EVERYDAY ELECTRONICS

1-99 MARCH 1988

INCORPORATING ELECTRONICS MONTHLY £1.30

S.O.S. ALERT

AUTO-WAGGLE JOYSTICK

LIE-DETECTOR

SEMICONDUCTOR TESTER

FREE! 24 page Circuit Exchange Booklet & DATA CARD

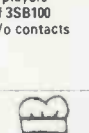
The Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

Price per pack is £1.00.* Order 12 you may choose another free. Items marked (sh) are not new but guaranteed ok.

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 3 flush electrical switches
4 – 4in flex line switches with neons
5 – 2 80 watt brass cased elements
6 – 2 mains transformers with 6V 1A secondaries
7 – 2 mains transformers with 12V ½A secondaries
8 – 1 extension speaker cabinet for 6½" speaker
9 – 5 octal bases for relays or valves
10 – 12 glass reed switches
11 – 4 OCP 70 photo transistors
12 – 4 tape heads, 2 record, 2 erase
13 – 1 ultrasonic transmitter and 1 ditto receiver
14 – 2 15000 mfd computer grade electrolytics
15 – 2 light dependent resistors
16 – 5 different micro switches
17 – 2 mains interference suppressors
18 – 2 25 watt crossover units 2 way
19 – 1 40 watt 3 way crossover unit
20 – 1 6 digit counter mains voltage
21 – 2 Nicad battery chargers
22 – 1 key switch with key
23 – 2 humidity switches
24 – 96 x 1 metre lengths colour-coded connecting wires
25 – 2 air spaced 2 gang tuning condensors
26 – 2 solid diaelectric 2 gang tuning condensors
27 – 10 compression trimmers
28 – 6 Rocker Switches 10 amp mains SPST
29 – 5 Rocker Switches 10 amp SPDT Centre Off
30 – 4 Rocker Switches 10 amp DPDT
31 – 1 24 hour time switch mains operated (s.h.)
32 – 1 6 hour clock timeswitch
33 – 2 6V operated reed switch relays
34 – 10 neon valves – make good night lights
35 – 2 x 12V DC or 24V AC, 4 CO relays
36 – 1 x 12V 2C O very sensitive relay
37 – 1 12V 4C relay
38 – 1 locking mechanism with 2 keys
39 – Miniature Uniselector with circuit for electric jigsaw
40 – 5 Dolls' House switches
41 – 5 ferrite rods 4" x 5/16" diameter aerials
42 – 4 ferrite slab aerials with L & M wave coils
43 – 4 200 ohm earpieces
44 – 1 Mullard thyristor trigger module
45 – 10 assorted knobs ¼ spindles
46 – 5 different themostats, mainly bi metal
47 – Magnetic brake – stops rotation instantly
48 – Low pressure 3 level switch
49 – 2 25 watt pots 8 ohm
50 – 2 25 watt pots 1000 ohm
51 – 4 wire wound pots – 18, 33, 50 and 100 ohm
52 – 4 3 watt wire wound pots 50 ohm
53 – 1 time reminder adjustable 1-60 mins
54 – 5.5 amp stud rectifiers 400V
55 – 1 mains shaded pole motor ¾" stack – ¼ shaft
56 – 25" ali fan blades fit ¼" shaft
57 – 23" plastic fan blades fit ¼" shaft
58 – Mains motor suitable for above blades
59 – 1 mains motor with gearbox 1 rev per 24 hours
60 – 2 mains motors with gearbox 16 rpm
61 – 4 11 pin moulded bases for relays
62 – 5 B7G valve bases
63 – 4 skirted B9A valve bases
64 – 1 thermostat for fridge
65 – 1 motorised stud switch (s.h.)
66 – 1 2½ hours delay switch
67 – 1 6v mains power supply unit
68 – 1 4½ V mains power supply unit
69 – 15 pin flex plug and panel socket
70 – 15" speaker size radio cabinet with handle
71 – 10¼" spindle type volume controls
72 – 10 slider type volume controls
73 – 1 heating pad 200 watts mains
74 – 1 1W amplifier Mullard 1172
75 – 1 Wall mounting thermostat 24V
76 – 1 Teak effect extension 5" speaker cabinet
77 – 2 p.c.b. with 2 amp full wave and 17 other recs
78 – 10 mtrs twin screened flex white p.v.c. outer
79 – 2 plastic boxes with windows, ideal for interrupted beam switch etc
80 – 3 varicap push button tuners with knobs
81 – 1 plastic box, sloping metal front, 16 x 95mm, average depth 45mm
82 – 1 car door speaker (very flat) 6½" 15 ohm made for Radiomobile
83 – 2 speakers' 6" x 4" 15 ohm 5 watt made for Radiomobile
84 – 2 mains transformer 9V ½A secondary split primary so OK also for 115V
85 – 1 mains transformers 15V 1A secondary p.c.b. mounting
86 – 2 6V 0.6V mains transformer .3a p.c.b. mounting
87 – 40 double pole leaf switches
88 – 1 7uf 660V 50hz metal cased condenser
89 – 2 2¼in 60 ohm loudspeakers
90 – 2 2¼in 8 ohm loudspeakers
91 – 1 mains operated relay with 2 sets c/o contacts
92 – 2 packets resin filler/sealer with cures
93 – 35A round 3 pin plugs will fit item 193
94 – 47 segment l.e.d. displays
95 – 4 pc boards for stripping, lots of valuable parts
96 – 13A double pole magnetic trip, saves repairing fuses
97 – 4 1000uf 25V axial electrolytic capacitors
98 – 1 Audax PM 8" speaker 15 ohm 5 watt rating
99 – 100 4BA 1½" cheesehead plated screws and 100 4BA nuts
100 – 1 pair stereo tape head as in cassette recorder/players
101 – 1 bridge rectifier 600V international rectifier ref 3SB100
102 – 2 battery operated relays (3-6v) each with 5A c/o contacts 2 pairs
103 – 2 lithium 3V batteries (everlasting shelf life)

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 leter

THIS MONTHS SNIP

3½ floppy Disk Drive, made by the Chinon Company of Japan. Beautifully made and probably the most compact device of its kind as it weighs only 600g and measures only 104mm wide, 162mm deep and has a height of only 32mm, other features are high precision head positioning – single push loading and eject – direct drive brushless motor – 500K per disc – Shugart compatible interface – standard connections – interchangeable with most other 3½ and 5¼ drives. Brand new with copy of makers manual. Offered this month at £28.50 post and VAT included.

CASE – adaptable for 3" or 3½" FDD, has room for power supply components price only £4 includes circuit of PSU. Our Ref 4P8.

POWER SUPPLY FOR FDD – 5V and 12V voltage regulated outputs, complete kit of parts will fit into case 4P8 price £8 or with case £11.

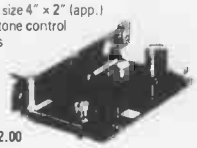
MULLARD UNILEX AMPLIFIERS

We are probably the only firm in the country with these now in stock. Although only four watts per channel, these give superb reproduction. We now offer the 4 Mullard modules – i.e. Mains power unit (EP9002) Pre amp module (EP9001) and two amplifier modules (EP9000) all for £6.00 plus £2 postage. For prices of modules bought separately see TWO POUNDERS.

CAR STARTER/CHARGER KIT

Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data case £17.50 post £2.

MINI MONO AMP on p.c.b. size 4" x 2" (app.)



Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or £13 for £12.00

LIGHT BOX

This when completed measures approximately 15" x 14". The light source is the Philips fluorescent 'W' tube. Above the light a sheet of fibreglass and through this should be sufficient light to enable you to follow the circuit on fibreglass PCBs. Price for the complete kit, that is the box, choke, starter, tube and switch, and fibreglass is £5 plus £2 post, order ref 5P69.

TANGENTIAL HEATERS

We again have very good stocks of these quiet runnng instant heat units. They require only a simple case, or could easily be fitted into the bottom of a kitchen unit or book case etc. At present we have stocks of 1.2kw, 2kw, 2.5kw, and 3kw. Prices are £5 each for the first 3, and £6.95 for the 3k. Add post £1.50 per heater if not collecting.
CONTROL SWITCH enabling full heat, half heat or cold blow, with connection diagram, 50p for 2kw, 75p for 3kw.

FANS & BLOWERS

5" £5 + £1.25 post. 6" £8 + £1.50 post
4" x 4" Muffin equipment cooling fan 115V £2.00
4" x 4" Muffin equipment cooling fan 230/240V £5.00
9" Extractor or blower 115V supplied with 230 to 115V adaptor £9.50 + £2 post.
All above are ex computers but guaranteed 12 months.
10" x 3" Tangential Blower. New. Very quiet – supplied with 230 to 115V adaptor on use two in series to give long blow £2.00 + £1.50 post or £4.00 + £2.00 post for two

9" MONITOR

Ideal to work with computer or video camera uses Philips black and white tube ref M24/306W. Which tube is implosion and X-Ray radiation protected. VDU is brand new and has a time base and EHT circuitry. Requires only a 16V dc supply to set it going. It's made up in a lacquered metal framework but has open sides so should be cased. The VDU comes complete with circuit diagram and has been line tested and has our six months guarantee. Offered at a lot less than some firms are asking for the tube alone, only £16 plus £5 post.

LOW COST OSCILLOSCOPE – kit to convert our 9" monitor into an oscilloscope with switched time bases to allow very high and very low frequency waveforms to be observed and measured. Signal amplitudes from as low as 10mV and as high as 1kV can easily be observed and measured. Ideal for servicing, also for investigating TV, radio and audio circuits.
Kit containing all the parts for the conversion and the power supply to operate from mains £25 our ref 25P3.

TELEPHONE LEAD

3 mtrs long terminating one end with new BT, flat plug and the other end with 4 correctly coloured coded wires to fit to phone or appliance. Replaces the lead on old phone making it suitable for new BT socket. Price £1 ref BD552 or 3 for £2 ref 2P164.

COMPACT FLOPPY DISC DRIVE EME-101

The EME-101 drives a 3" disc of the new standard which despite its small size provides a capacity of 500k per disc, which is equivalent to the 3½" and 5¼" discs. We supply the Operators Manual and other information showing how to use this with popular computers: BBC, Spectrum, Amstrad etc. All at a special snip price of £27.50 including post and VAT. Data available separately £2, refundable if you purchase the drive.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, shop, work room etc. Makes you feel better and work harder – a complete mains operated kit, case included. £11.50 + £3 P&P.

J & N BULL ELECTRICAL

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

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted. Brighton (0273) 734648 or 203500.

NEW ITEMS

Some of the many described in our current list which you will receive with your parcel.

SUPER WATER PUMP – Approx ⅓hp mains operated originally intended to operate a £300 shower unit at a controlled pressure – but of course suitable for many other water or liquid moving operations – where a good flow at a constant pressure is required – Price £25 each V.A.T. and Post Paid. Our Ref. 25P2.

VERY USEFUL MULTI TESTERS – These have all usual ranges AC & DC volts – DC MA and OHMS etc but an unusual and very useful feature is a "low OHMS" range. Very useful for checking dry joints etc. They are ex G.P.O., and may have faults but we test and guarantee the movement to be O.K. Price £3 each. Ref. 3P30.

AGAIN AVAILABLE – 12" mini fluorescent tubes – Price £1 each. Ref. BD314.

POWER PACK OR AMPLIFIER CASE – Size approx 10" x 8¼" x 4¾" plated steel – with ample perforations for cooling. Front panel has on/off switch and E.E.C. mains inlet plug with built in RF filter – undoubtedly a very fine case which would cost at least £50 from regular sources, our price is £5 each and £3 post. Ref. 5P111.

MINIATURE BCD THUMB WHEEL SWITCH – Matt black edge switch engraved white on black – gold plated, make before break contats – size approx. 25mm high 8mm wide 20mm deep – made by the famous Cherry Company and designed for easy stacking – Price £1 each. Ref. BD601.

EDGE METER – miniature, whole size approx 37mm x 13mm 100 ua fsd – centre zero scaled 0 to – 10 and 0 to + 10. Price £1 each. Ref. BD602.

LARGE 2 SPEED MOTOR – 1 hp at 2500 rpm and ¼hp at 200rpm – continental make, intended originally to power an industrial machine – regular price over £60, our Price £15 plus £5 carriage. Ref 15P5.

RUBBER FEET – Stick on – ideal for small instruments and cabinets – pack of 56 for £1. Ref. BD603.

CLEANING FLUID – Extra good quality – intended for video and tape heads – regular price £1.50 per spray can – our Price – 2 cans for £1. Ref. BD 604.

DON'T FREEZE UP! – We have had the strongest winds for over 200 years and who knows we may be in for the coldest winter, so if you have not already protected your water pipes you should do so now – our heating wire wound around the pipes will do this and will cost only about 50p per week to run – 15 metres (minimum length to connect to 230/240 v mains). Price £5. Our Ref. 5P 109.

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 it is ideal for computer and instrument cooling. Price is only £1 each. Ref BD605.

SPRING LOADED TEST PRODS – heavy duty, made by the famous Bulgin company. Very good quality. Price four for £1. Ref. BD599.

CURLY LEAD four core, standard replacement for telephone handset, extends to nearly two metres. Price £1 each. Ref. BD599.

TELEPHONE BELLS – these will work off our standard mains through a transformer, but to sound exactly like a telephone, they then must be fed with 25 hz 50v. So with these bells we give a circuit for a suitable power supply. Price 2 bells for £1. Ref. BD600.

ULTRA SENSITIVE POCKET MULTIMETER – 4k ohms per volt – 11 ranges – carry one of these and so be always ready to test ac/dc volts to 1000, DC milliams and have an ohms range for circuit testing – will earn its cost in no time. Price only £7. Ref. 7P2.

BLOW YOUR ROOF OFF 140 watt speaker systems – new type you must not hide! they have golden cones and golden surrounds and look really "Bootiful" 12" Woofer, Midrange and Tweeter and comes with a crossover at a special introductory price of £49, carriage paid. Two sets for £95 carriage paid. 140w Woofer only £35 carriage paid.

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.

COMPUTERS

Big consignment of computers expected in mid Jan, various makes and numbers, write or phone for details.

NOVEL NIGHT LIGHT – plugs into a 13A socket. Gives out a surprising amount of light, certainly enough to navigate along passages at night or to keep a nervous child happy. Very low consumption, probably not enough to move the meter. Price £1. Ref. BD563.

CASE WITH 13A PRONGS – to go into 13A socket, nice size and suitable for plenty of projects such as car battery trickie charger, speed controller, time switch, night light, noise suppressor, dimmers etc. Price – 2 for £1. Ref. BD565

SPEAKER EXTENSION CABLE – twin 0.7mm conductors so you can have long runs with minimum sound loss and for telephone extensions or burglar alarms, bells, intercoms etc. 250m coil only £3 plus £1 post. Ref. 3P28.

ALPHA-NUMERIC KEYBOARD – this keyboard has 73 keys with contactless capacitance switches giving long trouble free life and no contact bounce. The keys are arranged in two groups, the main area field 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.

TELEPHONE EXTENSIONS – it is now legal for you to undertake the wiring of telephone extensions. For this we can supply 4 core telephone cable, 100m coil £8.50. Extension BT sockets £2.95. Packet of 500 plastic headed staples £2. Dual adaptor for taking two appliances from one socket £3.95. Leads with B.T. plug for changing old phones. 3 for £2.

MODULAR SWITCH – Panel mounting highest quality and ideal where extra special front panel appearance is required, can be illuminated if required d.p.d.t. and latching. Price – 2 for £1. Ref. BD607.

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

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

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

TRANSMITTER SURVEILLANCE (BUG) – tiny, easily hidden, but which will enable conversation to be picked up with FM radio. Can be housed in a matchbox, all electronic parts and circuit. Price £2. Ref. 2P52.

VOL 17 No. 3 MARCH '88

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

ABC

The Magazine for Electronic & Computer Projects

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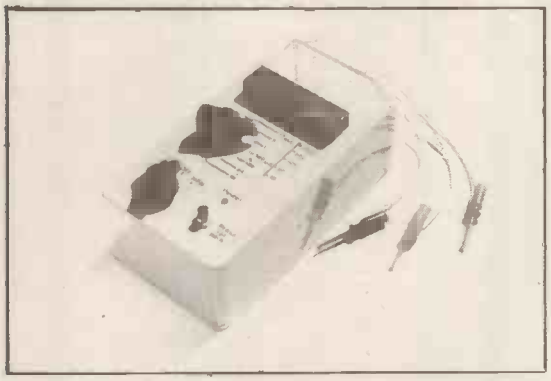
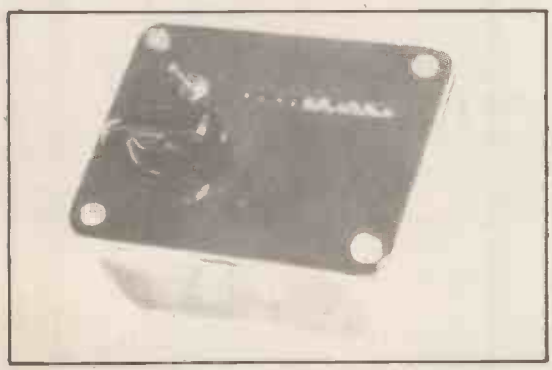
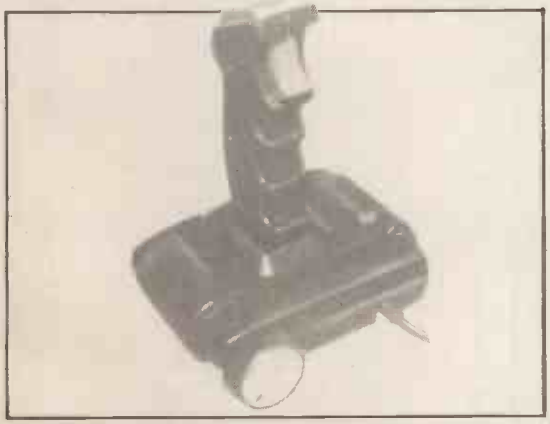
COMMENT . . . POPULAR FEATURES . . .







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FREE
24-page CIRCUIT EXCHANGE BOOKLET
DATA CARD

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BI-PAK BARGAINS

THE UNDISPUTED PACK KING FOR OVER 20 YEARS, we offer you the very best in Electronic Components and Semiconductors that your money can buy. Look at our lists and prices, they are unbeatable in value and quantity and you always have our "Satisfaction or money back guarantee". For 1988 we offer more and more Super Value Packs. All goods advertised in stock at time of going to press. Please note our new mail order address: BI-PAK, PO BOX 33, ROYSTON, HERTS SG8 5DF. Telephone orders: 0763-48851.

RESISTORS

Pak No	Qty	Description	Price
VP1	300	Assorted Resistors, mixed values & types	£1.00
VP2	300	Carbon Resistors, ¼-½ watt, pre formed, mixed	£1.00
VP4	200	½-1 watt Resistors, mixed values and types	£1.00
VP16	50	Wirewound Resistors, mixed watt values	£1.00
VP140	50	Precision Resistors, 1% tolerance	£1.00
VP181	100	1 and 2 watt Resistors, assorted values	£1.00
VP287	100	Close tolerance Resistors, .05-2%, 10-910 ohms, mixed	£1.50
VP288	100	Close tolerance Resistors, .05-2%, 1K-820K, mixed	£1.50
VP289	100	Metal oxide high stab. Resistors, ¼w 2%, mixed values	£1.50

CAPACITORS

VP5	200	Assorted Capacitors, all types	£1.00
VP6	200	Ceramic Capacitors, Min. mixed values	£1.00
VP9	100	Assorted Polyester/Polystyrene Capacitors	£1.00
VP10	50	C280 Capacitors, metal foil, mixed values	£1.00
VP11	50	Electrolytics, all sorts	£1.00
VP12	40	Electrolytics, 0.47mf-150mf, mixed volts	£1.00
VP13	30	Electrolytics, 150mf-1000mf, mixed volts	£1.00
VP14	50	Silver Mica Caps, mixed values	£1.00
VP15	25	.01/250v Min. Layer Metal Caps	£1.00
VP180	25	Tantalum Bead Caps, assorted values	£1.00
VP182	4	1000uf 50v Electrolytics	£1.00
VP192	30	Min. Electrolytics, mixed values, 0.47mf-1000mf 8/16v	£1.00
VP193	6	Sub Min. Electrolytics, 2 x 1000/2200/3300mf 10/16v	£1.00

OPTOS

VP24	10	.125" clear showing Red LEDs	£1.00
VP25	10	Mixed shape and colour LEDs	£1.00
VP26	15	Small .125" Red LEDs	£1.00
VP27	15	Large .2" Red LEDs	£1.00
VP28	10	Rectangular .2" Red LEDs	£1.00
VP57	25	Opto special pack. Assorted. Super Value	£3.00
VP130	6	RED 7 Seg. CC 14mm x 7.5mm RDP FND353 LED Display	£2.00
VP131	4	GREEN 7 Seg. CA .6" LDP XAN6820 LED Display	£2.00
VP133	6	RED Overflow .6" 3 x CA 3 x CC 6630/50 LED Display	£2.00
VP134	5	GREEN Overflow .6" CA XAN6530 LED Display	£2.00
VP138	20	Assorted LED Displays. Our mix, with data	£5.00
VP147	1	Pair Opto Coupled Modules	£0.80
VP199	4	LD707R LED Displays CA	£1.00
VP203	15	Triangular shape LEDs. Mixed colours	£1.00
VP204	10	Large Green LEDs, 5mm	£1.00
VP205	10	Small Green LEDs, 3mm	£1.00
VP208	10	Large Yellow LEDs, 5mm	£1.00
VP207	10	Small Yellow LEDs, 3mm	£1.00
VP208	10	Large LEDs clear showing Red, .2"	£1.50
VP241	2	ORP12 Light Dependent Resistor	£1.50
VP242	4	Tri-colour LEDs, 5mm Dia. 5mA 2v R.G.Y.	£1.00
VP243	3	Tri-colour LEDs. Rectangular 5mm R.G.Y.	£1.00
VP266	10	Orange LED's, 5mm large	£1.00
VP267	8	Stackable LED's, Rectangular, mixed, R.G.Y.	£1.00
VP268	15	LED Panel Mounting Clips, metal and plastic, 3-5mm	£1.00
VP269	2	Red Flashing LED's, 5mm	£1.00
VP284	2	Opto-Isolator IL74-4N27, single	£1.00
VP285	1	Dual Opton-Isolator ILD74	£1.00

DIODES AND SCRS

VP29	30	Assorted volt Zeners. 50mw - 2w	£1.00
VP30	10	Assorted volt Zeners. 10w, coded	£1.00
VP31	10	5A SCRs TO66, 50-400v, coded	£1.00
VP32	20	3A SCRs TO66, up to 400v, uncoded	£1.00
VP33	100	Sil. Diodes like IN4148	£1.00
VP34	200	Sil. Diodes like 0A200/BAX13-16, 40v 200mA	£1.00
VP35	50	1A IN4000 Diodes, all good, uncoded 50v min	£1.00
VP49	30	Assorted Sil. Rectifiers, 1A-10A, mixed volts	£1.00
VP143	40	IN4002 Sil. Rectifiers. 1A 100v, preformed pitch	£1.00
VP142	4	40A Power Rectifiers, silicon, TO48 300 PIV	£1.00
VP143	5	BY187 12kv Sil. Diodes, in carriers, 2.5MA	£1.00
VP184	3	4A 400v Triacs, plastic	£1.00
VP187	10	SCRs 800MA, 200v, 2N5064, plastic, T092	£1.00
VP194	50	OA91 point contact germ. Diodes, uncoded	£1.00
VP195	50	OA47 gold bonded germ. Diodes, uncoded	£1.00
VP196	50	OA70-79 detector germ. Diodes	£1.00
VP197	50	OA90 type germ. Diode, uncoded	£1.00
VP198	40	BA248 Sil. Diodes, 350v 2A, fast recovery	£1.00
VP222	20	3A Stud Rectifiers, 50-400v Assorted	£1.00
VP274	12	SCR's (Thyristors) 1A 100-400v, TO-39	£1.00
VP275	3	5A 400v SCR's, TO220, T1C106D	£1.00
VP276	5	SCR's standard type, 5-16Amp to 400v	£1.00
VP277	4	Triacs 2Amp 400v TO-39	£1.00
VP278	4	6Amp 1000v plastic Silicon Rectifiers	£1.00
VP283	5	Diac BR100, triac trigger	£1.00

TRANSISTORS

VP38	100	Sil. Trans. NPN plastic, coded, with data	£3.00
VP39	100	Sil. Trans. PNP plastic, coded, with data	£3.00
VP47	10	Sil. Power Trans. similar 2N3055, uncoded	£1.00
VP48	5	Pairs NPN/PNP plastic Power Trans. 4A, data	£1.00
VP50	60	NPN Sil. Switching Trans. T0-18 and T0-92	£1.00
VP51	60	PNP Sil. Switching Trans. T0-18 and T0-92	£1.00
VP60	100	All sorts Transistors, NPN/PNP	£1.00
VP150	20	BC183B Sil. Trans. NPN 30v 200mA Hfe240 + T092	£1.00
VP151	25	BC171B Sil. Trans. NPN 45v 100mA Hfe240 + T092	£1.00
VP152	15	TIS98 Sil. Trans. NPN 40v 400mA Hfe100 + T092	£1.00
VP153	15	TIS91 Sil. Trans. PNP 40v 400mA Hfe100 + T092	£1.00
VP154	15	MPSA56 Sil. Trans. PNP 80v 800mA Hfe50 + T092	£1.00
VP155	20	BF596 Sil. Trans. NPN eqvt BF184 H.F. T092	£1.00
VP156	20	BF495 Sil. Trans. NPN eqvt BG173 H.F. T092	£1.00
VP157	15	ZTX500 series Sil. Trans. PNP plastic	£1.00
VP158	15	ZTX107 Sil. Trans. NPN eqvt BC107 plastic	£1.00
VP159	15	ZTX108 Sil. Trans. NPN eqvt BC108 plastic	£1.00
VP161	25	BC183L Sil. Trans. NPN 30v 200mA T092	£1.00
VP162	5	SJE5451 Sil. Power Trans. NPN 80v 4A Hfe20 +	£1.00
VP163	2	NPN/PNP pairs Sil. Power Trans. like SJE5451	£1.00
VP164	4	2N6289 Sil. Power Trans. NPN 40v 40w 7A Hfe30 +	£1.00
VP165	6	BFT33 NPN Sil. Trans. 80v 5A Hfe50-200 T039	£1.00
VP166	5	BFT34 NPN Sil. Trans. 100v 5A Hfe50-200 T039	£1.00
VP167	1	BUY69C NPN Trans. T03 VCE 500, 10A, 100w, Hfe15 +	£3.00
VP168	10	BC478 eqvt BCY71 PNP Sil. Trans. TO18	£1.00
VP169	10	BX521 eqvt BC394 NPN Sil. Trans. 80v 50mA TO18	£1.00
VP170	10	Assorted Power Trans. NPN/PNP coded and data	£1.00
VP171	10	BF355 NPN TO-39 Sil. Trans. eqvt BF258 Z25v 100mA	£1.00
VP172	10	SM1502 PNP TO-39 Sil. Trans. 100v 100mA Hfe100 +	£1.00
VP200	30	OC71 type germ. AF Transistors, uncoded	£1.00
VP201	25	OC45 germ. RF Transistors	£1.00

TRANSISTORS (cont.)

Pak No	Qty	Description	Price
VP261	4	Programmable Unijunction Transistors, MEU22	£1.00
VP270	10	FET's UHF/VHF Amplifiers, switching & choppers, data	£1.00
VP271	10	FET's general purpose like 2N3819-2N5457, data	£1.00
VP272	10	MOS-FET's Signetics, SD304	£1.00
VP280	12	ZTX300 NPN Silicon Transistors	£1.00
VP290	15	MPSA06 Sil. Transistors. NPN 80v 500mA HFE50 + T092	£1.00
VP428	10	AC128K PNP Germanium Transistor, 1A 32v	£1.00
VP429	10	AC176K NPN Germanium Transistors. 1A 32v	£1.00
VP430	4	2N3055 Sil. Power Transistors, full spec	£2.00
VP431	25	PNP Sil. Transistors, T0-39 like 2N2905A	£1.00

I.C.S.

VP40	40	TTL I.C.s all new gates – Flip Flop – MSI. Data	£4.00
VP54	20	Assorted I.C. DIL Sockets, 8 – 40 pin	£2.50
VP59	20	Assorted I.C.s linear, etc. all coded	£2.00
VP209	12	74LS00	£2.00
VP210	12	74LS74	£2.00
VP211	10	CD4001B	£2.00
VP212	10	CD4011B	£2.00
VP214	10	CD4069B	£2.00
VP215	10	741P 8 pin	£2.00
VP216	10	555 Timers 8 pin	£2.00
VP223	50	Asst 74 TTL I.C.s "ALL GATES" new and coded our mix 7400-7453	£8.00
VP224	100	Asst 74 TTL I.C.s "ALL GATES" new and coded our mix 7400-7453	£10.00
VP282	1	Prog. Sil Gen. Chip, AY 3-8912	£3.00
VP291	1	Z80ACPU Microprocessor, 40 pin DIL	£2.00
VP292	1	Z80AP10 Parallel Interface Controller, 40 pin DIL	£2.00
VP293	1	Z80ACTC Counter Timer Circuit, 28 pin DIL	£2.00
VP294	1	Z732D 32K Eprom	£3.00
VP295	1	6821P Peripheral Interface Adaptor (PIA)	£1.50
VP296	6	LM324 14 pin DIL Quad Op-Amp	£2.00
VP297	6	CA3130E MOS-FET I/P, CMOS O/P, Op-Amp	£2.00
VP298	3	MC1310P Stereo Decoder, 14 pin DIL	£2.00
VP299	3	CA3085 Pos. Volt. Regulator, 1.7v-46v, 8 pin TO5	£2.00
VP400	1	Z7128 128K Eprom	£2.50
VP401	2	LM317T Adjst. Voltage Regulator, 1.5A	£1.00
VP402	1	2114 4K Static Ram	£2.00
VP403	1	TA7204 Audio Amp I.C. 4.2w, 12v, 2-4 ohms	£1.00
VP404	1	TBA681 Audio Power Amp, 4.5w	£1.50
VP432	8	CD4016B	£2.00
VP433	6	CD4017B	£2.00
VP434	10	CD4024B	£2.00
VP436	10	CD4028B	£2.00
VP7413	4	7413 Dual Nand Schmitt Trigger, 4 input	£1.00
VP7440	4	7440 Dual 4-input, Positive-Nand Buffer	£1.00
VP7470	4	7470 And-gated Positive-edge-triggered Flip-Flop with preset	£1.00
VP7480	4	7480 Gated full Adder	£1.00
VP7481	4	7481 16-bit Random Access memories	£1.00
VP7490	4	7490 Decade Counter	£1.00
VP7491	4	7491 8 Bit Shift Register	£1.00
VP7492	4	7492 Divide by 12 Counter	£1.00
VP7493	4	7493 4-bit Binary Counter	£1.00
VP7494	4	7494 4-bit Shift Register	£1.00
VP7495	4	7495 4-bit Shift Register	£1.00
VP74111	4	74111 Dual J-K Master Slave, Flip-Flop	£1.00
VP74141	4	74141 BCD – Decimal Decoder/Driver	£1.00
VP74151	4	74151 1 of 8 Data Selectors/Multiplexers	£1.00
VP74153	4	74153 Dual 4 line to 1 line Data Selectors/Multiplexers	£1.00
VP74164	4	74164 8-bit Parallel Output Serial Shift Registers	£1.00
VP74167	4	74167 Synchronous Decade Rate Multipliers	£1.00
VP74174	4	74174 Hex D type Flip-Flops	£1.00
VP74181	4	74181 Arithmetic Logic Units/Function Generators	£1.00
VP74193	4	74193 Synchronous Up/Down Dual Clock Counters. Binary Clear	£1.00
VP74279	4	74279 Quad S-R Latches	£1.00
BPX6	1	TTL Data Book 74 Series, including "LS". Complete with Pin out diagrams. 7400-74670. TTI interchangeability guide. Function selection guide and explanation of function tables. "NO VAT".	£1.00
BPX5	1	IC555 PROJECTS BOOK (TIMER). 167 pages. Over 50 project circuits to build and other information on IC555 Timers. Plus FREE with our compliments, 3 x IC 555 Timer, worth 80p. "NO VAT". Special offer price just	£2.95
BPX4	1	INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE, Babani Publishing's latest edition BP85, plus FREE with our compliments, 10 popular Silicon Transistors, worth £1.00. "NO VAT". Special offer price just	£3.50

MISC.

VP17	50	Metres PVC single strand Wire, mixed colours	£1.00
VP18	30	Metres PVC multi strand Wire, mixed colours	£1.00
VP19	40	Metres PVC single/multi strand Wire, mixed colours	£1.00
VP22	200	Sq. Inches total copper clad board	£1.00
VP23	10	40mm track slider pots 100K Lin	£1.00
VP42	10	Black heatsinks, fit TO3 and TO220, drilled	£1.00
VP43	4	Power-fin heatsinks, 2 x TO3, 2 x TO66	£1.00
VP44	15	Assorted heatsinks, TO1/3/5/18/220	£1.00
VP56	100	Semiconductors from around the world, mixed	£4.00
VP82	1	Electronic Buzzer, 3v, 25MA	£0.95
VP83	1	Electronic Buzzer, 6v, 25MA	£0.95
VP84	1	Electronic Buzzer, 9v, 25MA	£0.95
VP85	1	Electronic Buzzer, 12v, 25MA	£0.95
VP86	1	TECASBDTY Components Pack, semiconductors, caps, wire, etc	£8.00
VP87	1	Telephone pick-up coil with 3.5mm jack plug	£1.25
VP88	1	Pillow Speaker with 3.5mm jack plug	£1.45
VP107	1	Piezo Buzzer, minieture, 12v	£1.25
VP108	1	Piezo Buzzer, miniature, 240v	£1.25
VP113	1	Coax Antenna Switch, 2 way	£4.50
VP114	1	Coax Antenna Switch, 3 way	£4.75
VP115	1	High Pass Filter/Suppressor CB/TV	£0.50
VP116	1	Low Pass Filter, VHS/TV Band	£3.00
VP122	1	Precision Morse Key, fully adjustable	£1.95
VP144	4	100K Lin multi turn Pots, ideal vari cap tuning	£1.00
VP145	10	Assorted Pots, inc, dual and switched types	£1.00
VP148	30	Presets, horizontal and vertical, mixed values	£1.00
VP174	5	DIL Switches, 1 and 2 way slide, 6 way SPST, assorted	£1.00
VP176	30	Fuses, 20mm and 1¼" glass, assorted values	£1.00

MISC. (cont.)

Pak No	Qty	Description	Price
VP177	1	Pack assorted Hardware, nuts, bolts, etc	£1.00
VP178	5	Assorted Battery holders and clips PP3/9, AA/D, etc	£1.00
VP223A	6	Tag Boards, 18 way paxaline	£1.00
VP225	20	DIN Plugs, plastic 2-8 pin, 180°/240°/360° mixed	£2.50
VP226	20	DIN Chassis Skts, metal 2-8 pin 180°/240°/360° mixed	£2.50
VP227	18	DIN In-line Skts, plastic 2-8 pin 180°/240°/360° mixed	£2.50
VP228	10	C15 Computer Cassette Tapes, leadless	£3.00
VP232	1	Cassette Head Cleaner/Demagnetizer, in case	£2.00
VP233	1	Revolving Cassette Rack, holds 32, smokey perspex	£2.50
VP244	1	High Power Piezo Electric Siren, Emits earpiercing warbling sound. Ideal alarm. White plastic body with mounting bracket. Power 12vDC 150mA. Output 100db (A) at 1m typ. freq. 2.5KHz. Size: 57 x 42 x 37mm	£6.00
VP260	1	9" x 6" Elliptical 8 ohms 10W RMS Speaker. Freq. Res 60-10000 Hz. Gauss 10000. Centre HF cone	£4.50
VP260A	1	2¼" Transducer Waterproof Speaker, Polyester film diaphragm. Moisture res. 8 ohms 300mW Freq. Res. 20-20000 Hz	£1.00
VP273	10	10K Lin Rotary Potentiometers, slim spindle	£1.00
VP281	4	Plug-in Relays. Mixed volts, etc	£1.00

TOOLS

VP95	1	Plastic Vice, small, with suction base	£1.75
VP97	1	Logic Probe/Tester, supply 4.5v – 18v, DTL, TTL, CMOS	£9.50
VP99	1	Universal Tester, with ceramic buzzer	£5.00
VP103	1	6 pc Stanley screwdriver set, flat and crosspoint	£3.50
VP139	1	Pick-up Tool, spring loaded	£1.75
VP217	1	Helping Hand	£4.00
VP218	1	Watchmakers Screwdriver Set, 6 pieces	£1.75
VP219	1	Miniature Side Cutters	£1.55
VP220	1	Miniature Bent-nose Pliers	£1.55
VP221	1	Miniature Long-nose Pliers	£1.55
VP227	1	Universal Ni-Cad Battery Charger. AA-HP11-HP2-PP3	£8.00
VP238	4	AA Ni-Cad Batteries. 1.25v 500mAh C/R mA	£4.00
VP239	2	C7HP11 Ni-Cad Batteries. Rechargeable	£3.50
VP240	2	D-HP2 Ni-Cad Batteries. Rechargeable	£4.00
VP246	1	25w Quality Low Cost Soldering Iron. 240vAC	£3.50
VP247	1	15w "Lightweight" Quality Low Cost Soldering Iron. 240vAC	£3.50
VP248	1	High Suction Desoldering Pump. Teflon nozzle. Auto eject. Heavy duty return spring.	£4.00
VP250	1	Long Finger Grip. Soldering Aid. Heavy metal use. Serrated jaws with rev. Tweezer action. Ideal for holding small components. Fully adjustable.	£3.00
VP254	1	250 grams Etchant Granules (Ferric Chloride) makes ½ pint	£1.00
VP255	1	Etching Pen. Etch resistant. Spare tip. Blue	£1.00
VP258	1	Multicore Solder. 5m total. 10 and 22 SWG	£1.00
VP259	1	PCB Holder. Fully adjustable from 0-320mm wide and to any angle. Complete with iron stand and sponge. Strong metal construction with rubber feet. Very high quality	£15.00
VP286	2	Etch Resist PCB Transfer Sheets. Asst. symbols/lines	£1.00
VP405	2	Steel Rules 1 x 4", 1 x 10", measuring ins and mm	£1.00
VP406	1	Junior Hacksaw & 3 blades + hobby knife & 2 blades	£1.00
VP407	1	10 Piece Needle File Set	£3.00
VP408	1	4 Piece Stainless Steel Tweezer Set	£4.00
VP409	1	Set of 4 min. low cost Side & End Cutters, snipe & combination Pliers, 5" Insul. handles	£4.50
VP410	1	18 Pc Hex Wrench Keys. AF sizes in wallet	£1.50
VP411	1	16 Pc Hex Key Wrench Set. SAE and Metric	£2.00
VP412	1	Crimping Pliers. Wire Strippers & Bolt Cutters	£1.00
VP413	2	IC Extraction Tools, jaw width 18 and 25mm	£2.00
VP414	1	End Action Stripping Pliers. Adjustable jaws	£1.00
VP415	1	5" Grip Locking Pliers	£3.00
VP416	1	6" Long Nose Grip Locking Pliers	£3.00
VP417	1	6" Adjustable Wrench. Forged alloy steel	£2.50
VP418	1	8" Tin Snips. Hardened steel, spring joint	£2.00
VP419	2	"Chubby" Screwdrivers. Crosspoint No 1 and 2	£1.50
VP420	2	"Chubby" Screwdrivers. Flat blade 4.5 and 6mm	£1.50
VP421	1	Screwdriver 400mm long, 6mm flat blade	£3.00
VP422	1	Screwdriver 400mm long, No 2 crosspoint	£3.00
VP423	1	Vernier Caliper-Crosshorns. Depth gauge. Vernier Cap. 4¾" / 110mm reading 1/128" - 1/10mm	£2.50
VP424	1	Helping Hand with Magnifier	£4.50
VP425	1	7 Pc high quality Screwdriver Set	£9.50
VP426	1	7 Pc high quality Screwdriver Set 1000v	£12.50
VP427	1	6 Pc Cushion Grip Screwdriver Set	£4.00

LEADS

VP300	1	10m Speaker Lead 2 pin DIN Plug to 2 pin DIN Skt	£1.00
VP301	1	2m Video Lead Coaxial Skt to Coaxial Skt + 2 adaptors	£1.20
VP302	1	3m 4 core cable indv. screened 5 pin DIN Plug 5 pin DIN Plug	£1.80
VP303	1	TV Ext. Lead. Coax plug to Coax Plug. White	£1.00
VP304	1	1.5m 6 core indv. screen, 5 pin DIN Plug – tinned open end	£1.00
VP305	1	1.5m cable 5 pin DIN Plug – 3.5mm Jack Plug. Pin 1 & 4 connect	£1.00
VP306	1	2m Typewriter/Calculator Lead. 3 pin Plug, angled European IEC configuration	£2.00
VP307	1	60cm Patch Lead, PL259 Plug to PL259 Plug	£1.00
VP308	1	1.2m Patch Lead, PL259 Plug to PL259 Plug	£1.50
VP309	1	1.2m Lead 4 Phono Plugs to 4 Phono Plugs	£1.50
VP310	1	20cm Lead 2 x 2 pin DIN Plug to Stereo Inline Jack Skt	£1.00
VP311	1	2m Lead Scart Plug to 5 pin DIN Plug & 2 BNC Plugs	£3.00
VP312	1	1.2m Video Lead, BNC Plug to Phono Plug	£1.50
VP313	1	3m Headphone Lead, 3.5mm Jack Plug to 3.5mm Jack Skt	£1.00
VP314	1	2m Coax Lead BNC Plug to BNC Plug, 75 ohms	£3.00
VP315	1	2m Coax Lead BNC Plug to UHF Plug, 75 ohms	£3.00

TELEPHONE ACCESSORIES

VP316	1	5m Telephone Ext. Lead. Plug to Socket	£4.50
VP317	1	10m Telephone Ext. Lead. Plug to Socket	£6.00
VP318	1	3m Line Jack Cord. BT 4 way Plug to 4 Spade Terminals	£1.75
VP319	1	Double Adaptor. One IDC plug, 2 socket	£3.50
VP320	1	IDC Telephone Plug 4 way	£0.50
VP321	1	Telephone Master Socket Surface Box. Screw terminals	£3.50
VP322	1	Telephone Slave Socket Surface Box. Screw terminals	£2.25

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Neg. 1 Amp 7905-12-15-18-24 ..... 40p each
Pos. 100mA 78L05-12-15-18-24 ..... 28p each
Neg. 100mA 79L05-12-15-18-24 ..... 30p each

VPS30 REGULATED VARIABLE STABILISED POWER SUPPLY MODULE
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A 16 page supplement combining Bargain Lists 33-35 plus the 50% off supplement, with prices further reduced to 66% off!! It's FREE—send large SAE for your copy now!

COMPASSES
Z314 Precision spring bow 88mm long. Max dia 70mm. Replaceable pencil lead and steel tip. **£1.00**

VC1400 VIDEO COMPUTER.
Z816 Games machine that used cartridges (none available). Main console contains UHF modulator + various chips. PSU has mains input, 15V 0.16A and 8V 1.22A output. 2 hand held controllers each with joystick and 14 button keypad. All in original box. Note: These are returns, and may be faulty. **£12.50**

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Z003 Potted unit 60×45×30 has screw term i/p for mains, 20mm fuseholder & o/p tags for appliance **99p**

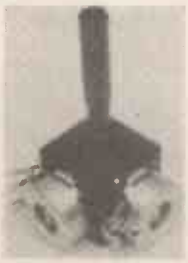
VIEWDATA LTU
Z697 Interface Panel 166×150 with 3×LM324, LM339, LM393, 4066, 11 transistors, 3 reed relays, etc. 3m lead with BT plug attached. Supplied with comprehensive data and ccts. **£2.90**

REED SWITCHES
K569 A selection of about 15 types from 12 to 50mm long, mostly form A, few form C. Pack of 30 **£2.75**
Z797 Min 15.3mm long. **20/£1.50; 100/£6; 250/£12**
Z798 Large 50.8mm long **10/£1.50; 25/£3; 100/£10**
Z799 Changeover 40mm long. **5/£1.50; 25/£6; 100/£20**

TOOLS
Scoop purchase of high quality surgical instruments ideal for electronics use.
Z308 5" lightweight long nose pliers **99p**
Z309 5½" as above but with ratchet. This enables pliers to be locked together – for holding small components, or as heat shunts etc. **£1.20**

Other types on Bargain List 36

ENTERPRISE PANELS
Z658 PCB 325×158 with 64K of RAM (8×4864). Z80A microprocessor, 21 other chips, UHF modulator, speaker etc. ROM and Nick and/or Dave chips missing, supplied with cct and data **£8.00**



Z004 Skeleton Joystick, switch type. Good quality, made by AB. Brass spindle has 44mm long black plastic handle attached. Body has 4 mounting holes. These really are a fantastic bargain!!

SWITCHED MODE PSU
Astec type AA7271. PCB 50×50mm has 6 transistor cct providing current overload protection, thermal cut-out and excellent filtering. Input 8-24V DC. Output 5V 2A. Regulation 0.2% **£5.00**

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OUT NOW – 88 pages of bargains from resistors to disco mixers. Price includes latest bargain list, discount vouchers, order form. Don't be without your copy – send £1.00 now!

Z810 KEYBOARD. Really smart alpha numeric standatd qwerty keyboard with seperate numeric keypad, from ICL's 'One Per Desk'. Nicely laid out keys with good tactile feel. Not encoded – matrix output from PCB taken to 20 way ribbon cable. Made by Alps. Size 333×106mm. 73 keys. **£8.95**

SPEAKERS
Z578 Sub-min speaker 30×30×3mm thick by Fuji. 16R 0.4W, 60p each; 10 £3.70; 25 £7; 100 £22; 1000 £180. Z575 70×45mm 45R 0.5W 55p each; 10 £3.30; 25 £6; 100 £20.

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500g reels resin cored, 18g **£5.95**
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Z620 68000 Panel. PCB 190×45 believed to be from ICL's 'One per Desk' computer containing MC68008P8 (8MHz 16/8 bit microprocessor, + 4 ROMs, all in skts; TMP5220CNL, 74HCT245, 138, LS08, 38 etc. **£5.00**

Z625 32k Memory Board. PCB 170×170 with 16 2k×8 6116 static RAMs. Also 3.6V 100 mA memopack nicad, 13 other HC/LS devices, 96w edge plug, 8 way DIL switch, Rs, Cs etc. **£4.80**

SOLAR CELLS
Giant size, 90mm dia giving 0.45V 1.1A output. £4 each; 10+£3.50.
Mega size – 300×300mm. These incorporate a glass screen and backing panel, with wires attached. 12V 200mA output. Ideal for charging nicads. **£24.00**

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COIN ACCEPTOR MECHANISM
Made by Coin Controls this will accept various size coins by simple adjustment of 4 screws. Incorporates various security features – magnet, bent coin rejector etc. Microswitch rated 5A 240V. Front panel 115×64, depth 130mm. Cost £10.85. Our price **£4.00.**

Z811 Cumana Touch Pad for the BBC Computer. This remarkable add-on enables you to draw on the screen using a stylus with the touch sensitive pad. Supplied with 2 stylii, power/data connecting lead & demo tape with 4 progs. Contains state of the art electronics. Originally being sold at £79.95, later reduced to £49.95 – but we can offer a limited quantity of these brand new and boxed for just **£19.95**

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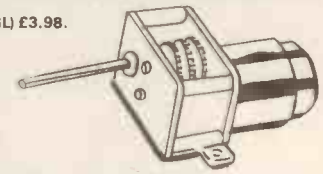

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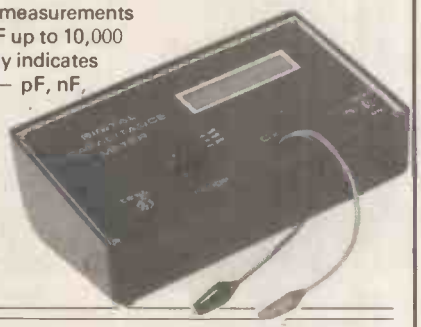

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FROM MAGENTA

ELECTRONICS TEACH-IN

By Michael Tooley BA and David Whitfield MA MSc CEng MIEE

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To complement the course computer programs have been produced for the BBC Micro and Spectrum or Spectrum Plus. The software is designed to reinforce and consolidate important concepts and principles introduced in the course, it also allows readers to monitor their progress by means of a series of multi-choice tests.

The book includes details of eight items of related test gear giving full constructional information and diagrams for each one. The items of test gear described are: Safe Power Supply; Universal LCR Bridge; Diode/Transistor Tester; Audio Signal Tracer; Audio Signal Generator; RF Signal Generator; FET Voltmeter; Pulse Generator.

This book is an excellent companion for anyone interested in electronics and will be invaluable for those taking G.C.S.E. electronics courses.

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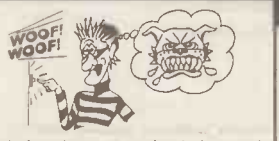

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MK12 IR Receiver (incl. transformer) **£14.85**

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ESI **£5.50**

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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

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EXTRA! EXTRA!

ONCE again we have included another extra item in the magazine. We will also be carrying extras in April and May (in addition to the free Data Cards that will continue to the June issue). In April we will give you a 24 page Spring Catalogue Supplement from Greenweld. A follow-up to their highly successful catalogue we provided with the November issue.

The May issue will carry another 24 page supplement entitled *Guide to Testing and Test Gear*. This very useful guide has been written for us by Robert Penfold; it looks at multimeters, logic probes, pulsers, a.f. generators, r.f. testing and power supplies, giving information on what is required and how to use the items. There is also a full length article on the oscilloscope which investigates the choice of 'scopes, timebase, sensitivity, squarewave testing, d.c. coupling, clipping, various measurements, a.c. voltage, logic testing, dual trace 'scopes and TV sync. In short an invaluable guide to all students of electronics.

CIRCUIT EXCHANGE

It is some time since we published any *Circuit Exchange* ideas in the magazine. This is quite simply due to lack of space. We do cram the magazine full, even keeping our typeface down in size to get the most we can on each page but there is not always room for everything even then. However this free booklet (you will find it attached between the centre pages) brings you a bumper bundle of ideas that cover a very wide range of applications—we hope you find them interesting and helpful.

BACK ISSUES

If you are looking for ideas the Index we publish in each December issue lists all the articles and projects that have appeared in *Everyday Electronics* over the year. We can also provide many back numbers going back to January 1982—or photostats of an article if we have sold out (the price is the same as a back number). See below for ordering details and a note of recent issues which have sold out.

MAKE SURE

We are now getting regular 'phone calls from readers who cannot get copies of *Everyday Electronics*. While we have been distributing extra copies each month the demand is continually growing and newsagents often sell out after 10 days or so. To avoid this problem either place an order with your newsagent—they will then save a copy in the shop or deliver one for you. Alternatively take out a subscription and we will post your copy to you each month—a subscription now represents excellent value for money, check for yourself. There is a subscription form and a newsagent order form on the tail of the pull-out Data Card in this issue.

Mike Kenward

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BACK ISSUES & BINDERS

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

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

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

OLD PROJECTS

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

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TRANSMITTERS

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

SEMICONDUCTOR TESTER

ANDY FLIND

This simple-to-use instrument will check leakage currents down to below 1μA. It will also give an indication of gain for both npn and pnp transistors

DESPITE the increasing prevalence of integrated circuits discrete transistors and diodes are still used in many projects, so a means of checking them quickly and easily is welcome in any enthusiast's workshop. This instrument will check leakage currents on scales down to 10μA, allowing values below 1μA to be clearly seen.

It will indicate transistor gain on scales suitable for both low-gain power types and modern small-signal amplifiers, which may have gains of 400 or more. It will often be possible to test "*in circuit*", useful when trouble shooting, whilst readings for devices on their own should be accurate to within five percent.

Both *npn* and *pnp* transistors can be checked, the tester is very simple to use and, provided no external voltages are applied to the probes, it is indestructible. Shorting the "*emitter*" and "*collector*" test leads whilst switched to the 10μA range for example, will not produce smoke or a bent pointer, simply a full-scale reading.

Diodes are easy to test. A reversible voltage is applied, and current should flow only one way, any current flow in the supposedly non-conducting direction is referred to as leakage. For most silicon diodes this is negligible, but with some germanium types it can be significant and highly temperature dependant.

To test a transistor, leakage between the emitter and collector is checked with the base shorted to the emitter; in this condition it should be "*off*". Again, silicon devices will not normally leak, but germaniums may resemble electronic sieves!

GAIN

To find the gain, a current of 10μA is supplied to the base and the resulting collector current measured. The gain is the ratio between collector and base currents, so if 2.5mA appears at the collector the gain will be 2.5mA/10μA, or 250.

On a 10mA scale this can be read directly from zero to 1000. Other scales are provided to enable lower gains to be read easily. These follow the pattern 1-5-10-50 . . . instead of the more usual 1-3-10-30, as this avoids the need for a second scale on the meter.

Since *npn* and *pnp* transistors have opposite polarities the tester must be capable of operating in either direction at the flick of a switch, which leads to some circuit complexity.

CIRCUIT DESCRIPTION

The full circuit diagram for the Semiconductor Tester, Fig. 1, looks complicated but can be easily understood if described in sections. Firstly, a voltage equal to half the supply is generated. The device to be tested can be connected between this and either supply rail to obtain the required polarity. The supply voltage is split by resistors R1 and R2 and buffered by IC1a.

The maximum test current, 10mA, is close to the op-amp's output current limit, so transistors TR1 and TR2 boost it where necessary. Capacitors C1 to C4 provide decoupling, and in effect a dual, positive and negative supply has been created. From here on the supply rails will be referred to as *zero*, *positive* and *negative*.

IC1d is connected as a voltmeter, reading to one volt either side of zero. Through feedback, any voltage at the op-amp's positive input must appear at the negative input, and hence across resistor R18.

As R18 is 1k, it follows that 1V will produce a current of 1mA, or full scale on a 1mA meter. The diodes D2-D4 route the current correctly through the meter for

COMPONENTS

Resistors

R1, R2, R5, R6, R7, R11, R12, R14, R15, R16, R27	10k (11 off)
R3	470
R4	1k
R8, R9, R28	100k (3 off)
R10	560
R13	15k
R17, R19	2k2 (2 off)
R18, R24	1k (2 off)
R20, R21	100 (2 off)
R22	820
R23	33k
R25	8k2
R26	330k
R29	390k

All 0.6W 1% metal film

Shop Talk
See page 158

Capacitors

C1, C2	100μ axial elec. 10V (2 off)
C3, C4, C5, C8, C9	100nf polyester layer (5 off)
C6, C7	47p ceramic plate

Semiconductors

D1	LED, miniature, red high-brightness type
D2, D3, D4, D5	0A47 germanium diode (4 off)
TR1, TR3, TR5, TR8	BC184L *npn* silicon (4 off)
TR2, TR4, TR6, TR7	BC214L *pnp* silicon (4 off)
IC1	LM324 quad op-amp
IC2	CA3130 CMOS op-amp
IC3	8069CCZR 1V2 voltage reference

Switches

S1	4-pole 3-way rotary
S2	Miniature push-button (push-to-break)
S3	1-pole 12-way

Miscellaneous

VR1 1k skeleton preset

Printed circuit board, available from EE PCB Service, code EE594; 8-pin DIL socket; 14-pin DIL socket; ME1 0-1mA moving coil meter; Case, ABS box 2005, 150×80×50mm; PP3 battery and connector; multi-coloured ribbon cable, 16-way plus; Subminiature probe clips, red, black, green; Pointer knobs (2 off); connecting wire and solder, etc.

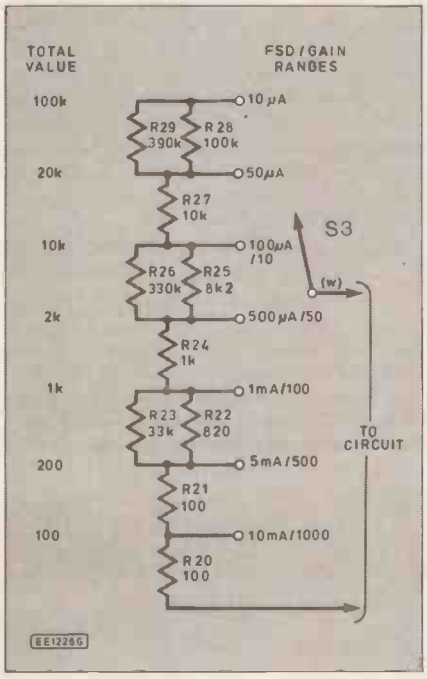
Approx. cost Guidance only **£24**

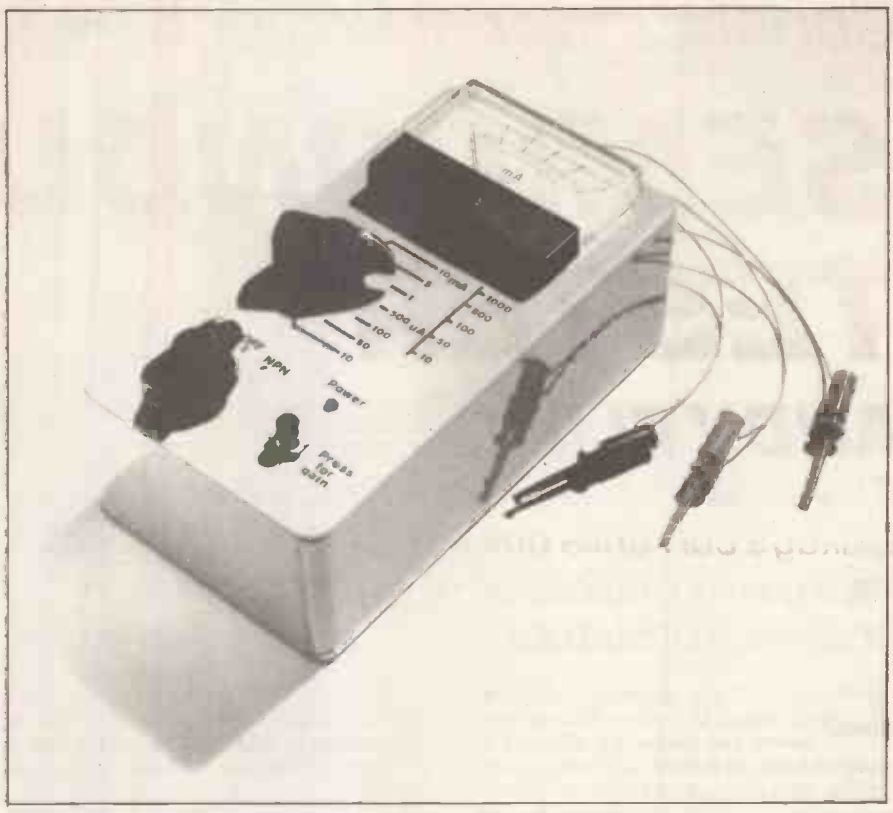
either input polarity and the op-amp automatically compensates for their forward voltage drops.

At full scale the op-amp's output voltage should consist of 1V for R18, plus the voltage across the meter, plus two diode forward voltage drops; in some cases it may not be able to reach this total with silicon diodes so germaniums, with lower forward voltages, are used here.

To measure current the input is shunted with a resistor, making the circuit into a bi-directional ammeter indicating current from either positive or negative so that it can accept collector current from both *pnp* and *npn* transistors. Ranges from 10μA to 10mA are provided with resistors selected by range switch S3, see Fig. 1b.

Fig. 1b. Circuit diagram for the range switch resistors.





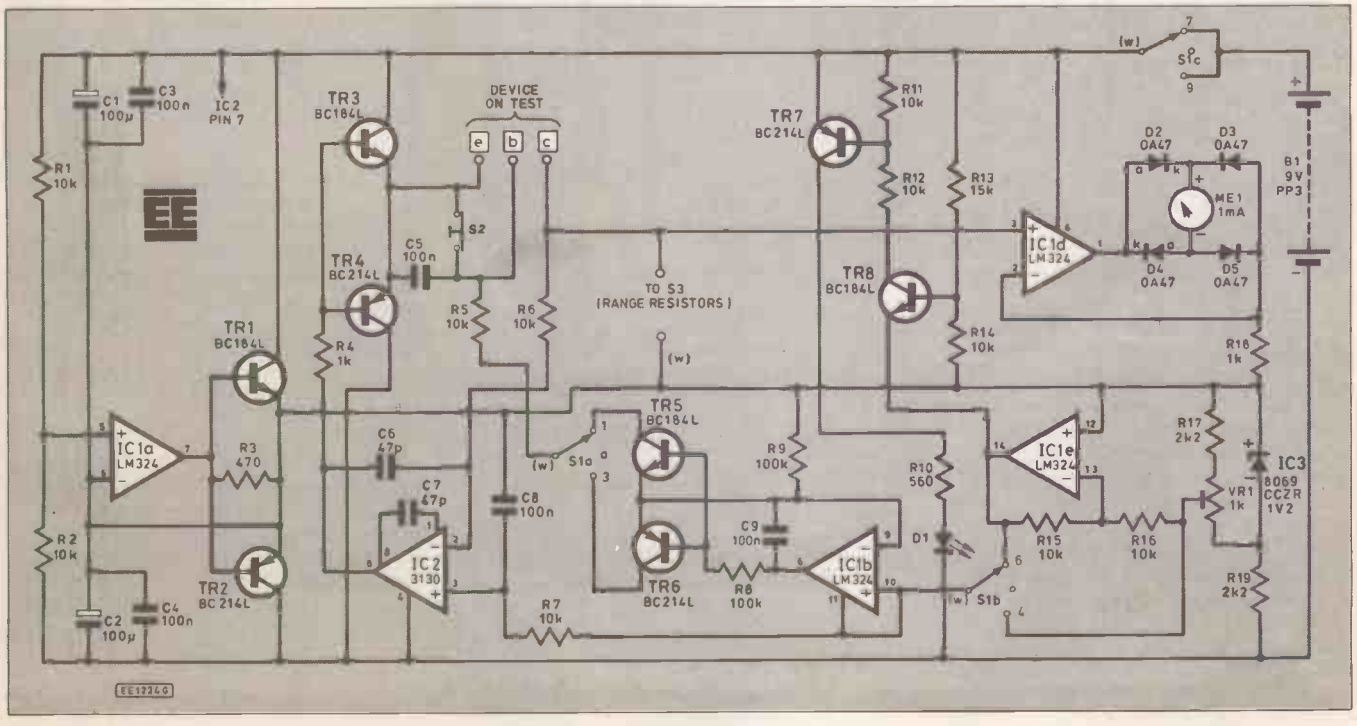
The emitter and base polarities must be switchable however, and a means of preventing overload is needed. First, a −1V reference (with respect to zero) is generated. IC3 is a "bandgap" device, more expensive than a Zener diode, but with a very constant (and convenient) output of 1.2V. Preset potentiometer VR1 allows adjustment to exactly 1V. A +1V reference is also generated through inversion by IC1c.

Switch S1 is the NPN/PNP (and ON/OFF) switch. If S1a is selected to +1V as shown; the positive input of IC2 will be at +1V.

For currents up to full scale the negative input of IC2 (taken from the meter circuit input) is lower, so the output rises to positive supply potential, taking the emitters of TR3 and TR4 with it. These supply the emitter of the device on test, providing conditions for *pnp* testing, with the emitter positive of the collector. If enough current flows to raise the voltage at IC2's negative input to 1V, IC2 will respond by reducing the emitter supply voltage to clamp it at this value.

With S1b selected to −1V the circuit operates similarly but in the opposite direction,

Fig. 1a. Complete circuit diagram, except range switch S3, for the Semiconductor Tester. The range switch arrangement is shown in Fig. 1b (above left).



setting up emitter-collector conditions for an *npn* device. It thus provides correct polarity, with overload protection for both the meter circuit and the device on test, on any range. IC2 is a 3130, selected for speed and the ability of the output to swing all the way to either supply.

The reference selected by S1b also goes to IC1b. When it is positive, transistor TR5 will be driven until +1V appears across resistor R9, causing 10μA to flow into the emitter.

Apart from the tiny portion going to the base, all of this will appear at the collector as a "*constant current source*" that can flow to the positive rail, so a suitable base drive for a *pnp* transistor has been generated. During leakage tests this is lost through switch S2, a press-to-break type which shorts base to emitter. Operation of S2 causes it to flow into the base, the current of 10μA being maintained regardless of the base-emitter voltage of the device being tested.

Once again this circuit works just as well in the opposite direction. The collectors of TR5 and TR6 cannot be coupled though, so S1a selects the appropriate output.

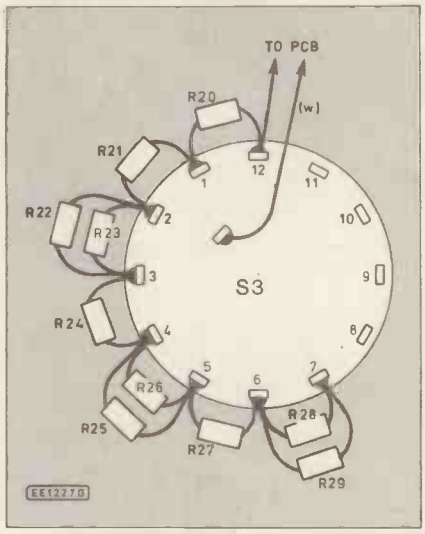
As false readings can result from the early stages of battery failure an l.e.d. indicates a healthy supply. This is supplied by transistor TR7, in turn driven by TR8, which compares a voltage derived from the positive supply with the positive reference.

With the values given the l.e.d. extinguishes sharply as the battery falls below about eight volts. The circuit will, in fact, function down to about seven volts, so this provides a useful safety margin.

CONSTRUCTION

Board construction should present no particular problems, the component layout and printed circuit board copper foil pattern, Fig. 2, being quite straightforward. This board is available from the EE PCB Service, code EE594.

Fig. 3. Wiring details for range selector switch S3.



Take care to fit the capacitors C1, C2 and the four diodes the correct way round, and ensure all transistors are both the right type and correctly orientated. IC3 was once a three-lead device similar to a transistor, the third lead being unconnected. A smaller, two-lead package seems to be the current version, though if the former is supplied it should be fitted with the flat as shown, with the top lead cropped.

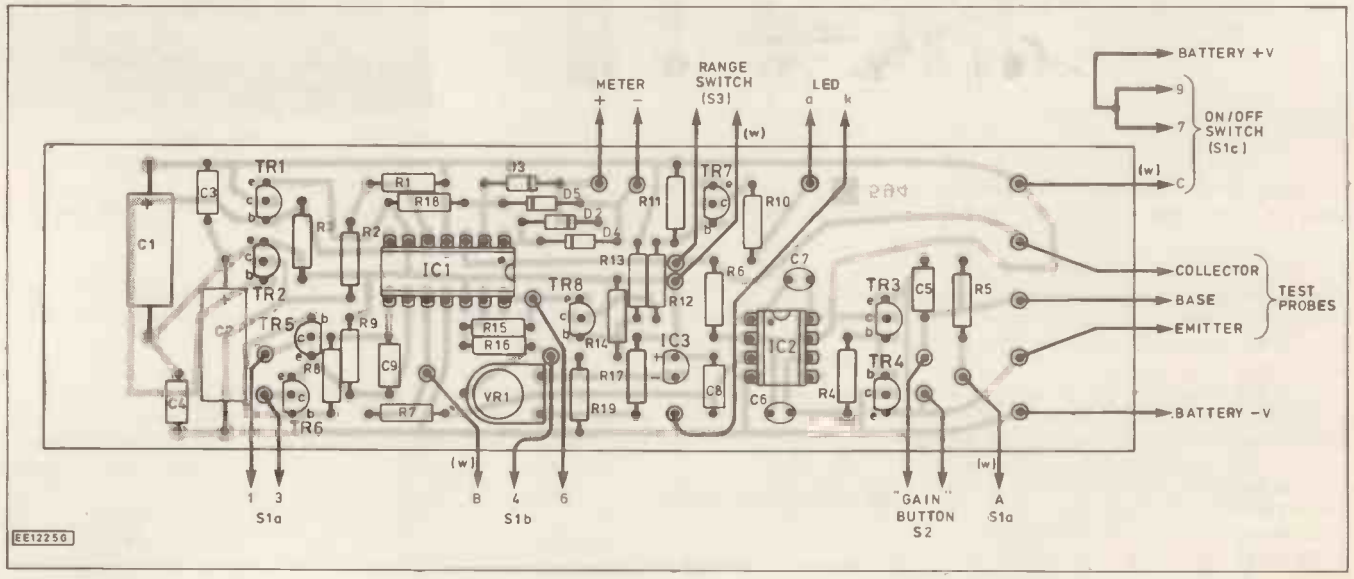
Use sockets for IC1 and IC2, both to protect them and because it can simplify matters a great deal should trouble-shooting be required. Ensure IC1 is the right way round when plugging it in, pin 1 is at top right.

CASE AND WIRING DETAILS

If the specified case is used it should be marked out with care to ensure that the board, when fitted, does not foul switch S2. Marking of ranges, etc. is done with rub-down transfers, protected with clear adhesive backed film.

The board slots in with the components facing the side of the box, in the space between the corner pillars, to provide room for the remaining hardware. The connecting wires pass beneath it, allowing it to be lifted for access to preset VR1.

As there are rather a lot of connections the use of a few inches of ribbon cable makes for



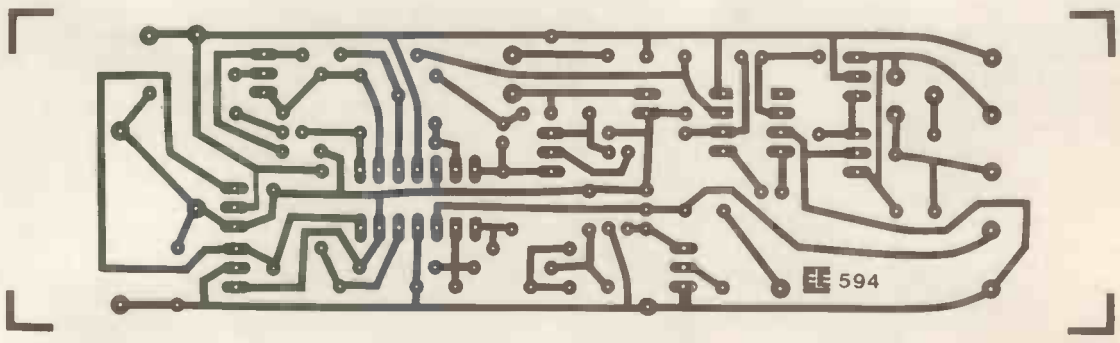
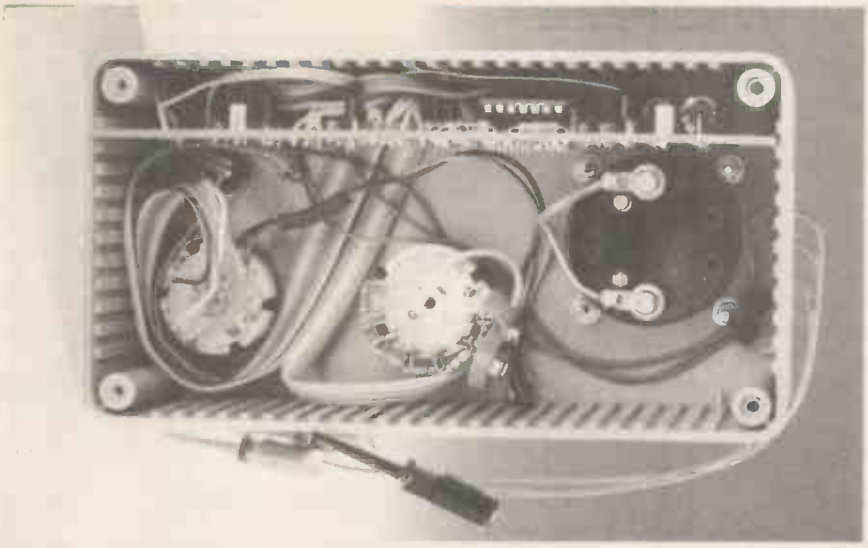
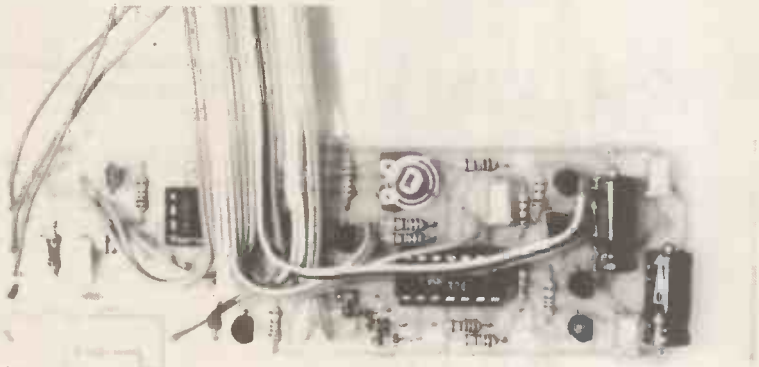


Fig. 2. Component layout, wiring details and full size printed circuit board foil master pattern. Wiring of the range resistors is shown in Fig. 1b above.



Internal view showing the circuit board slotted in position and the use of coloured ribbon cable to wire-up the range and *pnp/npn* rotary switches.



The completed circuit board showing component layout and the use of ribbon cable for board connections from front panel components.

The completed Semiconductor Tester showing meter scale and range switch lettering. The three leads from the top of the case are connected to the three miniature probes.

a neater job; everything save the test leads can be wired in this, a total of sixteen wires. The ribbon's colour coding also simplifies the job, reducing the risk of errors.

The switches specified for S1 and S2 are marked with letters and numbers to which connections should be made as shown in Fig. 2. Though the negative battery connection is shown as being wired direct, on the prototype it was taken through S1d, mainly because this provided a good anchorage for the battery lead! Three lengths of flexible wire pass through three small holes at the top of the case and are fitted with miniature probe clips, for connection to the "device on test".

The resistors on the Range switch S3 are connected in single and parallel combinations as required to make up the total needed at each step, as shown in Fig. 1b. the physical wiring arrangement for S3 is shown in Fig. 3.

The switch S3 is a twelve-way type, provided with an adjustable stop which is used to limit it to seven. As position 12 is not used, the end of resistor R20 may conveniently be anchored to it. The resistors should be fitted to this switch before it is mounted in the case.

TESTING

Testing of the prototype consisted of wiring it up and switching on—it worked, first time! Seriously though, it is worth keeping an eye on the current drawn when turning it on for the first time.

Without a load, the tester takes about 17mA, the bulk of this going to the l.e.d. (D1). Without the light, the drain is about 6mA. Any significant variation indicates a need to switch off and re-examine the wiring.

SIMPLE CHECKS

Some simple checks that can be made include the voltages across capacitors C1 and C2, which should both be half the battery supply voltage. This will confirm correct operation of everything around IC1a.

With respect to zero, which can be conveniently picked up from the negative end of C1, the voltage across IC3 can be verified as being about −1.2V. Operating S1 between PNP and NPN should cause the "emitter" test lead to switch from positive to negative respectively about the zero rail, and with a sensitive meter the bias current can be measured.

Bear in mind that this is generated from zero, so it can only flow to one of the supply rails (or to the emitter test lead). Its precise value may not be 10μA unless preset VR1 has been adjusted, and if S2 has been connected it will, of course, be necessary to press this.

Setting up consists of shorting the emitter and collector test leads together and adjusting VR1 for a spot-on full scale reading, which automatically sets up everything else.

IN USE

Using the tester is simplicity itself. To test a diode, connect it between the emitter and collector test leads, with the cathode (marked end) to the collector.

Switching to "PNP" applies forward voltage, which should give a full-scale reading on any range. "NPN" applies reverse voltage, and leakage (if any) can be read on a suitable range. LED's can be tested too, and the current available on the 10mA range is sufficient to light them.

For transistors, connect all three leads, switch to PNP or NPN as appropriate, check leakage if necessary, then press the button to read the gain. It's virtually impossible to damage a device with this tester. Incorrect connection,or operation of S1 to the wrong polarity will usually just produce "silly" readings.

With practice it's possible to sort out the polarity of an unknown transistor and determine which lead is which. The possibility of "in circuit" testing depends, of course, on the circuitry around the device to be tested, but in many cases it will be possible to make at least a functional test without unsoldering it, which can be a great help when fault-finding.

Constructional Project

LIE DETECTOR

T. R. de VAUX-BALBIRNIE

We make no pretence to accuracy, however this simple skin resistance detector will provide hours of fun.

IT IS well known that a person's skin resistance varies with the emotional state. For example, many readers will have experienced sticky hands while waiting to see the dentist.

It is this moisture, together with the presence of salt, which reduces the skin resistance. It may be easily measured using an ohmmeter with one probe held in each hand. A typical "dry" resistance is 200k ohms but with wet hands it may fall to 10k ohm or less.

This effect is used in the "polygraph" or lie-detector. Here, changes in skin resistance cause pens to trace graphs on a moving paper roll. From the appearance of these traces, an expert operator can judge, with fair accuracy, whether or not the subject is lying.

This battery-operated device is much simpler than a professional polygraph. The subject holds a pair of electrodes and a row of ten l.e.d.s glow, thermometer fashion, according to the skin resistance.

It makes no pretence to accuracy—indeed, considerable training is needed to obtain reliable results from any type of lie-detector. However, it is good enough for entertainment and may be used either in its own right or in games where the detection of a lie might prove helpful to an opponent.

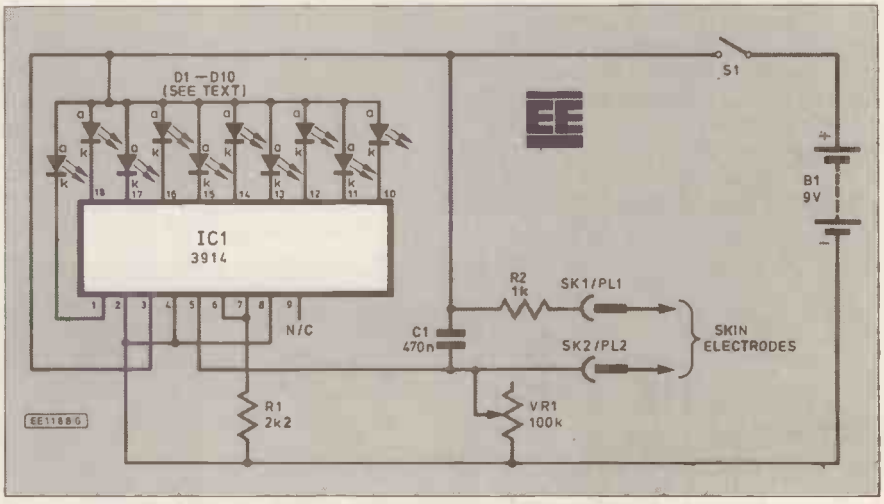


Fig. 1. Complete circuit diagram for the Lie Detector. The arrangement of the "lie detection" l.e.d.s is shown in the photograph

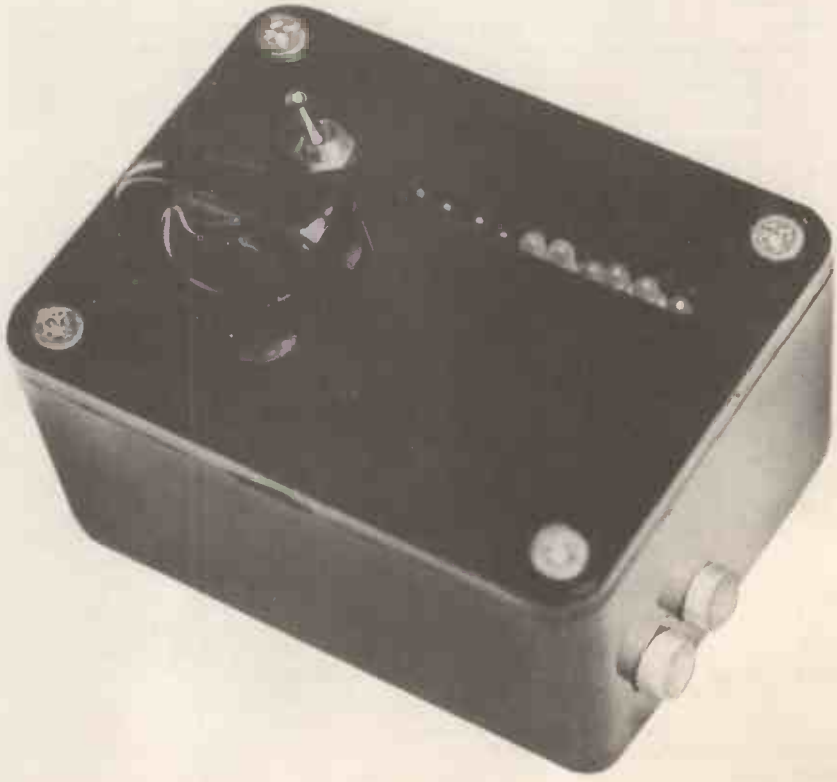
CIRCUIT DESCRIPTION

The circuit for the Lie-Detector is shown in Fig. 1. The principle component is the bar driver IC1. This accepts an analogue voltage at the input, pin 5, and lights one of a row of ten l.e.d.s connected to the outputs (pins 1 and 10 to 18) according to the voltage level.

The skin resistance, together with resistor R2 and potentiometer VR1, form a potential divider across the supply so a voltage appears at pin 5 whose value increases as skin resistance falls. This operates the i.c. in the manner described. VR1 sets the operating range and resistor R1 determines the l.e.d. operating current and hence their brightness.

Capacitor C1 prevents possible erratic behaviour caused by mains hum pick-up and also serves to slow down the response time. Resistor R2 prevents a short-circuit to the supply if the electrodes are allowed to touch while VR1 is set to minimum.

The circuit is battery-operated and so safe in use. ***On no account should it be converted to mains operation or a mains power supply used.*** The current requirement is about 20mA so the internal battery will give excellent service.



COMPONENTS

Resistors

R1	2k2
R2	1k

Both 0.25W 5% carbon

Potentiometer

VR1	100k min.

Capacitor

C1	470n

Semiconductors

IC1	LM3914N linear bar driver
D1-D10	3mm l.e.d.s: red (4 off); yellow (2 off); green (4off) (or red 10 off)

Miscellaneous

Plastic case, size 76×56×35mm internal (MB1 box); 0.1in. matrix stripboard, size 13 strips×16 holes; S1 sub-miniature s.p.s.t. toggle switch; Pointer knob for VR1; 2mm plugs and sockets (2 off); PP3 battery and connector; Electrode materials (see text); Adhesive fixing pads; connecting wire and solder etc.

Approx. cost Guidance only **£6**

Shop Talk See page 158

CONSTRUCTION

Most of the components are mounted on a circuit panel consisting of a piece of 0.1in. matrix stripboard, size 13 strips×16 holes, as shown in Fig. 2. Make all breaks in the copper strips as shown and insert the inter-strip links.

Mount the soldered components as indicated but do not insert the i.c. into its holder until the end of construction. Pay particular attention to the polarity of the l.e.d.s and when soldering them in position, note that the wire ends must be bent gently so that the array occupies the whole width of the circuit panel (see photograph).

Also, take care to ensure that all l.e.d.s reach the same height. In the prototype unit, D1 to D4 were red, D5 and D6 yellow and D7 to D10 green. This adds to the fun but they could all be the same colour if desired. Solder 10 cm. pieces of light-duty stranded connecting wire to each of strips *A*, *B*, *G* and *J* as indicated.

Drill holes in the case for S1, VR1 and for the sockets. Cut a slot in the lid size 3mm×40mm. for the l.e.d. display. Mount the remaining components and complete all wiring as shown in Fig. 3.

Without touching the pins, remove the i.c. from its special packing and insert it into its socket. This precaution is necessary since IC1 is a CMOS device and therefore liable to be damaged by static charge.

Fit the battery and secure the circuit panel with the l.e.d.s occupying the slot in the lid. An adhesive fixing pad applied to the top of IC1 will serve this purpose. Attach the battery to the base of the box with a similar pad.

ELECTRODES

The choice of electrodes is left to the constructor and may be the subject of experiment. One may be held in each hand or they may be combined for single-handed operation.

In two-handed use, response depends largely on the pressure which the subject exerts on the electrodes. This may be seen as an advantage since a nervous person will tend to grip them more tightly.

On the other hand, a combination electrode responds mainly to the presence of moisture. Such a device may be made from a piece of stripboard with adjacent copper tracks joined together (see Fig. 4). It may be taped to the subject's palm with the copper strips touching the skin. Light-duty twin wire connects the electrodes to SK1 and SK2 on the unit.

OPERATION

Arrange the electrodes and switch on. Adjust VR1 for the required range of operation. Decreases in skin resistance will now cause the l.e.d.s to glow in turn.

Although the Lie-Detector is great fun to use, the results should not be taken too seriously! □

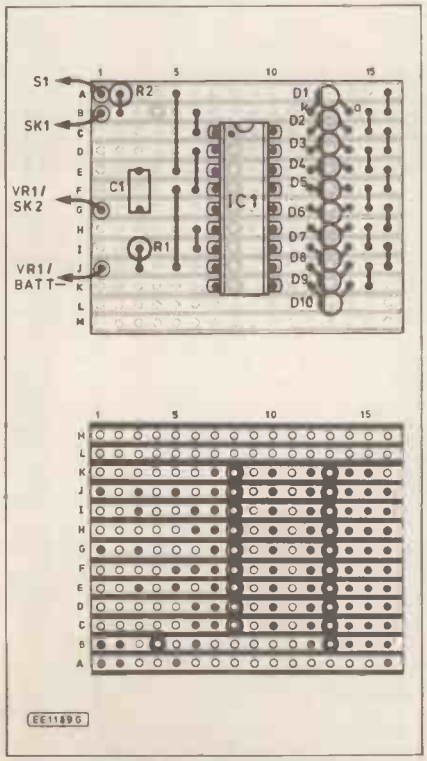


Fig. 2. Circuit board component layout

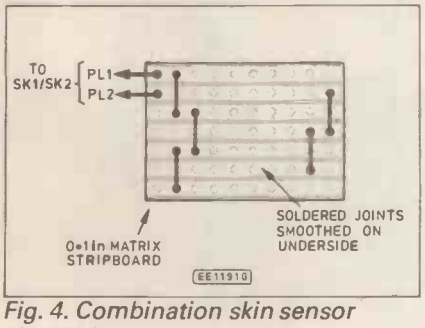


Fig. 4. Combination skin sensor electrode

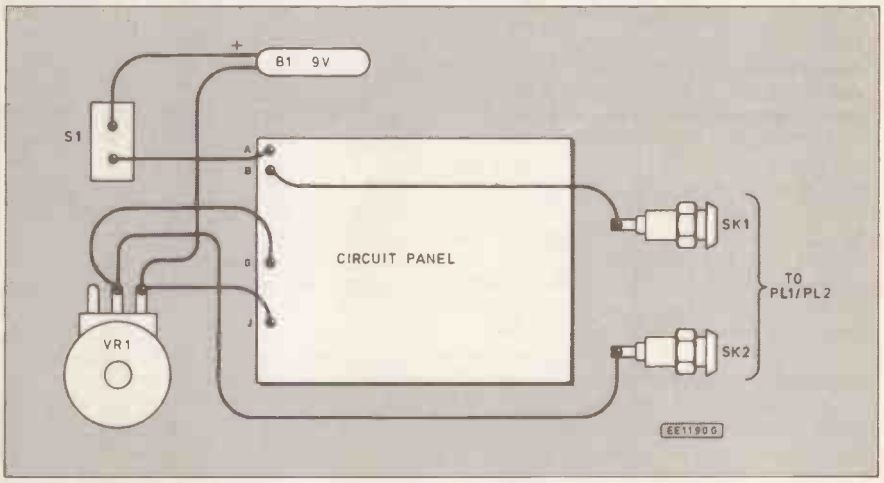
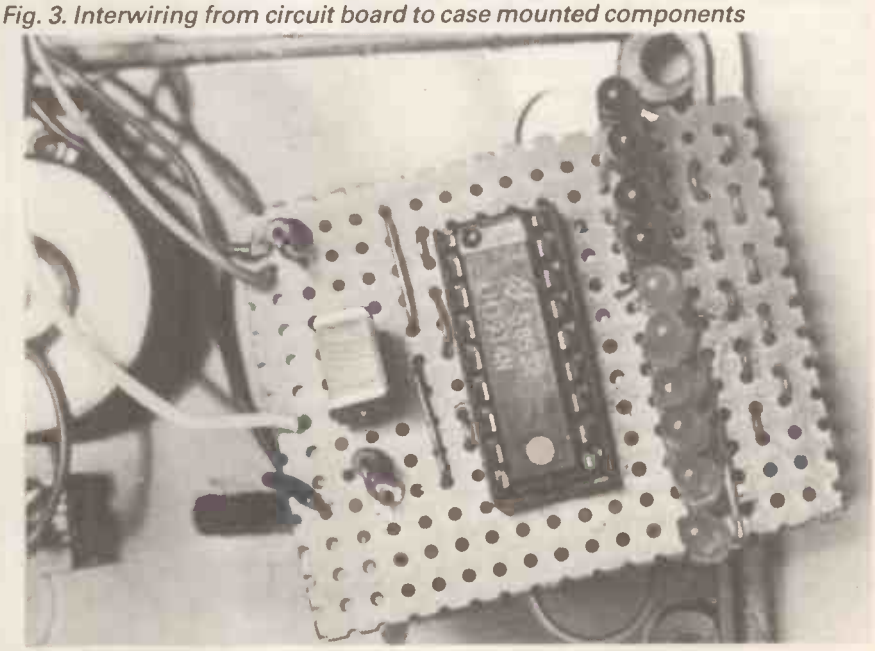


Fig. 3. Interwiring from circuit board to case mounted components



...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

The second Annual Report of the Radiocommunication Division of the DTI—for the financial year 1986/87—was published recently. The Division has now almost completed the process of reorganisation begun in 1983 when it moved to the DTI.

Its many functions have now been grouped into a more coherent structure which it is hoped, says Kenneth Clark, Minister of Trade and Industry, in his foreword to the report, "*will enable customers to receive a better standard of service.*"

WHO ARE THE CUSTOMERS?

Its immediate customers, says the report, are the 280,000 radio licensees and the 1,000,000 people whose use of radio is exempted from licensing. There are users of private mobile radio, mobile phones, ships' and aircraft radio, amateur radio, CB radio and more.

The report describes what is going on in each of these areas, outlining policies, plans and achievements. "We collect £13,000,000 in licence fees and it is good discipline to have to explain how we spend it . . . the better will our customers understand our actions and intentions."

This column is, of course, concerned with amateur radio so, fascinating as it is, we must put the rest aside to concentrate on our proper subject. During the year 1986/7, fees received for amateur licences amounted to £671,000 and the number of licences as at 31 March 1987 was 57,692, an increase of 240 per cent since 1974, when the figure was 24,000.

CHANGES A number of beneficial changes and events during the year in review are reported. On 27 March 1987, John Butcher, Parliamentary Under Secretary of State for Industry, when opening the National Convention of the RSGB at the NEC in Birmingham, announced the award of a DTI prize for youth achievement in amateur radio in the hope of focussing the attention of young people on the hobby. Mr Butcher promised a further review of the 50MHz band and the possibility of access to it by class B operators—both of which were realised.

The Division worked with the Radio Society of Great Britain to establish a chain of experimental packet radio relay stations. Old call-signs were permitted to be re-claimed by their original owners; the Morse test became valid for life; and class B operators were allowed to use Morse code on the v.h.f. bands on a permanent basis.

An eleven-point plan to deal with cases where amateurs were involved in domestic TV interference problems was evolved, and plans were in hand for a major revision of the amateur radio licence. In summary, the report comments, "Altogether it has been a very interesting year for the amateur service, with the promise of further benefits to come".

NEW LEAFLET

The DTI has also just published Information Sheet No. 6: *Radio Amateurs' Examination*, in conjunction with the City & Guilds of London Institute which is responsible for setting the RAE on behalf of the licensing authority. The DTI says that its intention in producing the sheet is to encourage interest in as many people as possible who would not normally consider amateur radio as a potential hobby.

The leaflet explains what amateur radio is, why it is necessary to take an appropriate technical examination (and pass a Morse test in some cases) to become a radio amateur. It explains what the examination is; how to study for it; and how to obtain further information.

During 1988, the RSGB's 75th anniversary year, there is to be a special effort to bring newcomers into the hobby, and this leaflet is part of that effort. If you would like a free copy, write to DTI, Radiocommunications Division, Amateur Radio Section, Waterloo Bridge House, Waterloo Road, London, SE1 8UA.

COLLECTING

Wireless, both amateur and professional, has been in existence for so long now that early transmitters, receivers, and related items, have become collectors' pieces—of special interest to amateurs since it is often possible to use them on the air today.

The Norwegian Historical Radio Society, for instance, will be holding its second "clandestine" field-day on 28 May, when it will be trying to contact UK amateur stations with original equipment as used by Resistance operators in Norway during WW2. In the USA, the Antique Wireless Association holds regular "vintage" events. Its members operate transmitters and receivers dating back, in some instances, to the 1920's, and anything later than 1942 is designated "modern"!

Morse keys are, of course, still usable and since these go back to 1884—when Morse telegraphy was by wire rather than by wireless—there is a great interest among some amateurs in collecting these and using them for present-day communication. There is something quite fascinating in sending Morse on a 100-year old key and knowing that it is performing exactly the same function, and using exactly the same code, as it did when it was first used.

CLOCKWORK MORSE

An interesting link between landline and wireless telegraphy is a Morse code learning machine patented in New York in 1904. This is the *Omnigraph*, a clockwork driven instrument with a number of rotating discs. Each disc has saw-tooth projections cut on its edge representing different Morse signals. As the discs turn a moveable lever follows the projections activating an on-off switch which, in turn, keys a signalling circuit containing a buzzer or other Morse receiving instrument.

The lever moves from one disc to another to vary the order in which the Morse signals are received, and listening to them a beginner can learn the code. The speed is variable, and when the received signals become so familiar they can be anticipated the 15 discs can be taken off, shuffled or twisted around to new positions relative to each other, and replaced to provide a completely different code sequence.

This was a serious learning instrument. Discs could be obtained in original American Morse code for land-line operators, covering single letters, numerals, and punctuation as well as practice messages. They were also available to teach the special codes and procedures used by the railroads, commercial, and press, telegraph networks.

With increasing interest in new-fangled wireless telegraphy, discs were soon produced for Radio code (International Morse as we know it today) and the Omnigraph remained in use for quite a long time. It was still being sold to amateurs, and aspiring professionals, in the 1920's, when it was also used to administer the Morse receiving test for professional Radio Officers in America.

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IT MANAGEMENT

Information Technology helps those who help themselves

MAKING the most of today's complex communications systems is not always as easy as the manufacturers would have us believe. Telecommunications and Information Technology (IT) are two of the rapidly developing industries. So much so that even specialists can find it difficult to keep pace with the unceasing influx of complex technologies. So what chance does an IT director or manager have of keeping on top of the situation?

Regular financial audits ensure that a company's accounts and book-keeping are as healthy as possible. More often than not the status and efficiency of the telecommunications system are ignored or overlooked. Yet this is an area where great savings can be made, while improving efficiency is a vital part of a company's infrastructure.

IRREGULARITIES

When it comes down to the day to day running of a typical telephone or telecommunications system, whether large or small, the most surprising irregularities occur. Future foul-ups can only be guessed at, if the present day findings of a Buckinghamshire company are anything to go by. The company, Surecom, specialises in analysing telecomms networks, in order to assess efficiency and plan improved system solutions.

Monitoring and analysis have taken place in numerous companies, including some major telecommunications networks. Stories of companies which have store cupboards full of unused phones for example, or of organisations where employees or students are actually running their own business when they should be otherwise employed, are apparently not pure myth. During its daily endeavours Surecom has liberated many skeletons from cupboards.

At a leading telephone/mail order firm which takes 90 per cent of its orders by telephone on 200 phones, the telecomms manager discovered that 40 per cent of all calls were not being recieved or were just lost. Asked what he had done to rectify the problem he replied that he had written a memo to his boss six months ago but had not had a response and he had not persevered. In such a competitive environment this suggests a lack of management motivation and control. By simply replacing the existing Auto Call Distribution system the manager could save both his company and his job.

Then there is the case of a major market research company which operates a 64-line exchange.Following constant monitoring of the telecommunications system, it became clear that only 16 out of the 64 lines were regularly in use. At a rough calculation this implies that the company unnecessarily spent at least £50,000 on such a big exchange system.

Yet another company allowed British Telecom to charge it for the rental of 200 phones which did not exist. Another had been paying an exchange supplier a maintenance contract for seven years for work which was not carried out.

One major telecomms manager admitted he could not put an accurate figure on his telecomms costs except to say it was between £10 million and £15 million a year.

PERSPECTIVE

Unhappily, the list of foul-ups is almost endless. Such problems do not excuse BT from being inefficient but they do put the situation into perspective. The key aspect of BT's reputation is partially the responsibility of its customers. If Telecom's service is as bad as some people claim, then surely the fault lies with the people driving the service. Too many people ignore the old adage 'let the buyer beware'.

The question is how can IT managers stop the rot setting in, or at least take preventative care. It is obvious that a comprehensive educational effort could be initiated on both sides of the fence. If BT's recent advertising campaign is to be believed, one side of the fence seems to be covered. For the rest of us perhaps companies such as Surecom present a temporary solution.

BLIND SPOT

Telephones and IT equipment seem to have become a blind spot in many organisations, large and small. For example, a number of major organisations (typically the Civil Service) run regular clamp downs on expenditure like enforcing the reuse of old envelopes and limiting numbers of notepads available, while at the same time allowing money to be frittered away on inefficient or even nonexistent phone systems.

Part of the problem seems to be the fact that telecommunications is principally an invisible activity and as such it tends to be ignored. Energy consumption used to suffer from the same problem because it was also largely unseen. Through a lot of Government sponsored publicity, energy conservation has been recognised by senior management and finance directors as being a serious source of money wastage. Unfortunately, communications has not achieved this threshold of awareness in many company boardrooms.

There seem to be two common ways of approaching communications issues at board or senior management level. The first and most popular attitude is to ignore it whenever possible. The second approach is to be aware that it could be a problem but to panic over the decision making process through 'techno fear'.

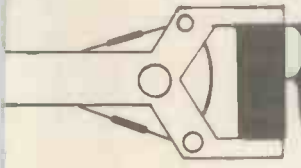
"If you are going to invest in information technology equipment the key point is to ensure you manage it properly", says Tom Yates, Surecom's managing director. "The management role should be considered as part of the communications

'utility' as far as the technology is concerned. Instead of shouting about the evils of British Telecom the real issue is the lack of knowledgeable management. The UK has failed so far to provide worthwhile training and education for would-be managers on the issues relating to telecommunications and information technology. What is really required, and urgently, is a good basic education and training programme to be set up in the tertiary stages of education. Information technology is gravely in danger of reliving the numerous disasters of the dataprocessing revolution. Information should be regarded as a 'utility'. Every time a company changes its market it must change its communications technology and management strategy accordingly. If it fails to do so then inefficiency is guaranteed. Investment in IT is not, as it is often regarded, a luxury if you get it right; it is a compulsory business issue".

The case then seems proven, too many companies fail to plan their telecommunications activities correctly from the start. For example, too few actually assess their requirements when they move into a new building. They fail to review their telecommunications needs regularly enough, if at all. A good telecommunications system provides a sound infrastructure to support fully all a company's communications requirements. A sensible policy would be for every company to audit its telecommunications system and equipment at least annually.

Tom Yates is well known and respected in the fields of telecommunications and IT. Specially commissioned by the Government, he researched and wrote an independent report on System X and his many qualifications include representing Rolls Royce at Oftel.

Surecom Ltd., are at Montague House, 23 Woodside Road, Amersham, Buckinghamshire HP6 6AA. Telephone: (02403) 28083.



Robot Roundup

NIGEL CLARK

FOR those of us who are interested in robots and robotics it may come as a surprise to find that the subjects are not given top priority at all levels of education.

After all new technology is going to be the next big provider of jobs and prosperity, if the Government is to be believed. And money and effort has been put into spreading the word to schools through a variety of means, including the reduced cost of buying computers and the Microelectronics Programme.

However not only are there people who have not yet heard the word, there are others who doubt whether the promotion of robots and robotics, particularly in schools, is of any value.

Dave Doyle, deputy director of the Inner London Education Authority Design and Technology Centre, says that there are a number of teachers in the craft, design and technology area who feel that the main aim of the subject – problem solving to meet human need – can be satisfied within existing technologies without the need for electronics. That raises a number of questions in the area of teaching about robots and robotics, most of which relate to the definition of the subjects.

DIVERSITY

Doyle makes his comments in a recently-published book, which also goes some way to providing the answers. The book is a collection of papers under the general title of *Teaching and Learning with Robots* which shows the diversity of subjects covered by what is considered to be connected with robots.

Almost everyone who attempts to give a definition of a robot comes up with broadly the same view that it is a programmable mechanical device of some sort. However the machine is merely the taster for what is of real interest to those involved in education.

Learning to build and work with robots sounds more interesting than control technology and working with automated manufacturing systems. However once hooked by the buzzword, if the book is a good guide, it is an easy matter to expand the subject while retaining the students' interest, particularly those in school.

For the most part it is the control technology area in schools which is the more interesting part of considering the uses of robots in education and the book reflects this. In further and higher education the emphasis appears to be on preparing people to work in automated manufacturing. Out of 15 chapters there are only three which cover that.

This reflects the differing uses to which robots are put. In schools they are a means to an end, in higher and further education they are an end in themselves.

FASCINATING

Control technology in schools makes a fascinating subject which would probably deserve a book on its own. As Doyle says, electronics has an attraction which if treated properly can be very rewarding. Unlike other CDT subjects like woodwork or metalwork, it does not come with a ready-built bias against girls and attracts pupils across the ability range, not just the less academic who were always assumed to be more practically minded.

Also by its very nature of being a "new" and developing technology it upsets the traditional distinctions between teacher and pupil, that of a learned person imparting knowledge. In electronics or robotics the teacher becomes a guide as the pupils make their own discoveries with which the teacher may, or may not, be familiar. This of course places a strain on the teacher. They need to learn new skills and accept the fact that they do not have all the answers.

However, judged by some of the case studies in the book the rewards can be large. There can be nothing as fulfilling as the discovery that a child can possess hitherto unknown abilities.

An example is given by Alan Giles, principal lecturer at the British School of Technology of Paul "a shy retiring pupil who made few friends". Teachers had the greatest difficulty in getting him to talk to them or the other children. However after making a candle which could flicker on and off he could not stop talking of his success and there was a noticeable change in him. There are other examples in all the case studies.

The key to this success is the engaging of the child's imagination and making sure that interest is maintained. From the examples chronicled in the book it appears the first part is no problem the difficulties can arise in the second. Teachers must be able to ask questions or make suggestions at the right time and ensure that they have sufficient of the necessary components not to hinder development.

That can be frightening, but the book not only gives studies of how others have coped but also gives more specific projects to be tackled which can be used as a starting point.

HARDWARE PATH

Most follow the hardware path which is the essence of robotics, making the computer control physical activities. However Paul Chung of Edinburgh University suggests an alternative with the teaching of control applications through programming; the solving of the problems through working out a system required and preparing that system as a program rather than the pupils being distracted by details of the computer hardware, as he puts it.

But those following the hardware route are by no means united in their approach., Some believe in the in-at-the-deep-end way with the learning of skills as and when they are required. Others take the preparation route with skills that will be needed later learnt at the beginning so that the momentum is not lost when the more complex work is tackled.

But their uniting belief is that it is the thinking and doing which is more important than the result. It is preparing the children to be adaptable in an ever-changing world. It could be any subject but at the moment robots and robotics have an advantage in being attractive.

Teaching and Learning with Robots, edited by Colin Terry and Peter Thomas (Croom Helm £25).

City and Guilds

INTRODUCING MICROPROCESSORS

MIKE TOOLEY B.A.

Part 5

MEMORIES

In the last part we explained how readers should go about registering for assessment with a local centre and provided samples of the written and practical assignments which readers should now be ready to undertake. This month we shall return to the main theme of the course by introducing readers to the semiconductor devices which provide storage for programs and data within a microprocessor based system.

LEARNING OBJECTIVES

The general learning objectives for Part Five of *Introducing Microprocessors* are that readers should be able to:

(a) Understand the characteristics and applications of semiconductor read-only memory (3.1).
(b) Understand the characteristics and applications of semiconductor random-access memory (3.2).
(c) Understand memory maps for typical 8-bit microprocessor based systems (3.3).

(Note: City and Guilds module document reference numbers are shown in brackets).

The specfic objectives for Part Five are as follows:

3.1 SEMICONDUCTOR READ-ONLY MEMORY

3.1.1 State why read-only memory is needed.
3.1.2 Give examples of the use of ROM devices to implement read-only memories.
3.1.3 Explain, in simple terms, the arrangement of a semiconductor read-only memory cell matrix.
3.1.4 Distinguish between mask-programmed or fusible-link (PROM) and erasable-programmable (EPROM) devices, state typical applications and give relative costs.
3.1.5 Explain, in simple terms, the process of programming mask-programmed, fusible-link, and erasable-programmable ROM devices and explain the process of erasure.

3.2 SEMICONDUCTOR RANDOM-ACCESS MEMORY

3.2.1 State the need for read/write memory and distinguish between read/write memory and read-only memory.
3.2.2 State that semiconductor random-access memory (RAM) provides read-write memory of a transient nature.
3.2.3 State typical applications of random-access memory.
3.2.4 Explain, in simple terms, the arrangement of a semiconductor random-access memory cell matrix, and how it is accessed.
3.2.5 Distinguish between static and dynamic RAM.

MEMORY MAPS

3.3.1 Explain the need for a memory map.
3.3.2 Draw and interpret the memory map for a representative microcomputer system showing addresses in both decimal and hexadecimal form.
3.3.3 Explain the allocation of total memory space available in a representative microprocessor-based system.

STORAGE

All microprocessor-based systems require a means of storing their control programs (or operating systems), applications programs and data. Furthermore, the microprocessor itself will require some means of storing transient data (e.g. variables used in a program) and implementing a stack.

Storage may take a variety of different forms including magnetic tape, magnetic disk, and semiconductor memories. Indeed, microprocessor-based systems are often designed so that they can take advantage of more than one storage method. A simple home computer, for example, will contain semiconductor memory devices to satisfy the needs of the microprocessor and to provide storage for a BASIC interpreter. The computer may also be able to save and load programs and data using an external cassette tape recorder or disk drive.

The types of storage device which are relevant to Introductory Microprocessors are the semiconductor read-only memory (ROM) and semiconductor random access memory (RAM). These devices are both simple and compact. Furthermore, when compared with magnetic disk and tape storage, they offer very fast access times.

Read-only versus read/write memory

The term "read-only" applies to a wide variety of memory types and all provide permanent or semi-permanent storage and, whilst the contents of a read-only memory cannot normally be changed, certain types of read-only memories may be re-programmed. Read/write memories, on the other hand, allow both reading and writing to take place and their contents can be modified at will.

Unlike magnetic disk and tape (which both exhibit read/write characteristics), the data stored in a semiconductor read/write memory will, unless special precautions are taken in the form of a battery-backed supply, be lost when the power is switched off. Such memories are thus often said to be "volatile" Semiconductor read-only memories, on the other hand, are permanently programmed and thus are said to be "non-volatile"

Random access memory

Semiconductor read/write memory is usually implemented by so-called "random access" memories (RAM). The term "random access" simply indicates that one can access stored data anywhere within the memory with equal ease. Readers should contrast this form of memory with the "sequential access" form of read/write memory provided by magnetic tape in which data is stored one item after another.

SEMICONDUCTOR READ-ONLY MEMORY (ROM)

Microprocessors require non-volatile storage for their control programs and, where appropriate, operating systems and high-level language interpreters. Since its contents will not be lost when the power is disconnected, this is an ideal application for a semiconductor ROM. Furthermore, if it becomes necessary to update the control program, operating system or high-level language interpreter, it is possible to remove the ROM and replace it with a later version.

We shall now briefly consider the characteristics of each of the most popular types of semiconductor ROM device:

Mask programmed read-only memories

When large-scale production of a microprocessor based system is envisaged (as is the case with a home computer, for example), the most cost-effective method of implementing read-only memory is with the aid of a mask programmed device. Such devices are programmed by the semiconductor manufacturer who uses a mask to determine the data that will be permanently stored within the chip. The programming information (used to generate the mask) is supplied to the semiconductor manufacturer by the manufacturer of the microprocessor-based system.

Since the process is only cost-effective for quantities in the tens of thousands, it should be obvious that the manufacturer of the microprocessor system needs to be very confident that the stored data and program is free from errors and will require no further modification.

Fusible-link programmable read-only memories

Fusible-link programmable read-only memories (PROM) are cost-effective for medium scale production and are programmed by the equipment manufacturer rather than the semiconductor manufacturer. The PROM consists of an array of nichrome or polysilicon fuses (see Fig. 5.1(a)). These fuse links may be "blown" by applying a current pulse of sufficient magnitude to rupture the link. Programming takes a considerable time but the equipment required is simple and relatively inexpensive equipment.

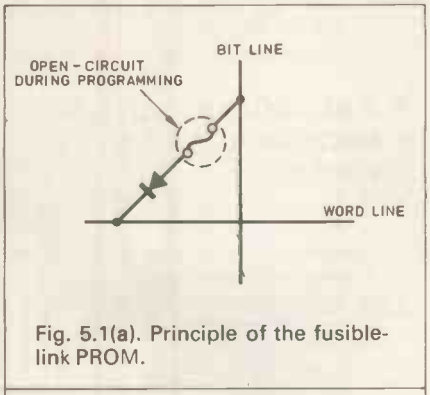


Fig. 5.1(a). Principle of the fusible-link PROM.

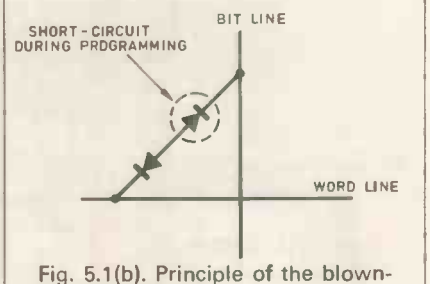


Fig. 5.1(b). Principle of the blown-diode PROM.

EE12080

Often, early variants of microprocessor-based systems are supplied with PROM devices which are later replaced with mask ROM devices as soon as teething troubles and bugs have been eliminated and large scale production commences.

An alternative to the fusible-link ROM is the "blown junction" ROM shown in Fig. 5.1(b). The operation of this type of ROM is similar to that of the fusible-link type but with the important difference that the diode junction is short-circuited rather than open-circuited during programming.

Erasable-programmable read-only memories

The programming of mask-programmed and fusible-link memories is irreversible. Once programmed, devices cannot be erased in preparation for fresh programming. The erasable-programmable read-only memory (EPROM) can, however, be "wiped clean" allowing the device to be programmed and re-programmed many times over.

EPROM devices are fitted with a window which allows light to fall upon the memory cell matrix. When this area is exposed to strong ultraviolet (UV) light over a period of several minutes, the stored data is erased. The EPROM may then be re-programmed using a low-cost device which supplies pulses of current to establish the state of individual memory cells. This process takes several minutes though some EPROM programmers can program several devices at once.

EPROMS are ideal for small-scale production and software development. They are, however, relatively expensive and thus are inappropriate for large-scale production. Typical capacities for EPROMs are within the range 2K to 32K bytes.

Readers may be forgiven for thinking that EPROM devices are really forms of read/write memory. In a sense they are: but it is rather more important to make a distinction between these memories and "true" read/write memories (e.g. semiconductor RAM) in which individual bytes can be changed at will.

Another important point is the time and ease with which a device may be re-programmed with data. A single byte of data can be accessed from a semiconductor RAM in a typical time interval of 150ns. An entire 8K byte RAM can have its data changed in a time interval of 8192×150ns (plus an additional overhead for the processor). This results in a total programming time which can be measured in milliseconds. An 8K byte EPROM, on the other hand, may require several minutes of programming not to mention the time taken for removal and erasure under UV-light!

SEMICONDUCTOR RANDOM ACCESS MEMORY (RAM)

Microprocessors require access to read/write memory to implement stacks on which register contents can be stored during processing. Control programs and operating systems also require access to RAM for temporary storage of data and system variables. A further area must be made available for the user to store his or her own programs and data. In addition, where a raster scanned display is used, an area of RAM is usually devoted to a "screen memory". With modern systems, this reserved area of memory is invariably "bit mapped" (i.e. each bit of "screen RAM" corresponds to a particular pixel). The typical allocation of RAM on an 8-bit microcomputer might be as follows:

Function	Storage capacity	Notes
System variables	512 bytes	A fixed address is used for each system variable
Stacks	0–256 bytes	Changes in size during program execution
Screen memory	16K	Bit-mapped screen
User's program and data	Up to 31.5K	Amount used depends upon individual program

We shall continue by briefly describing two different forms of semiconductor RAM; static and dynamic.

Static RAM

Static memories are based upon bistable cell configuration as shown in Fig. 5.2(a). This configuration will remain in a "set" or "reset" state (storing a 1 or 0) until changed or until the power supply is removed. The use of NMOS or CMOS (rather than conventional bipolar) technology ensures that each cell consumes very little current and thus a very large number of cells can be present within a small area of integrated circuit.

Dynamic RAM

Dynamic RAM utilises the principle of charge storage within a capacitor. The simplified circuit of an NMOS dynamic memory cell is shown in Fig. 5.2(b). The charge stored in the capacitor, C, inevitably leaks away and thus dynamic memories require periodic "refreshing". The process of refreshing a dynamic memory involves periodically reading the data stored and then writing it back to the memory. Some microprocessors (such as the Z80) incorporate a means of refreshing dynamic memories, alternatively the task can be consigned to a dedicated dynamic memory controller chip.

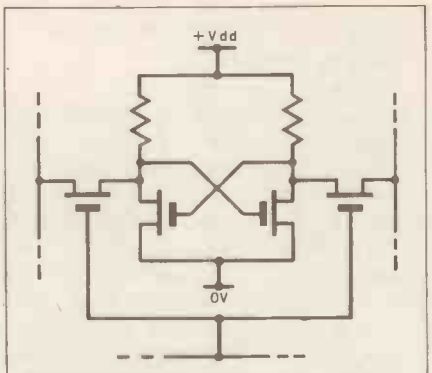


Fig. 5.2(a). Static memory cell configuration.

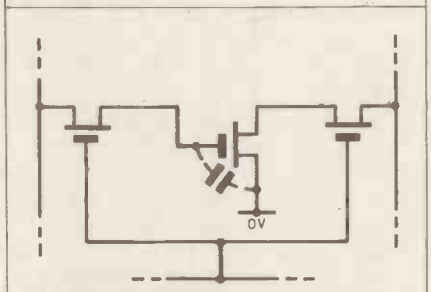


Fig. 5.2(b). Dynamic memory cell configuration.

MEMORY ORGANISATION AND STORAGE CAPACITY

Read-only memories are, for obvious reasons, "byte wide" (i.e. all eight bits stored at each location are contained within the same semiconductor device). Thus, a 4K byte EPROM would be organised as 4096 words each of 8 bits and its total storage capacity would be 32768 bits.

A wide variety of semiconductor RAM devices is currently available with storage capacities ranging from as little as 4096 bits (1K words×4 bits) to as much as 262144 bits (256K words×1 bit.

Each location within a semiconductor memory, whether it be ROM or RAM, comprises a "cell" at which a single bit of data (either a 1 or a 0) is stored. The memory cell matrix for a semiconductor RAM is shown in Fig. 5.3. The matrix comprises 64 rows and 64 columns and thus has a total of (64×64)=4096 individual cells.

The six least-significant address lines (A0 to A5) are used to form the column address whilst the six most-significant address lines (A6 to A11) are used to form the row address. Note that the action of the column and row decoders is that of selecting only ONE of the column and row lines at a time hence a unique cell is addressed which corresponds to the binary pattern placed on the address lines.

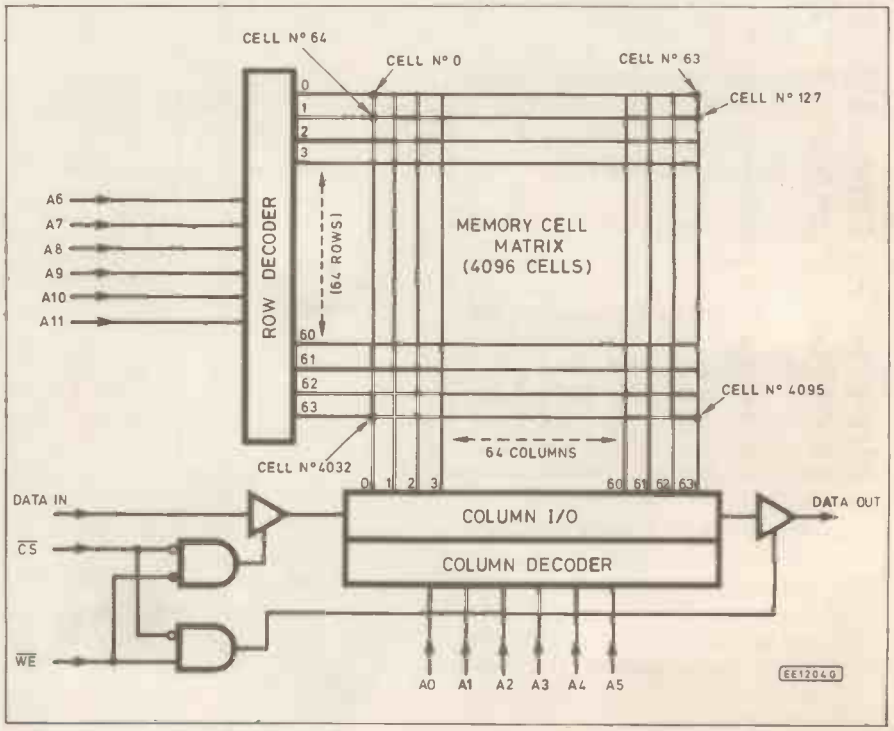
Fig. 5.3 also shows how data is transferred into and out of the memory cell matrix (by means of the column I/O) and how the active-low chips select ($\overline{CS}$) and write enable ($\overline{WE}$) lines are connected.

Problem 5.1

The data sheet for a semiconductor memory device is shown in Fig. 5.4.

(a) State the type number of the device.

Fig. 5.3. Memory cell matrix for a typical semiconductor RAM.



(b) State the manufacturer's name.
(c) State the type of device.
(d) State the storage capacity of the device.
(e) State the organisation of the memory.
(f) State the number of the pin which is connected to the:
(i) positive supply
(ii) GND or 0V
(iii) least significant address line
(iv) most significant address line
(v) programming supply voltage

Problem 5.2

The data sheet for a semiconductor memory device is shown in Fig. 5.5.

(a) State the type number of the device.
(b) State the manufacturer's name.

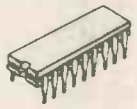
HM6147, HM6147-3 HM6147P, HM6147P-3

4096-word×1-bit High Speed Static CMOS RAM

■FEATURES

- Single 5V Supply and High Density 18 Pin Package
- High Speed: Fast Access Time 55ns/70ns Max.
- Low Power Standby and Low Power Operation, Standby: 100μW typ., Operation: 75mW typ.
- Completely Static Memory — No Clock nor Timing Strobe Required
- No Peak Power–On Current
- No Change of t_{ACS} with Short Chip Deselect Time
- Equal Access and Cycle Time
- Directly TTL Compatible — All Input and Output
- Separate Data Input and Output: Three State Output
- Pin-out Compatible with Intel 2147 NMOS STATIC RAM

HM6147, HM6147-3

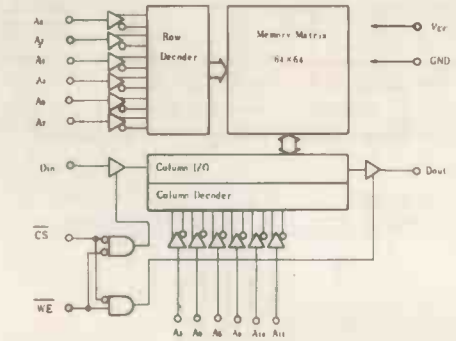


(DG-18)

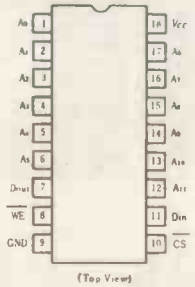
HM6147P, HM6147P-3

(DP-18)

■BLOCK DIAGRAM



■PIN ARRANGEMENT



(Top View)

Fig. 5.5. See problem 5.2.

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Rating	Unit
Voltage on Any Pin relative to GND*	V_T	−0.5 to +7.0	V
Power Dissipation	P_T	1.0	W
Operating Temperature	T_{opr}	0 to +70	°C
Storage Temperature (Ceramic)	T_{stg}	−65 to +150	°C
Storage Temperature (Plastic)	T_{stg}	−55 to +125	°C

* V_{IN} min = −1.0V (Pulse Width ≤ 20ns)

■RECOMMENDED DC OPERATING CONDITIONS (0°C ≤ Ta ≤ 70°C)

Parameter	Symbol	min	typ	max	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	GND	0	0	0	V
Input High (logic 1) Voltage	V_{IH}	2.2	3.5	6.0	V
Input Low (logic 0) Voltage	V_{IL}	−0.3*	—	0.8	V

* V_{IL} min = −1.0V (Pulse width ≤ 20ns)

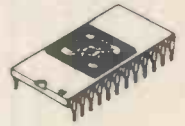
HN462716, HN462716G

2048-word × 8-bit U.V. Erasable and Electrically Programmable Read Only Memory

The HN462716 is a 2048 word by 8 bit erasable and electrically programmable ROMs. This device is packaged in a 24-pin, dual-in-line package with transparent lid. The transparent lid allows the user to expose the chip to ultraviolet light to erase the bit pattern, whereby a new pattern can then be written into the device.

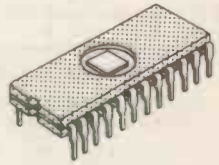
- Single Power Supply .... +5V ±5%
- Simple Programming .... Program Voltage: +25V DC
  Programs with One 50ms Pulse
- Static ..... No Clocks Required
- Inputs and Outputs TTL Compatible During Both Read and Program Modes
- Fully Decoded-on Chip Address Decode
- Access Time ..... 450ns Max.
- Low Power Dissipation .. 555mW Max. Active Power
  161mW Max. Standby Power
- Three State Output ..... OR-Tie Capability
- Interchangeable with Intel 2716

HN462716



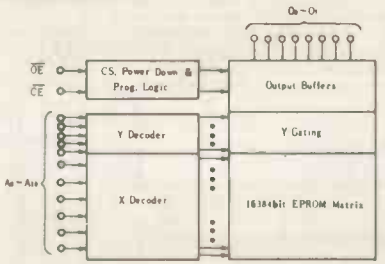
(DC-24C)

HN462716G



(DG-24B)

■BLOCK DIAGRAM



■PROGRAMMING OPERATION

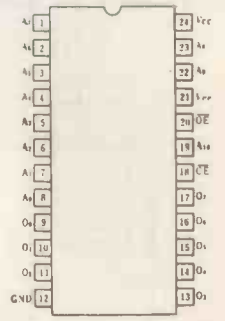
Mode \ Pins	CE (18)	OE (20)	V_{PP} (21)	V_{CC} (24)	Outputs (9~11, 13~17)
Read	V_{IL}	V_{IL}	+5	+5	Dout
Deselect	Don't Care	V_{IH}	+5	+5	High Z
Power Down	V_{IH}	Don't Care	+5	+5	High Z
Program	Pulsed V_{IL} to V_{IH}	V_{IH}	+25	+5	Din
Program Verify	V_{IL}	V_{IL}	+25	+5	Dout
Program Inhibit	V_{IL}	V_{IH}	+25	+5	High Z

■ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Operating Temperature Range	T_{opr}	0 to +70	°C
Storage Temperature Range	T_{stg}	−65 to +125	°C
All Input and Output Voltages*	V_T	−0.3 to +7	V
V_{PP} Supply Voltage*	V_{PP}	−0.3 to +28	V

* With respect to Ground

■PIN ARRANGEMENT



(Top View)

Fig. 5.4. See problem 5.1.

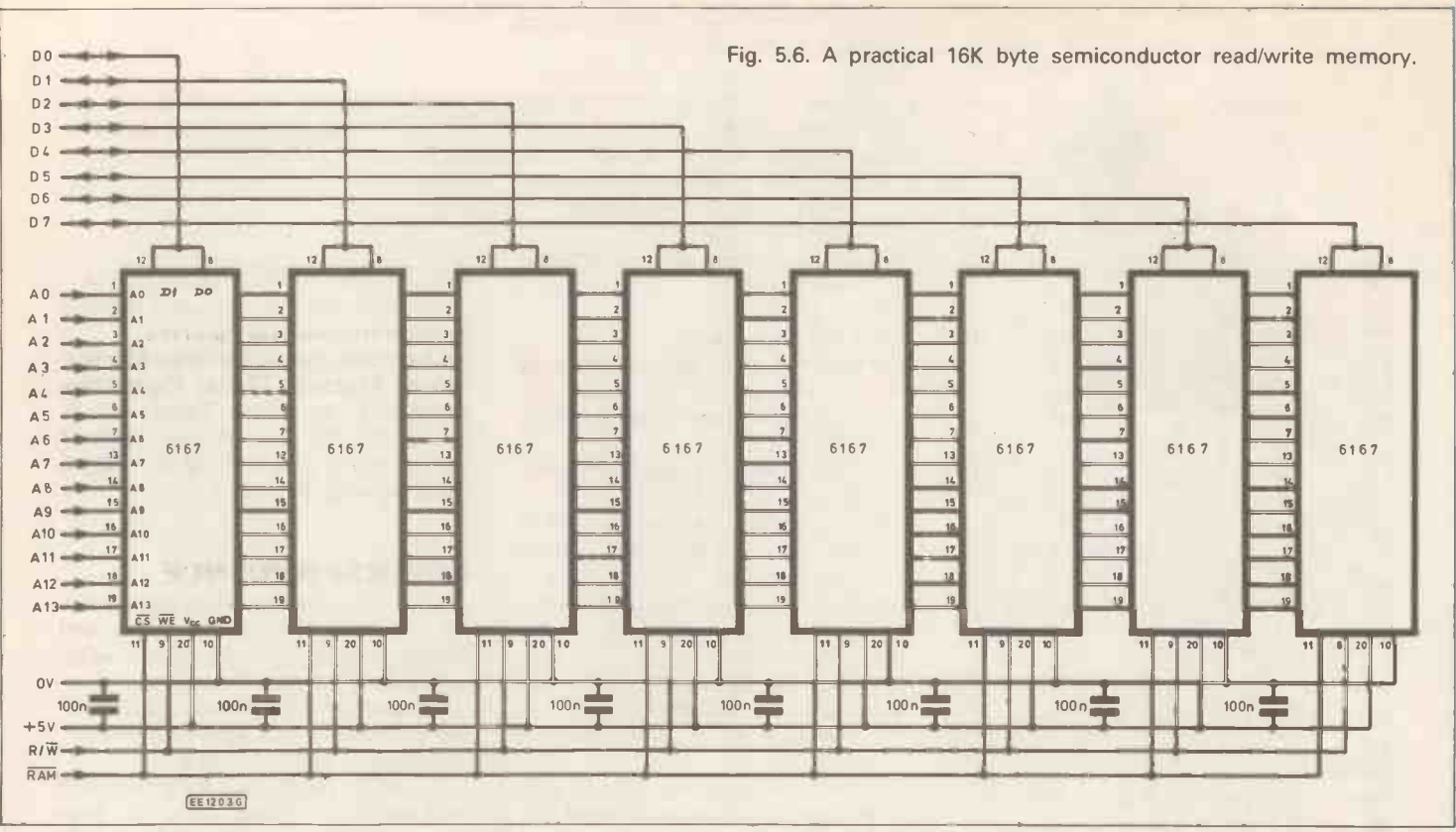


Fig. 5.6. A practical 16K byte semiconductor read/write memory.

(c) State the type of device.
(d) State the organisation of the memory.
(e) State the number of the pin which is connected to the:
  (i) positive supply
  (ii) GND or 0V
  (iii) least significant address line
  (iv) most significant address line
  (v) active-low write (WR) line
  (iv) address decoding logic

A practical semiconductor read/write memory

Fig. 5.6 shows the basic arrangement of a practical 16K byte semiconductor read/write memory based on eight 6167 CMOS static RAM devices. Each 6167 RAM is organised on the basis of 16384 words×1 bit and thus eight 6167 devices will be required (one for each data bit). Note that address lines A0 to A13 are common to all of the RAM devices and that the active-low chip select (CS) line is driven from the address decoder (not shown) which uses the two most significant address lines (A15) and (A14) as inputs to determine which of the four 16K byte blocks of memory is actually being used. The problem of decoding the two most significant address lines is easily resolved using some fairly simple logic but this topic must be left for Elementary Microprocessors!

The eight 100n capacitors shown in Fig. 5.6 provide decoupling of the +5V supply rail. To be effective, these capacitors are located close to the +5V and GND pins of each integrated circuit. The penalty for not taking adequate care with decoupling the supply rail is that unwanted noise and transients can result in the corruption of data.

MEMORY MAPS

Each location in semiconductor ROM and RAM must have its own unique address. At each address a byte (comprising eight bits) is stored. Each ROM, RAM (or bank of RAM devices) accounts for a particular block of memory, its size depending upon the capacity of the ROM and RAM in question. Furthermore, I/O devices such as keyboards, VDU displays, parallel and serial ports may also be "memory mapped" into the microprocessor's address space. As an example, a simple home computer may have 12K byte ROM, 4K bytes reserved for I/O, and 16K bytes of RAM allocated to addresses shown in the following table:

Device	Capacity	Address	Range
	(bytes)	Hexadecimal	Decimal
ROM	12K	0000-2FFF	0-12287
I/O	4K	3000-3FFF	12288-16383
RAM	16K	4000-7FFF	16384-32767
unused	32K	8000-FFFF	32768-65535

A more meaningful way of expressing the allocation of addresses to RAM, ROM and I/O is by means of a "memory map" along the lines of that shown in Fig. 5.7. Note that the map is drawn to scale with addresses ranging from 0000H (at the bottom) to FFFFH (at the top) and that not all of the address space is populated (the upper 32K bytes of memory is unused and any attempt to read or write to this area would be unproductive!).

Problem 5.3

Fig. 5.8 shows the memory map for a microprocessor based system.

(a) State the total amount of ROM available.
(b) State the total amount of RAM available.
(c) If the ROM space is populated by devices each organised on the basis of 4096 words of 8 bits, how many ROM devices will be present?
(d) If the RAM space is populated by devices each organised on the basis of 16384 words of 4 bits, how many RAM devices will be present?
(e) What is present at each of the following memory addresses?
  (i) 007F hexadecimal
  (ii) 32767 hexadecimal
  (iii) 8001 hexadecimal
  (iv) 49150 decimal
  (v) 1111111110101000 binary

SECOND PRACTICAL ASSIGNMENT

Readers are now ready to undertake the second Introductory Microprocessors Practical Assignment. This assignment involves identifying semiconductor memory devices and investigating the memory map of a microprocessor-based system. The module objective references are 3.3.2, and 3.3.3.

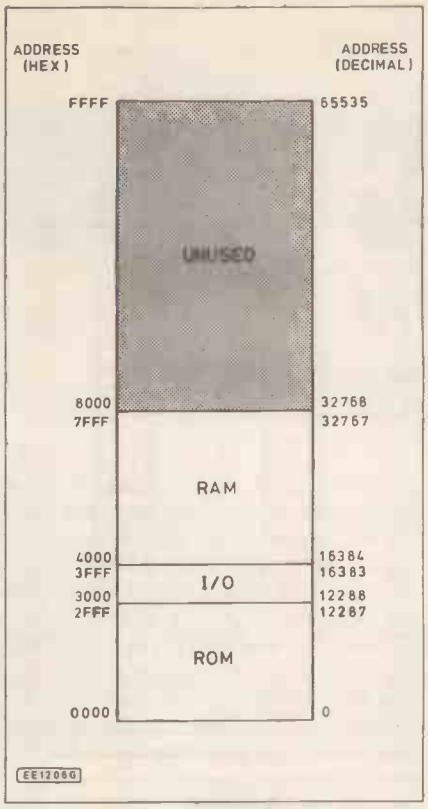


Fig. 5.7. Memory map for a simple home computer.

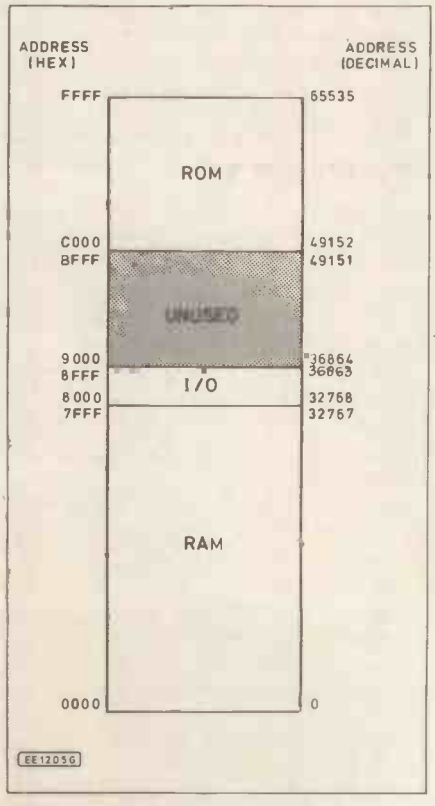


Fig. 5.8. See problem 5.3.

As before, the Practical Assignment must be undertaken at an approved local centre where candidates will be provided with supervision and appropriate working conditions. Candidates should, however, provide their own A4 note paper, pens and pencils. For its part, the Centre will supply candidates with the necessary data sheets, books and handbooks.

During the Practical Assignment, candidates will be required to use data sheets to determine the characteristics of one of each of the following semiconductor memory devices:

(a) a mask-programmed ROM
(b) a fusible-link ROM
(c) an erasable-programmable ROM (EPROM)
(d) a static RAM
(e) a dynamic RAM

For EACH of your chosen memory types you should:

(i) State the type number (e.g. 2732)
(ii) State the manufacturer's name
(iii) Sketch the pin-out and label the address, data and control pins (using standard conventions to clearly indicate the orientation of the device)
(iv) State the storage capacity (e.g. 4K bytes)
(v) State the organisation of the memory (e.g. 4K words×8 bits)

For the microprocessor-based system provided, you should read the documentation provided and draw a memory map for the system clearly showing:

(i) Addresses at boundaries (stated in decimal and hexadecimal)
(ii) Areas occupied by ROM, RAM, and I/O (where appropriate)
(iii) Identify any areas reserved for special use (e.g. screen memory, system variables etc.)

Marking

Candidates will have satisfactorily completed this Practical Assignment if they can demonstrate success in all items marked with a square and at least THREE out of FIVE items marked with a circle in the list below:

Completed within two hours	○
Correct classification for each type	□
Manufacturer identified correctly for each type	○
Correct pin-out with orientation information for each type	○
Correct storage capacity for each type	○
Correct organisation for each type	○
Memory map shows addresses at boundaries	□
Correct memory allocation	□

Where candidates are deemed unsuccessful, a period of at least seven days must elapse before a retake is permitted. This should give candidates an opportunity to prepare themselves. Note also that most centres will expect candidates to use different data sheets/books and microprocessor-based systems for any further attempts.

NEXT MONTH: We shall be dealing with methods for input and output of data from microprocessor-based systems.

BACKGROUND READING

The following background reading is recommended for Part Five:

Chapter 6 (Semiconductor Memories) of **Practical Digital Electronics Handbook** by Mike Tooley (Published by PC Publishing), ISBN 1 870775 00 7. **Available from the EE Book Service. See page 000.**

CORRESPONDENCE

Comments and queries from readers are welcome and should be sent directly to the author at the following address:

Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey KT13 8TT.

Please include a stamped addressed envelope (and be prepared to wait a little!) if you require an individual reply. General queries will be dealt with in "Readers Forum" which will next appear in Part Nine of the series.

GLOSSARY FOR PART FIVE

Address decoder
A decoder which selects a specific address or field of addresses to enable unique devices.

Erasable programmable read only memory (EPROM)
A programmable read-only memory that can be erased and reprogrammed. Most EPROM devices can be erased by exposing them to ultraviolet (UV) light.

Memory map
A drawing or table which shows the address assignments for each device in the system.

Memory mapped I/O
Input/output devices that are accessed using the same group of instructions and control signals as used by the memory devices (RAM and ROM) present in the system. The memory and I/O devices thus share the same address space.

Non-volatile
Property of a memory in which data is not lost when the power supply is removed or disconnected.

Read/write memory
Memory in which data can be read from or written to. Semiconductor RAM is an example of read/write memory.

ANSWERS TO PROBLEMS
The answers to this month's problems are shown on page 174.

SUPERCONDUCTORS

GEORGE HYLTON

Recent discoveries of new materials which lose all electrical resistance when cooled promise to open up new fields in electronics.

THE first superconductors—discovered many years ago by a Dutch researcher—were just metals. Lead, for instance, loses its resistance when cooled to liquid helium temperature, just a little above absolute zero. The discovery of superconductivity seemed to offer the prospect of electrical machines with greatly increased efficiency. An electric motor or generator wound with superconductive wire would have no "copper loss".

Hopes were dashed by the discovery that superconductivity was destroyed if the superconductor was immersed in a magnetic field of moderate strength. This meant that the resistance of a superconducting winding would be restored as soon as enough current flowed through it to create a moderate magnetic field. In time, however, alloys were discovered—notably niobium-tin—which remain superconductive even in high fields. Niobium-tin wire or tape is used nowadays for the coils of very powerful electromagnets. No resistance means no power consumption. A current, once started, will flow for ever in a short-circuited winding. Of course, it is still necessary to expend energy in keeping it cool. Liquid helium refrigeration doesn't come cheap. But it's still worthwhile in some applications.

ACTIVE DEVICES

Low-temperature research began to yield discoveries which opened up startling new possible applications for superconductivity. These included the superconductive computer. This depends on the fact that by turning resistance on or off with a magnetic field, gates can be made. If you have gates you can make computers. Another application stems from the possibility of using the sensitivity of a superconductor to a magnetic field as a means of detecting and measuring the field itself. In time, an active device called a SQUID was invented. SQUID is an acronym for Superconductive Quantum Interference Device. For practical purposes, a SQUID is just an extremely sensitive detector of magnetic fields. A SQUID placed near the skin, over an artery, has been used to measure the flow of blood through the artery. Blood, since it contains iron, is magnetic.

Other SQUID applications have been proposed. One is to detect radio waves, by responding to the magnetic field of the wave.

TOO COLD FOR COMFORT

The need to operate at liquid helium temperature was a great hindrance to these low-power applications. It's all very well to install a helium refrigerator for a large machine like a big particle accelerator but it is an embarrassment to have to do so for a compact computor. For this reason the superconductive computer, though shown to be feasible, never got off the ground. Now, however, things are changing. IBM, who had done much of the research, announced about a year ago that their laboratories had discovered a new superconductive material, capable of working at temperatures around minus 196 degrees C. This is still very cold, BUT liquid nitrogen boils at −196 degrees C and can therefore be used as a coolant.

Unlike liquid helium, which is very expensive and difficult to handle, liquid nitrogen is cheap and easy to handle. At a recent demonstration at the Royal Society in London, scientists from Birmingham University kept a supply of it in ordinary vacuum flasks (the kind you keep coffee in). When one of their superconductivity demonstrations stopped working because its liquid nitrogen had evaporated they simply topped it up from a flask.

CERAMICS

The new superconductive materials are quite unlike the traditional ones. Instead of metals, black ceramic materials are used. Chemically they are combinations of the oxides of several elements. A key constituent of the IBM compound was lanthanum, but more recent research at Houston, Texas has shown that yttrium compounds can also superconduct. The one being used at Birmingham is yttrium barium copper oxide, chemical formula $YBa_2Cu_3O_7$. It is made by grinding up suitable constituents then sintering them at about 950 degrees C: quite a simple process.

You end up with a piece of black, rather brittle and hard material. Not, on the face of it, the sort of thing which can be made into wire. Fortunately the material can, if properly treated, retain its properties even when ground to a powder. To make wire, you pack a copper pipe with the powder then reduce the pipe's diameter by a wire-drawing process. A final heat treatment makes the now fairly thin wire ready for use.

APPLICATIONS

If you take a block of copper and move it into the field of a powerful magnet you can feel the copper being repelled by the magnet. This seems surprising, since copper is not a magnetic material. The explanation is that motion of a conductor (the copper block) through a magnetic field causes electromotive forces to be created in the conductor. These drive currents through the conductor which in turn produce a magnetic field. This secondary field opposes the primary field of the magnet itself. Hence the repulsion.

The effect has been used in vehicles to make "eddy current brakes". It is also the basis of a school physics experiment in which a magnet, held near the metal bob of a swinging pendulum, damps down the swinging. Transferred to the field of superconductors this effect produces a spectacular result. Place a magnet on the table, move a block of superconductor above it and let go. The block floats in the air above the magnet. The induced currents, once started, go on undiminished for ever—or at any rate until the block warms up and stops superconducting. So the block floats at a point where its own field just produces enough repulsive force to support it.

The practical use of this physicist's parlour trick could be to make frictionless bearings (Fig.1). An axle carrying a rotor is supported by two blocks of superconductor floating in the field of a magnet. If the whole assembly were in a vacuum (to avoid air resistance) friction in the ordinary sense would be eliminated. There are plenty of potential applications (including gyroscopes for inertial navigation) which could benefit from such an arrangement.

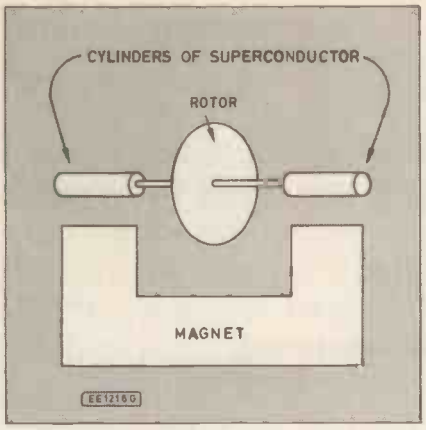


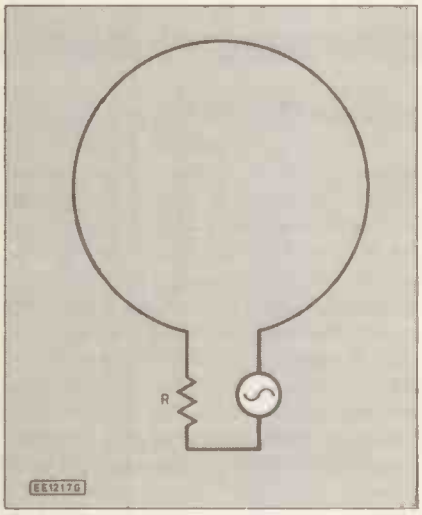
Fig.1 Frictionless bearings exploit the repulsion of a superconductor by magnetic field. Here the two cylinders of superconductive material float above the magnet, allowing the rotor to turn without any of the normal bearing friction.

ELECTRICAL USES

Apart from the obvious attractions of no-resistance windings for magnets and motors, superconductors have a place in areas more familiar to the classical electronic engineer. Any transducer which involves magnetism—and these include moving-coil microphones and sound generators—could, in principle, benefit from the use of superconductive windings. It would, of course, be inconvenient to operate domestic equipment at liquid nitrogen temperature, so the superconductive hi-fi speaker is unlikely. But there may be specialised areas, such as sonar, where the improved performance repays this inconvenience.

One intriguing possibility is the superconductive, miniature radio aerial. Any radio engineer will tell you that an aerial can only be efficient if its dimensions bear some close approximation to the wavelength. A typical example is the dipole aerial, which works best when half a wavelength long. Attempts to shorten it result in reduced efficiency. A one-tenth wavelength dipole is a terribly bad launcher of radio waves.

Fig.2 In a superconductive loop aerial, the resistance of the loop wire and the r.f. generator would be reduced to zero, allowing large currents to circulate without ohmic losses.



Despite this, engineers have also known for a long time that reducing aerial size to a small fraction of a wavelength would be theoretically possible if only resistance could be eliminated. Take for instance a single-turn loop aerial (Fig.2). A tiny loop, much less than a wavelength across, could in theory radiate as much energy as you want. It's just a question of increasing the circulating current sufficiently. What stops you from doing so is the resistance of the loop and of the generator which feeds it. If these resistances could be eliminated by using superconductors then the applied energy would all be radiated instead of dissipated in the internal resistance R (Fig. 2). Promising experiments have already been done at 300MHz.

FURTHER OUTLOOK: WARMER

The race is on not only to exploit liquid-nitrogen temperature superconductivity but to discover new materials that superconduct at even higher temperatues. Ideally, they would superconduct at ordinary room temperatures, so that no cooling at all would be needed. Whether that is possible remains to be seen. In the meantime the new so-called high temperature superconductors will certainly make fortunes for people clever enough and quick enough to exploit them.

New Book

Title: Practical Digital Electronics Handbook; Author: Mike Tooley; **Pages:** 208; **Format:** 216 x 138mm; **Illustrated:** 100 line drawings; **ISBN:** 1 870775 00 7; **Price:** £6.95.

We are pleased to bring you this new book; published in association with PC Publishing it has been reprinted and updated from the *Digital Trouble Shooting* series published in EE.

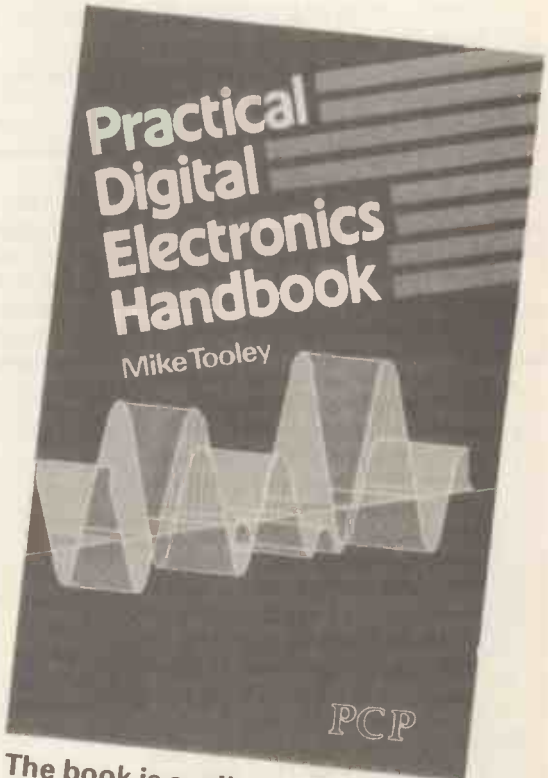
The vast majority of modern electronic systems rely heavily on the application of digital electronics, and the *Practical Digital Electronics Handbook* aims to provide readers with a practically based introduction to this subject. The book will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry, as well as to those wishing to update their knowledge of modern digital devices and techniques.

The book introduces digital circuits, logic gates, bistables and timers, as well as microprocessors, memory and input/output devices, before looking at the RS-232C interface and the IEEE-488 and IEEE-1000 microprocessor buses.

A special feature of the book is the section on digital test gear projects, and the practical emphasis is continued with appendices on test equipment and useful reference data.

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.



The book is available through the *EE Book Service* – see page 176.

exploring electronics

OWEN BISHOP

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

Part 21 More computer maths

THE chips used in microcomputers and pocket calculators have many *Full Adder* circuits (see last month) connected so as to perform all the arithmetical operations that are needed. There are hundreds of gates on the chip.

The advantage of these very complicated circuits is that they work very fast. They give a result in a few nanoseconds, so that we can perform hundreds of stages of a very long calculation in a reasonably short time. Their other advantage is that they do not make mistakes.

In our Simple Adder demonstration project we use a much simpler i.c. that can add two binary numbers together, each number having four digits. A number that has four binary digits is said to be a four BIT number. We call this i.c. a 4-bit adder (Fig. 21.1). It has a carry-in input, so the biggest addition it can do is to add 15 plus 15, plus 1 carried in, to give a total of 31.

This may not seem much compared with what a cheap calculator can do, yet the i.c. needs 43 logic gates to perform this relatively simple task. The gates, consisting of over 150 transistors, 150 resistors and 40 diodes, are all on the single chip of the 7483.

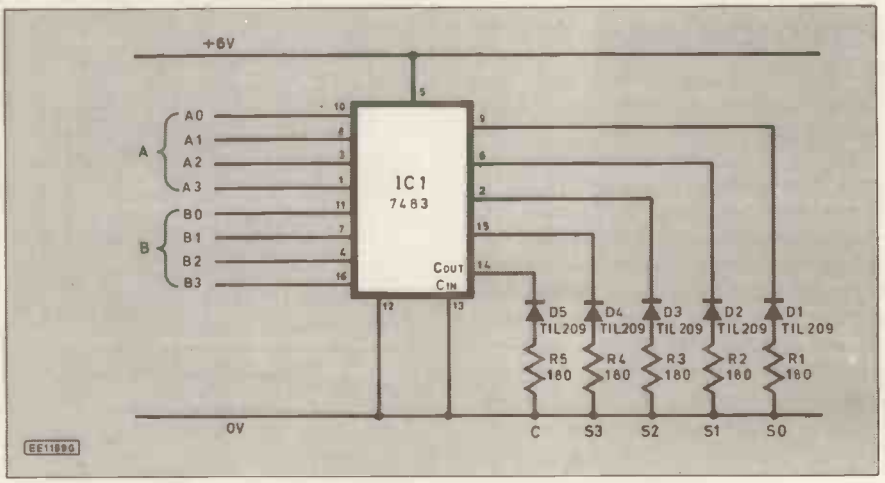
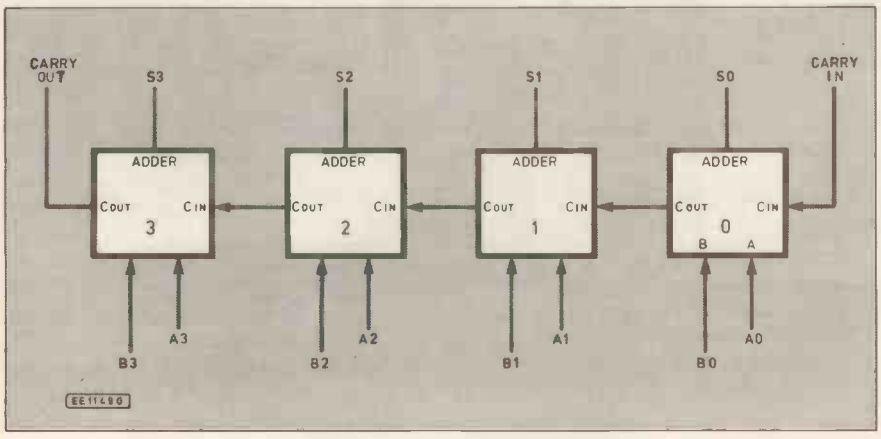


Fig. 21.2. Circuit diagram for the demonstration Simple 4-Bit Adder (A+B).

SIMPLE ADDER

The demonstration circuit diagram for a Simple 4-Bit Adder is shown in Fig. 21.2. Building and operating this rather basic summing circuit will help you understand how your pocket calculator works. The breadboard component layout and wiring (Fig. 21.3) looks rather complicated, but it would be even more complicated if you had to build and connect together 43 individual gates!

Fig. 21.1. How four adders are connected to add two 4-bit numbers. A0, A1, A2, A3 are the four digits of number A, where A0 is the least significant (right-most) digit.



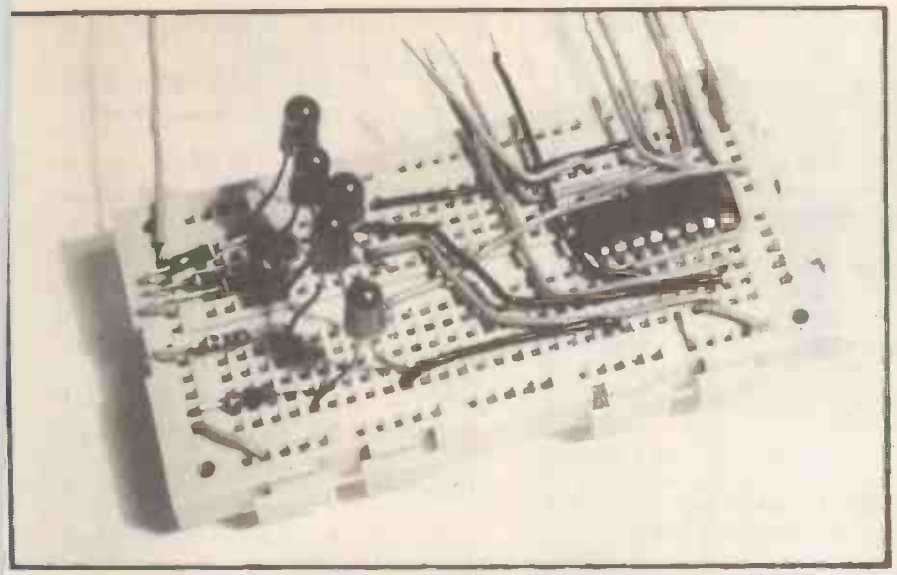
The i.c. has nine inputs, four for the 4-bits of number *A*, four for the 4-bits of number *B* and one carry-in bit from an earlier stage of addition (if any). To begin with "ground" the carry-in pin (pin 13) by plugging it into one of the sockets in the bottom row, so that carry-in is at logic "0".

The inputs to the adder are either connected to +6V (*high=1*, top row sockets) or connected to 0V (*low=0*, bottom row sockets). Try plugging A1, A3, B0 and B1 into the bottom row (0V) and the others into the top row. This is the equivalent of giving *A* the value 1010 and *B* the value 0011.

The result of this addition is 1101, which is indicated by the state of the five l.e.d.s (D1-D5). Fig. 21.4 shows the logical situation.

Try setting up these additions on the circuit and see if you get the result you expect.

1001	0101	1011	1111
+0010	+0101	+0001	+0001



COMPONENTS

Resistors

R1-R5	180 (5 off)

All 0.25W 5% carbon

Semiconductors

D1-D5	TIL209 l.e.d. (or similar) (5 off)
IC1	7483 4-bit binary Full Adder
IC2	7400 quad 2-input NAND gate (see text)

Shop Talk

See page 158

Miscellaneous

Breadboard (e.g. Veroblock); connecting wire and 5V to 6V supply.

Approx. cost Guidance only **£7 each**

If you want to add numbers with more than four digits, you can do it in stages, 4-bits at a time. For example try adding:

00011100

+10101001

First set up the circuit to add the 4-bits to the right (the least significant bit). You get the answer 10101, in which the carry bit is "1". Before you go on to add the four most significant bits write down the answer obtained so far, which is 0101, carry 1.

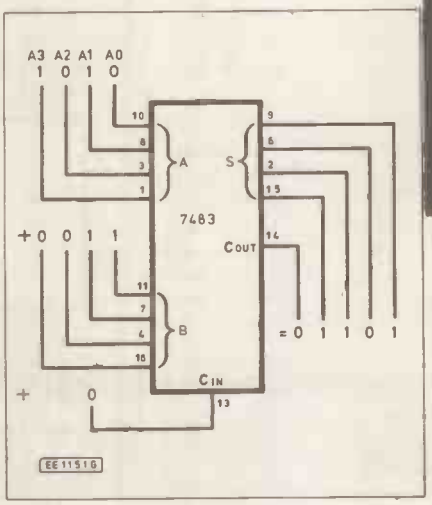


Fig. 21.4. Adding two 4-bit numbers (see text).

For the second stage of the addition, the high carry digit is taken care of by joining the carry-in input (pin 13) to the 6V line. Set up the circuit to sum the remaining digits 0001+1010 (plus the carry-in, which is already set). The answer indicated on the lamps is 1011.

Write this in the four spaces left in the answer line. This gives the final result:

00011100
+10101001
10110101

By using this method numbers with any reasonable number of digits can be added step by step. The same thing could be done in a single stage by using two 7483's and wiring the "carry-out" of the first to the "carry-in" of the second.

SUBTRACTING

No, there is no such thing as a subtractor i.c. But by a simple way of playing with the digits we can perform subtraction using an *adder circuit*. This is because of a useful property of binary

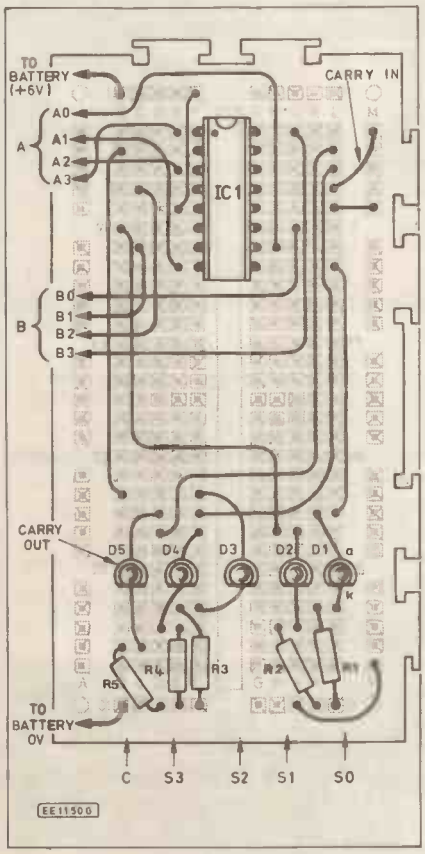
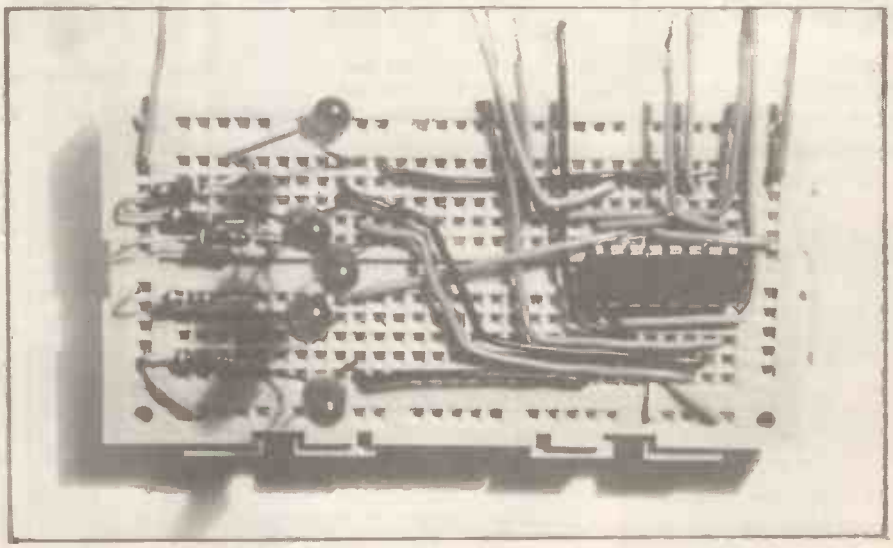


Fig. 21.3. Demonstration breadboard component layout for the Simple Adder.



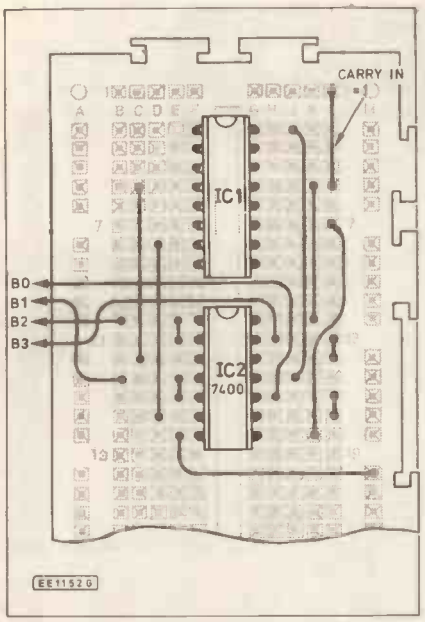


Fig. 21.5. Converting the adder of Fig. 21.2 and 21.3 into a subtractor; replace "B" wiring as shown and alter carry-in wire; leave "A" wiring and l.e.d.s as in Fig. 21.3.

numbers. If we want to subtract 0110 from 1010 for example, the first thing we do is find the *complement* of the number we want to subtract. The complement of a number is obtained by writing a "0" for each "1" and a "1" for each "0". So the complement of 0110

is 1001

To perform the subtraction:

1) Write down the number to be taken away from 1010
2) Write down the *complement* of the number that is to be taken away 1001
3) Write down "1" 1
4) ADD these three together and cross out the 5th (carry) digit, if any ~~1~~0100
5) What is left is the answer to the subtraction 0100

This works with all binary numbers and is an easy task for the adder i.c. To make it take *B* from *A* we need to obtain the complement of *B*.

This is done by inverting each digit of *B*. We use a 7400 with its four gates wired as INVERT gates (Fig. 21.5). To provide that extra "1" that has to be added, we connect the carry-in input (pin 13) to the 6V line. We remove the D5 LED, as this is not required in the answer. The diagram shows the adder performing the subraction given in the example above.

Try this circuit with these subtractions:

1001	0101	1000	1000
−0010	−0101	−0001	−0111

MULTIPLICATION AND DIVISION

If we want to calculate the product of 4×5, for example, we can set this out as an addition:

4×5=5+5+5+5=20

We add 5 to itself 4 times. Multiplication is simply repeated *addition*. When we ask a computer or calculator to multiply, it is programmed to obtain the product by using its adder several times.

Division is basically a matter of *subtraction*. To divide 16 by 5, for example:

We first take 5 from 16	16−5=11
Take 5 from what is left	11−5=6
Repeat this	6−5=1

Now only 1 is left and the result of the next subtraction would be less than zero. We can subtract 5 from 16 three times, leaving 1. In other words 16 divided by 5 is 3, remainder 1.

A computer is programmed to perform this operation automatically—using its *adder* to perform the subtractions. Thus the adder is the basis of all calculations performed by a computer or pocket calculator.

Next month: An I.C. Radio using the ZN414 radio chip.

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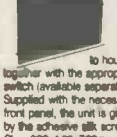

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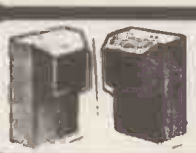

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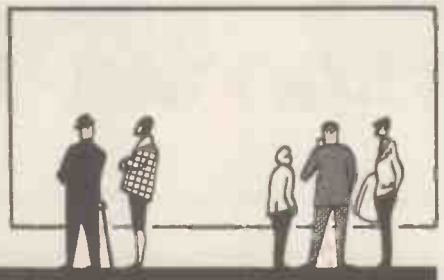


BY DAVID BARRINGTON

Component Buying

Over the last four to six months our "mailbag" has shown us that there are many new entrants into the world of electronic construction, as a hobby or a future career. So this month we should like to make a couple of points about component purchasing.

It would appear that the majority of constructors obtain their components by mail order. Therefore, the first step should be to obtain as many catalogues as possible from different advertisers.

As well as listing components and equipment, most catalogues contain useful data and certainly at least three should be purchased. We suggest that one of these should be purchased from your nearest stockist so that you can always make a personal call at the advertiser's shop to get to know his stock.

The charge for catalogues varies from the price of a stamp to about £1.60. In most cases the outlay for catalogues is redeemable with component order vouchers or it contains a selection of "special discount lines" which will usually cover the price of the catalogue.

It is important to study these catalogues as it will help constructors to familiarise themselves with components and typical sizes and values usually stocked. Also, it can save money when looking for the more unusual devices.

When ordering from a catalogue always follow any instructions contained therein. Most contain an order form on which the stock number, quantity and price should be entered clearly. To help cut down on the number of mis-directed parcels always print name, address and post code in *block capitals*.

If an order form is not supplied, always follow the recommendation given in the particular Components List contained in the published article and try to use types specified. If in doubt, cut out the list or better still make an exact copy and send this to the advertiser, including the title of the project and issue date it appeared.

Catalogue Received

Over the years we have often used the name of **Maplin** when recommending a standard for electronic supplies catalogues and a mail order service *par excellence*.

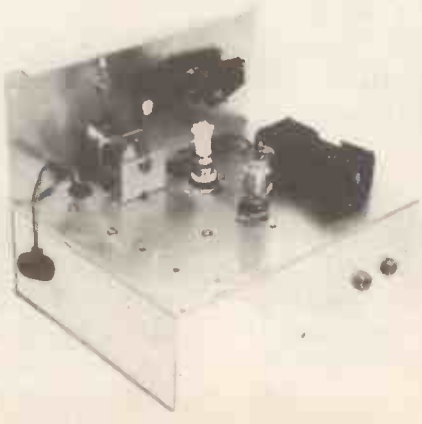
We see from their latest mammoth 512-page offering that they have installed a new, super fast, computing system; introduced their own Mapcard credit card system and improved their Cashtel ordering from home, via a home computer system. Cashtel stands for Computer Aided SHopping by TELephone and all you need is a modem and interface for your computer to be able to use their service.

This year they have introduced a new "Radio Control" section which lists complete systems, such as the Apache racer cum buggy, to servos and R/C crystals. Another section which appears to increase with each edition is the "Connectors" listing. This time it contains 34 pages with probably the largest addition of "new" items.

In the latest edition is a half-price offer for a Digital Watch Kit for the sum of just £1. Copies of the Maplin 1988 Components Catalogue (£1.60) should be available from most big W. H. Smiths shops or direct from Maplin Electronic Supplies. It is also available from any of their components shops.

One Valve Radio

As with most early radios, the *One Valve Radio* featured last month must have a good aerial and earth if it is to give reasonable reception. For best results the designer recommends that the aerial should comprise of around 30ft of insulated wire slung between the house and a tree or clothes post.



A shortwave aerial kit and accessories, ideal for outdoor hookup, is available from Tandy shops. The kit (code no. 278758) includes 75ft of copper antenna wire, 50ft lead-in wire, window feedthrough, insulators and complete instructions.

Introducing Microprocessors

Readers who have been following our highly popular City & Guilds 726 programme on *Introducing Microprocessors* may be interested in some news we have received from two ITeC Centres.

The **Rochdale ITeC Centre** inform us that they are fully accredited by C&G, and as such, they would be willing to undertake local assessment for any readers in their area. Being linked to the *Open College*, their staff are fully experienced in dealing with students who are using remote learning materials.

Dependant on demand and other training commitments they are considering setting up a "Workshop" type of meeting, possibly on Saturday mornings, where students can meet to discuss their problems and obtain tutorial help. Obviously, a nominal charge will have to be levied but we understand that this will be kept to a minimum.

For further details contact Alwyn Davis at Rochdale ITeC on ***0706 350600***.

Another centre that is prepared to offer similar facilities is **Borders Information Technology Unit** of Galashiels, Scotland. They have also informed us that they are also prepared to offer assessment assistance in completing the 726 module.

Borders ITeC intend providing practical and written assessment at Galashiels, Peebles, Kelso, Eyemouth and Hawick. For further information on how to join one of their study groups contact Ewan Davidson at Borders ITeC on ***0896 56461, 56512/17***.

CONSTRUCTIONAL PROJECTS

This month we expect very little component sourcing problems for most of our constructional projects. In fact, most of our advertisers should be able to supply the items called for in the components lists "off-the-shelf".

SOS Alert

The choice of relay for the *SOS Alert* is left to the constructor, but the switching contacts MUST be capable of handling the loads used. This is particularly important if switching mains lamps.

The voltage range at which the relay will operate also governs the power supply to the circuit.

Semiconductor Tester

The only component called for in the *Semiconductor Tester* that is likely to cause sourcing problems is the voltage reference device.

The 1.2V temperature compensated 8069 Voltage Reference i.c. is currently listed in the Maplin catalogue for the sum of £1.95, quote order code YH39N (8069CCZR). The printed circuit board is available from the *EE PCB Service*, code EE594 (see page 190).

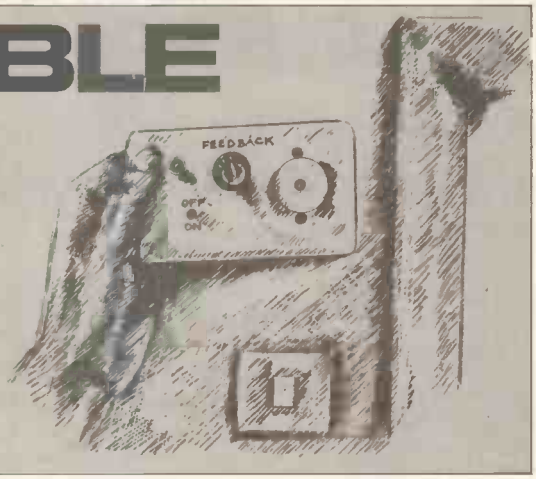
FREE INSIDE!

24 page GREENWELD

SPRING CATALOGUE SUPPLEMENT

Our November 87 issue carried the full Greenweld catalogue—now we present their spring supplement

PIPE & CABLE LOCATER



Ever worried about drilling through the wiring or a pipe? This simple project will allow you to trace those hidden obstacles before you make a mess of d.i.y.

AUTO POWER OFF

Do the kids leave their TVs on and fall asleep, or is it the garage light that everyone forgets? This practical unit will switch the mains off at a preset interval of between 3 and 30 minutes.

LOW FUEL ALERT

Save the walk and the frustration, this unit gives an audible warning when the fuel tank nears empty.

FREE DATA CARD

EVERYDAY ELECTRONICS

APRIL ISSUE ON SALE FRIDAY MARCH 4th

NEXT MONTH

Constructional Project

ENVELOPE SHAPER

RUSSELL G. PAYNE

Keyboard players and guitarists are sure to make a big impact with this low cost sound effect box

ALTHOUGH there are a large amount of devices on the market to enhance (or disguise!) the guitarist/keyboard players' sound, the author has not come across this device in the shops—at least not in such a simple and inexpensive form as this one. The effect produced is best described as that obtained by playing a tape backwards—the natural "envelopes" (or waveform profiles) are all reversed.

Hence a guitar, for example, with its natural short sound rise time and long fall time would sound more like a violin, with its long attack time. Some players produce this effect simply by winding the volume control up and down.

ENVELOPE SHAPING

Envelope shaping, as this technique is called, has been around for a long time: commercial envelope shapers giving control over attack, decay, sustain and release times (see Fig. 1), are available but are inevitably expensive and often over-complex.

This circuit, which generates the "reverse attack" effect can be considered to be a simple form of envelope shaping; in the terms of Fig. 1, the attack time is variable; the release time is a fixed short period and the sustain and decay periods follow the input waveform envelope.

There are easier ways to produce this effect without actually tape-recording the sounds and reversing them, or wearing out your volume control. This project employs an op-amp whose gain is varied to "amplitude modulate" the incoming waveform.

Op-amps are convenient to use here, because their gain can be changed by varying either the feedback or the source resistor. In this circuit, a field effect transistor (f.e.t.) is used as a variable resistor inserted as one of the gain defining resistors in the op-amp circuit. By changing the Gate-Source Voltage (Vgs) the effective Drain-Source Resistance (Rds) is also changed.

A graph of Vgs against Rds to illustrate this effect is shown in Fig. 2. When Vgs exceeds a value known as the "pinch-off" voltage (VP), the f.e.t. becomes cut-off and Rds is virtually open-circuit. The minimum Rds value, when Vgs=0 however, is less well defined and depends on the f.e.t. manufacturing process; the exact value is not critical in this circuit.

To digress a little, the idea of using d.c.levels to control sound in this way is actually the basis of analogue sound synthesis. Voltage Controlled Oscillators (VCO's) and amplifiers (VCA's) are common jargon in the synthesiser world. Furthermore, the amplitude modulation technique mentioned above is the principle used in the generation of many radio wavebands although the "incoming" waveform ("carrier") would be of fixed frequency and amplitude.

HOW IT WORKS

A block diagram of the Envelope Shaper circuit is shown in Fig. 3. The main signal path is through amplifier IC1 whose gain is

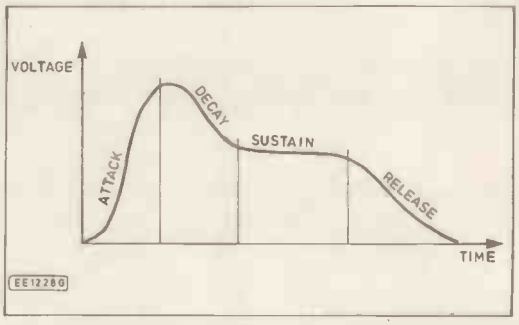


Fig. 1. A generalised sound waveform "envelope" showing the four controlled periods used in the synthesis of sound.

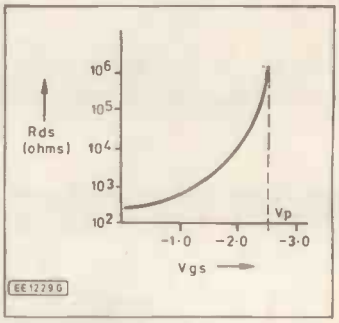


Fig. 2. How the drain-source of an n-channel varies with gate voltage.

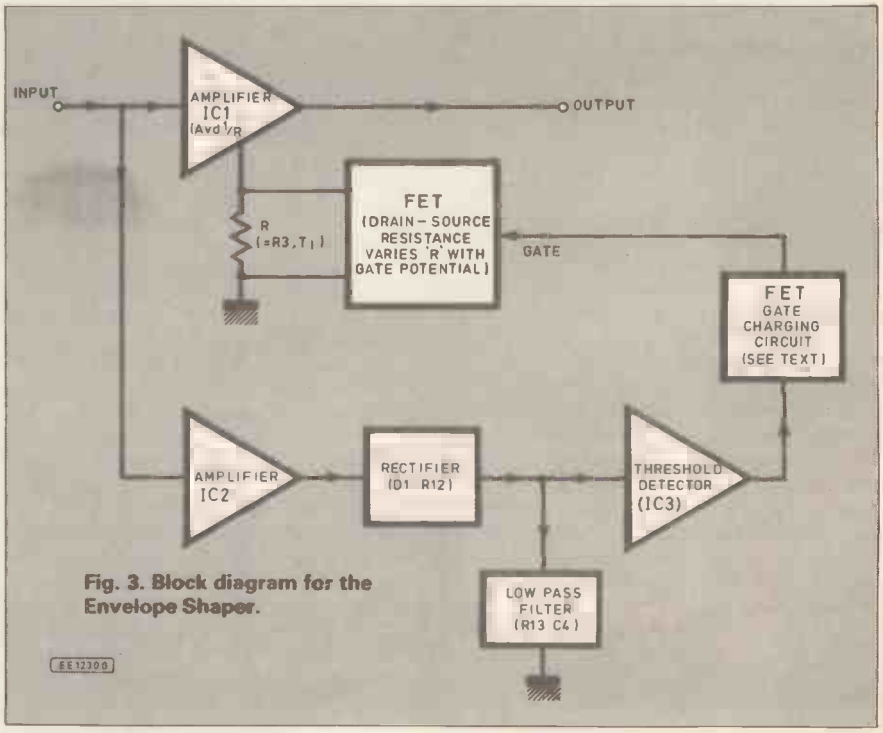


Fig. 3. Block diagram for the Envelope Shaper.

dependent on the Rds of the f.e.t. The overall "attack" profile depends on the signal applied to the gate of the f.e.t.—a d.c.voltage derived from the detector circuit. IC2/IC3 is used to charge a capacitor in the f.e.t. gate circuit and hence vary Vgs.

The lower half of the circuit, IC2 and IC3 forms, in essence, a switch to trigger the f.e.t. gate charging circuit whenever a large enough signal appears at the input.

The charging time is variable in the range 22 milliseconds to 0.6 seconds, a range found to be quite adequate in practice. The "recovery time" (i.e. time taken for IC1's gain to return to normal after the input signal has decayed) is fixed at about 15 milliseconds.

CIRCUIT DESCRIPTION

The full circuit diagram for the Guitar Envelope Shaper is shown in Fig. 4. The heart of the circuit is IC1 which is wired as a non-inverting voltage amplifier. Clearly its gain is governed by the feedback resistor R5 and the resistances in the inverting input circuit, resistors R3, R4, and the field effect transistor TR1.

Note that TR1 and resistor R4 appear in parallel with R3, so the overall gain of IC1 (which is what we wish to control), is really defined by the drain-source resistance (Rds) of TR1. The gain of IC1 is therefore:

$$Av = 1 + (R5/Req)$$

where Req is the combined resistance of R3//(Rds+R4).

When an input signal is applied—say, from an electric guitar—we require IC1's gain initially low. It can't go to zero, but by ensuring that resistor R5 is a lot less than Req(max) we can make it near enough unity.

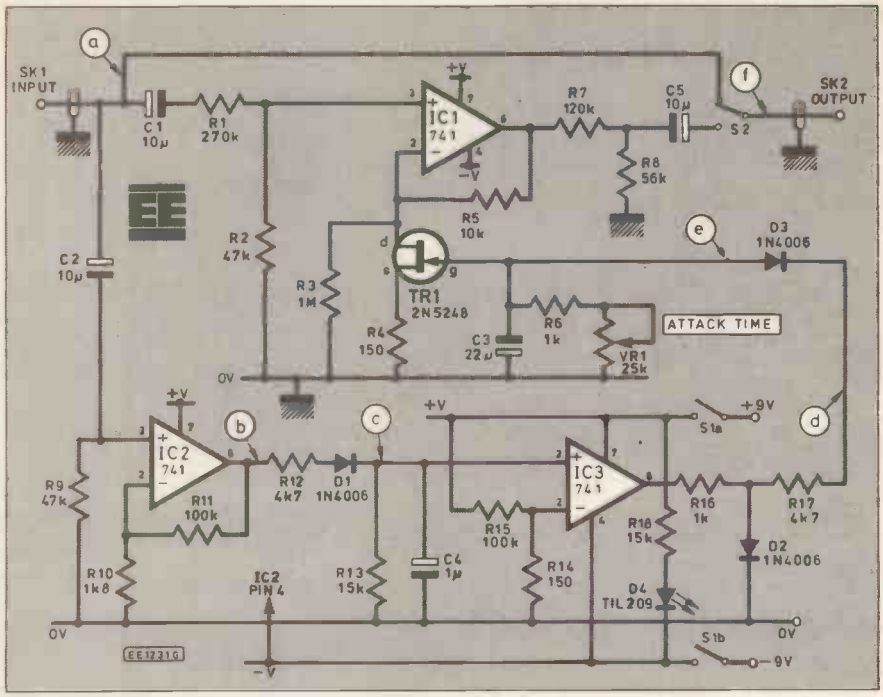


Fig. 4. Complete circuit diagram for the Envelope Shaper. The letters inside circles refer to waveforms shown in Fig. 5.

Given that Rds(max) is near enough infinity, and Rds(min) is of the order of 500 Ohms, we find:

Req(max)=1M
Req(min)=650

Hence, IC1's gains are: Av(max)=16
Av(min)=1

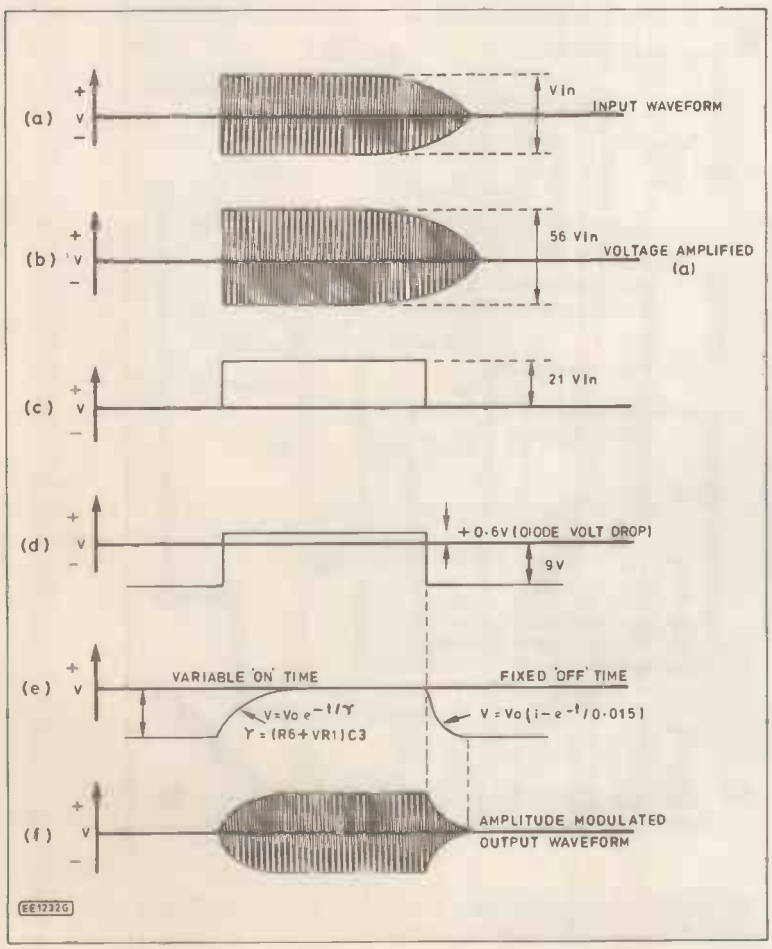
A diagram showing voltage waveforms at various points in the circuit should be useful at this stage and is shown in Fig. 5.

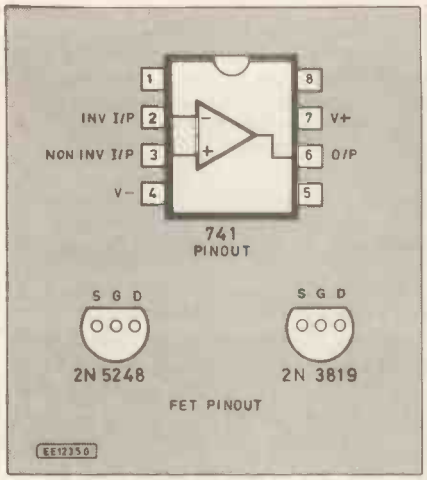
To vary IC1's gain we need firstly to detect the presence of an input signal. IC2 is another non-inverting voltage amplifier with a fixed gain of 57 simply to boost the signal level.

The output is half-wave rectified by diode D1, and smoothed (or "low-pass filtered") by C4/R13 to produce a positive "d.c." level proportional to the input waveform amplitude. (It isn't really d.c. in the usual sense (e.g. power supply output d.c.) because it is varying quite quickly—strictly we should call it a "unipolar control voltage".)

IC3 is wired as a comparator with a triggering level (set by the voltage divider resistors R14/R15) of about 15mV to prevent

Fig. 5. Typical waveforms at the various points in the circuit diagram.





Pinout details for the f.e.t.

COMPONENTS

Resistors

R1	270k
R2, R9	47k (2 off)
R3	1M
R4, R14	150 (2 off)
R5	10k
R6, R16	1k (2 off)
R7	120k
R8	56k
R10	1k8
R11, R15	100k (2 off)
R12, R17	4k7 (2 off)
R13, R18	15k (2 off)

All ⅛W 5% carbon

Potentiometer

VR1 25k carbon lin.

Shop Talk
See page 158

Capacitors

C1, C2, C5	10μ elec. 40V (3 off)
C3	22μ elec. 40V
C4	1μ tant. bead 35V

Semiconductors

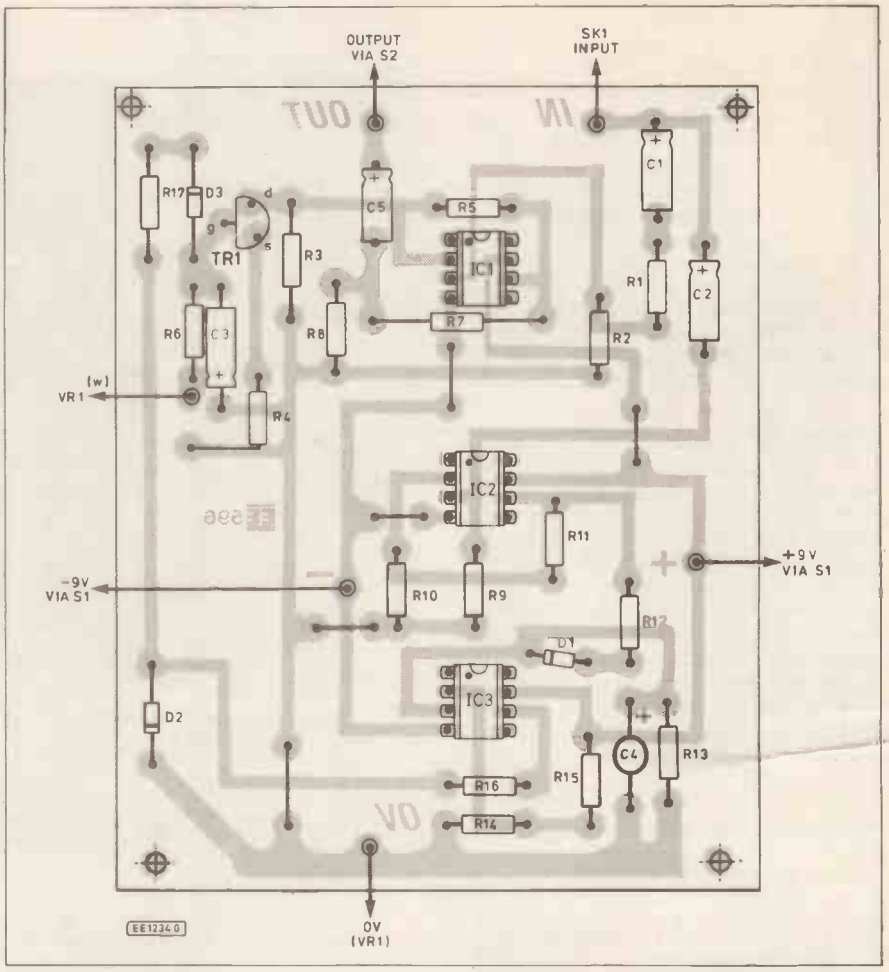
D1, D2, D3	1N4006 (3 off)
D4	Red l.e.d.
TR1	2N3819 n-channel f.e.t. (or similar)
IC1, IC2, IC3	741 op-amp (3 off)

Miscellaneous

S1	2-pole miniature slider switch
S2	Single-pole push-button changeover switch (push-on push-off)
SK1, SK2	Standard ¼in. jack socket (2 off)

Printed circuit board, available from the *EE PCB Service*, code EE596, case,diecast aluminium approx. 115mm×90mm×50mm; PP3 batteries (2 off) and connectors; connecting wire; solder; nuts, screws, etc.

Approx. cost Guidance only **£15**



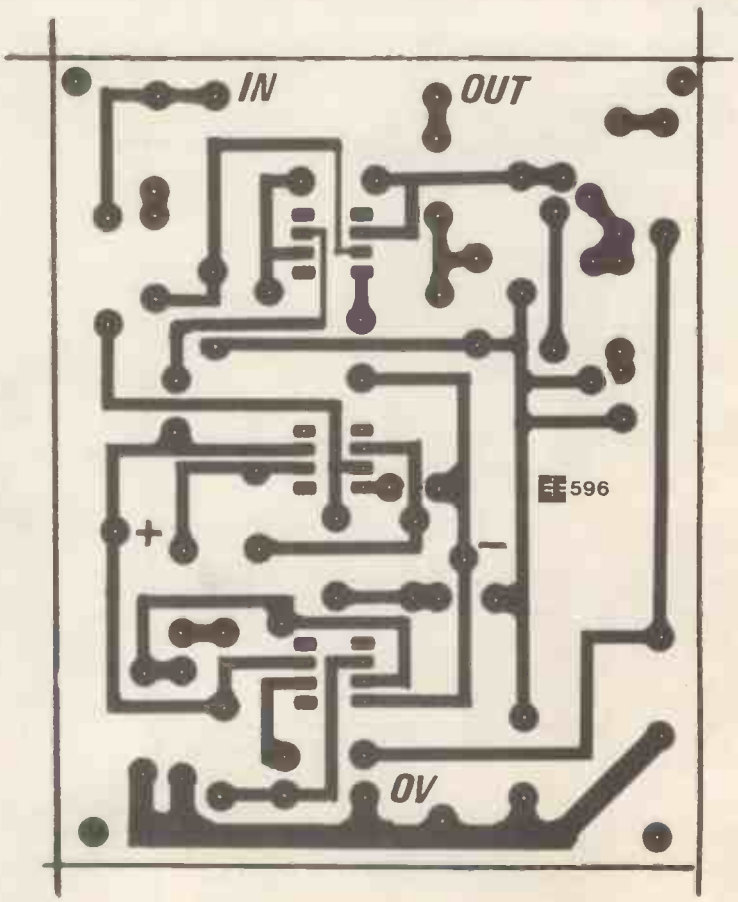


Fig. 6. Full size printed circuit foil master pattern and board component layout. This board is available from the EE PCB Service, code EE596.

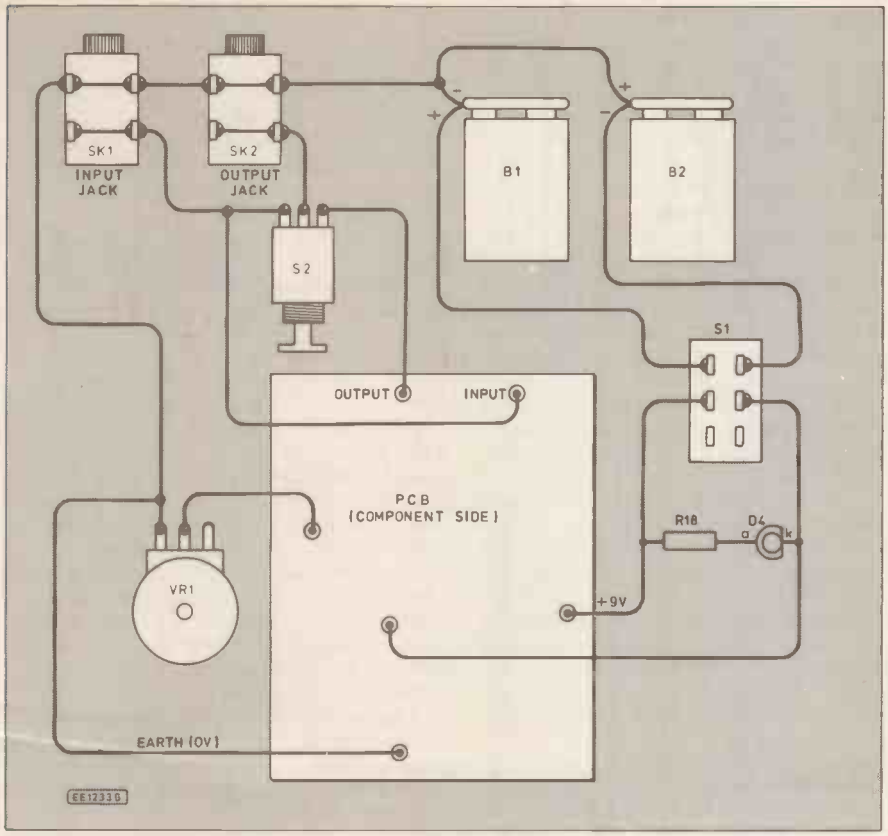
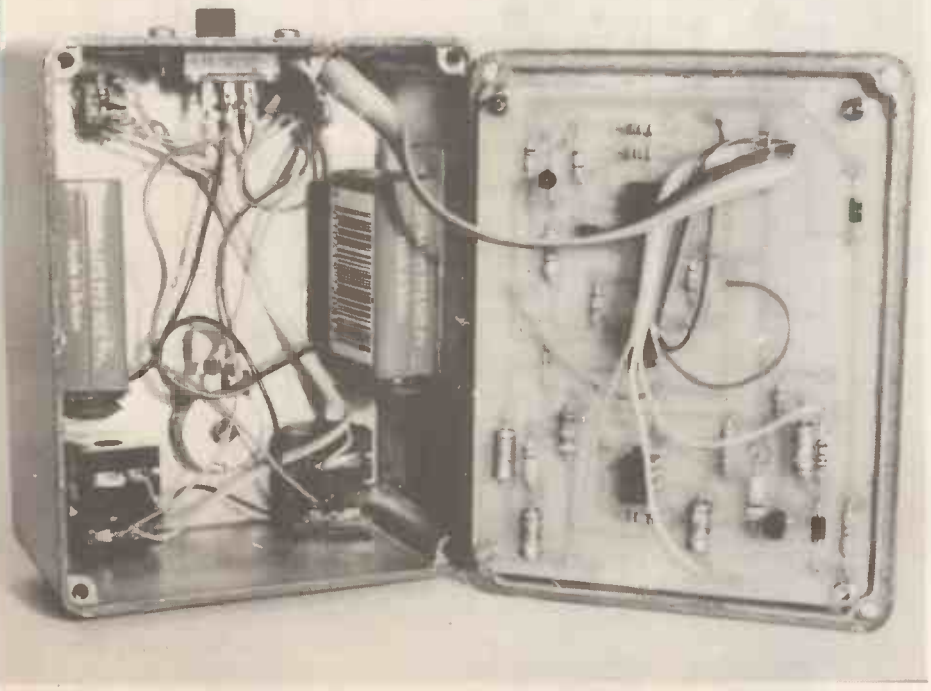


Fig. 7. Interwiring details for the case mounted components.

the circuit from triggering on noise, etc. from IC2. When the signal level in pin 3 of IC3 exceeds 15mV the output flips up from −9V to +9V.

The positive outputs are dumped to earth through R16/D2 so that the f.e.t. gate charging circuit "sees" a rising square edge from −9V to +0.6V. The f.e.t. gate potential rises towards 0V at a rate defined by capacitor C3 and (resistor R6+potentiometer VR1). Note that the charging waveform due to capacitor C3 is always exponential—it's only the charging time that is changed by varying the setting of VR1.

Finally, you'll notice an attenuator at the output (pin 6) of IC1. This is necessary to "trim" the overall gain of the system to suit both the characteristics of the f.e.t. (remember the Rds(min) is not well defined), and the taste of the user! The prototype used the values for R7/R8 given and gave quite a nice swell effect as the attack built up.



CONSTRUCTION

The component layout and full size printed circuit board foil master pattern for the Guitar Envelope Shaper is shown in Fig. 6. This board is available from the *EE PCB Service*, code EE596.

The p.c.b. shown is fairly large so there should be no problem fitting everything on. Start with resistors and capacitors, then fit the diodes, i.c.s and finally the f.e.t. Don't forget that there are five wire links on the board. The capacitors are all polarised types and must be fitted the right way round.

All the connections to the board were made using a 28cm length of 6-way ribbon cable on the prototype and secured by looping it under one of the wire links as shown in the photographs. No problems with hum were encountered, but use screened cables in the signal lines if this becomes a problem.

The case used for the prototype was a cast aluminium box measuring 115mm×90mm×50mm. The circuit board fits nicely under the lid (using short spacers), leaving the box free for the batteries, switches, etc. The internal layout is largely a matter of personal taste, but make sure everything fits before drilling any holes in the case! The interwiring from the board to the case mounted components is shown in Fig. 7.

TESTING

Before fitting the board into the case, temporarily connect the potentiometer VR1, the two jack sockets and the two 9V batteries to check operation. Apply a signal source (guitar, etc.) to the unit with VR1 set somewhere midway and you should hear the "reverse attack" effect. If not, having rechecked your circuit, follow this procedure:

A good place to start is with the batteries. Check the power supply levels on pins 7 and 4 on the i.c.s—you should, of course, find +9V and −9V respectively. If one line is low, measure the current flowing in that line—the load on each line should be between 3 to 7 milliamps.

Check the operation of IC1 by applying −9V and then 0V to the gate of the f.e.t.—you should hear some sound through IC1 with 0V applied. If so work backwards and try triggering IC3 by touching −9V and then +9V on pin 3. Any error here will probably be due to the d.c. effect on pin 2.

Test IC2 by comparing the signal levels at pins 3 and 6 using either a 'scope if you have one, or the input of your hi-fi amplifier if not! When it's working fit the board in the case together with the l.e.d. D4 (and its series resistor R18), jack sockets SK1, SK2 and the switches. The batteries were simply stuck to the sides of the case using double-sided tape, the current drawn is very low and they should last a fair time.

IN USE

Experience will improve technique, but a few tips to get started:

If using keyboards, make sure the input to the unit is not so large that it triggers on keyboard output noise.

With guitars, the opposite is generally true—keep the pickup volumes wound up or you won't get much sustain. This is particularly true of the higher notes. Connecting this unit after your amplifier preamp may help here.

Finally, don't overdo it with this device. All sound effects become boring if they're constantly in use, so only switch it on when it's needed. □

ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month we shall be rolling up our shirt sleeves in preparation for another hardware project. This takes the form of a versatile Add-on I/O Port capable of generating and accepting TTL compatible signals as well as controlling high current d.c. and a.c. mains connected leads.

Adding a User Port

The Spectrum family of home computers has been progressively updated over the years to take in an ever expanding range of facilities, including RGB video and internal cassette and disc drives. Unfortunately, one item which has been totally ignored, and which must surely be the "*missing link*" as far as electronics enthusiasts is concerned, is the continuing absence of any form of User Port. This is a shame since many other home computers offer a User Port which opens the door (quite literally!) to a thousand and one applications in which external hardware may be connected to a machine and controlled by it.

User ports are invariably based on one or more programmable parallel I/O devices. Indeed, we described one such interface (based on the Z80-PIO) in an earlier instalment of *On Spec*. This month (and since the latest version of the Spectrum still does not possess a User Port!) we show how a low cost parallel interface can be added to the Spectrum.

This interface will provide a total of 24 I/O lines arranged in three groups of eight. We shall also show how it can easily be extended for controlling a very wide range of external devices including high-current d.c. and mains operated loads such as pumps, motors, lamps and heaters.

Enter the 8255

Our Spectrum User Port employs the versatile 8255 Programmable Parallel Interface (PPI). This device, which was originally designed by Intel for use with 8-bit microprocessors of the 8080 variety, is available from a number of suppliers including Electromail and Maplin. The 8255 may be very easily interfaced to the Z80 CPU used in the Spectrum and offers a number of advantages over the Z80-PIO which we have previously described in this column.

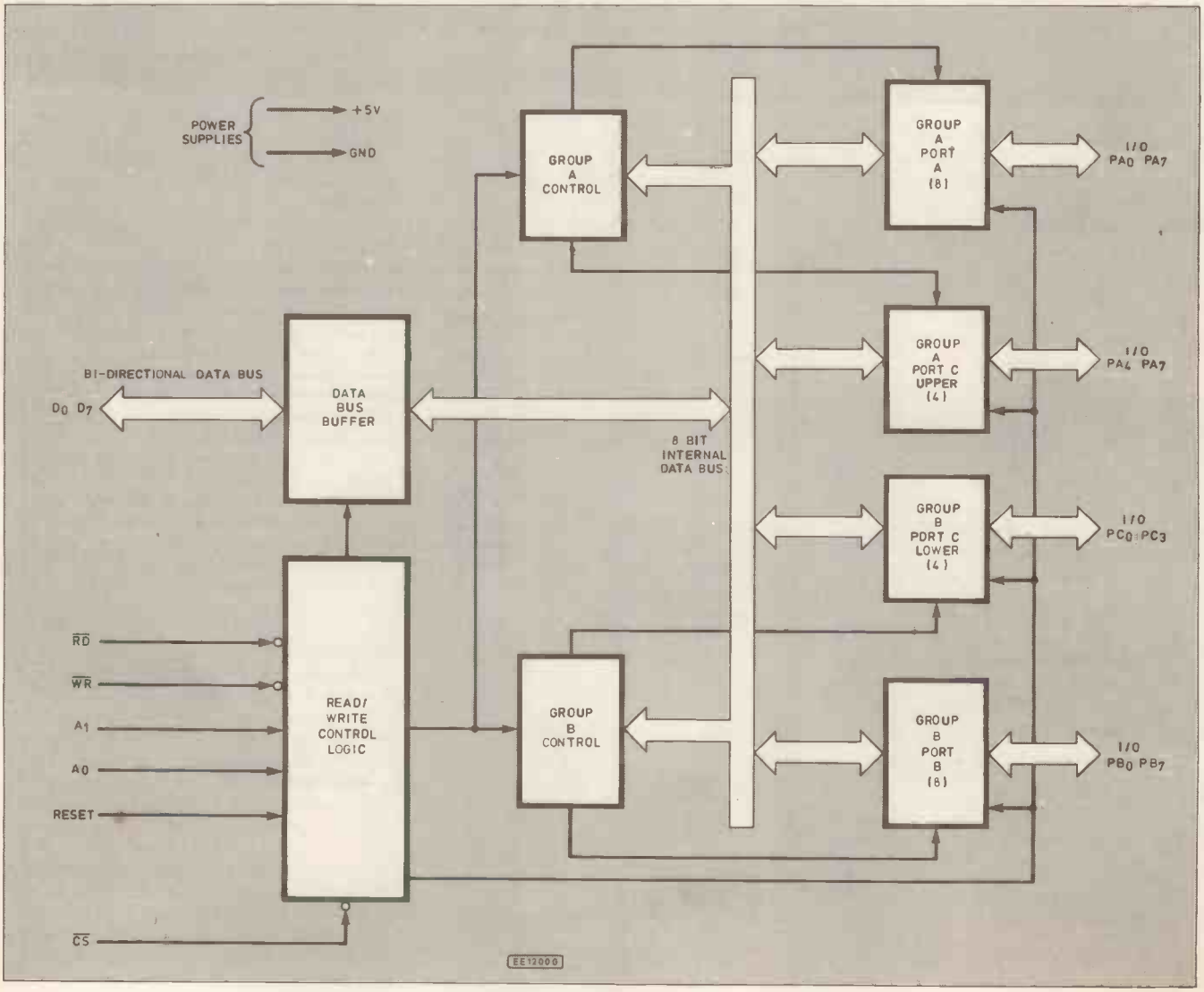
The internal arrangement of the 8255 is shown in Fig. 1. The tri-state bi-directional data bus buffer is connected to the data bus accessible at the edge connector fitted to the rear of the Spectrum's p.c.b.

The data bus buffer allows data to be transferred to or from the Spectrum whenever the CPU executes an IN or OUT instruction to an appropriate I/O address. The Read/Write and Control Logic block manages all internal and external data transfers and provides a means of chip selection via the active low $\overline{CS}$ line which is driven from external address decoding logic.

The functional configuration of each of the 8255's ports is software programmable. The CPU outputs a Control Word (more of this next month) which determines the mode selected and which can also be used to set or reset individual bit lines provided in Port C.

Each of the 8255's three I/O ports comprises an 8-bit output latch/buffer and an 8-bit input buffer. At this point it is important to note that the 24 I/O lines are, for control purposes, divided into two logical groups (A and B).

Fig. 1. Internal block diagram of the 8255 device



Group A comprises the entire eight lines of Port A together with the four upper (most significant) lines of Port C. Group B, on the other hand, takes in all eight lines from Port B together with the four lower (least significant) lines of Port C. The upshot of all this is simply that Port C can be split into two in order to allow its lines to be used for status and control (handshaking) when data is transferred to or from Ports A or B.

ADD-ON I/O PORT

The complete circuit diagram of the 8255 interface is shown in Fig. 2. A two-input OR gate (IC3) is used to provide the $\overline{CS}$ signal which is supplied to pin-6 of IC1. This signal goes low (selecting the 8255) whenever the input/output request ($\overline{IORQ}$) line and address line A7 are simultaneously low. Hence, the 8255 is addressed whenever an I/O operation is being performed to an address in which bit-7 is reset.

Port A not only provides a TTL-compatible input but is also fitteed with a d.i.l. s.p.s.t. switch package. In normal use, these switches are left open (off), however they can be invaluable when testing the interface and can also be used for configuring the system. Port B may be programmed for use as either an input or output port accepting and providing TTL-compatible signals.

Finally Port C, which has a unique software bit set/reset mode, has been reserved for output and fitted with an octal Darlington output driver (IC2). In practice, a modified Control Word may be used to turn any of Port C's output lines on or off (without affecting any of the other lines) and this leads to extremely simple programming.

Construction

The Add-On I/O Port may be assembled on a piece of stripboard measuring approximately 80mm×125mm. The precise dimensions of the board are unimportant provided that it has a minimum of 28 tracks aligned in the vertical plane sufficient to allow the mounting of a 28-way double-sided edge connector. This connector should be fitted to the lower edge of the board and will require five holes across the full width of the stripboard so that the board stands vertically when the connector is mated with the Spectrum.

Before soldering any of the components (including the four i.c. sockets) it is important to allow some clearance for the rear overhang of the case. For the Spectrum this gap should correspond to 8 rows of holes (20mm approx.) whilst for the Spectrum Plus, 128k and +2 machines, the gap should be increased to 12 rows of holes (30mm approx.).

Component layout is generally uncritical though, as with most of our *On Spec* projects, considerable economies can be made by carefully planning the layout in advance of mounting the components and i.c. sockets. Readers are advised to carry out this exercise on paper first (using, if desired, the layout sheet provided with our *On Spec Update*).

COMPONENTS

Resistors

R1	220
R2 to R9	1k (8 off)
R10 to R17	10k (8 off)

All 0.25W 5% carbon

Capacitors

C1, C3	220μ elect. 16V (2 off)
C2, C4	10n ceramic disc (2 off)

Semiconductors

D1-D8	Red l.e.d.
IC1	8255
IC2	ULN 2803A
IC3	74LS32

Shop Talk

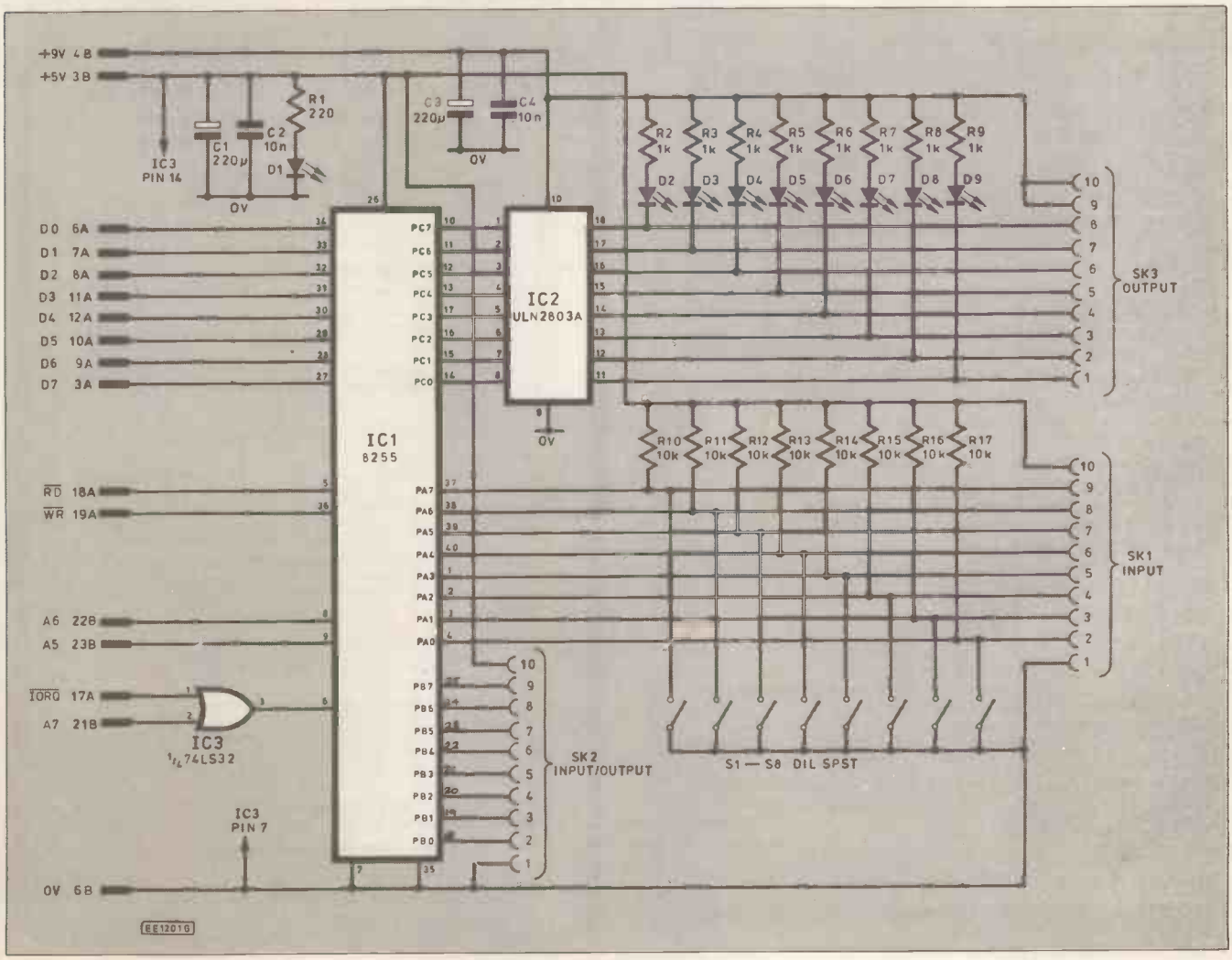
See page 158

Miscellaneous

D.I.L switch (8×s.p.s.t. in a 16-pin d.i.l. package); 40-pin, 18-pin, 16-pin, and 14-pin low-profile d.i.l. sockets (1 of each); 10-way 0.1in. pitch p.c.b. mounting connectors (3 required); Veroboard, 0.1in. pitch, measuring approx. 80mm×125mm; 28-way open end double-sided 2.54mm (0.1in.) pitch edge connector (e.g. Vero part number 838-24826A).

Approx. cost Guidance only **£16** *plus battery*

Fig. 2. Complete circuit diagram of the Add-On I/O Port



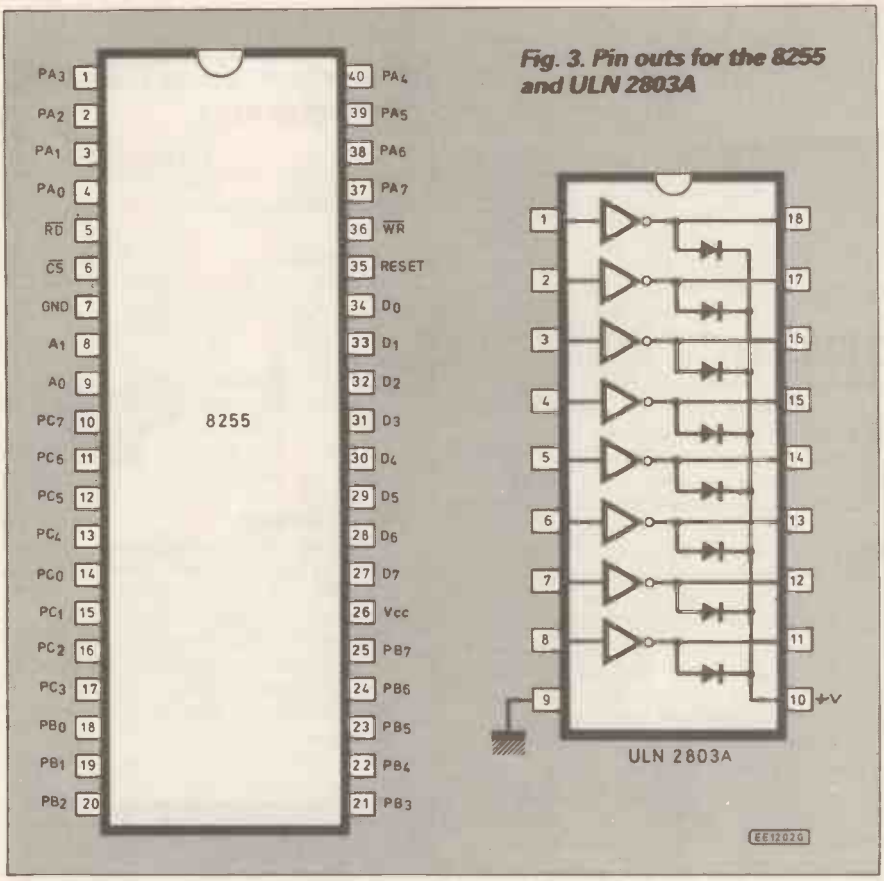


Fig. 3. Pin outs for the 8255 and ULN 2803A

spot-face cutter is ideal for this purpose or, if such a tool is not obtainable, a small sharp drill bit may be used.

The remaining components (resistors, capacitors, connectors and l.e.d.) should then be fitted to the board. As usual, the decoupling capacitors (C1 to C4) should be distributed around the board with the smaller value capacitors (C2 and C4) being placed close to the supply inputs of IC1 and IC2.

After mounting the i.c.sockets, great care must be taken to ensure that all unwanted tracks are cut (including, in particular, those which link the upper and lower sides of the 28-way connector). A purpose designed

Links on the underside of the board should make use of appropriate lengths of miniature insulated wire (of the type normally used for wire wrapping). Readers requiring further information on the connector should refer to March 1985 *On Spec* or send for the *Update*.

When the stripboard wiring has been completed, the d.i.l. switch and integrated circuits should be inserted into their sockets (taking care to ensure correct orientation of each i.c. device). Finally, the entire board and wiring should be very carefully checked before attempting to connect it to the Spectrum. (Note that the Spectrum should ALWAYS be disconnected from its supply before either connecting or disconnecting *any* interface module).

If all is well, when power is re-applied, the normal copyright message should appear. If not, disconnect the power, remove the interface and carefully check again!

If you would like a copy of our *On Spec Update*, please drop me a line enclosing a large (250mm×300mm) stamped addressed envelope.

Mike Tooley, Department of Technology, Brooklands Technical College, Heath Road, Weybridge, Surrey, KT13 8TT.

Next month: We shall describe the testing and programming of the Add-On I/O Port. We shall also be taking a look at Mira Software's new Pascal compiler for the Spectrum.

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NEWS

. . . from the world of electronics

YOUNG ELECTRONIC DESIGNER AWARDS

THE 1988 Young Electronic Designer Awards Scheme has been officially launched with renewed sponsorship from electronics distribution company Cirkit Holdings PLC and leading semiconductor and computer manufacturers Texas Instruments.

Governed by the YEDA Trust, a registered charity, and organised under the chairmanship of John Eggleston, Professor of Education at Warwick University and a member of the Council of Europe, the Awards Scheme offers design awards to young people in the junior (under 15), intermediate (15-18) and senior (19-25) age groups, who attend educational institutions in the UK.

John Eggleston speaking at the 1987 YEDA presentations ceremony with (from left to right): John Wesley, Investors in Industry; Sir Alec Morris KBE, C.Eng., British Aerospace; Richard Reisz, Editor, "Tomorrow's World"; Professor Eggleston; Tina Jenkins, Presenter, Thames TV and Sir John Egan B.Sc., Chairman and Chief Executive of Jaguar Cars plc.

How To Enter

To enter the Scheme, students must produce an electronic device of their own which is original, effective and has a useful application in everyday life. A prestigious trophy and valuable cash prizes are presented to the winners in each category and in the senior age group there are the prospects of a job in electronics and course sponsorship.

Each secondary school or college with one or more entrants reaching the regional judging stages in May qualifies for a special award of useful electronic equipment from Cirkit, for example multimeters, furthermore the finalist whose project is adjudged to have the most commercial potential will win a sophisticated computer system and software valued at around £10,000 from Texas Instruments for his or her educational institution. Every finalist wins a personal prize as does their teacher and there are many more attractions for the successful entrant.

For further information and entry forms contact: *The YEDA Trust, 24 London Road, Horsham, West Sussex RH12 1AY.*

QUICKFARE

The new "Quickfare" automatic ticket machines from Westinghouse Cubic, undergoing trials at London Bridge Station, are speeding passengers to 40 British rail destinations in South and South-East London as well as stations in kent and Surrey. Since their installation in June, the two custom-built machines have recorded a total of over 40,000 ticket sales.

A variety of ticket combinations including adults single and return, children's tickets, cheap day, Network and Capital cards are available to travellers from the automatic machines. Each machine has an electronic clock mechanism capable of calculating off-peak periods, weekends, bank holidays and even leap years.

SOUND TRACK

As more musicians move into soundtrack work an increasing number of films, TV productions and advertisements are having their music generated on the NED Synclavier system, reports European distributor Harman UK.

The two most recent major cinema releases where the music has been created entirely on Synclaviers are *Beverley Hills Cop 2* and *Cry Freedom*.

Special rates

The CD-ROM market has taken off and 1988 will see drive prices tumble—predicts Nick Rogers, UK Marketing Manager of Hitachi New Media Products, who claim to have captured 60 per cent of the market share worldwide.

Hitachi is also offering special discounts to universities, colleges and schools involved in the government sponsored ECCTIS scheme under which details of some 50,000 courses and broadcast education programmes have been compressed onto a single 552 Mbyte compact disc.

Women-Only Training Course

Eighteen female employees, most of whom have non-technical backgrounds, are being sponsored by British Telecom on a women only course that should lead to a degree in engineering or science-based technology. The women are six clerical assistants, five clerical officers, five junior technicians, a telephonists' supervisor and a junior manager.

The women have just started a one-year bridging course at the Essex Institute of Higher Education, Chelmsford, on full-pay from the company. Success on the course will lead to British Telecom sponsorship for first degree courses in engineering, science, mathematics and computing.

On successful completion of the course, candidates will qualify for British Telecom sponsorship to attend university or polytechnic and perlods of industrial training will be given during vacations. On graduation, award holders will be eligible for management jobs in engineering, information technology or other applied science.

"This scheme is an extension of our other efforts to improve opportunities for women within BT . . ." *said ken Leeson, Director of Corporate Personnel.*

Constructional Project

S.O.S. ALERT

MUNGO HENNING

. . . Emergency Beacon . . . Panic Button . . . Hypothermia Alarm

Can flash a lamp or sound a warning in the international distress Morse "SOS" Code. Can be adapted for use by hill-walkers, boat owners or the elderly.

MOST of us have an elderly person living within the immediate vicinity of our homes. Have you considered what you would do if you saw a mains light flash on and off in such a neighbour's house—would you investigate it or not?

Speaking personally I would wait until it continued for a short time before investigating further. It could be an erratic switch of course, or it could be a cry for help.

The dilemma of investigation is further increased should the flashing stop: incapacity of a sick person or correction of a fault?

SOS ALERT

Next consider your action should you observe the light flash the international distress code SOS. I would suggest that action would be more immediate in this case.

The project to be described will generate the SOS sequence. The circuit is designed to power a relay, which could switch mains loads such as a few lightbulbs or even a mains bell. Triggering of the unit is by actuating a switch, but some readers may care to hook the device up to a thermal sensor (hypothermia alarm), resettable timer or low-powered perimeter switch.

The idea is to build a small, low-powered unit so that it could be used by climbers (in their torches), hill-walkers, elderly people or even emergency services.

HOW IT WORKS

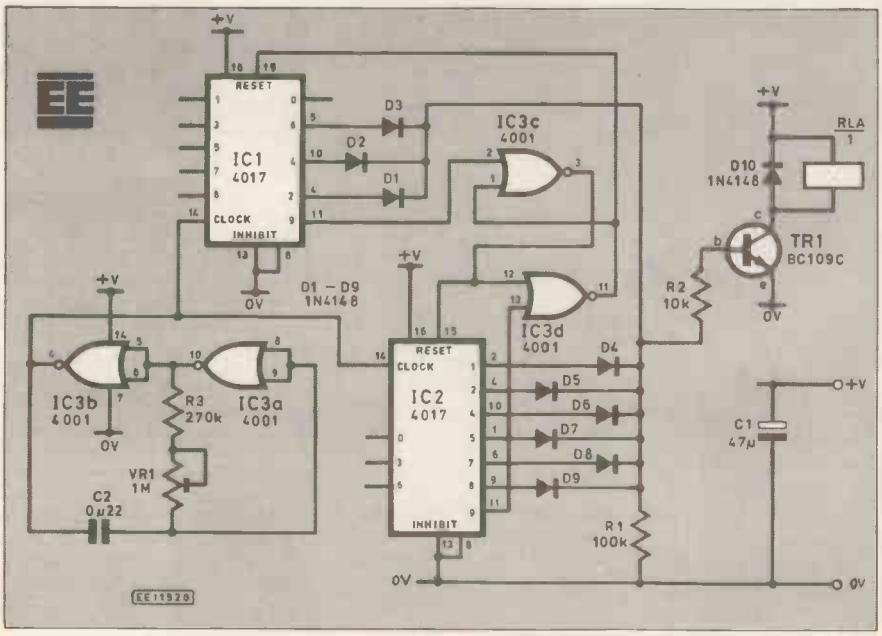
The full circuit diagram for the SOS Alert is shown in Fig. 1. The circuit consists of two decade-counters (IC1, IC2) both driven by a common clock (IC3a, IC3b, VR1, R3, C2) and inter-connected by a flip-flop (IC3c, IC3d) so that when one counter is enabled the other is disabled and vice-versa.

The common 4017 CMOS decade counter (IC1, IC2) has ten output lines which individually go "high" as the count increases. The flip-flop essentially makes it appear as if we have a single counter chip with twenty output lines.

Certain output lines are selected from the choice of twenty, and these are wire-O Red through diodes, D1 to D9, to give the SOS waveform. This signal is then buffered via transistor TR1 to drive a relay or other output device.

Diode D10 is used to protect the transistor from the back e.m.f. of the relay (should one be used), and capacitor C1 acts as a reservoir of power to the circuit. Although the sequence generated is not strictly SOS (the mark/space ratio is incorrect, and the output is SOSOSOSOS . . . rather than SOS SOS SOS . . .), the output gives a plausible "cry for help".

Fig. 1. Complete circuit diagram for the SOS Alert.



CONSTRUCTION

The component layout and full size printed circuit board foil master pattern for the SOS Alert is shown in Fig. 2. The printed circuit board for this project is available from the *EE PCB Service*, code EE595.

Due to the nature of this project, the standard of construction becomes highly important, so take your time. Note that the p.c.b. has fine tracks between adjacent pins of IC2 and IC3 and care should be taken when soldering components on the board.

Insert the single wire link first, then solder in the i.c. sockets (if used), resistors, diodes, transistors, capacitors and the preset potentiometer VR1. Examine the p.c.b. for solder bridges, especially around the i.c.s, and double-check the components for their value and insertion polarity.

TESTING

Connect either a relay or a buzzer across diode D10 and apply power to the circuit. The relay should operate in the three-dots three-dashes mode. If it fails to work, remove power immediately and re-check component values.

If this doesn't highlight the problem, use a piezo buzzer (PB2720 or equivalent) to listen-in on the circuit as follows. Connect the buzzer across IC3 pins 4 and 7, listening for the clock pulsing. If there are no clicks,

suspect IC3 and/or the clock resistors and capacitor.

If the clock seems okay, connect the buzzer to IC1 across pins 8 and 15 listening for the flip-flop toggling this reset line. This click will be a lot fainter than that of the clock, so listen carefully. Apply this test to IC2 as well.

If there is still no joy, check the base of the transistor for a signal: it could be that the transistor is duff. If none of these tests work, try replacing each i.c. individually until it does work!

IN USE

Though some people may connect this device to their burglar alarm it is *STRONGLY* suggested that this should *NOT* be done so that the SOS code is used for people in distress rather than property. One day *your* life may depend on the SOS code, so please do not use it frivolously.

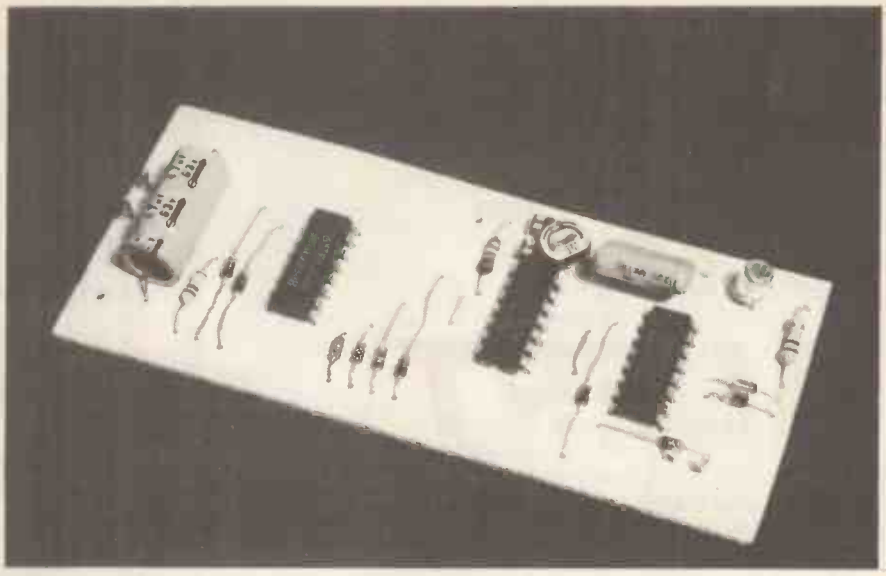
Also be careful when testing the unit, since certain emergency services may be called out on a false alarm (for example the coast-guard service).

Other than the restrictions mentioned, the unit could be used in an elderly person's home suitably connected to a panic switch or even a temperature alarm (hypothermia alert). If a mains lamp is used as the output device, make sure the relay contacts are rated for the mains load.

The use of CMOS devices gives a wide range of power supplies from which the device can operate, but note that some 12V relays will not pull-in at 9V or less, so consider the relay when you choose the power source. Rather than using a relay, a power f.e.t. could be used to drive a torch bulb from the circuit. This would give hill-walkers an additional emergency beacon, rather than having to tap out SOS on their torch themselves.

It would be prudent to test the unit every so often and especially before embarking on a journey where you may require its use. In these circumstances a false sense of security could be deadly. A complacent attitude to safety should not be engendered simply because you have built and installed this unit: there is no guarantee that the signal emitted will be received and understood by anyone.

As a further precaution against accident, it may be wise to encase the electronics in a plastic resin.



COMPONENTS

Resistors

R1	100k
R2	10k
R3	270k

All 0.25W carbon

Potentiometer

VR1	1M miniature skeleton

Capacitors

C1	47μ elec. 25V
C2	0μ22

Semiconductors

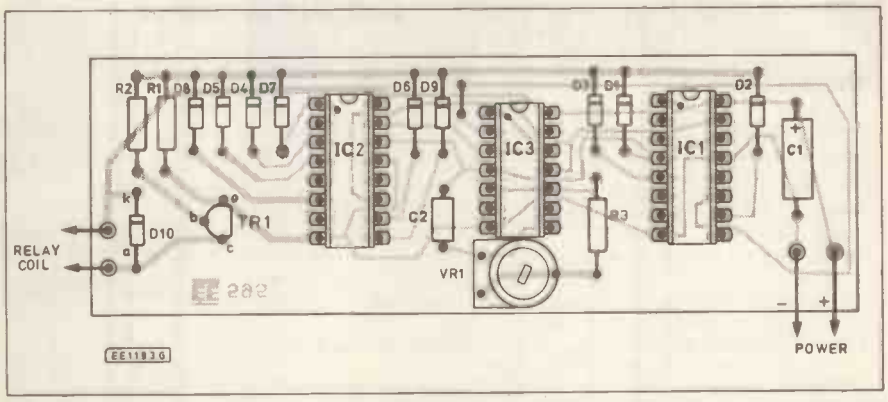
IC1, IC2	4017 CMOS decade counter/ divider (2 off)
IC3	4001 CMOS quad NOR
TR1	BC109C
D1-D10	IN4148 signal diode (10 off)

Miscellaneous

Cable, to suit application; printed circuit board, available from the EE PCB Service, code 595; 16-pin i.c. sockets (2 off); 14-pin i.c. socket; relay, contacts to suit load (see text); connecting wire; solder, etc.

Approx. cost Guidance only **£7.50**

Shop Talk See page 158



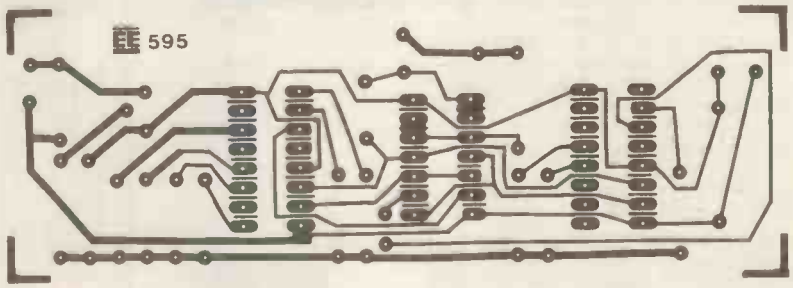


Fig. 2. Component layout and full size printed circuit board copper foil master pattern for the SOS Alert. The lamp(s) or siren are wired directly to the relay contacts. Rather than using a relay, a power f.e.t. could be used to drive a torch bulb.

EE CROSSWORD No. 2

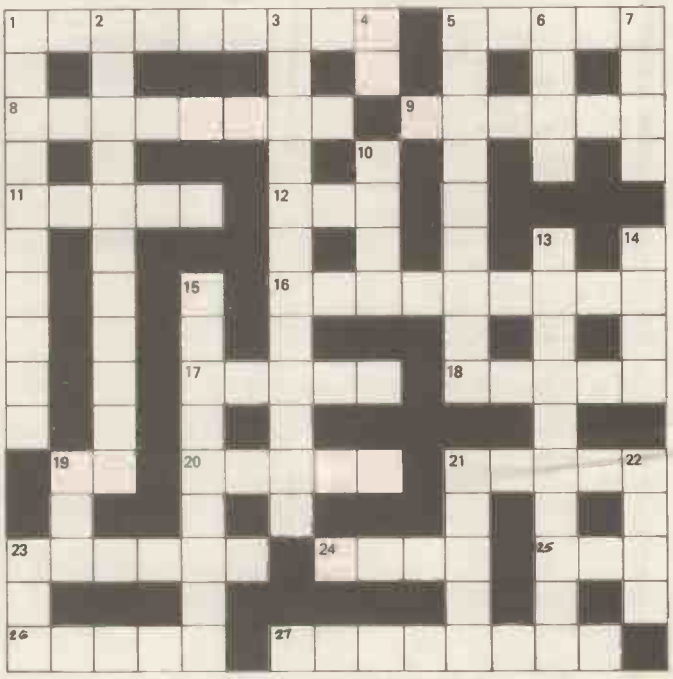
CLUES ACROSS

1 After the invention by E. H. Armstrong, radios became known by this name. (9)
5 At a squeeze, this wheel converts rotory movement into a linear one. (5)
8 Logic circuits that produce something for nothing? (8)
9 Electrodes in a vacuum. (6)
11 Capacitors used to be made with this. (5)
12 Minimum number of logic levels that can convey information. (3)
16 Combination of reactances. (9)
17 Unwanted signals fall into these? (5)
18 An electron revolves in one of these. (5)
19 Initially sets the standards. (1, 1)
20 A two state device in early days? (5)
21 Type of transistor. (5)
23 A selection signal. (6)
24 This circuit causes inflation? (4)
25 Solid state memory. (3)
26 IN television, 70% above the porch. (5)
27 **A check before switching on.** (4, 4)

CLUES DOWN

1 These keep televisions in step. (4, 6)
2 Any hardware device. (11)
3 and 15 Erasable ROM. (12, 9)
4 International system of units. (1, 1)
5 Junction devices having an intrinsic layer. (3, 6)
6 Minimum voltage point for example. (4)
7 Colloquil term for background noise. (4)
10 This pool is found in feedback control. (4)
13 One transmitter can do this to another. (10)
14 and 22 The actual period in which a physical process transpires (4, 4)
19 Unit of information equalling one binary decision. (3)
21 Signals applied at this point. (5)
22 See 14.
23 Solid state filter (1, 1, 1)

For fun only—answers on page 000



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BC547L	0.055	0.045
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4011B	0.120
4012B	0.120
4016B	0.265
4017B	0.220
4018B	0.225
4022B	0.245
4028B	0.180
4029B	0.250
4042B	0.185
4046B	0.320
4049UB	0.165
4050B	0.133
4071B	0.130
4081B	0.130
40106B	0.300

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Mixed Quantity Pricing

DEVICE	100+
74LS00	0.125
74LS01	0.145
74LS02	0.130
74LS04	0.130
74LS08	0.135
74LS10	0.130
74LS11	0.130
74LS14	0.210
74LS22	0.155
74LS42	0.245
74LS47	0.410
74LS48	0.550
74LS51	0.135
74LS86	0.150

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W04	0.215	0.210

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Plug–431A	25p
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Conversion Kit with Wiring Diagram	£6.99

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GREEN	10p	9p	6p
AMBER	12p	10p	8p
YELLOW	12p	10p	8p
HOLDERS	3p	2p	1.5p
LED 5mm			
RED 9p 8p 5p4 GREEN	11p	9p	6p
AMBER	12p	10p	8p
YELLOW	12p	10p	8p
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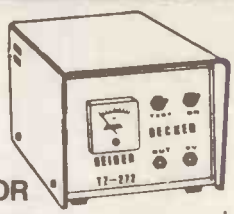

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b...Beeb...Beeb...Beeb...B

. . . Serial-to-Parallel Conversion . . . Dual Port Converter . . .

IN THE previous *BEEB Micro* article we considered serial interfacing in general, and the BBC computer's RS423 serial port in particular. As will have been apparent from the description of asynchronous serial signals, they can not be used to directly drive such things as digital to analogue converters, l.e.d. displays, relays, and other standard peripheral devices. It is necessary for a serial to parallel conversion to be made first, which is the topic that is covered this month.

It is worth making the point that the unit described here will work with any standard RS232C or RS423 serial interface, and that it is not only suitable for use with the BBC range of computers. As most computers have a built-in serial port, or an add-on serial board, this unit is usable with virtually any home or personal computer. Of course, the method of directing data to the serial port is different for each computer, and the notes on driving the interface are specific to the BBC machines.

UARTs

There are a number of special serial to parallel interfacing chips available, and these also seem to handle parallel to serial interfacing as well. Most of these integrated circuits are intended for use in circuits that are based on a microprocessor. These chips are virtually unusable in a stand-alone unit that does not incorporate a micro-controller.

Apart from problems with a bidirectional bus (which would probably be surmountable) there is the difficulty of programming the control registers. These provide software control of such things as the word format and the baud rate. For our present purposes it is much more practical to have a system where these factors are under hardware control, with their selection being made using switches, link-wires, or whatever.

The only devices which are really well suited to this type of control are the UARTs (Universal asynchronous transmitter/receivers). These have tri-state outputs which permit their use in microprocessor based systems, but they also have control inputs that permit either bus or straighforward hardware control.

The industry standard UART is the 6402 type, which is available from several manufacturers who use this basic type number plus various prefixes and suffixes. The CDP6402CE is the RCA version for example.

Serial to parallel conversion is a fairly complex process which is not quite so easy to achieve properly as you might think. Things are greatly complicated if a range of word formats have to be accommodated. UARTs do all the hard work for you, and can handle any normal word format, including the more obscure ones such as five data bits with one and a half stop bits!

Although most serial interface integrated circuits have quite high levels of current consumption, and generally operate quite warm or even hot, the 6402 is a low power CMOS device. This factor can be more than a little useful in an application where battery operation is required, such as when the main item of equipment is a "turtle" type robot.

The power supply current is typically only about five microamps when the device is static, and is no more than nine milliamps when the device is operated with the maximum usable clock frequency of 4MHz. When I first saw these figures in the 6402 date sheet I thought that they must be errors, but on measuring the current consumption of some 6402 based circuits the current consumptions seemed to be about one milliamp or less.

Dual Port Converter

The block diagram for the serial to parallel converter unit is shown in Fig.1. The basic converter simply decodes any received serial bytes and converts them into a corresponding 8-bit binary pattern on its latching outputs.

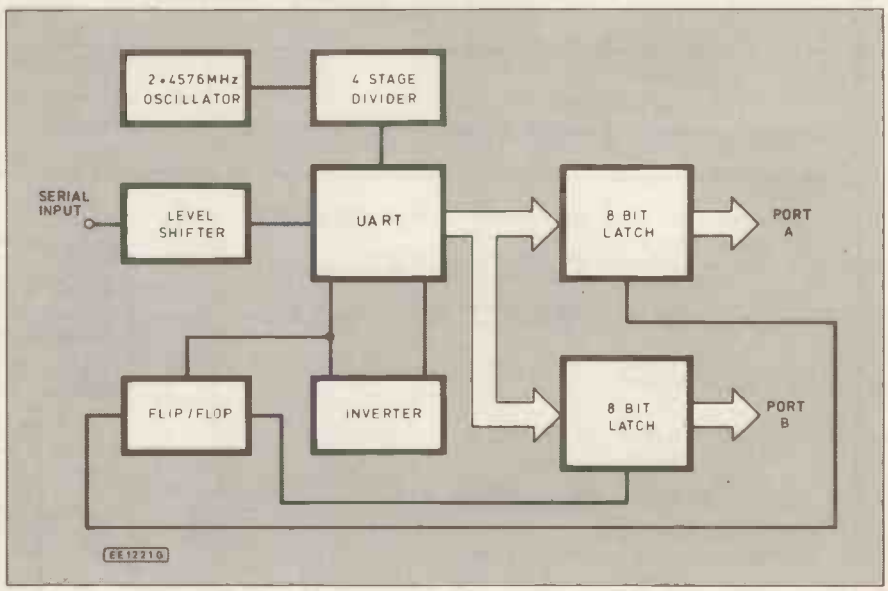

Fig. 1. Block diagram for the serial to parallel Dual Port Converter.

No handshaking is required because the UART will almost instantly decode any received data, and even at a baud rate of 19200 it cannot be overloaded with data. Presumably in most applications the devices driven from the outputs will also be able to keep up with the flow of received data, and no handshaking will be required. However, the handshake input of the RS423 port is there should it be required.

Some additional (and optional) stages enable sixteen latching outputs to be obtained. This system requires sets of two bytes to be sent, with the first byte being directed to Port A, and the second being sent to Port B. Note that because of this sequential system both bytes must always be sent, even if only one port must be sent a new value.

Clock

Looking at the unit in more detail, the baud rate of the 6402 is controlled by an external clock circuit. This must provide a clock signal that is at sixteen times the required baud rate.

In this case a 2.4576MHz crystal oscillator provides the basic clock signal, and a four stage binary divider gives a divide-by-16 action that provides a 153.6kHz clock signal to the UART. Dividing 153600 by sixteen reveals that the unit operates at a baud rate of 9600 baud.

This is high enough to permit data to be sent to the port reasonably quickly, with a maximum rate of just under one thousand bytes per second being possible. It is not so high that the range or reliability of the system are compromised though. However, the device used as the binary divider is actually a seven stage type with all outputs accessible, and it can therefore operate at the other standard speeds of 1200 baud, 2400 baud, 4800 baud, or 19200 baud simply by selecting the appropriate output.

The serial input is not at standard logic levels, and it is of the wrong phase to drive the UART. The input signal is therefore fed to the UART by way of a level shifter circuit that provides a signal inversion. For an 8-bit output this is all that is required, and the rest of the unit can be omitted.

In order to provide sixteen outputs (in the form of two eight-bit ports) two data latches are fed from the output lines of the UART.

The latch inputs of these are fed from the Q and not Q outputs of a flip/flop.

For those who are not familiar with this type of circuit, initially the Q output is high and the not Q output is low, but with each successive clock pulse that is received these outputs swap states. The clock pulses are obtained from the UART, and a pulse is produced each time a fresh byte is decoded by the UART. Data is latched on a low to high transition, and the circuit is arranged so that data is first latched into a Port A latch, then into the Port B latch, then the Port A latch again, and so on.

The UART does not actually produce a pulse each time a byte of data is received. Its action is to set its DR (data received) output high when a byte has been decoded, and this output can then be reset by applying a low level to the DRR (data received reset) input.

Transistor TR1 operates as a simple common emitter inverter stage which is preceded by a resistor/diode circuit to protect it against excessive base-emitter voltages and currents. This is a very basic form of level shifter and inverter stage, but in my experience circuits of this general type perform quite reliably in practice.

Twin Outputs

The additional circuit required in order to provide the unit with twin 8-bit output ports is shown in Fig.3. Transistor TR3 is the inverter which fits between the DR output and DRR input. Capacitor C5 provides a short delay before the DR flag is reset, and this is simply to ensure that the output pulses are of sufficient duration to drive IC5 properly.

IC5 is a CMOS 4017BE one of ten decoder, but in this circuit diode D2 is connected to reset the device when output "2" goes high. It therefore operates as a simple divide by two flip/flop with outputs "O" and "1" acting as the Q and not Q outputs respectively.

Capacitor C7 and resistor R11 provide an initial reset pulse to IC5 at switch on, so that it always commences with the Q output high and the not Q output low. This is important, as otherwise the bytes of data could be directed to the wrong data latches.

The latter are 74LS273 octal D type flip/flops. The outputs of the UART connect to their data inputs, while their Q outputs provide the sixteen latched output lines. The latching signals are fed to what are strictly speaking the "clock pulse" inputs rather than the latch inputs. The C-R networks provide negative reset pulses at switch-on, and all sixteen outputs initially go the low state.

In Use

When the BBC computer is switched on it sometimes seems to produce spurious signals on the serial output that can put this unit "out-of-sync", and I would therefore recommend that power should be applied to the interface *after* the computer has been switched on.

The interface can be powered from the computer if desired, and there then seems to be no problem with the unit responding to spurious signals at switch-on. As an initial check, use a multimeter or logic tester to ensure that all sixteen outp;uts are at logic 0 (i.e. about 0 to 0.8 volts).

Assuming that the recommended baud rate of 9600 is to be used, the operating system command "*FX8,7 will set the BBC computer to the correct transmission baud rate. Page 424 of the "*User Guide*" provides the operating system calls for other transmission baud rates.

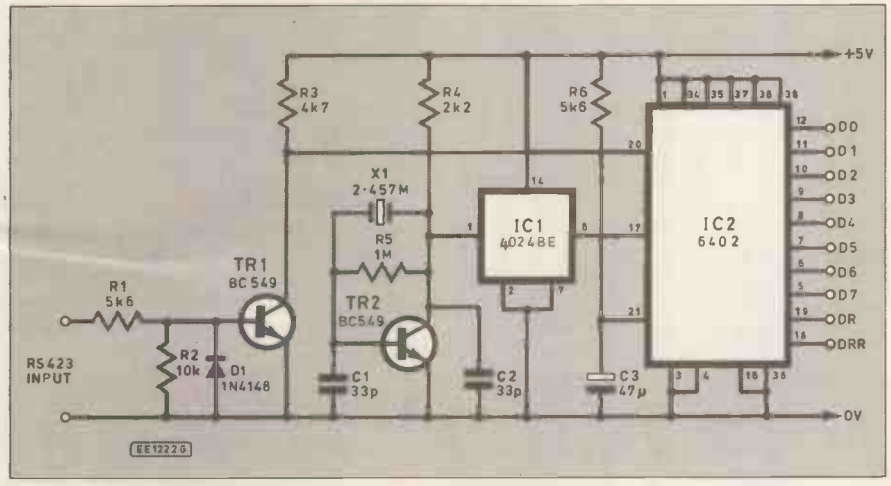

Fig. 2. The basic serial to parallel converter circuit diagram.

In order to produce the required clock pulses it is therefore just a matter of driving the DRR input from the DR output via an inverter. The DR flag then automatically resets itself.

Circuit Description

The circuit diagram for the basic 8-bit version of the converter is shown in Fig. 2. IC2 is the UART, and as this is both a MOS device and a fairly expensive type, the standard anti-static handling precautions should be taken when dealing with it.

The word format is programmed by applying the appropriate set of logic levels to pins 35 to 39 and taking pin 34 (the control register load input) high. With these inputs taken to the states shown in Fig.2 the word format is set at one start bit, eight data bits, one stop bit, and no parity.

This is the obvious format to use as it is the default one of the BBC computers. Also, it uses a total of only ten bits per byte, but provides full eight bit bytes of data.

Table.1 shows the other formats available, and the programming codes needed to select them. Note that for word formats which have less than eight bits it is the most significant bit or bits that are not implemented. Resistor R6 and capacitor C3 provide IC2 with a reset pulse at switch-on.

The clock oscillator is a standard crystal type which is based on transistor TR2, and the divider circuit (ICI) is a CMOS 4024BE seven stage binary divider. For baud rates of 1200, 2400, 4800, and 19200 baud drive pin 17 of IC2 from pin 3, 4, 5, or 9 (respectively) of ICI.

Fig. 3. Additional circuit diagram to provide sixteen output lines.

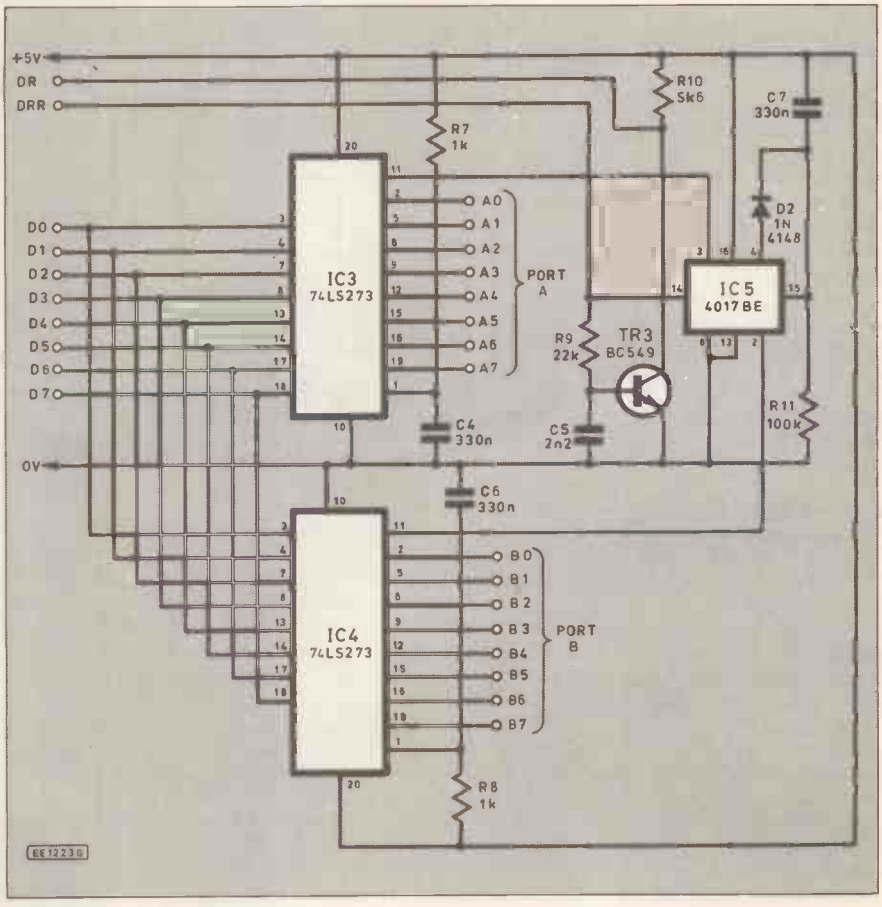

Table 1: Format Codes

DATA BITS	PARITY	STOP BITS	Pin No's 37	38	35	39	36
5	ODD	1	L	L	L	L	L
5	ODD	1.5	L	L	L	L	H
5	EVEN	1	L	L	L	H	L
5	EVEN	1.5	L	L	L	H	H
5	NONE	1	L	L	H	E	L
5	NONE	1.5	L	L	H	E	H
6	ODD	1	L	H	L	L	L
6	ODD	2	L	H	L	L	H
6	EVEN	1	L	H	L	H	L
6	EVEN	2	L	H	L	H	H
6	NONE	1	L	H	H	E	L
6	NONE	2	L	H	H	E	H
7	ODD	1	H	L	L	L	L
7	ODD	2	H	L	L	L	H
7	EVEN	1	H	L	L	H	L
7	EVEN	2	H	L	L	H	H
7	NONE	1	H	L	H	E	L
7	NONE	2	H	L	H	E	H
8	ODD	1	H	H	L	L	L
8	ODD	2	H	H	L	L	H
8	EVEN	1	H	H	L	H	L
8	EVEN	2	H	H	L	H	H
8	NONE	1	H	H	H	E	L
8	NONE	2	H	H	H	E	H

Sending Data

Provided no second processor is fitted, the easiest way to send data to the ports is to write direct to the transmit register of the 6850 serial interface chip at address &FE09. To check that everything is working properly, try these two commands:-?&FE09=15 &&FE09=240

On Port A this should set AO to A3 high, and A4 to A7 low. On Port B it is B4 to B7 that should be high, and BO to B3 that should be low.

If you send data to the serial port using operating system commands you may find that the computer refuses to transmit data, but writing direct to the 6850 is successful. This seems to be due to the operating system reading the CTS line and not sending data until it is at the correct state.

Unfortunately, it seems to drift to the hold-off state if it is left floating. Simply linking the CTS and RTS terminals of the RS423 port seems to be the easiest solution.

Having the two ports at the same address slightly complicates any software which uses the ports. The easiest way of handling things is probably to have the values for the ports held in variables ("A" and "B" being the obvious choices for the variable's names).

Have a short PROCedure which outputs variable A and then variable B to address &FE09 each time it is called. When a new value must be sent to one of the ports, it is then just a matter of changing the appropriate variable and then calling the PROCedure.

Experimentation

Sixteen output lines are probably sufficient for most requirements, but it would probably be possible to modify the circuit to provide more outputs. This would be a matter of adding more latches and bringing more outputs of IC5 into operation.

In order to avoid overloading the outputs of the UART it might be necessary to use a CMOS version of the 74273 for each data latch, and inverters might be needed at the outputs of IC5. It should be a worthwhile avenue for experimentation, but I must admit that I have not tried it, and can not guarantee that this method of expansion is feasible.

Also, bear in mind that adding further latches will generally slow things down and make the software that much more cumbersome. Keep things within reason.

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(f) (i) 24
(ii) 12
(iii) 8
(iv) 19
(v) 21

5.2 (a) 6147 (HM6147, HM6147-3, HM6147P, HM6147P-3)
(b) Hitachi
(c) CMOS static RAM
(d) 4096 words×1 bit
(e) (i) 18
(ii) 9
(iii) 1
(iv) 12
(v) 8
(vi) 10

5.3 (a) 16K bytes
(b) 32K bytes
(c) 4
(d) 4
(e) (i) RAM
(ii) RAM
(iii) I/O
(iv) nothing (i.e. unpopulated)
(v) ROM

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+8V 0.1A	.28
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14 Way	.11
16 Way	.13
18 Way	.15
20 Way	.16
22 Way	.18
24 Way	.20
28 Way	.23
40 Way	.33
Turned Pin	
6 Way	.12
8 Way	.16
14 Way	.28
16 Way	.32
18 Way	.36

20 Way	.40
22 Way	.44
24 Way	.48
28 Way	.56
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15 W Plug	.53
15 W cover	1.07
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25 W Plug	.53
25 W cover	1.16
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15 W Plug	.39
25 W Plug	2.15
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4.7µF 63V	.06
33µF 16V	.04
47µF 10V	.06
47µF 25V	.06
47µF 35V	.08
47µF 63V	.08
47µF 100V	.17
10µF 35V	.06
10µF 63V	.06
22µF 100V	.21
100µF 10V	.06

100µF 16V	.06
100µF 25V	.07
100µF 35V	.08
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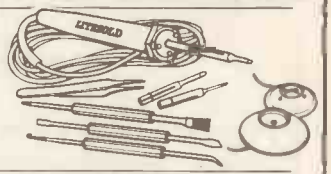

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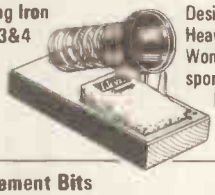

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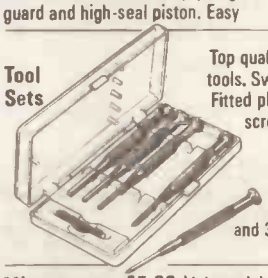

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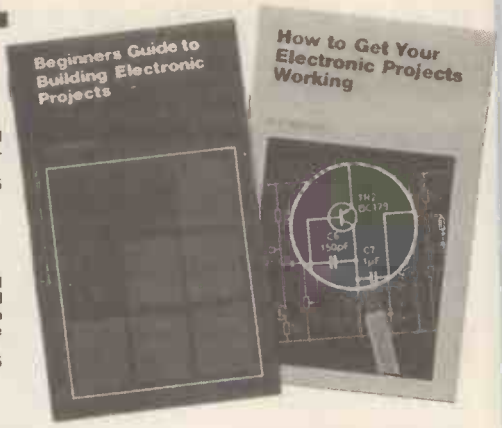

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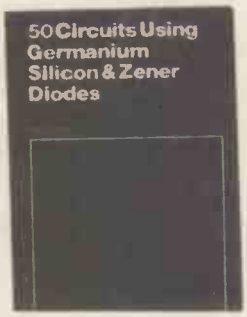

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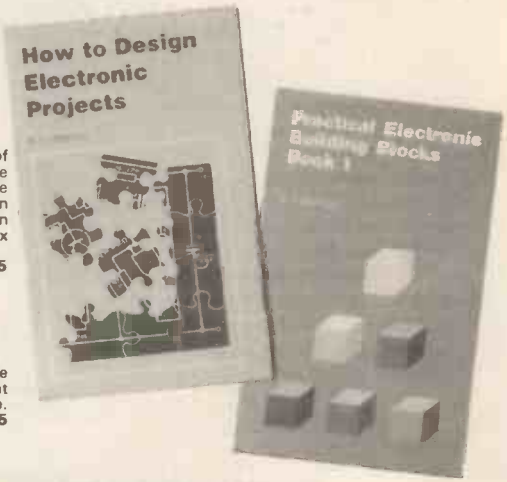

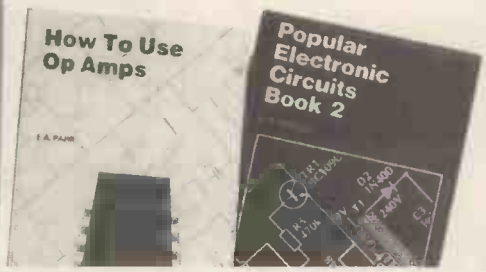

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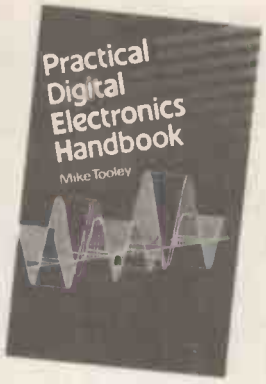

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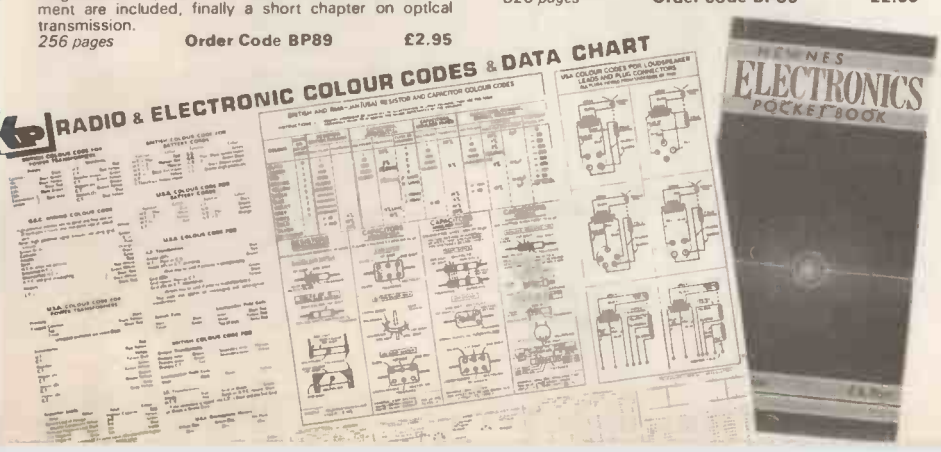

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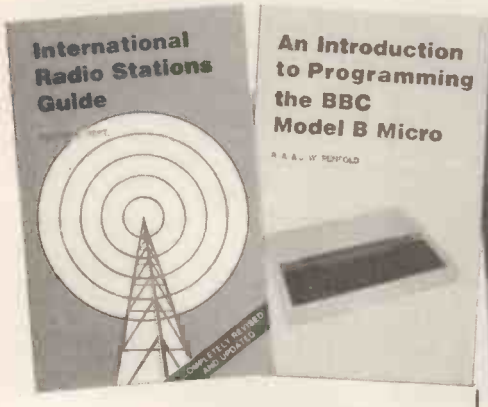

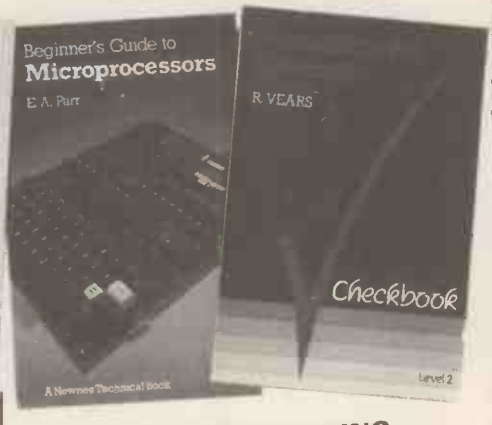

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Constructional Project

AUTO-WAGGLE JOYSTICK

RICHARD CLARK

Cheat a little—save your joystick wear—stop your wrist aching—all these are yours with our auto-waggle add on. Your game scores could improve dramatically!

THERE are now on the market a large number of computer games, mainly of the sports simulation variety, which require the player to waggle the joystick left and right as quickly as possible. Whilst these games are great fun to play, they are unfortunately both tiring on the wrist and, much more serious, very hard on the joystick being used. Frequently this results in the early demise of the joystick in question.

This article will show you a way of not only massively increasing your score but also saving your joystick from destruction when playing these games. The circuit described can be fitted into a Quick Shot II joystick or any other "switch type" commercial unit with some room to spare, or built as a separate complete joystick unit.

There are some notes at the end of the article to help with the production of a home made joystick. Also some suggestions to connect this or any other auto-fire joystick to those computers which are not normally equipped to take such a useful accessory, for example, the Spectrum computer.

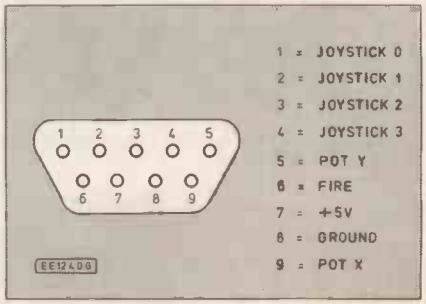
CIRCUIT DESCRIPTION

Before the actual circuit is described in detail we will take a brief look at the connections between the joystick and the computer. Taking the standard (well as near a standard as we are likely to get) Commodore/Atari 9-pin "D" plug, see Fig. 1 for pinout details. This plug contains five direction lines, a common ground line, a five volt line and two lines used for computer dependent purposes. The computer normally holds the five direction lines high internally. When the joystick takes any of these lines low, by connecting them to the common ground line with a simple switch, the computer senses this line has been taken low and performs the appropriate action.

As can be seen from this description to produce the required auto waggle effect it is only necessary to alternately ground the left and right direction lines. This is similar to the existing auto-fire found in some joysticks. This auto-fire effect is produced by a 555 timer circuit which runs continuously and is switched to the fire button line by a change-over switch when required. In an early version of the auto waggle unit this timer circuit was used to supply the pulses for the waggler but was found to be unsuitable because of the different speed requirements of the new unit.

A word of caution before we go into the construction. The chips used in this unit are CMOS and must be handled with care. Pay particular attention to the prevention of static; it is a good idea to touch an earthed point before handling the chips, avoid touching the pins, use sockets for the chips and insert the chips last.

Fig. 1. Commodore/Atari "D" plug connections.



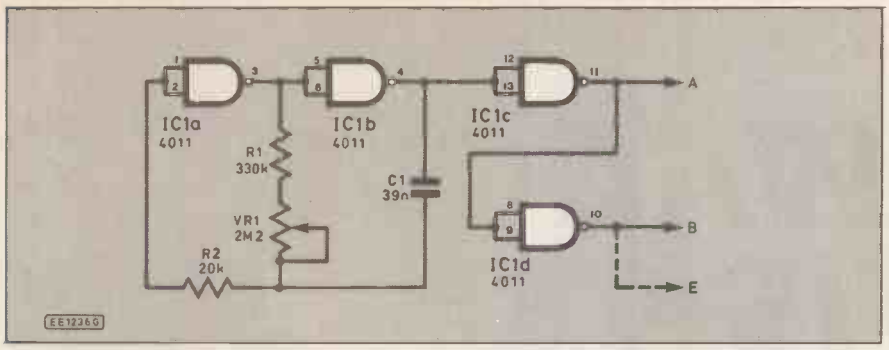


Fig. 2a. The Auto-Waggle oscillator circuit which is built on board 1.

The circuit is in two parts (Fig.2a, 2b), which are mounted on two small pieces of Veroboard shaped to fit the Quick Shot II joystick as detailed in Fig. 3.

The circuit on board 1 (Fig. 2a) is built around a 4011 quad two input NAND gate. Gates IC1a and IC1b along with R1+VR1, R2 and C1 are configured as a free running variable speed oscillator. This produces a square wave pulse train of variable frequency—approximately 4Hz to 800Hz. This pulse train is fed to IC1c which is used as a buffer. The output of IC1c is fed to IC1d which inverts the signal. The outputs of IC1c and IC1d then give a pair of identical but

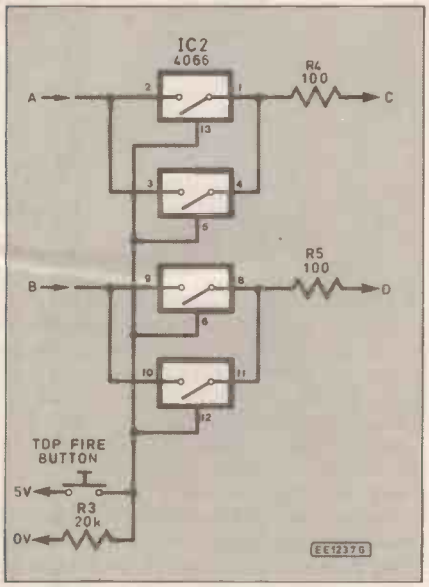


Fig. 2b. Using the top fire button to control the Auto-Waggle.

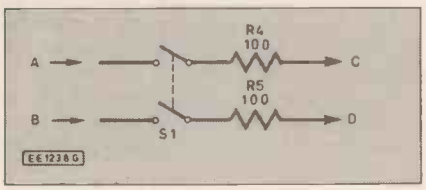


Fig. 2c. Simple connection method.

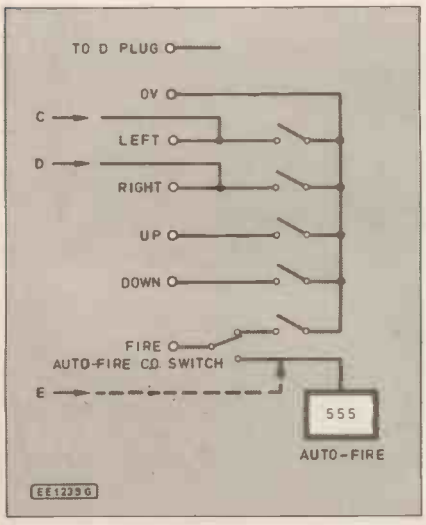


Fig. 2d. Circuit showing joystick connections.

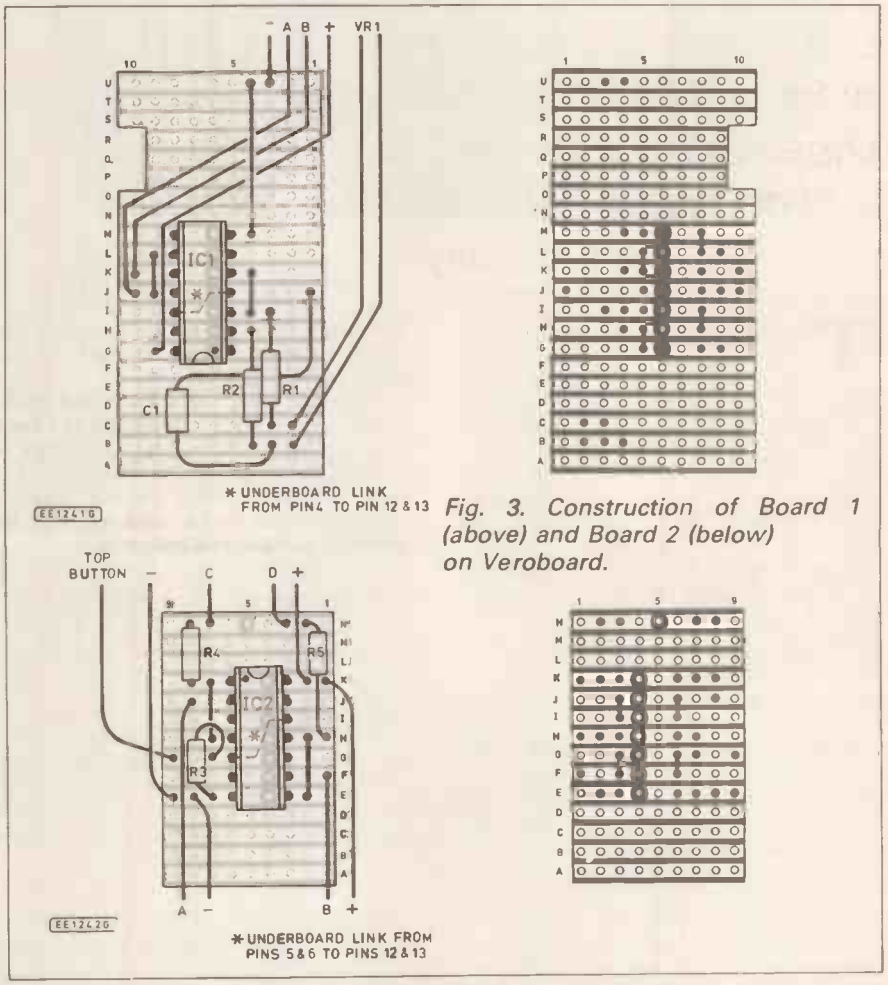


Fig. 3. Construction of Board 1 (above) and Board 2 (below) on Veroboard.

The circuit is mounted on two small pieces of Veroboard shaped to fit the Quick Shot II joystick as detailed in Fig. 3.

COMPONENTS

Resistors

R1	330k
R2	20k
R3	20k
R4, R5	100

All 0.25W 5%

Potentiometer

VR1	2M2 lin

Capacitor

C1	39n poly layer

Integrated Circuits

IC1	4011 quad 2-input NAND gate
IC2	4066 quad bilateral switch

Shop Talk
See page 158

Switches

*Double pole push button switch
*Small push to make switches

Miscellaneous

Quick Shot II joystick; Veroboard; 14 pin i.c. sockets (2 off); wire; knob for VR1.
*Case
*7 core cable
*9 pin "D" plug

***Optional for modified joystick**

Approx. cost Guidance only **£4 plus joystick**

opposite pulse trains of variable frequency. These two outputs are the required pulses to be fed to the left and right joystick lines.

The pulses can be connected to the computer in different ways depending on the precise configuration of your joystick, the only important requirement being the connections must have floating outputs when not in use.

Option 1: The simplest connection method is to use a double-pole changeover switch, momentary or latching, to connect to the left and right lines as in Fig. 2c. This is ideal for a home-made joystick or a re-used broken joystick fitted with left, right, fire and waggle buttons connected as shown in Fig. 3. The above photo shows an early prototype unit which is still sometimes preferred.

Option 2: The smart way is to utilise the top fire button on the Quick Shot II to control the waggle. This requires board 2, circuit 2b. Board 2 accommodates a 4066 quad bilateral switch. The outputs from board 1 are fed to the inputs of the 4066 switches. The outputs of these switches being connected, via R4 and R5 to the left and right lines of the joystick. The resistors R4 and R5 prevent a dead short should the joystick be moved whilst the auto-waggle output is connected. The 4066 switches are held normally open by R3, which connects the switch line to the 0V line, and closed by pressing the top fire button which connects the switch line to 5V. These wires connecting the switch line to the top button must be of a very thin and flexible type. A separate button could be used if desired but the top fire button was thought to be both the most ideally placed and smartest looking solution to the switch requirement.

CONSTRUCTION

The construction of the boards 1 and 2 should not present any problems if the layout in Fig. 3 is followed. Take care to make the correct breaks in the tracks, there are 15 in total, and fit the wire links. Sockets should be used for IC1 and IC2. All the components must lay as close as possible to the boards as space is restricted in the joystick. In particular capacitor C1 should lay flat on the board as shown.

To save on the number of wire links, pins 1 and 2, 5 and 6, 8 and 9, 12 and 13 on IC1 and pins 2 and 3, 5 and 6, 9 and 10, 12 and 13, on IC2, can be linked by solder bridges between the pins on the soldered side of the boards. Also pins 4 and 12 on IC1 and pins 5 and 12 on IC2 are connected by short wire links under the boards. The connections between the boards should be around 60mm long.

INSTALLATION

The installation of the electronics into a Quick Shot II joystick is simple but fairly fiddly. To dismantle the joystick first remove the three screws holding the handle together. Gently prise the handle apart taking care not to pull the fire button wires.Pull the two circuit board switches out of their slots and lay aside the handle halves. Now turn the unit upside down and remove the four screws in the base. Whilst holding the unit together turn it back the right way up, then lift the top off the base, carefully threading the switches through the hole in the top. Lift the inner handle vertically from the base unit, note how the wires are threaded through the slot and fibre ring between the bottom of the handle and the joystick base. The circuit board may now be lifted off its mounting pins and away from the base.

The only modification needed to the circuit board is to accommodate the variable resistor VR1. This requires a cutout in the corner of the board at the connection end. First pull off the green wire, then carefully saw off the corner as in Fig. 4, check this is the correct size for your VR1, then saw a slot next to the circuit board track to enable the green wire to be reconnected. Cut suitable notches in the case halves to take the spindle of VR1, which should be as tight to the corner of the case as possible. Slight trimming of the case may be required to obtain a good fit of VR1.

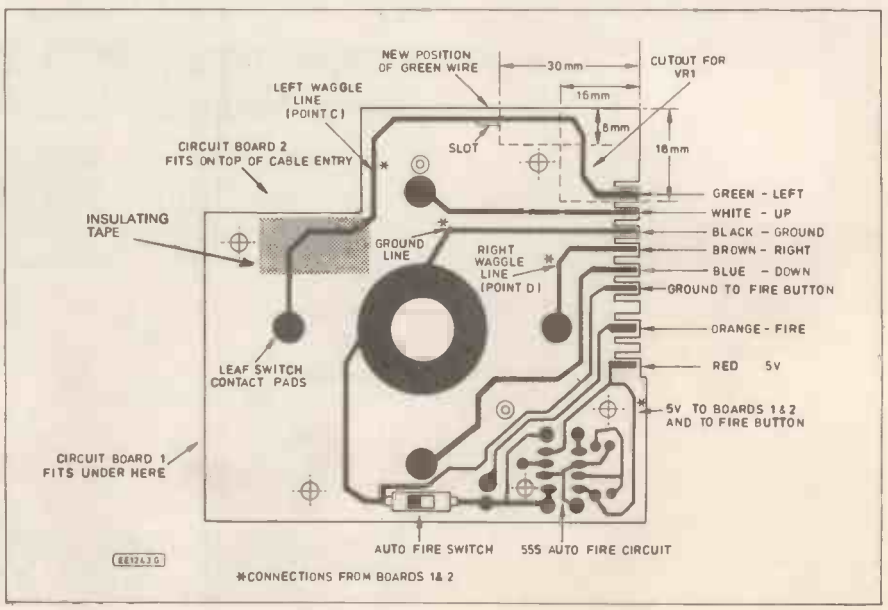
Solder the five volt, ground and signal lines to the tracks on the p.c.b. as shown in Fig. 4. Disconnect the wires from between the top two fire buttons. Thread the switch and 5V wires from circuit board 2 up through the handle and solder to the top fire button in place of the ones just removed. The unit is now ready for final testing.

TESTING

If you are brave or confident spread the circuit boards out ensuring there are no short circuits, plug the unit into port 1 of your (expensive) computer. Everything should behave normally until the waggle button is pressed when a stream of '2' 'space' should appear on the screen. If not switch off and check everything carefully.

For the less brave connect a 5V supply to the circuit (see Fig. 4)—four 1.5V batteries will do (it's all CMOS). The circuit should take a current of around 2.5mA. If you have a 'scope check for the pulse trains on the output of board 1 points A and B, then press the top fire button and check board 2 points C and D. If you do not have a 'scope connect a 0.25μ capacitor across C1, this slows down the oscillator sufficiently to easily see the pulses. The pulses can now be seen with a logic probe or an ordinary multimeter set to volts, connected between ground and the appropriate pins. The pulse speed will

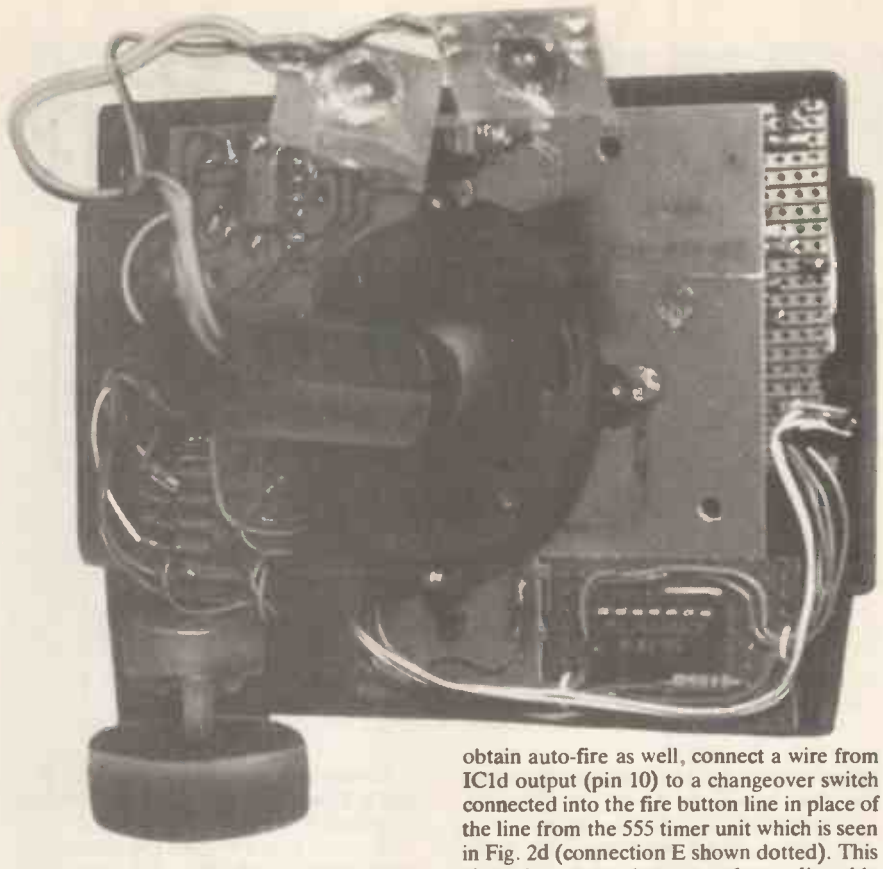
Fig. 4. P.C.B. modification and connections for the two Veroboards.



depend on the setting of VR1. Try the other outputs to prove all is working correctly. When you are happy with the circuit remove the temporary capacitor. It should now be safe to try the joystick on your computer.

When the circuit is correct you can reassemble the joystick. First check the push-on tags on the original p.c.b. Now position the p.c.b. on the joystick base, slide board 1 underneath the p.c.b. opposite VR1, note board 1 is mounted upside down, board 2 sits on top of the cable entry to the joystick. The photo on the right shows the boards in their final position. Ensure the cables are not trapped, interfering with the leaf switches or across any of the screw holes in the base. Position the inner handle, carefully placing the wires in the slot in the base. The notch in the ring on the bottom of the handle indicates the correct orientation. Fit the base top cover, turn the unit over and insert the four screws. Turn the unit the right way up, slide the fire and waggle switches into the handle, refit the outer handle and insert the three screws.

Your auto waggle joystick is now ready for use, just one button to press and you are "world champion"!



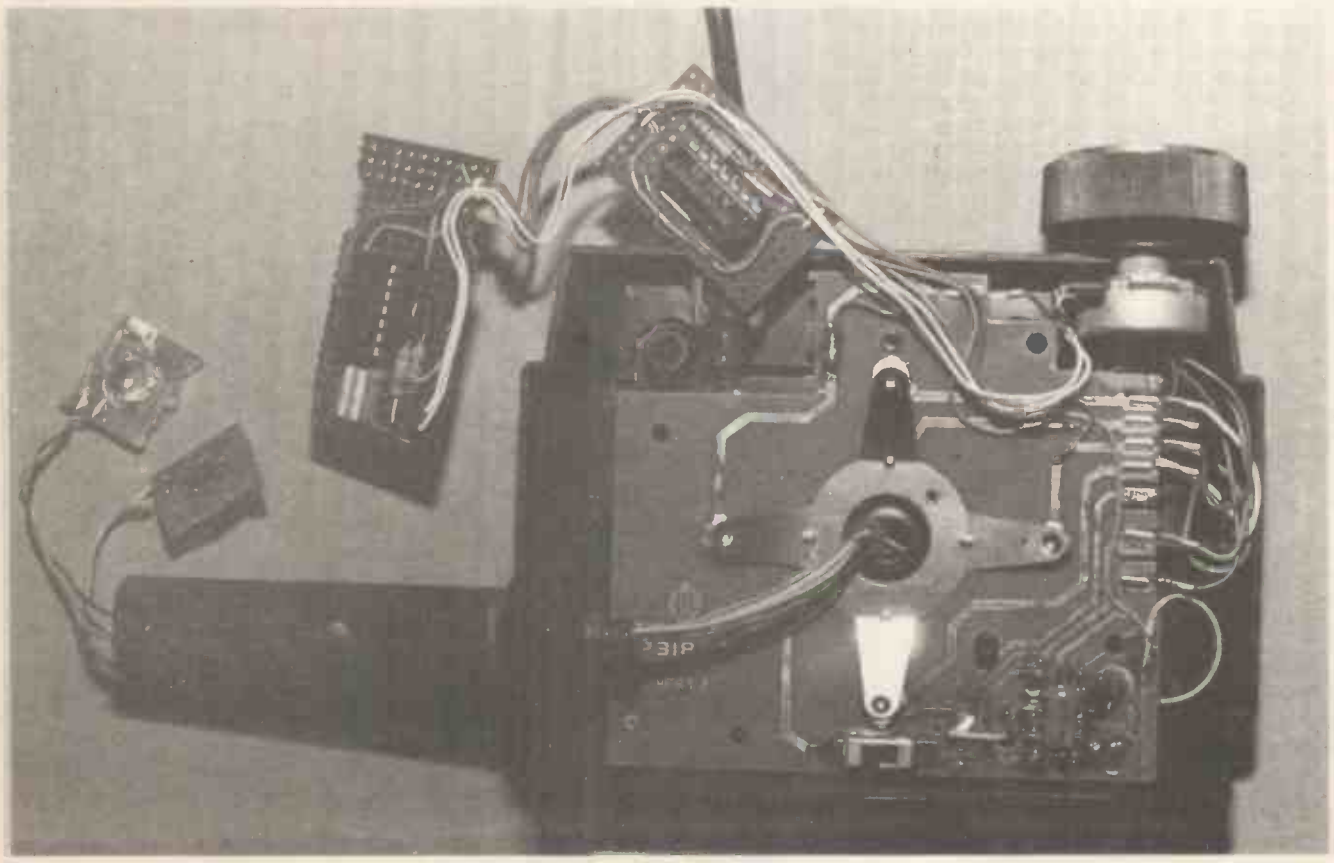
HELPFUL HINTS(?)

The connection of this auto-waggle joystick or any other auto-fire joystick is not possible to some computers; for example the Spectrum, because of its different joystick port configuration. Do not despair for it is possible to adapt the unit for this computer.

For the Spectrum with a Kempston adaptor unit, take the cover off the adaptor and you will notice that pin 7 on the D plug (the 5V line in the Commodore plug) is not connected to anything. All that is required then is to connect this pin 7 to the 5V supply, pin B3 on the edge connector bottom row. Reassemble the adaptor and waggle away. A similar approach should work with any other Spectrum joystick adaptor. This modification also allows auto-fire joysticks to be used on the Spectrum.

To produce a personalised joystick is quite straightforward. All that is required are five push-to-make-switches, a suitable case, a length of seven core cable and a 9 pin "D" plug. The cable and "D" plug are best, i.e. cheapest, obtained from an extinct joystick (if you have not got one try your local computer shop). Connect up the switches as in Fig. 2d along with the auto-waggle unit. To obtain auto-fire as well, connect a wire from IC1d output (pin 10) to a changeover switch connected into the fire button line in place of the line from the 555 timer unit which is seen in Fig. 2d (connection E shown dotted). This gives the extra advantage of an adjustable rate of fire.

A small tip whilst you have your iron handy. Put a small amount of solder onto each of the direction switch pads under the leaf switches on the p.c.b. to improve the connection. The circuit board is coated with a layer of varnish which can interfere with the switch connection. I have had several apparently faulty joysticks where this was all that was required to get them working again. □



FOR YOUR ENTERTAINMENT

BY BARRY FOX

In The Picture

Every year, with the first cuckoo of spring, someone predicts that there will "soon" be a thin, flat display panel to replace the traditional bulky cathode ray tube. Already there are portable TV sets which use flat displays. But for screens large enough for the living room, tubes remain both cheaper and better.

Although Finlux recently scored publicity with the promise of a panel which "hangs on the wall much like a picture frame" and will supposedly soon make conventional sets "obsolete", the Finlux panel is still only 7in. in size which is far smaller than any conventional living room set. And it still only gives black and white pictures!

Sony and Sir Clive Sinclair have separately offered pocket TV sets which use a flattened cathode ray tube to give a black-and-white picture. The beam of electrons is turned back on itself to scan a screen on the side. The Philips Research Laboratories Centre at Redhill has been working on similar technology but warns that large flat tubes could weigh as much as a piano. The flattened shape is mechanically weak, so heavy glass and a steel frame are needed to withstand atmospheric pressure on the vacuum inside.

Solid state displays are lighter but even more difficult to make in large sizes. The image is created by a matrix of individual cells, like a chess board, which generate picture points or pixels.

To reproduce a colour TV image with no loss of quality, the panel would need 0.7 million separate cells with connecting wires to control them. If the panel size is small, a matrix of less than 0.1 million picture cells can produce an image that looks clear.

The new Ferguson pocket TV set (made in Japan by Epson) has 56,000 cells. Because the screen is only 2.5 in. (diagonal) the eye is fooled by the small cells.

When the panel size increases the cells get bigger and more must be used. This greatly increases cost. Also production yield of the panel falls because it is very difficult to make a panel with all cells 100 per cent perfect.

Unfortunately, any faulty cell stands out like a sore thumb as a stationary blemish in the TV picture. Manufacturers may be able to make one perfect prototype—the trick is in mass producing fault-free panels which match a tube for picture clarity and price.

Some small portable TV sets, like the Ferguson-Epson, use liquid crystal displays because small LCDs can be formed on a silicon wafer like a microchip. Also LCDs use little power, because they alter ambient light instead of emitting it.

Colour is produced by tiny red, green and blue filters over groups of three cells. The penalty is a dim picture in dim light, unless a back-light is used. Top size for LCD screens is usually 5 in.

Panels made from light emitting diodes (l.e.d.s) or gas discharge cells emit their own light so look brighter. But the image is coarser because the individual cells are larger, and the panel consumes too much power for portable use.

Electroluminescent panels, like the Finlux, generate light when a high voltage is passed through small spots of phosphorescent material. Designers have had difficulty making the cells small enough for a large clear picture at economical price and in matching the light output from the red, green and blue cells, so that the colours in the picture look natural and balanced. Hence the Finlux monochrome screen.

Big displays are ideal for computer graphics where fine detail is not needed. But for true colour TV pictures, industry estimates are that cathode ray tubes will for at least five years be best for screen sizes over 11 in.

Witness the fact that Sony has just invested yet more millions in the cathode ray tube plant in Wales.

Down to Earth

Here's a tip that could be very useful, with the impending re-launch of Laservision under the new guise of CD Video.

More and more people will in future be hooking up a TV set, video recorder and video disc player with a hi fi system. Quite often the hi fi will be in a different part of the room to the video gear and TV set. So you will need long screened cables to connect the two together. And there is a good chance you will get nasty hum or frame buzz breaking through into the hi fi sound. There are two things you should know.

Most hi fi and video equipment is double-insulated, and thus fed from the mains by only a two-core lead. Intentionally, there is no earth to the mains. The earth returns for the audio and video leads runs through the screened cable braid, and from there down to earth wherever there is an earth connection.

Make sure there is only *one* main earthing point for all this screening. Usually it will be at the hi fi amplifier.

Don't be tempted to connect separate earthing wires to individual pieces of equipment. Using several earth points will create *"earth loops"* through which low level signals can run round in circles.

Unwanted signals will be induced in the loops by radiation, for instance from a transformer or the tube coils of a TV set. This is what makes nasty sounds through the hi fi.

Don't use a separate power point for the two halves of an audio video set-up. Power all the audio and all the video equipment from the same wall socket. If necessary run an extension lead across the room.

The problem here is that the mains power from different sockets may vary slightly in phase, depending on the load being placed on those sockets. The load can come from different parts of the A/V system, or from other electrical equipment elsewhere in the house. Slight mismatch of phase between the power supply for different parts of the same system can create "beat frequency" hum bars which roll up and down the TV picture, or put buzz on the sound.

So, if your A/V system plays odd tricks, which vary during the evening for no apparent reason (as electrical appliances in the house are switched on and off) make sure that everything in the A/V system is earthed to a single point and everything is running from a single power socket.

Viewpoint

Large screen video displays are now big business.

There is nothing new in projecting a video image onto a screen, but getting a large bright picture is still very expensive. The reason for this is simple. In a film projector the starting point is a transparent image, through which light is concentrated and then focused by a lens system.

To increase the picture size and brilliance, all you do is increase the light source power. Of course this brings its own problems, like keeping the film frame cool, but it is tried and tested mechanical technology.

The picture we see on a TV screen is created by an electron beam spot which

Counterfeit Embargo

Fake audio and video tapes, with a poor quality iron oxide coating that is little better than rust, can ruin the heads on a recorder. Replacing these in a video machine can easily cost over £100.

Until now some firms have got away with murder selling terrible quality tape under names which are either the same or almost the same as famous brands, e.g. TKD, Maxwell or Sonny. The genuine manufacturer has to wait until it is on sale and then take private, civil action.

As a lot of the junk comes in from abroad e.g. Hong Kong, it would be far easier to nail it at the docks or airport. But so far that hasn't been legally practical.

Well it's bad news for the counterfeiters and good news for the rest of us. The Common Market Eurocrats have taken time off from making mountains out of food and drink (to keep the price up) and done something about the forgery problem.

Ministers in Brussels have agreed to give Customs officers throughout the EEC power to seize any goods which are counterfeit. The new ruling came into force on 1 January and is tied to trademark ownership.

Anyone with a registered trademark who suspects that competitors are importing counterfeit goods under the same or confusingly similar name, can apply to their national Customs authority and point to a suspect consignment of goods. For a £500 fee the Customs will then check the goods, detain anything which infringes the trademark, and give the importer and complainant 10 days to prove who is in the right or wrong.

is scanning a coating of light-emitting phosphors on the inner surface of the glass screen tube. So there is no transparent image through which light can be shone.

A video projector throws an image on a reflective screen by focusing the light emitted by the tube. There is a finite limit to the amount of light which a tube can emit, and this puts a similar limit on picture size and brilliance. Using three separate image tubes, one for the red light component, one for the blue and one for green, increases light output but it can never match the 1000 watt lamp of a 16mm film projector, let alone the arc lamp of a 35 or 70mm cinema projector.

The most efficient video projectors, made by Eidophor in Switzerland and GE in America, use the light valve principle. The electron beam scans a thin film of oil which distorts in the shape of the image to create the temporary equivalent of a film frame. A triple system is needed for colour.

Light valve projectors cost many tens—or hundreds—of thousands of pounds and are difficult to install and align. And even the most expensive light valve projectors still have difficulty in producing watchable pictures in brightly lit surroundings.

For sporting events and pop concerts, there are several systems now which build up a picture from a matrix of individual light sources. This goes back full circle to the days when John Logie Baird installed a light bulb screen in a London theatre for closed circuit television. A matrix of small lamps are switched on and off by the scanning signal.

Ordinary light bulbs produce a very smeared image, because they heat and cool too slowly. It is much better, but more expensive, to use light emitting diodes, liquid crystal filters or even miniature TV tubes.

Three different light sources, red, green and blue, are needed for each point of the picture—"pixel"—and obviously each light source has a finite size. So the mosiac of light sources is inevitably rather coarse and the picture only looks reasonable when viewed from a long distance, e.g. across a football pitch, concert stadium or sports arena.

Video Wall

The latest approach is the so-called Video Wall. This is a vertical wall panel built from many small TV screens. Electronically, this is a very flexible approach. The full TV image can be spread over the entire wall area, with each individual screen showing its own section of the picture, or groups of screens can show separate images, to create a mosaic effect or inset images within the main overall picture.

But once again there is a problem. It is physically impossible to put two TV screens so closely together that their adjacent images merge seamlessly. There is always a black line between adjacent screens, so the Video Wall ends up looking like a draught board. Recently I saw some interesting modifications of the wall system.

Back Projection

The JVR Projection Video Wall (from Dutch company Jongenelen Video Roosendaal) is a vertical matrix of 64 back projection TV sets, arranged in eight rows of eight. Each screen is a sheet of translucent material with red, green and blue projection tubes behind it. The projectors are fed video signals sourced from a bank of video disc and professional tape players, with the picture signals switched in varying patterns under computer control.

The individual screens are pushed flush one against the other in a very tight mosiac. There is still a draught board matrix of black dividing lines, but they are very thin and not noticeable, especially when the screen is being used for special split image effects.

The penalty is price. A full size screen with computer-controlled video sources costs almost £1 million.

Another approach comes from Italy. The country is now trying to make its name as a manufacturer of high technology electronics. The government has taken a 49 per cent stake in Seleco, a new company which is producing 0.4 million TV receivers a year and making computers for IBM, Olivetti and AT and T, Zanussi, Electrolux and Indesit own the remaining 51 per cent.

In an effort to boost the high tech image, Seleco is also making two flagship products, a giant electrostatic graphics display which can be run from a personal computer and a wall of TV sets which uses optical fibre technology to blend up to 100 part pictures into a single giant whole.

The graphics display, called Winex, can be six metres wide and is connected to the printer output of any MS DOS PC. It is built up from a matrix of dots, each 1cm square, and each switchable between two colour states.

The dot is formed from two plastic strips, one red and one yellow. A small piece of flimsy aluminium foil is trapped in the nip between the strips.

The data signal from the PC is converted into an electrostatic charge pattern. When a yellow strip is charged it attracts the foil, so the yellow strip is covered and the adjacent red strip is exposed. The foil also reflects the red light to double the effective area of the red dot. When a red strip is charged the dot changes colour to yellow. The graphics pattern for the PC is thus displayed on the panel.

The Winex panel can be waterproofed for outside use. Seleco is soon to install two Winex screens at Italian railway stations, to display train times. Cost is £20,000 per square metre, but Seleco believes this can be halved if more orders roll in.

Light Pipe Screen

Whereas Winex can display only two colour digital graphics, Seleco's Kreon screen displays full colour TV pictures as big as a house. Up to 100 separate TV sets are arranged in a video wall, to create a total picture area around 4×3 metres in size.

As with all tube walls, there is always a gap of at least 50mm between each screen. Seleco overcomes the problem by putting a modified Fresnel lens over each TV screen. The lens looks like a dart board, with four rings of optical diffractors around a central bull's eye.

Behind each lens there are 15,000 light fibres moulded from hard plastics. These diverge slightly and act as light pipes. They pick up light from the TV picture tube and channel it to the lens, expanding the picture slightly in all directions. This has the optical effect of closing the 50mm gap, between separate screens to around 1mm.

So instead of seeing a fragmented mosiac of widely spaced screens, the viewers see a single flat screen with only narrow cracks between lenses. From a distance, the cracks disappear or become unobtrusive.

Because the light emitted by the lenses comes from a bank of conventional TV picture tubes, the full screen can produce an image which is bright enough to cut through daylight or artificial lighting. The Seleco light pipe screen can also be watched from a very wide angle, almost 180 degrees, whereas projected pictures must be viewed head on.

The system is expensive because the lenses and light pipes must be moulded from optically pure plastics. A 5×5 matrix of 25 TV screens and lenses costs around £100,000. They will be hired out to pop concerts, political conventions, video conferences and advertising displays.

Reluctantly Seleco admits that both the displays are made under licence from American inventors.

ELECTRONICS TEACH-IN £1.95

By Michael Tooley BA and David Whitfield MA MSc CEng MIEE

A COMPREHENSIVE background to modern electronics including test gear projects. This 104 page, A4 size book forms a complete course in basic electronics; designed for the complete newcomer it will however also be of value to those with some previous experience of electronics. Wherever possible the course is related to "real life" working circuits and each part includes a set of detailed practical assignments.

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Send a cheque, PO or bank draft for £1.95 (overseas readers please add £1 postage. Payment in £ sterling only) to Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel: 0202 881749.

Actually Doing it!!

MODERN methods of electronic construction have to a large extent done away with traditional wiring methods. Most commercial equipment seems to have everything "on-board", and this trend has been spreading to designs for the home constructor.

Despite this, there are few projects that are truly" wireless", with printed circuit tracks carrying every connection from its beginning to its end. Some projects still require quite large amounts of hard-wiring, point-to-point wiring, "spaghetti" or whatever term you prefer

Learning to successfully put together a well built circuit board is an important first step in the art of electronic project construction, but competence at wiring finished boards to potentiometers, switches, and other off-board components is equally important. A large percentage of current projects seem to be based on custom printed circuit boards, and they offer a fair chance of success even to complete beginners.

However, it is all too easy to fall into the trap of painstakingly building a circuit board, only to then make a mess of things when wiring to the controls, sockets, etc. When building circuit boards the main problem to avoid is accidental short circuits, but with the hard wiring there are a number of possible and common pitfalls.

MISSING LINK

Before considering the topic of off-board wiring, it would perhaps be as well to take a quick look at on-board wiring. The complexity of many modern projects means that the use of link-wires is very common, and the nature of stripboard is such that few circuits can be built on it without resorting to a sprinkling of link-wires.

Most link wires are quite short, and pieces of wire trimmed from resistors and capacitors are ideal for making these. Sometimes longer links are called for, and 22 s.w.g. tinned copper wire is suitable for these. It is a good idea to have a small reel of this wire as part of the standard workshop equipment.

The quick way of adding link-wires is to cut a piece of wire that is about 10 to 20 millimetres over-length, solder one end in place, thread the other end of the wire through the second hole, pull it tight with the aid of pliers, trim the lead to length, and then make the second connection. I must admit to having used this method a great deal, but I have also experienced a lot of problems with link-wires breaking.

The problem is that in pulling the wire tight it is taken close to breaking point. It will not often actually break, but it may be seriously weakened and can then easily fail at some later time.

The slower but much more reliable method is to carefully form each link-wire to the right shape, fit it in place, trim off the excess wire, and then solder both ends in place. With short links there is not normally any risk of accidental short circuits, provided the wires run reasonably straight from one hole to the other *(which they always should)*.

With link-wires of more than 20 millimetres in length there is a much greater risk that at some stage the wire will be knocked slightly out of place, and that it will then come into contact with another link-wire, pins of an integrated circuit, or whatever. Unless they are well separated from other wires and components, it is a good idea to insulate any long links with p.v.c. sleeving.

With custom printed circuit boards it is unlikely that a link wire would be accidentally omitted, as there would be two unoccupied holes left in the board. It is all too easily done when using stripboard though, and looking to ensure that all links are present and correct should be a standard check on completed stripboards.

GENERAL WIRING

The normal kind of wire to use for point-to-point style wiring is a p.v.c. insulated multi-strand type. This type of cable will usually be described as 7/0.2 wire in catalogues, which simply means that there are seven cores of wire that are each 0.2 millimetres in diameter.

You may also come across thinner types such as 7/0.1 cable, but these are a little on the light side for general project wiring. Most suppliers also sell single strand equipment wire (usually having a 0.6 millimetre core), and this has the advantage that it can be easily formed into any desired shaped and routed around a project.

Although the single core type may seem to be a better choice it is little used in practice. It has a major disadvantage in that it tends to break much more easily than the multi-core variety, and often proves to be hopelessly unreliable. I would certainly not recommend the use of any form of single strand cable for wiring up projects.

Most wiring does not consist of single wires, and in most cases there will be something like three wires running together from the circuit board to a potentiometer, or perhaps even a dozen or more leads running from the board to a switch.Traditionally this type of wiring is completed using single wires which are then tied together into a single cable.

This tying together was originally done using thin cord, but making a neat job of this is at least as difficult as it looks. The more recent approach to the problem is to use the cable ties that are now readily available from a number of component retailers. These offer a skill-free solution as they are simply looped around the leads and pulled tight.

My preferred method of tackling multi-way leads is to use pieces of ribbon cable. This cable consists of a number of multi-strand insulated leads bonded together side-by-side, giving it a flat ribbon-like appearance.

A lot of the ribbon cable currently on sale is the light duty (7/0.127) type intended for use with i.d.c. connectors. This is usable in the present application except where high currents are involved, but it is not very easy to deal with. The heavier gauge (14/0.13) is much better for general wiring purposes, and is much easier to use.

Ribbon cable is available in a grey colour, or at a higher price the so-called "rainbow" type can be obtained. The latter is very much better for project wiring as the leads are of different colours, and are easily identified. Using the single colour type is likely to be much slower as there will be difficulties in determining which lead is which, and the likelihood of errors being made is very much greater.

Ribbon cable is generally only available in strips having ten or more leads, but there is no difficulty in peeling off a cable having the desired number of ways. In fact this cable has to be designed to enable the individual leads to be easily separated, since the leads have to be separated at the end of the cable so that they can individually have a small piece of insulation stripped off.

STRIPPING AND TINNING

Removing a short length of insulation from the end of a cable is a job that should be undertaken using proper wire strippers, not a pair of scissors or a penknife. A pair of combination wire strippers and cutters can be obtained quite cheaply, and will do a far better job than improvised cutting and stripping tools.

Proper wire strippers have circular blades that cut through the insulation right around the cable, and they also have some form of limiting mechanism that prevents the blades from closing down beyond a certain diameter. The idea is to have the minimum aperture of the cutters set just fractionally larger than the core diameter of the cable.

The strippers will obviously not cut right through the insulation, but as the lead is pulled away from the strippers the uncut part of the insulation will simply snap and the piece of insulation will be removed without difficulty. This ensures that the core of the lead is left undamaged. Although a minor nick into the core may not seem to be of tremendous significance, it would in fact greatly weaken the wire, almost certainly causing it to break before too long.

The bare ends of leads should be generously tinned withsolder. The insulation invariably protects the wire against dirt and corrosion, so that there should be little difficulty in tinning leads.

To tin a lead simply apply the iron to the bare end and feed in a small amount of solder. If the solder does not flow right around the wire, repeat the process but apply the solder to the opposite side of the wire. If there is still difficulty in getting the solder to flow properly, gently scrape the wire clean with a knife blade and then try again.

It is also essential to tin each tag or

pin before a lead is connected to it. Again, in most cases the solder will flow with no difficulty, but sometimes it will accumulate on the bit of the iron and refuse to go where you want it.

Some careful scraping with a blade to produce a clean and shiny surface on the tag should banish the problem. With the lead and tag both well tinned with solder, placing the two together and briefly applying the bit of the iron (which should be loaded with a *small* amount of solder) should produce a strong soldered joint.

Try to keep the wiring neat and tidy, and do not use leads that are barely long enough. Project layouts are generally designed so that long wires trailing all over the place are avoided, but where necessary route cables around or under circuit boards rather than over them.

This is not just a matter of making the finished assembly look good. If at some later date a project should require servicing, it will be very much easier to repair it if the wiring has been done neatly and carefully. Otherwise it might be like mending a roof—as you mend one thing you break something else.

MAINS LEADS

Presumably all readers of *Everyday Electronics* know the colour coding for mains leads, and will have no difficulty in getting the connections right. I wonder how many readers fit the mains plugs of their projects with a fuse of suitable rating? Most projects draw only a few watts of power, and a 2A or 3A fuse is much more suitable than the 13A variety.

The point where the mains cable enters the case is a potential source of disaster. The entrance hole should be fitted with a rubber grommet having an inside diameter which matches the diameter of the cable. This is especially important with metal cases where there is otherwise a very real risk that before too long the case would cut into the cable and come into contact with a bare wire.

Some form of strain relief for the cable is needed, and a knot in the cable on the inside of the case is definitly not a good way of providing it and must be avoided at all cost. The type of cable grip

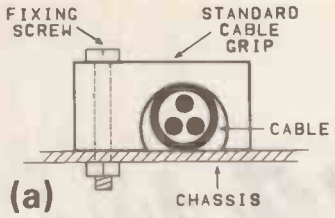
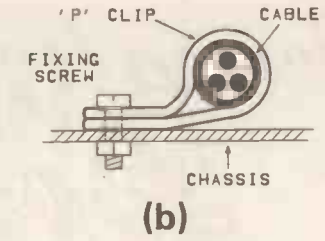


Fig.1. A standard cable grip (a) is usable in project applications, but a "P" clip (b) seems to provide a more secure result.



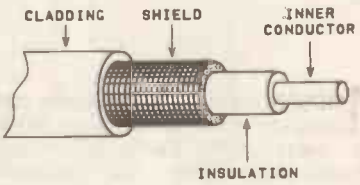


Fig. 2 (right). The basic make-up of a screened cable. This type of cable is also referred to as a co-axial cable ("Co-ax").

shown in Fig. 1(a) is really intended for use when undertaking house wiring, and they are usually supplied complete with masonry nails to fix them in place. These are not exactly ideal for project use.

The "P" style clips (Fig.1(b)) on the other hand, are well suited to fixing mains cables in projects. Note though, that you must select a clip to suit the diameter of the mains cable you are using. If the clip is slightly too large it will not retain the cable properly, and if it is too small it will probably break when the fixing nut is tightened./ Do not make the mistake that I once made, of carefully fixing a mains cable in such a position that when the lid of the case was fitted one of its fixing screws went straight into the lead! Some cases have fixing screws that protrude well into the case.

Combined grommets and cable grips can be obtained. I have used these successfully, but the panel cutout must be very accurately made or they can tend to jump out of place.

SCREENED LEADS

Screened cable is mainly used in sensitive audio circuits. A single screened cable has the general make-up shown in Fig.2. The outer braiding normally connects to earth, and screens the inner conductor against stray pick up of mains "hum" and other electrical noise.

Some twin screened leads are effectively just two single types joined side-by-side, but there is also a type which has a single outer braiding for both inner conductors. This second type is unsuitable for many purposes as it tends to give strong cross coupling of the signals in the two cables.

To prepare a screened lead for connection it is a matter of first stripping off about 20 millimetres or so of the outer cladding. With the thinner types this can be accomplished using ordinary wire strippers, but few strippers can accommodate the thicker screened cables. With these there may be no alternative to using a sharp knife to cut away the cladding, trying not to damage the outer braiding.

The braiding is then combed out with the aid of your thumbnail or a small screwdriver, and then twisted together to form a lead. This is then heavily tinned with solder to stop it from unravelling. Finally, a small piece of insulation is stripped from the inner conductor and it too is tinned with solder. Make sure that there are no odd bits of wire sticking out of the outer braiding that could short circuit to the inner conductor.

Robert Penfold

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DOWN TO EARTH

BY GEORGE HYLTON

CONNECTING a test meter to a circuit can upset the circuit. Textbooks will tell you all about the measurement errors which can be caused by the meter loading the circuit. What they don't tell you about is other forms of trouble, some puzzling, some disastrous which arise from a simple attempt to make a measurement.

Way back in the days when I was green and growing I was foolish enough to lend my multi-meter to an engineer, "to test the mains". This man, who should have known better, set the meter to its highest current range and connected it across line and neutral. There was a blue flash and the lights went out. He explained that all he'd wanted to do was measure how much current the mains could deliver, from a particular socket. Indeed, he was successful, up to a point. The answer was, clearly, "More than enough to blow the fuse".

Fortunately, neither the man nor my meter was damaged. (That meter had a good magnetic cut-out, unlike many of today's cheap jobs.) It taught me to be chary about lending instruments, even to people who should know how to use them. It does teach another lesson: that it's very easy, by loose thinking or carelessness, to ask a test meter to do a job which is damaging to itself. A common mistake is to try to make an ohms measurement on a live circuit. The rush of current which may result can wreck the meter. Even if it doesn't the reading is most likely to be misleading.

LEAKY JUNCTIONS

My second story is about a much more subtle effect. I supplied a friend at work with some silicon power transistors. Being a careful chap, he made some quick ohmmeter tests on them before use. He applied the test leads to each junction (base-emitter and base-collector). In the "forward" direction the junctions all registered a lowish resistance, as they should. But in the reverse direction, where they should have registered an infinite resistance, or at most a very high one, in fact they all showed a few thousand ohms. Clearly, the transistors were "leaky".

I swapped them for new ones, which I first tested in the same way and found good. To my surprise he brought them back, complaining of the same fault. I took them home and re-tested them. No problem.

HIDDEN VOLTAGE

Whatever was going wrong? My friend is no fool. I knew he'd have made the test correctly. But so did I. So why the discrepancy? It must be the result of some difference in the particular circumstances in which the tests were performed. But what?

Was there something wrong with his multimeter? Breaking my rule, I lent him my own. He took it home and retested the leaky junctions. They were still leaky. Yet, on my bench, the same meter, applied to the same transistors, had shown no leakage.

This farce might have gone on for ever, if my friend hadn't mentioned that the leakage readings he was getting weren't constant. The meter pointer wandered about a bit. That wouldn't be very surprising if the transistors were really on the blink with junctions in the process of breaking down because of some internal fault. But I was sure they were OK. Something was getting to them, in my friend's home, which was absent in mine. This reflection eventually caused light to dawn. I remembered where he lived, rang him up, and said: "Look out of your window. What landmark do you see?".

Answer: "The Crystal Palace TV mast, of course". And that was it. The transmitter was less than a mile away. The ohmmeter leads were acting as an aerial and picking up enough signal voltage to be rectified by D1 (Fig.1). This internal diode is present for making a.c. measurements and is normally inoperative (but still connected) during resistance measurements. In circuit terms, at my friend's home the meter circuit (Fig.1) was not the normal one (a), but had a.c. voltage sources in it (b), representing the aerial effect (V1, V2).

The spurious leakage reading varied because the aerial pickup changed as vehicles went by or my friend moved himself or the meter leads.

INSTABILITY

Such a bizarre example of misleading meter indications is unlikely to happen to you. But is does point to another effect which you may well come across. If meter leads can act as a receiving aerial then they can also act as a transmitting aerial.

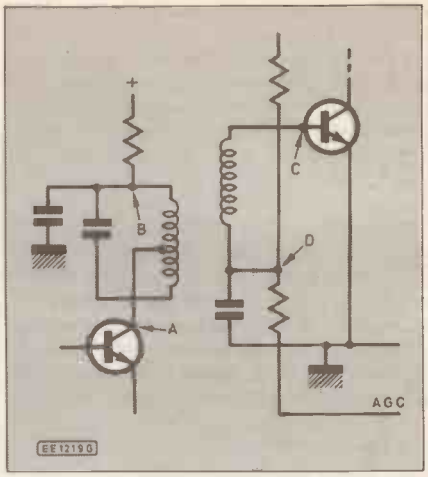
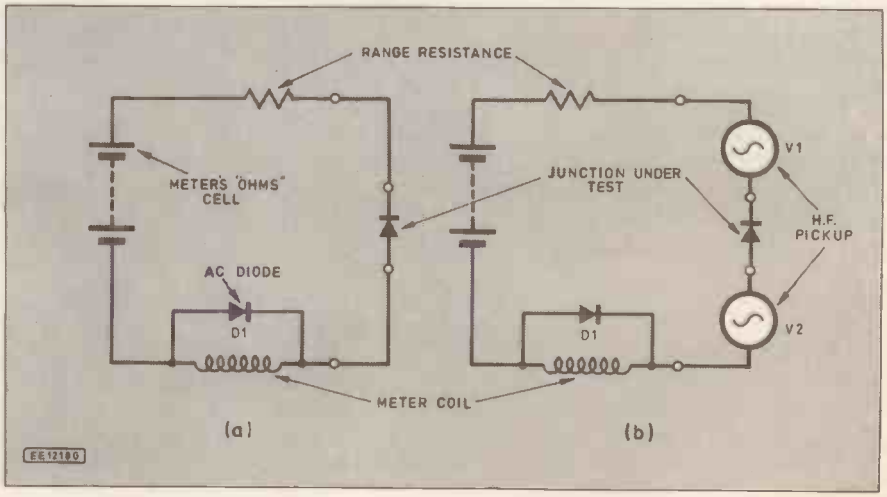


Fig. 2 Typical discrete-transistor i.f. amplifier section. Attaching meter leads to points A or C may cause instability.

If you connect a meter to a point in a circuit where there is a high-frequency signal then the lead may radiate that signal to another part of the circuit where it can cause trouble. Fig. 2 shows the coupling between stages of a tuned amplifier such as the i.f. amplifier of a receiver. In fault tracing you may want to make sure that points A and C are at the correct d.c. voltages. Both these points are "live"; i.e. h.f. signals may be present. Connecting the meter lead may transfer some signal back to an earlier stage. This is feedback. If positive it may provoke oscillation (instability). This is likely to upset the circuit.

Measuring at points B and D should yield the correct voltages, since these points are decoupled to earth and not live. The d.c. resistance of the windings, being low, will not affect the voltage. However, there is the possibility that the fault you are seeking might be a break in a winding, and testing at the decoupled points will not find this. You can safely make tests at A and C if you shunt these

Fig. 1(a). Normal ohmmeter circuit as used in multimeters. (b). Effective circuit when the meter leads pick up radio frequency signals (V1, V2). The internal diode D1, used on a.c. ranges but still present, rectified the signals and produces a meter reading.



points to earth via a capacitor (say 100n) to short out any h.f. signals.

A 100n capacitor of generous voltage rating, provided with croc-clip leads, is a useful adjunct to any test bench. If your meter has a very high resistance (e.g. if it's an electronic meter) you may get away with just using a shortlead resistance (say 100k) as a temporay test probe. This may block the passage of h.f. signals to the meter lead well enough to avoid trouble. It does reduce the d.c. voltage being measured but this may be acceptable. If for instance you are using a digital voltmeter whose resistance is 1M then the 100k probe will reduce the readings by about nine per cent.

CURRENT MEASUREMENTS

Service engineers usually try to avoid current measurements. To make one requires breaking the circuit. This is often difficult, physically (it may call for breaking the foil on a printed circuit) and is also apt to be time-consuming.

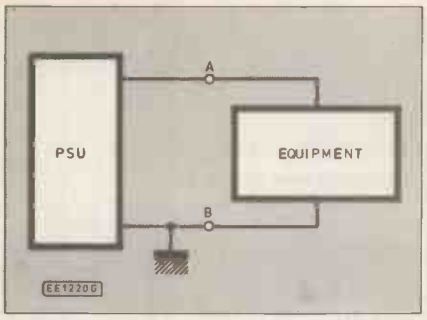


Fig. 3 Current may be measured by breaking the supply lead at A or B to insert a meter. But using point B can be dangerous to some kinds of equipment.

However, there are circumstances in which current can easily be measured. A common case is when equipment has a separate d.c. power supply (Fig.3). The current meter can then be inserted into one of the supply leads. At first sight, it doesn't seem to matter which, since the current is the same at points A and B. In some cases, however, inserting the meter at B can wreck the equipment. Audio power amplifiers may be vulnerable in this way.

The explanation is that the impedance of the meter, though low on a current range, may be sufficient to develop a.c. signals and these are fed into the equipment, getting into low-level stages as positive feedback. The resulting instability causes oscillating currents of damaging amplitude. It is not necessary for any genuine signals to be present to set this process going. The inevitable noise in a circuit is enough.

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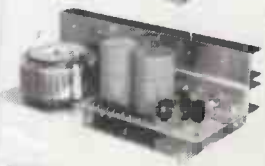

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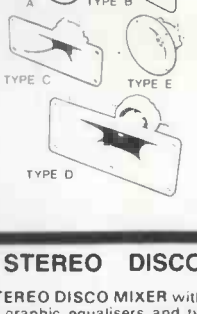

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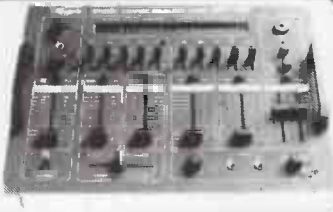

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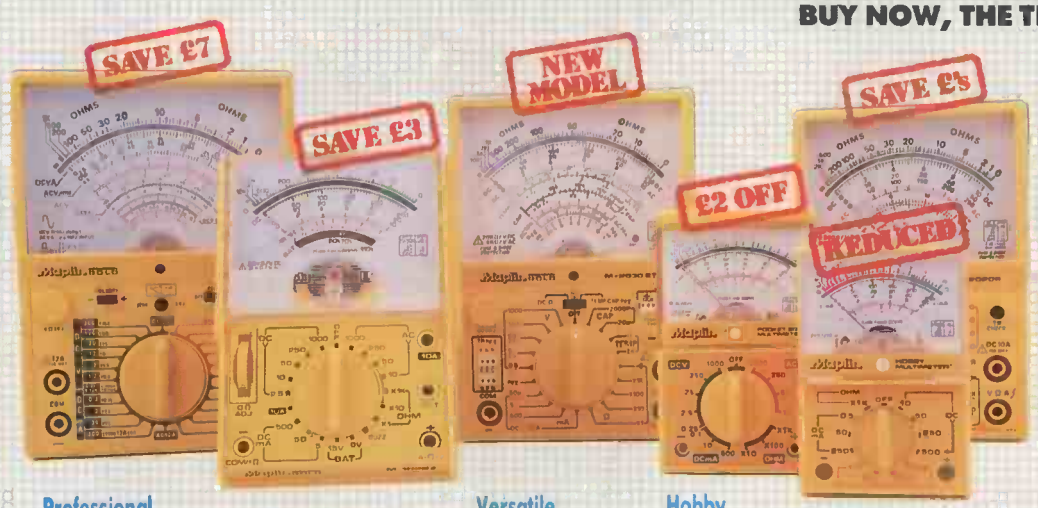

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THE 6800 MICROPROCESSOR

The 6800 was developed by Motorola and was the first in a family of successful 8-bit microprocessors which includes the popular and powerful 6809. Despite its age, the 6800 family remains popular in a variety of applications including 8-bit bus-based process control systems.

The 6800 and its successors all operate from a single +5V supply and this undoubtedly gave the processor a distinct edge over its original rival, the 8080 (this latter device requires three separate supply rails of +5V, −5V and +12V). The 6800 employs a similar bus structure to that of the 6502 and thus the two devices are broadly compatible with the same range of common support devices (e.g. 6520/6820).

The 6800 has extremely simple architecture which features two accumulators (A) and (B), a condition code (status) register (CC), one 16-bit index register (IX), a 16-bit stack pointer (SP) and a 16-bit program counter (PC). Note that unlike the 6502, the stack pointer is a 16-bit register and thus the stack is not constrained to a particular region of memory.

The 6800 employs the following fixed vector locations in high memory (usually ROM):

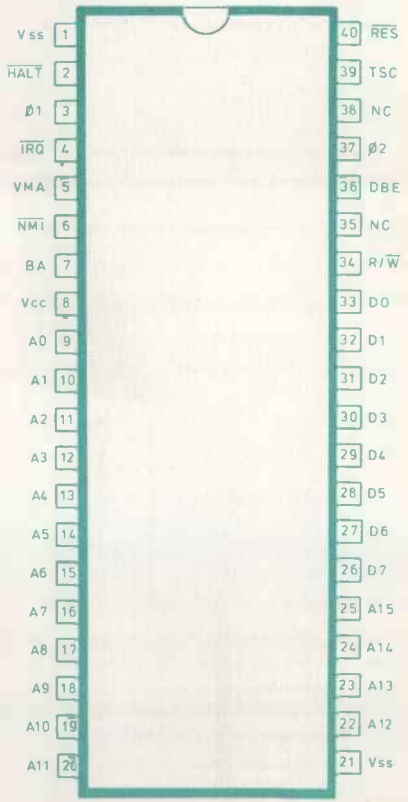
$FFFE and **$FFFF** reset vector
$FFFC and **$FFFD** non-maskable interrupt (NMI) vector
$FFFA and **$FFFB** software interrupt (SWI) vector
$FFF8 and **$FFF9** interrupt request (IRQ) vector

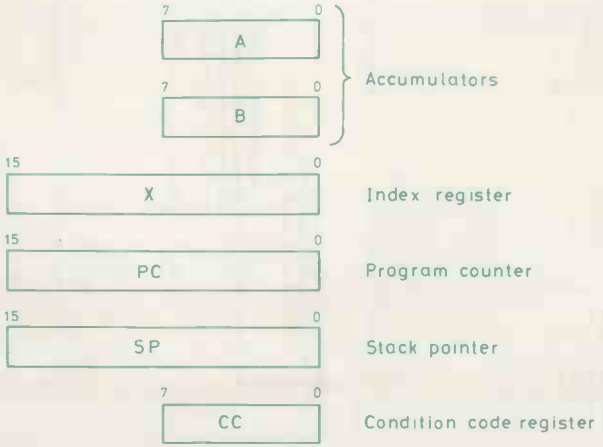
The 6800 operates from a two-phase 1MHz clock which must be supplied by a dedicated clock device (e.g. 6870, 6871 or 6875). High-speed versions are available in the form of the 68A00 and 68B00 which operate at 1.5MHz and 2MHz respectively.

The 6800 employs seven addressing modes (direct, relative, immediate, indexed, extended, implied and accumulator) and the instruction set comprises 72 instructions.

6800 Signal Lines

Signal	Function	Direction
A0-A15	Address bus	Output
D0-D7	Data bus	Bi-directional (tri-state)
R/$\overline{W}$	Read/Write control	Output
$\overline{IRQ}$	Interrupt request	Input
$\overline{NMI}$	Non-maskable interrupt	Input
$\overline{RESET}$	Reset	Input
	Clock (phase 1)	Input
	Clock (phase 2)	Input
VMA	Valid memory address	Output
DBE	Data bus available	Output
TSC	Tri-state control	Output
$\overline{HALT}$	Halt	Output





EE DATA CARD ⑤

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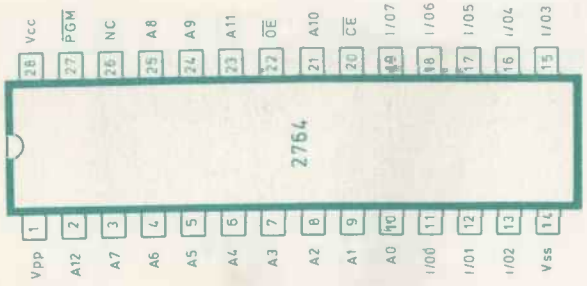
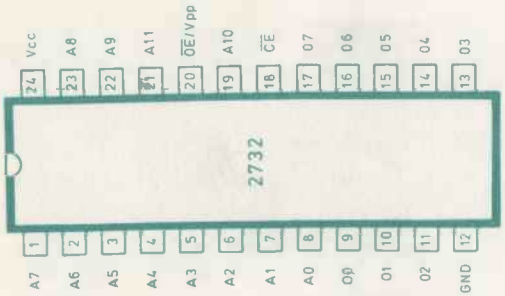
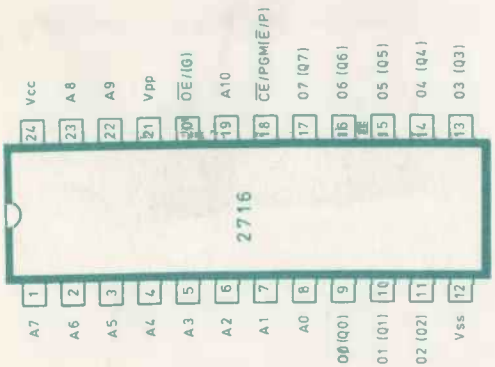
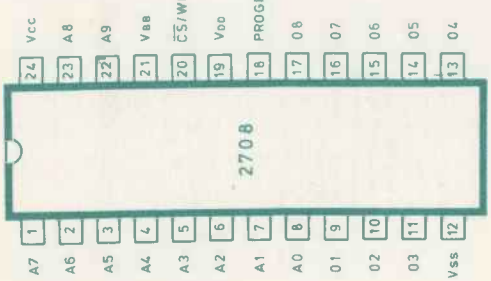
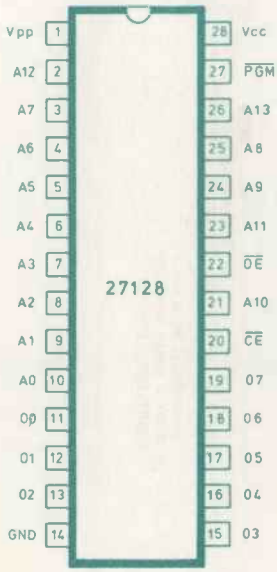
2708	8192	1K words×8 bits	24-pin DIL
2516	16384	2K words×8 bits	24-pin DIL
2716	16384	2K words×8 bits	24-pin DIL
2532	32768	4K words×8 bits	24-pin DIL
2732	32768	4K words×8 bits	24-pin DIL
2764	65536	8K words×8 bits	28-pin DIL
27C64	65536	8K words×8 bits	28-pin DIL
27C101	1048576	128K words×8 bits	32-pin DIL
27128	131072	16K words×8 bits	28-pin DIL
27C128	131072	16K words×8 bits	28-pin DIL
27C301	1048576	128K words×8 bits	32-pin DIL
27256	262144	32K words×8 bits	28-pin DIL
27C256	262144	32K words×8 bits	28-pin DIL
27512	524288	64K words×8 bits	28-pin DIL
27C512	524288	64K words×8 bits	28-pin DIL
27C1024	1048576	64K words×16 bits	40-pin DIL

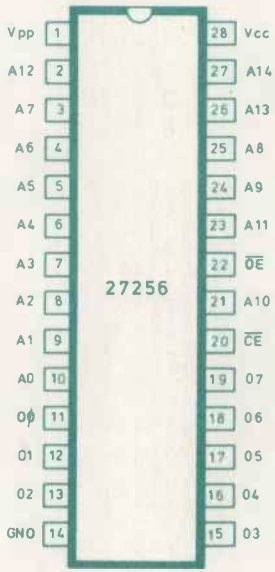


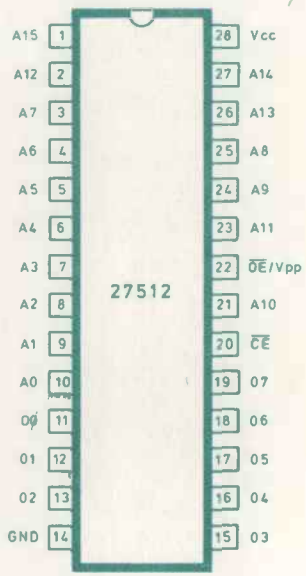












CIRCUIT EXCHANGE SUPPLEMENT

The circuits in this booklet cover an amazing range of applications. They have all been sent in by EE readers and have not been tried or tested by us; they will, however, provide an excellent basis for those that enjoy experimenting or project building from circuit ideas.

PAGING SYSTEM

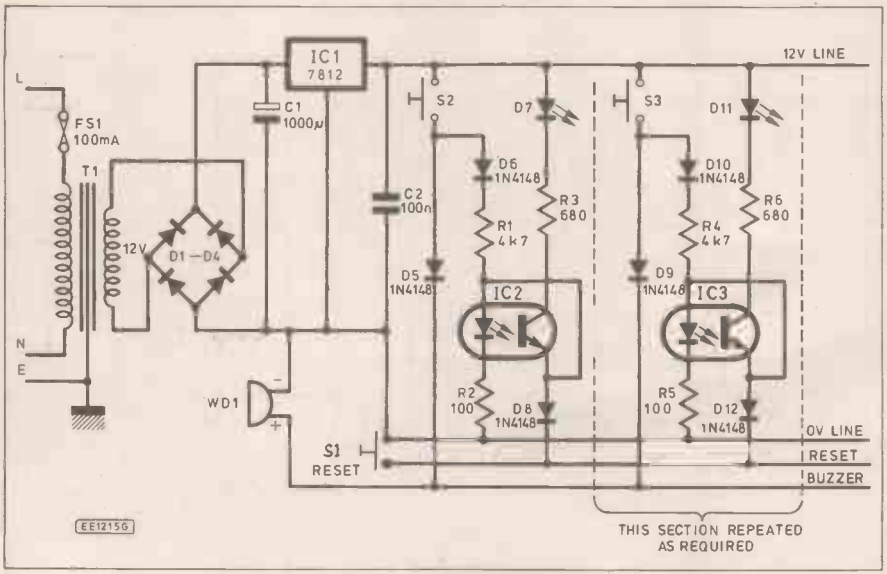


Fig. 1. Paging system

THE requirement was for a paging system for a retirement home, such that any of the residents pushing his "Call Nurse" button would sound a buzzer and also light an indicator panel showing who was in need of assistance. The first attempt used some 74LS28 i.c.s for the latches, but it was soon found that stray pick-up in the wiring throughout the home caused spurious indications on the light panel. The prototype has a total of 12 channels, but this is, of course, a matter of individual requirement.

This successful design (Fig. 1) uses opto-isolators as relay latches. The switches S2, S3, etc. are the remote switches in the residents' rooms and when one is pressed momentarily, current flows through the buzzer and also, via a current limiting 4k7 resistor, through the l.e.d. of an opto-isolator. This causes the light dependent diode to conduct, drawing current through an l.e.d. on the panel and keeping the encapsulated l.e.d. on. Thus the system latches on until the reset button S1 pulls the opto-isolator down to 0V. The 680 and 100ohm resistors limit the current through both l.e.d.s to about 16mA which is well within their tolerance. As an added refinement the prototype uses several strategically positioned buzzers, selectable with a simple rotary switch.

The humble opto-isolator is often overlooked by construtors but it is actually a very versatile device which provided the solution in this situation where the more "high tech" answer had failed.

P A Spencer, Wokingham

B.F.O. METAL DETECTOR

THIS metal detector has two oscillators. One is a "reference" type of local oscillator. It consists of a unijunction transistor, TR2, and its associated components. The other oscillator is a Colpitts oscillator, based around TR1 with L1 as its active component.

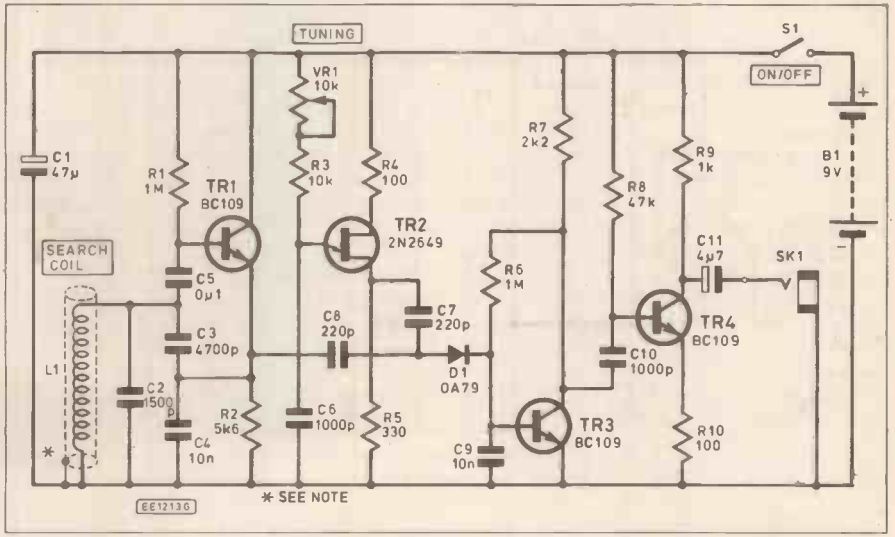
L1 consists of about 50 turns of 28 s.w.g. enamelled copper wire. It is wound around a flat, circular wooden former. A "Faraday Shield" is incorporated in its design, and consists of tin foil wrapped round the flat coil to produce a "hoop". The coil can then be incorporated into whatever kind of search coil casing that the constructor may desire, provided it is not a ferrous metal.

L1 and C1 provide a resonant "tank" circuit for the "active" oscillator. The outputs of the two oscillators are fed via the germanium signal diode, D1, to a simple mixer circuit based around TR3. This mixer compares the two r.f. signals from the oscillators, and its output is the a.f. "beat frequency". This beat frequency is the difference between the two frequencies entering the mixer. The a.f. signal is amplified by TR4, and the output can then be fed directly to headphones with an eight ohm impedance. The tone heard in the headphones can be adjusted with the "tuning" control, VR1.

Power is provided by a PP3 battery which easily supplies the 10mA or so that the circuit requires. The nine volt supply rail is protected from r.f. interference by C1.

Note that the circuit should operate below 150kHz to be legal. The author's operates at 125kHz but component tolerances may affect this and should be carefully monitored.

R Çasbierd, Berkshire



B.F.O. Metal Detector

MORSE TONE REGENERATOR

MOST SW listeners who use a computer such as the ZX81 or Spectrum with a morse decoding program, will be aware of the need for a good clean signal from the receiver to be fed into the computer "Ear" socket. This circuit was developed to extract a weak signal from the tape recorder socket on a SW receiver and to output a constant level, noise free tone to the computer. It was found possible to copy code which was far too weak and noisy to be fed direct to the computer.

The output from the receiver tape socket is fed into a two stage amplifier TR1/2, then into a 567 PLL, the tone capture frequency of which is set by VR1. The input frequency is of course determined by the receiver BFO setting.

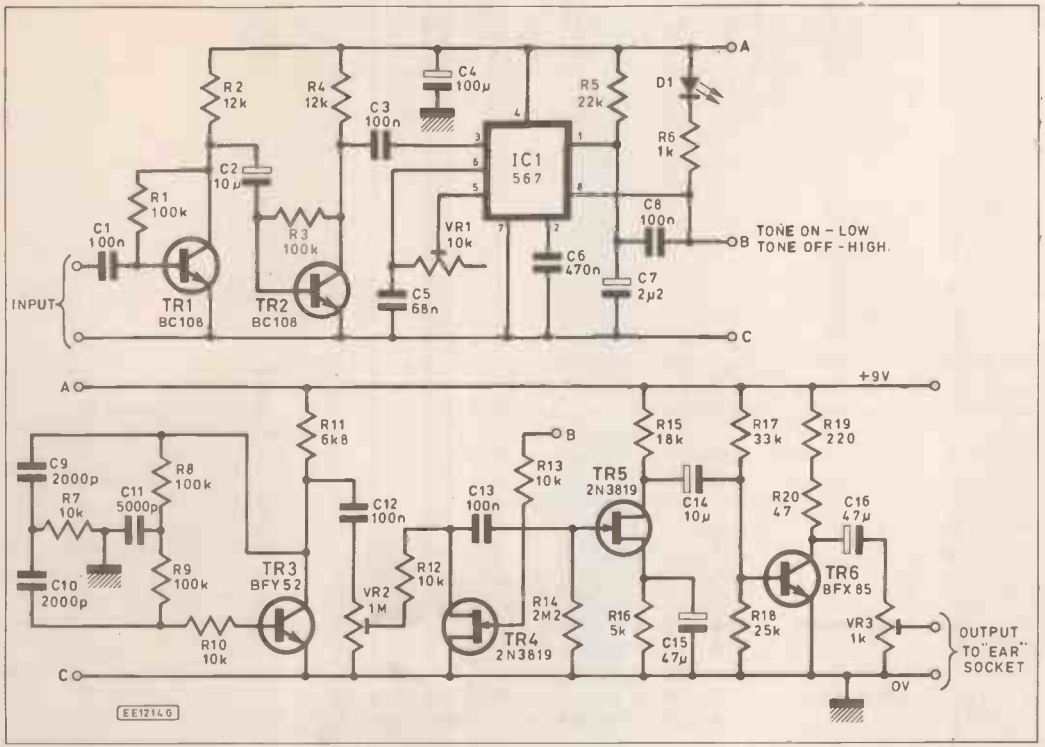
D1 acts as a tuning indicator enabling the BFO to be set at the centre frequency of the PLL and flashes in sympathy with the code received. TR3 is a Twin-T oscillator at about 1kHz fed into a two stage amplifier TR5/6. A sinusoidal oscillator was chosen to avoid harmonic radio interference typical of square wave sources. TR4 is a shunt attenuator switched by the output of the PLL. When tone within the passband of the PLL is present, IC1 output is low, TR4 is high impedance and the output of TR3 is passed to TR5. When no tone is present, the output of IC1 is high, TR4 becomes low impedance and TR3 output is shunted to 0V line.

The clean tone from TR3 is keyed to the computer "Ear" socket via TR5/6, by TR5 which is controlled by the output of IC1; the received code thus being regenerated.

It is suggested that VR1 and VR3 are made front panel controls (board mounted) so that the capture frequency of the PLL can be changed when listening under QRM conditions and the signal to the computer can be optimised. Once set VR2 should not need adjusting, so can be a preset type.

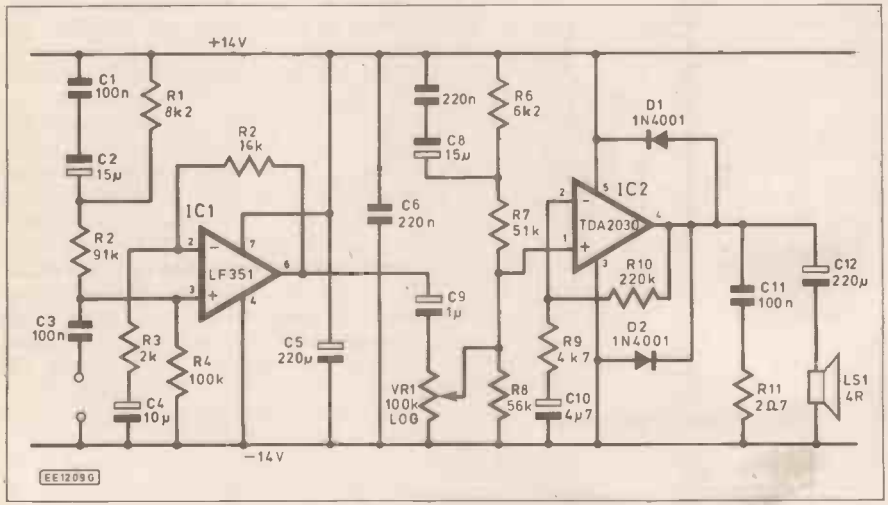
If an oscilloscope is available, the drive level to TR5 should be set by VR2 to obtain the maximum sinusoidal output from TR6, just below the level at which distortion takes place.

M Bradbury, Stoke-on-Trent



Morse Tone Regenerator

GUITAR AMPLIFIER



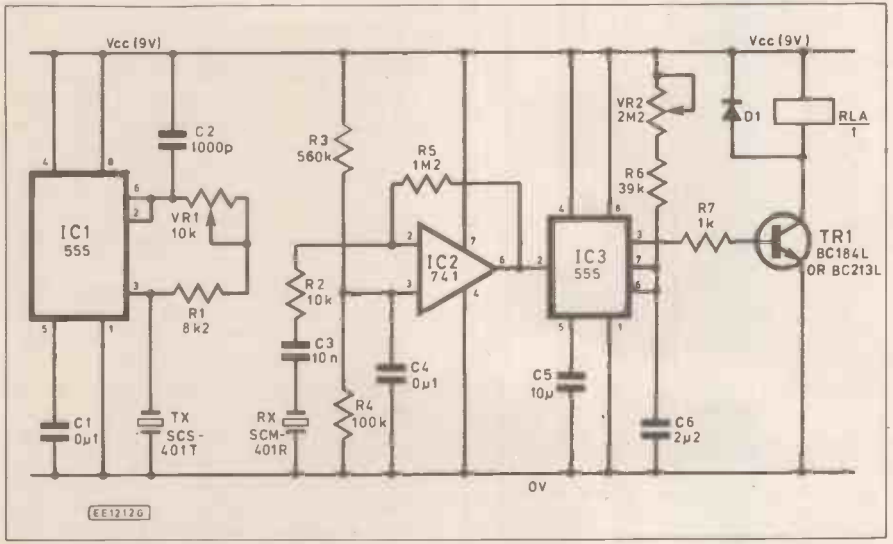
Guitar Amplifier

THIS unit is a 12W guitar amplifier. It was designed for use with an electric guitar and tested with such so that specific component values could be optimised for this purpose. The good output volume enables the guitarist to use this unit when practising with the band. It could also be used when experimenting alone, with the volume turned down. LS1 could also, of course, be replaced by a suitable pair of headphones when practising alone.

The distortion figures are as low as 0.2 per cent, and the unit gives very good frequency response over the full audio bandwidth. IC1 and associated components form the pre-amp, with IC2 providing the main amp section. To mount IC2 smear some silicone grease on the metal tab and bolt directly to a 4°c/w heatsink. VR1 is the volume control. The unit can be powered from a single 0-28V or split ±14V 1.5 ampere power supply.

N O'Connor

ULTRASONIC COLLISION DETECTOR



Ultrasonic Collision Detector

THIS circuit allows a buggy to detect the presence of an object without actually hitting the object.

The circuit can be divided into two main parts, the transmitter and the receiver. The transmitter is based around IC1, an NE555 timer in the astable multivibrator configuration. The 10k preset VR1 sets the frequency of the ultrasonic emitter, and can be adjusted to change the sensitivity of the system.

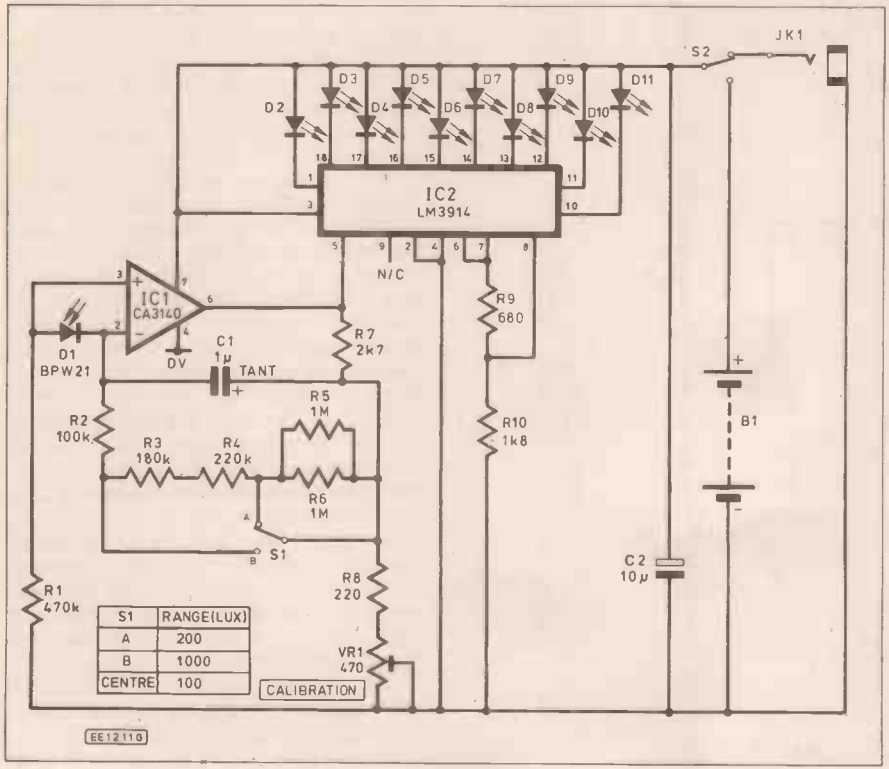
The ultrasonic transducer which receives the signal is a.c. coupled to the 741 op-amp by C3. The op-amp IC2 is connected as an inverting a.c. amplifier, R3 and R4 bias the amplifier with C4 decoupling the non-inverting input, and R5 keeping the output midway between the supply and 0V. The gain of the amplifier being determined by R2 and R5.

The output of the op-amp is taken to the trigger input of IC3, an NE555 timer in the monostable configuration. The output of IC3 turns on RLA via TR1 for a fixed length of time determined by VR2 and C6. The timed period can be changed using VR2. VR2 could be set so RLA turns on long enough for the buggy to turn through 90 degrees. The capacitor C5 stops unintentional initiation of RLA on application of the supply, and D1 protects the circuit from back e.m.f.

Once constructed experimenting with the ultrasonic transducers and VR1 is necessary to obtain the best results.

S Armstrong, Cumbria

SIMPLE LIGHT METER



THIS simple general purpose light meter is a low cost alternative to expensive digital meters where high resolution is not necessary. One alternative would be a standard moving coil meter, but these are bulky and damage-prone. In this circuit, an LM3914 l.e.d. dot/bargraph driver is used.

The small current resulting from light falling onto the photodiode is amplified by IC1 to produce a voltage of sufficient magnitude to be fed to IC2, the l.e.d. driver. The "full-scale" light level (at which D11 lights), is proportional to the resistance between pin 2 of IC1 and the junction of R7 and R8. S1, a centre-off s.p.d.t. switch, selects different resistance values, which gives ranges of 100, 200 and 1000 Lux with the values shown.

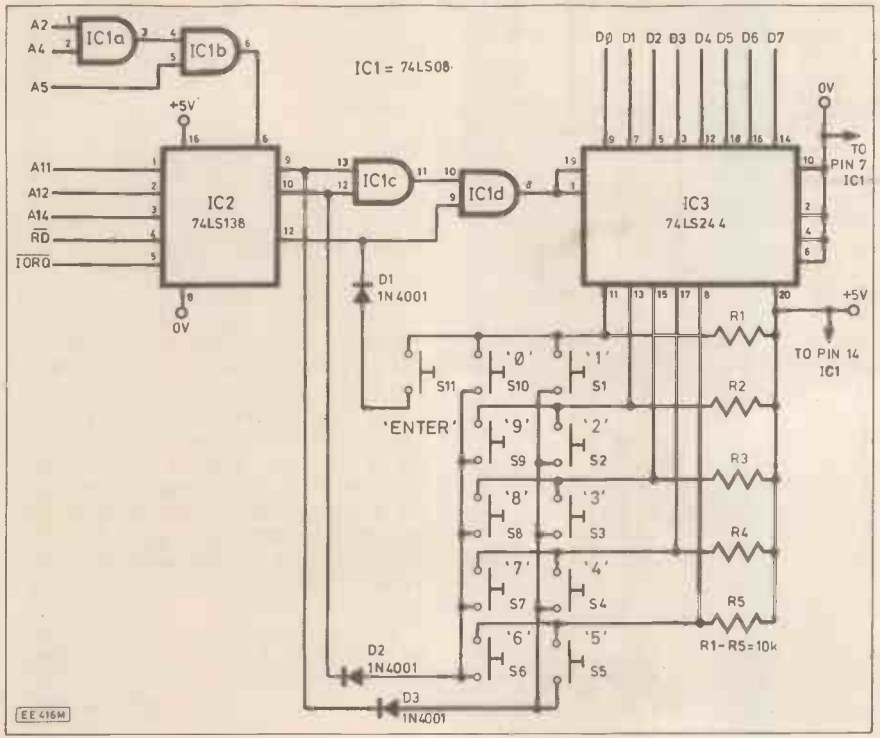
There is some degree of non-linearity in the response of both the LM3914 and the simple amplifier design; however, the overall effect on the readings is negligible.

To keep power consumption low, IC2 is used in the "dot" mode and the on-off switch, S2, is a "biassed" s.p.d.t. type, arranged so as to connect the circuit to the external supply socket when in the released position.

A PP3 battery is used; when approaching exhaustion, D11 will not light. Note that as the specified photodiode has colour-correction giving a response similar to that of the human eye, an alternative must NOT be used.

R Ormston, Hants

SPECTRUM KEYPAD



OFTEN when using the Spectrum keyboard only the numerical keys are utilised (particularly when typing in data). This is a slow method of typing in numbers. Many, more expensive machines have a numerical keypad reserved for typing in decimal numbers. Such keypads have the numerical keys compacted together to speed up operation.

This circuit is for an add-on plug-in keypad for the Spectrum, and it includes an "ENTER" key. Ideally it should be constructed on two p.c.b.s: one for the electronics and edge-connector, and one for the switch assembly.

As can be seen from the circuit diagram it utilises only three i.c.s. IC1 is a 74LS08, a set of four two-input AND gates. IC2 is a 74LS138, a 3-bit demultiplexer. IC3 is a 74LS244, an 8-bit buffer.

When the Spectrum is testing a row of keys, the outputs (from the Z80, but available along the edge-connector [for connections see chapter 23 of the old manual]), $\overline{RD}$ and $\overline{IORQ}$ both go low, and the address of the row of keys is placed on the address bus. The circuit tests for these conditions, but does not thoroughly check the address bus. This may mean that the circuit will refuse to work with certain peripherals (however, it has been

SPECTRUM KEYPAD

tested with the ZX printer and Kempston joystick interface).

IC1a and b provide one of the three enables required by the 74LS138, when A2, A4 and A5 are all high. $\overline{RD}$ and $\overline{IORQ}$ each provide the other two enables.

Only three outputs of IC2 are used (there are eight). These will normally be held high, and one will go low if: the i.c. is fully enabled and when one of A11, A12 or A14 goes low, i.e. when one of the three relevant rows of keys is being tested.

IC3's outputs are normally held in the high-impedance state, as IC1c and d provide a high to the strobe inputs of IC3 unless one of the outputs of IC2 go low, in which case the outputs of IC3 become active, giving the value for the row of keys addressed to the data-bus.

The outputs to D5, D6 and D7 on the data-bus are low whenever the outputs are active. The outputs to D0 to D4 are normally high, when the outputs are active, as the corresponding inputs to the buffer are held high by resistors R1 to R5. However, if a key is being pressed on a row that is being addressed, the output to the row from IC2 will be low, and the closed switch will cause the input to the buffer, IC3, to which it is connected, to go low, thus, causing the relevant output to the data-bus to go low. This "low" is recognised by the Spectrum as a depressed key.

Diodes D1 to D3 are used to protect IC2 in the case of two or more keys being pressed together on two different rows, i.e. without them, unlimited current would flow between the outputs.

This circuit does not have any debounce circuitry, this is merely because debounce is software-achieved on the Spectrum.

J Duffy, Co. Dublin

PULSE GENERATOR

THE circuit was designed to connect to a function generator to supply the repetition rate (frequency) of the pulses. Also included is an indicator letting you know if the pulse width is longer than the repetition rate.

The input signal is buffered by TR1 and IC1a to produce a correct TTL signal. C1, R3 and R4 convert the signal to a short pulse which is "cleaned up" by IC1b. This signal is fed to the trigger input of IC2, a 555 timer wired in its monostable mode. The output of IC2 can be from 1.1μS to 110mS.

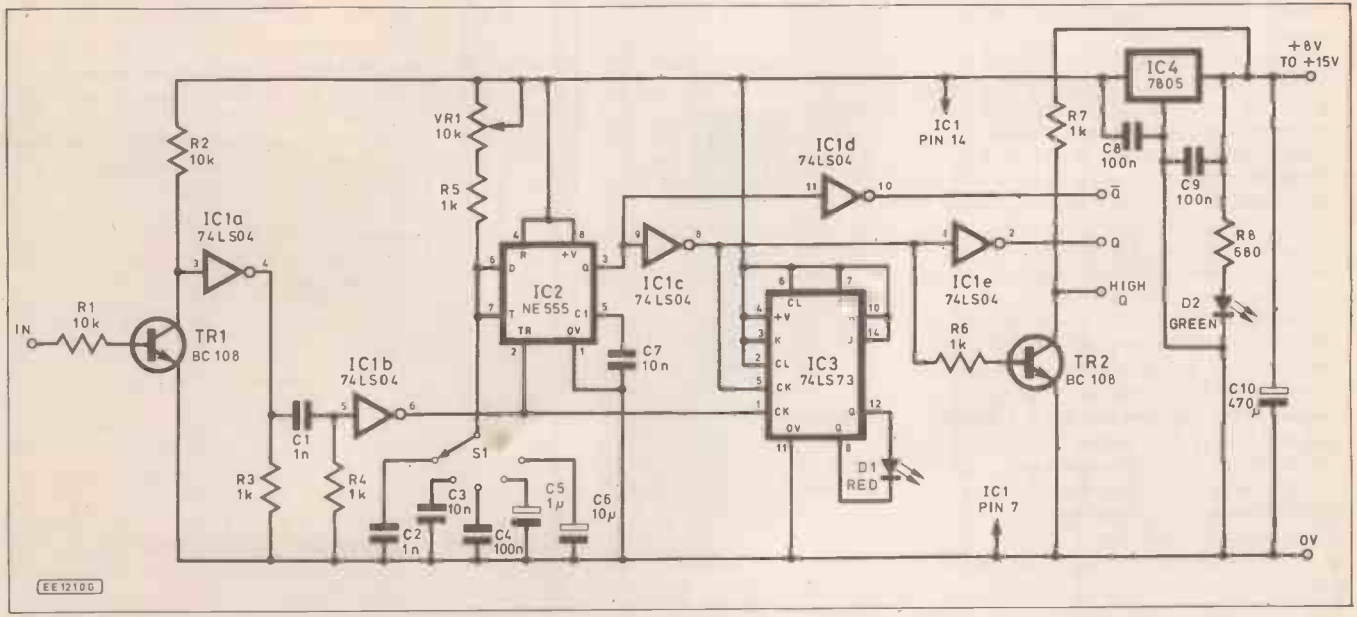
The output is buffered and inverted by IC1c to IC1e to produce Q and not Q ($\overline{Q}$) outputs. TR2 is included to raise the level and create a high Q output whose peak voltage is determined by the supply.

IC3, a dual J-K flip-flop is wired as two divide by 2 circuits with clock inputs from the trigger pulse and the output signal. If the frequency of the pulse is less than the pulse width then the two outputs of IC3 are in phase with each other and the same frequency, therefore D1 doesn't light. If the input signal has a faster repetition rate than the pulse width, the output from IC2 will be less frequent than the trigger pulse. So the outputs from IC3 will be of different frequencies and D1 will light.

The supply to the circuit is regulated to 5V by IC4 with the capacitors smoothing the supply rails.

D Smith, Essex

PULSE GENERATOR



Pulse Generator

A MORE SENSITIVE HEAT SENSOR

ONCE little known, the LM35DZ temperature sensor i.c. now seems to be moving up the popularity charts. Indeed, an article in *EE* called for TWO of these sensors.

While the LM35DZ has its advantages, notably an apparently very simple mode of use, it also has disadvantages, some of which I mention here for consideration before your readers rush round to their friendly neighbourhood electronic parts shop!

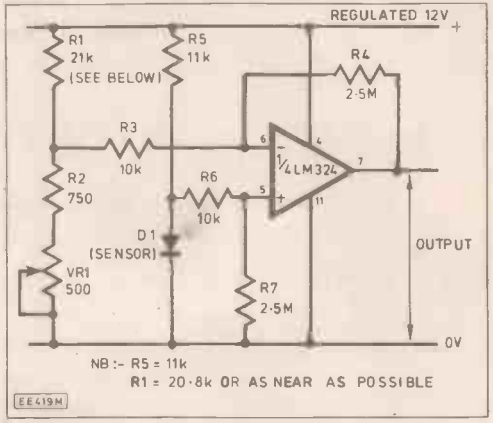
Firstly, it is not easy to find, even now. Secondly, it is fairly delicate and does not take kindly to repeated or unskilful soldering. Thirdly, its comparatively large mass makes it slow to respond to changes in ambient temperature. Fourthly, its responsive curve is not always the clean, step-free straight line graph that one would wish. Lastly, and perhaps worst, it is far from cheap, the new Maplin catalogue listing it at £3.30 and its companion, the LM35CZ at £4.95.

For those willing to spend a little more time with the soldering iron, may I recommend the circuit herewith, which uses a silicon diode, preferably but not essentially the 1N916, as a sensor.

This diode costs only a few pence and, being so tiny, responds with great rapidity to temperature changes in its surroundings. When a steady current of 1mA or so is passed through the diode, a voltage of approximately 600mV develops across it. This voltage falls by some 2mV for every one deg. C rise in ambient temperature.

If we use an op-amp as a differential amplifier, we can amplify the *difference* between the two input voltages.

Thus, if we take our 600mV (or so) from the sensor diode to the non-inverting (+) terminal of the op-amp and approximately 550-570mV (from an adjustable voltage divider) to the inverting (−) terminal, we can then amplify the difference between these inputs by any chosen factor, up to a maximum, of course, of just under the supply voltage.



Sensitive Heat Sensor

A MORE SENSITIVE HEAT SENSOR

The circuit shown gives a gain of 250 and the voltage divider gives a voltage of some 500-650mV which can be adjusted by the pre-set. It helps here to use a multi-turn type for precise adjustment.

As for the op-amp, the trusty 741 will do nicely but its need for a dual power supply can make its use rather awkward. The LM324 has the great advantage here of needing only the usual single supply, so I have quoted the pin numbers for this op-amp. Incidentally, the LM324 is a *quad* op-amp (and only costs some 50-60p!) so the other three op-amps on the chip, come in handy for other uses, e.g. as the comparator in a thermostat arrangement.

The voltage divider is best set up using a millivoltmeter but this is by no means essential as, when the voltage divider is correctly set, even by trial and error, the way the output voltage zooms up and down between about 2V and 10V as one merely breathes on or holds a warm finger near the sensor diode is very gratifying.

Further, the response curve of the sensor (mV change against temperature change), is pleasingly near a straight line.

The complete device probably costs less than the LM35DZ alone and lends itself readily to accurate and sensitive applications, such as a room thermostat of very small temperature differential.

A McCrae, Isle of Man

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USER PORT INTERFACE

THIS project was designed for Commodore 64 owners who wish to use their computer to control external devices.

The simple circuit allows the computer, via the user port to control a set of relays. The circuit is based around the ULN2801A octal Darlington driver array.

This i.c. contains eight separate Darlington amplifiers, each amplifier in this case is able to supply an output of 500mA at 5V (outputs may be paralleled to give 4A at 5V).

In this circuit four of the possible eight lines of the user port (PBO-PB3) have been used as outputs, and are taken directly to inputs (pins 1-4) of their respective outputs of the i.c. (pins 15-18), and to the common (pin 10). The common connection is also taken to the +5V supply of the user port.

No diodes are required across the relay coils to protect against back e.m.f. since the i.c. itself contains internal diodes for inductive loads.

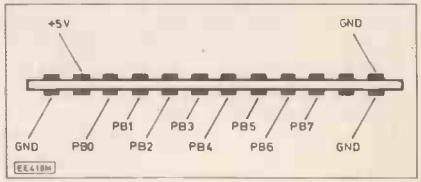
When an output of the user port is taken high the signal is amplified by the i.c. and the amplified output drives the relays. (In the prototype relays with 6V coils were used, the 5V supply from the computer was able to drive them with no problems.)

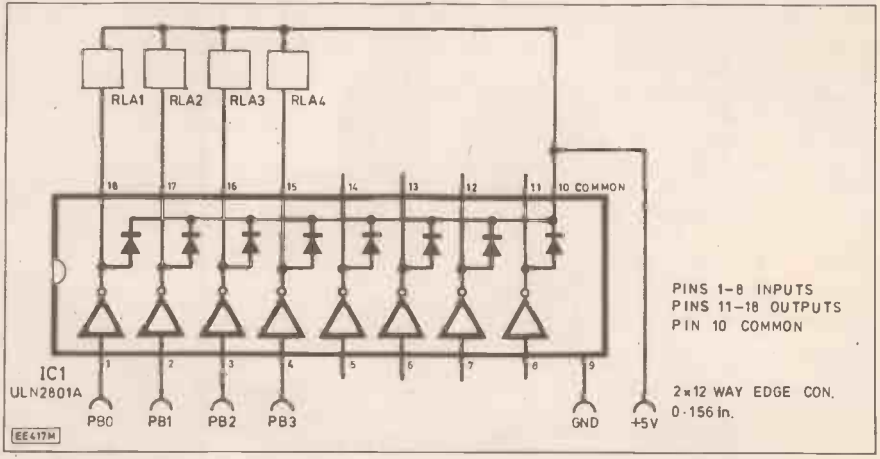
To turn the relays on/off the appropriate line(s) of the user port must be poked. The following is a program to do this:

```
10 POKE 56579,15. :REM SETS DATA
   DIRECTION REGISTER SO PB0-PB3
   ARE OUTPUTS.
20 POKE 56577,A* :REM SETS OUTPUTS
   FOR PB0-PB3 DEPENDING ON VALUE
   OF A.
```

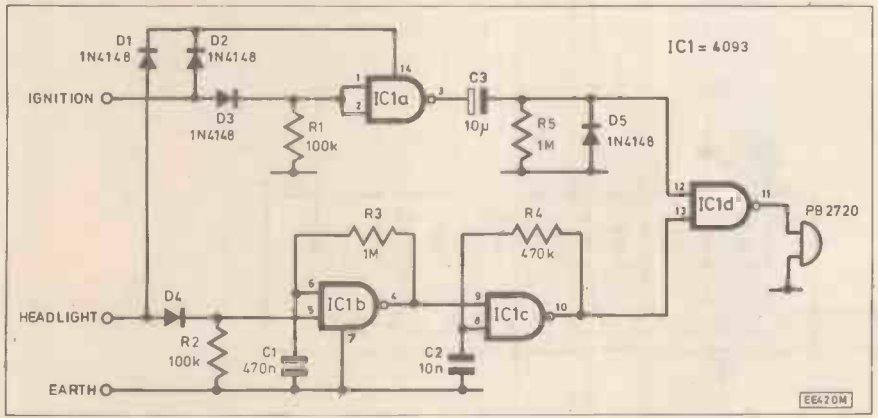
*By choosing different values of A between 0 and 15 any combination of relays can be turned on/off.

S R Armstrong, Cumbria





YOU'VE LEFT YOUR LIGHTS ON!



Lights on Reminder

HOW oftenhave you had neighbours knocking on the door uttering those immortal words "You've left your lights on"? Well don't just sit there, build one of these alarms on Veroboard, mount it in a suitably cheap black plastic box and stick it under the dashboard. With just a single i.c. what could possibly go wrong!

Connections to the unit have been minimised by powering the 4093 from the circuit inputs via D1 and D2. D3 and D4 ensure the inputs do not go above the supply voltage. Gates b and c form a two tone oscillator at quite a pleasant frequency (earlier versions emitted a piercing sound that soon became annoying) with C2 and R4 giving a high frequency note, and C1 and R3 producing the warbling effect. Gate d allows the oscillations through to the piezo resonator when the IGNITION input goes low via gate a. The circuit is now powered from the HEADLIGHT input, and when you turn the headlights off the circuit powers down.

One further feature I required was for the alarm to turn itself off in case you wanted to leave the car with side lights on. C3 and R5 produce about a 10 second delay before the input to gate d is disabled. D5 shunts the voltage away from C3 when the unit is turned off.

IGNITION needs to be connected by either a spade terminal or block connector to the switched +12 Volt side of the ignition. HEADLIGHT is connected to the +12 Volt supply to the lights after the switch.

John Garnham, Essex

SIMPLE SOUND EFFECTS GENERATOR

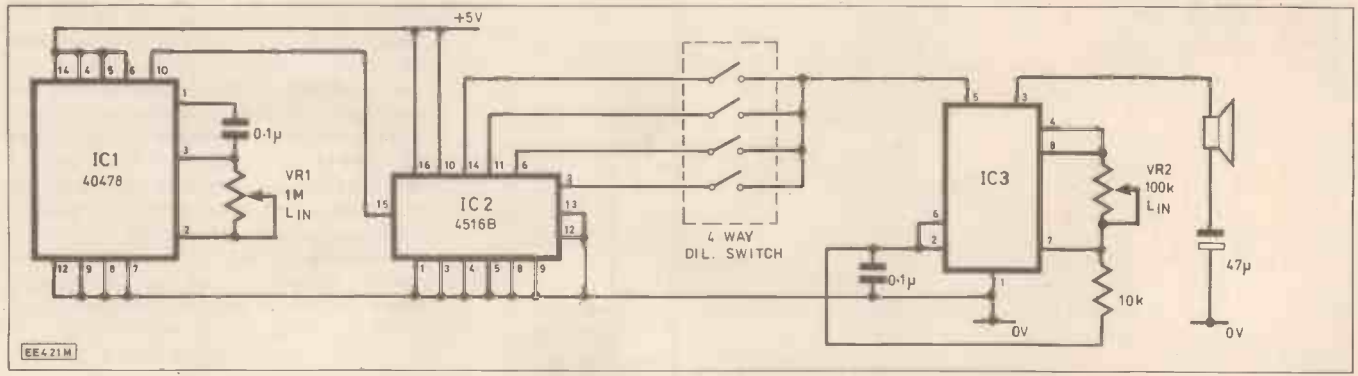
THIS simple sound effects generator can produce some quite interesting and weird noises.

Basically the unit produces four notes, but by combining or separating these notes other notes can be formed. The length and pitch (frequency) of the note can be varied using variable resistors.

The circuit consists of three i.c.s and minimal external components. IC1 is used as a pulse generator the speed of pulses being varied by VR1. These pulses are fed into IC2, a 4516B, modulo 16 binary counter.

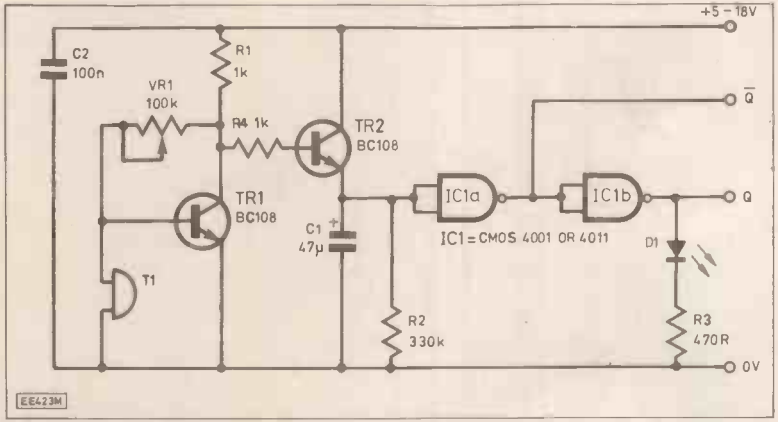
The four outputs of IC2 are taken to the voltage control of IC3, a 555 timer. The pitch of the notes can then be varied by VR2.

Aaron Forshaw, Chester



Sound Effects generator

VIBRATION SENSOR



Vibration Sensor

THE vibration sensor is a device that samples sound. When sampling the sound it looks for any loud noises or bangs, i.e. vibrations or shocks. The sensor can be used in all alarms as it has two digital outputs. One is always the opposite of the other (in digital terms only).

The sensor can be fitted to a shop window or door or anything that is not supposed to be banged, thus alerting the owners of a possible break.

The sensor is a small piezo transducer which costs around 30p and so makes the circuit quite cheap. The rest of the components cost around two pounds.

The transducer is fed to a small amplifier which has a gain control (VR1) and then fed to two switching gates, which cause the delay and output of the two digital signals. The circuit has been designed so that once the sensor has been triggered it does not latch, but gives out logical levels for a few seconds.

The sensor can be fitted inside the box lid, and glued to the door or window or the small transducer can be stuck onto the window or door, with an interconnecting wire to the small box.

The outputs are TTL and CMOS compatible and also can be used in analogue alarms. There is also an onboard indicator to test the unit externally.

Steven Holland, Grimsby

LOW COST SERVO

HAVING seen several projects in robotics publications most of which used servos for positioning, I decided to look around for the price of them so I could build up some of the models to experiment with. To my amazement the price of these devices was too high for me to consider, so it was decided to experiment with what I had in my junk box to get the desired effect.

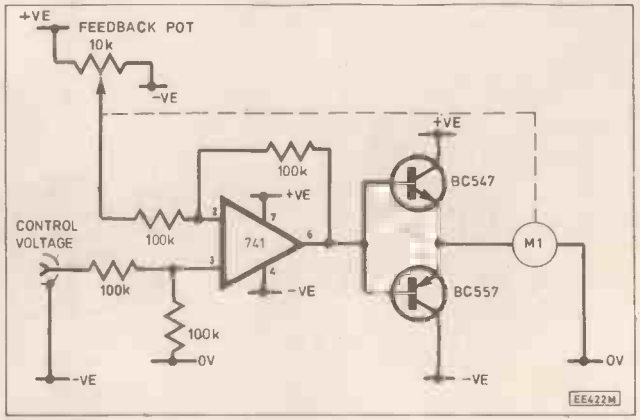
The circuit is centred around a difference amplifier which when a control voltage is fed to the control input pin of the op-amp, the difference between the control and the feedback pin is produced at the output in the form of a negative or positive voltage with reference to 0 volts. This output is fed to the motor amplifier which controls the motor in a forward or reverse action.

The motor drives a gearbox to obtain the high torque required to drive the model. The output shaft is connected to a feedback potentiometer, this pot. is wired to the feedback input of the op-amp. The output of the feedback pot. follows the control voltage until feedback equals control voltage which will be 0 volts.

When built, if the motor drives to one end and you cannot control it, reverse the motor leads, this will rectify the problem.

The control voltage can be driven from a potentiometer or from a digital to analogue converter. You could also switch the motor 0 volt line with the use of relays and an appropriate decoder to control several motors via a computer, i.e. upper 4 bits could be 4 bit d.a.c. and the lower 4 bits to operate a 4 to 16 line decoder to control relays operating the motors. The choice is up to you and your requirements.

G R Skate, Peterborough



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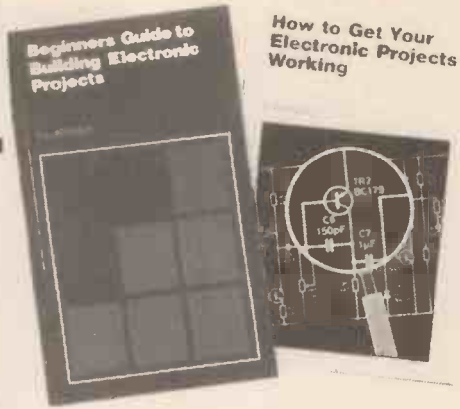

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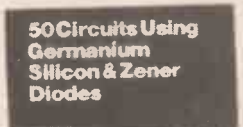

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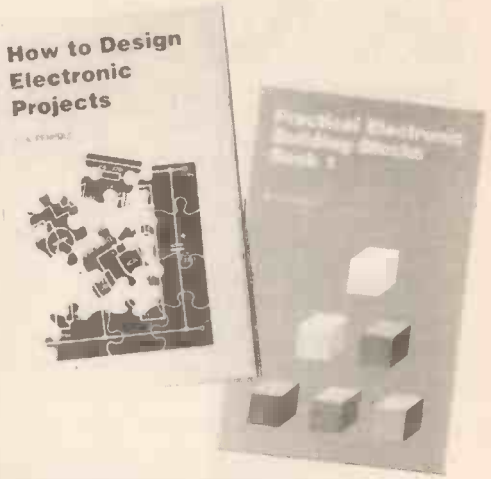

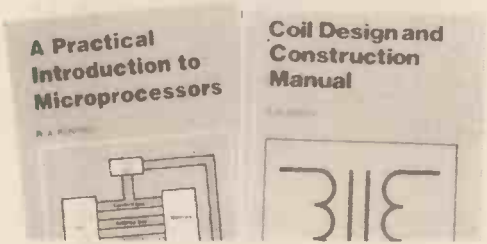

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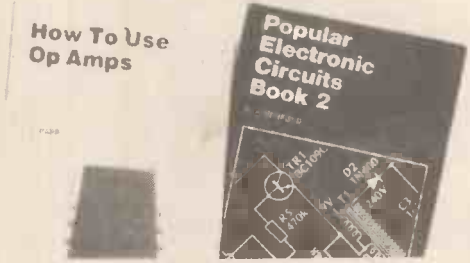

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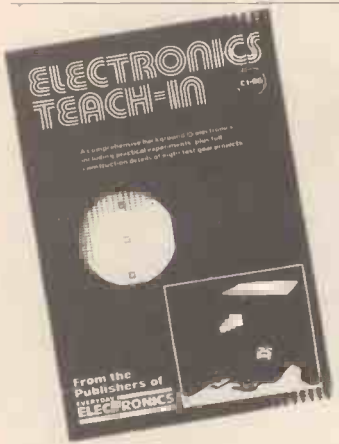

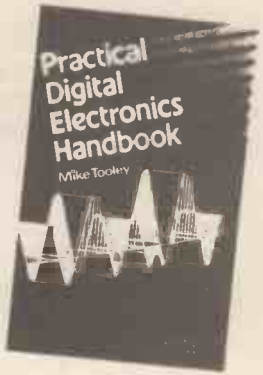

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