74LS162	0.26
74LS164	0.24
74LS168	0.54
74LS193	0.24
74LS196	0.33
74LS243	0.34
74LS279	0.09
74LS367	0.16
74LS368	0.18
74LS373	0.33
74LS374	0.38
TAICOM LOW PROFILE IC SOCKETS	
8 PIN SKTS	0.02
14 PIN SKTS	0.03
16 PIN SKTS	0.03
24 PIN SKTS	0.07
28 PIN SKTS	0.08
40 PIN SKTS	0.11
RECTIFIER DIODES	
1N4007	0.01
1N4001	0.01
1N5400	0.04
1N5402	0.05
1N5404	0.06
1N5406	0.07
1N5408	0.08
SIGNAL DIODES	
1N4148	0.01

MEMORY DEVICES	
4116 (THOM)	0.40
41464 (NEC)	2.56
6116 (HIT)	0.95
LINEAR DEVICES	
CA1352E	1.00
CA3130E	0.49
CA3018A	1.03
CA3018	0.62
CA3046E	0.37
CA3081E	0.33
CA3085	0.42
CA3088E	1.38
CA3089E	0.72
CA3090A	0.97
CA3094E	0.54
CA3141E	0.41
CA3146E	0.75
CA3160E	0.45
CA3189E	0.78
CA3140E	0.27
CA3240E	0.49
ICL7107	3.00
ICM7556	0.79
LF347	0.60
LF351	0.79
LF353	0.35
LF398N	2.00
LM2902	0.38
LM2907N	2.10
LM2917N	2.22
LM2917N-14	2.22
LM301AN	0.40
LM301AH	0.71
LM304H	2.60
LM305H	0.93
LM307H	1.06
LM307N	0.50
LM308AH	3.75
LM308AN	0.52
LM309K	1.52
LM310H	2.05
LM310N	1.33
LM311N	0.25

LM317HVK	5.50
LM317K	2.94
LM317T	0.62
LM317MP	0.67
LM319N	2.67
LM323K	3.15
LM324N	0.26
LM331N	2.94
LM337MP	0.94
LM339AN	1.25
LM339N	0.18
LM345K5.0	7.14
LM348N	0.71
LM358N	0.24
LM359N	1.35
LM360N	4.18
LM361N	2.40
LM377N	2.01
LM380N-16	0.90
LM380N8	0.90
LM383T	1.68
LM384N	1.78
LM386N1	0.67
LM3302N	0.76
LM3914N	2.30
LM3916N	2.00
LM748CH	0.26
LM318H	1.63
MC1408L	1.75
MC1408P	1.25
MC3357	1.02
MC3240	2.02
MC3423P	0.55
MC3441P	2.18
MC3446P	2.19
NE531N	0.97
NE544N	1.18
NE556N	0.44
NE558N	0.87
NE565N	0.69
NE570N	1.35
NE571N	1.18
NE572N	1.30
NE592N14	0.49
RC4558	0.33
SP0256AL2	3.75

SL490	1.52
STK8250	6.00
TBA120S	0.39
TCM5089	1.35
TDA1072	1.79
TDA2003	0.80
TDA2004	1.20
TDA2005	1.20
TDA2006	1.40
TDA4600	2.75
TLO71	0.38
TLO72	0.35
TLO74	0.60
TLO81	0.35
TLO82	0.34
UA739PC	1.90
ULN2803	0.90
Z80A CPU	0.88
Z80A CTC	1.50
Z80A DMA	4.26
Z80A PIO	1.26
Z80A SIO	3.50
ZN1034E	1.28
ZN1040E	4.90
ZN414N	0.55
ZN425E	2.75
ZN426E	1.48
ZN427E	4.83
ZN428E	3.68
ZN447N	5.65
ZN449E	1.99
ZN450E	4.20
LATEST ADDITIONS	
LM318H	1.63
LM393N	0.27
MC3487P	0.94
MC3486P	2.18
LM387N	1.33
MC3340P	1.29
VOLTAGE REGULATORS	
7805	0.14
7812	0.14

7808	0.26
7815	0.26
7905	0.26
7908	0.33
7912	0.22
7915	0.21
78T12CT	1.00
78L05	0.17
79L05	0.26
79L12	0.26
78L15	0.17
78L08	0.17
DISCRETE DEVICES	
BC107	0.06
BC108	0.06
BC109	0.06
BC140	0.30
BC109C	0.09
BC182B	0.02
BC182L	0.03
BC183L	0.05
BC184L	0.05
BC212	0.03
BC212L	0.05
BC213	0.02
BC213L	0.05
BC214L	0.06
BC237	0.03
BC238B	0.03
BC327	0.03
BC328	0.03
BC337	0.03
BC338	0.03
BC546	0.03
BC547C	0.03
BC548	0.02
BC549	0.03
BC550C	0.03
BC556	0.04
BC557	0.03
BC558	0.02
BC559	0.03
BC560B	0.03

TIC225M	0.42
TIC246D	1.16
TIP41A	0.24
2N706	0.14
2N3053	0.12
2N3819	0.19
2N5060	0.14
2N5061	0.15
2N5062	0.15
2N5064	0.16
2N2646	0.66
2N3704	0.06
2N3702	0.07
ZTX108	0.10
ZTX109	0.13
ZTX300	0.10
ZTX301	0.14
ZTX302	0.14
ZTX303	0.11
ZTX310	0.11
ZTX312	0.12
ZTX313	0.13
ZTX314	0.16
ZTX341	0.12
ZTX450	0.16
ZTX500	0.10
ZTX530	0.13
ZTX632	0.11
ZTX650	0.20
ZTX750	0.21
ZTX753	0.27
BD131	0.23
BD135	0.12
BD136	0.13
BD138	0.13
BD139	0.15
BCY71	0.19
BFX84	0.18
BFX85	0.38
BU806	0.60
BU807	0.55
C106D	0.22
MPSA06	0.09
MPSA13	0.09
MPSA42	0.12
MPSA64	0.14
TIC206D	0.35
TIC225D	0.42

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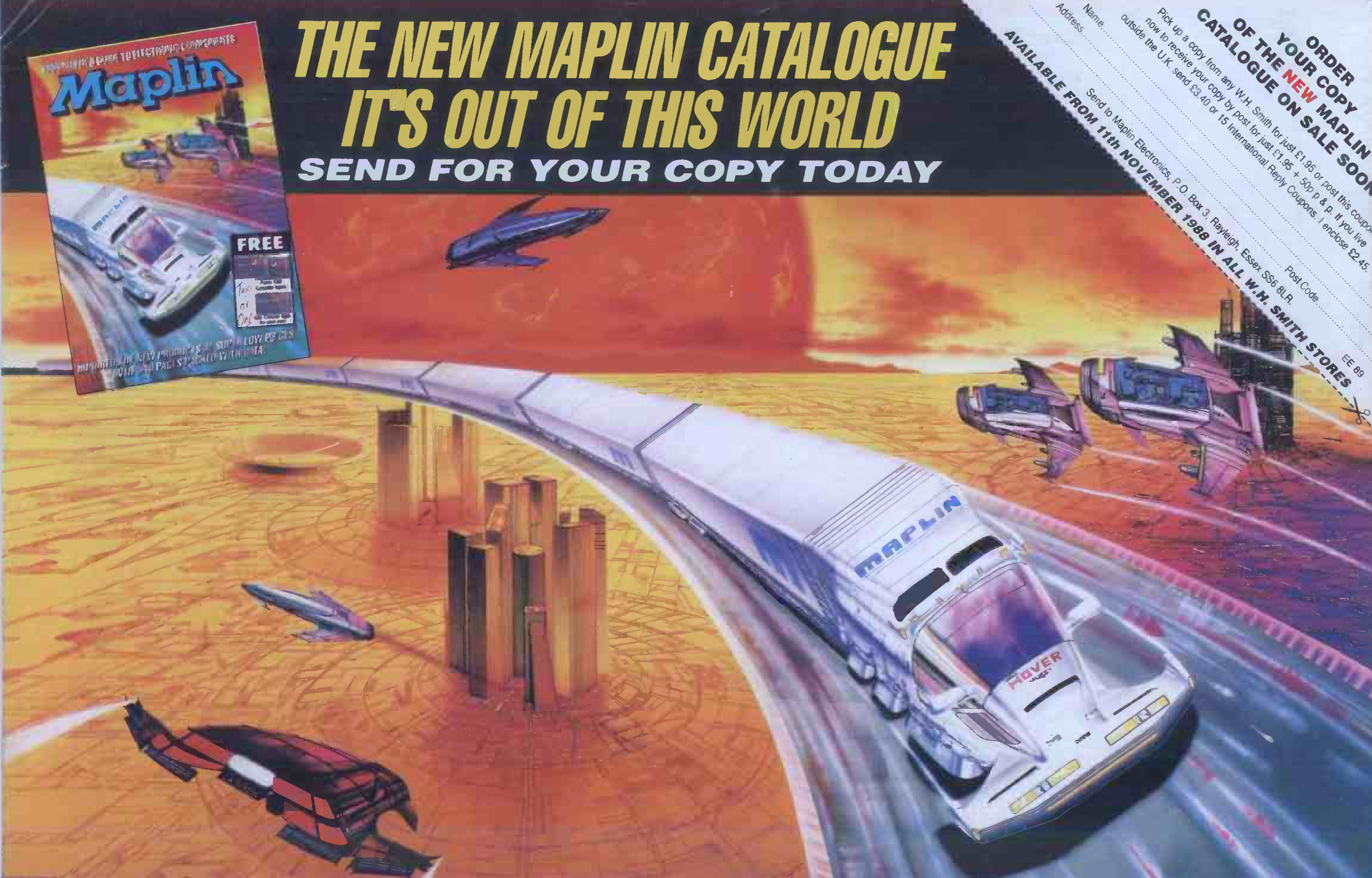

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