EVERYDAY ELECTRONICS and computer PROJECTS

JULY 1985 £1·00

New REGULAR PAGE

Actually Doing it!

CONTINUITY TEST UNIT

Train Signal Controller

Amstrad User Port

Australia $1.75 New Zealand $1.95 Malaysia $4.95

BAKERS DOZEN PARCELS

All the parcels listed below are brand new components. Price per parcel is £1.00, but if you order 12 you get one extra free.

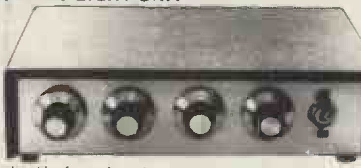
1 — 5 13 amp ring main junction boxes
2 — 5 13 amp ring main spur boxes
3 — 25 13 amp fuses for ring mains
4 — 5 surface mounting switches suitable insulated for mains voltage
5 — 3 flush electrical switches intermediate type, will also replace 1 or 2 way switches
6 — 5 in flex line switches
7 — 4 in flex line switches with neons
8 — 2 80 watt brass cased elements
9 — 2 mains transformers with 6v 1a secondaries
10 — 2 mains transformers with 12v ½a secondaries
11 — 1 extension speaker cabinet for 6½" speaker
12 — 5 octal bases for relays or valves
13 — 12 glass reed switches
14 — 4 OCP 70 photo transistors
15 — 25 assorted gemanium transistors OC45 etc
16 — 4 tape heads, 2 record, 2 erase
17 — 2 ultra sonic transmitters and 2 ditto receivers
18 — 2 15000 mfd computer grade electrollics
19 — 2 light dependent resistors similar ORP12
20 — 5 diff micro switches
21 — 2 mains interference suppressors
22 — 2 25 watt crossover units
23 — 1 40 watt 3 way crossover unit
24 — 250 various screws and self tappers
25 — 1 of each wafer switches — 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 — 2 tape deck counters
27 — 1 6 digit counter 12v
28 — 1 6 digit counter mains voltage
29 — 1 BOAC in flight stereo unit (second hand)
30 — 2 Nicad battery chargers
31 — 1 key switch with key
32 — 2 humidity switches
33 — 2 aerosol cans of ICI Dry Lubricant
34 — 96 x 1 metre lengths colour-coded connecting wires
35 — 4 battery operated model motors
36 — 2 air spaced 2 gang tuning condensors
37 — 2 solid diaelectric 2 gang tuning condensors
38 — 10 compression trimmers
39 — Long and Medium wave tuner kit
40 — 4 x 465 KC IF transformers
41 — 8 Rocker Switches 10 amp Mains SPST
42 — 6 Rocker Switches 10 amp Mains SPDT
43 — 5 Rocker Switches 10 amp SP DT Centre Off
44 — 4 Rocker Switches 10 amp DPDT
45 — 1 24 hour time switch mains operated — (s.h.)
46 — 1 6 hour clockwork timeswitch
47 — 2 lever switches 4 pole changeover up and ditto down
48 — 2 6v operated reed switch relays
49 — 10 neon valves — make good night lights
50 — 2 x 12v DC or 24V AC 4CO relays
51 — 1 x 12v 2C 0 very sensitive relay
52 — 1 x 12v 4C 0 relay
53 — 2 mains operated relays 3 x 8 amp changeovers (secondhand)
54 — 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 — 1 locking mechanism with 2 keys)
56 — Miniature Uniselector with circuit for electric jigsaw puzzle
57 — 5 Dolls' House switches
58 — 2 telephone hand sets incorporating ear piece and mike (p)
59 — 2 flat solenoids — ideal to make current transformer etc.
60 — 5 ferrite rods 4" x 5/16" diameter aerials
61 — 4 ferrite slab aerials with L & M wave coils
62 — 4 200 earpieces
63 — 1 Mullard Thyristor trigger and modules
64 — 10 assorted knobs ¼ spindles
65 — 5 different thermostats, mainly bi-metal
66 — Magnetic brake — stops rotation instantly
67 — Low pressure 3 level switch
68 — Heavy duty 4 pole contactor — 24v coil
69 — 2 25 watt pots 8 ohm
70 — 2 25 watt pots 1000 ohm
71 — 5 wire wound pots — 18, 33, 50, and 100 ohm
72 — 1 1250 watt dimmer Ultra ref SE20
73 — 4 3 watt wire wound pots 50 ohm
74 — 50 1/3 watt carbon film resistors food spread 10 values
75 — 20 2 watt carbon resistors 10 values
76 — 30 1 watt carbon resistors 15 diff values
77 — 1 time reminder adjustable 1-60 mins
78 — 5 5 amp stud rectifiers 400V
79 — 4 2a bridge rectifiers 400V
80 — 2 10a bridge rectifiers 30V
81 — 2 30a panel mounting slydlok fuses
82 — 4 porcelain fuse holders and fuses
83 — 1 fluorescent choke — your choice — 15, 20, 30, 40 or 65 watt
84 — 10 1 mains voltage suppressor condensors
85 — 1 mains shaded pole motor ¾" stack
86 — 2 5" ali fan blades fit ¼" shaft
87 — 2 3" plastic fan blades fit ¼" shaft
88 — Mains motor suitable for above blades
89 — 1 mains motor with gear box 1 rev per 24 hours
90 — 1 mains motor with gear box 1 rev per 12 hours
91 — 2 mains motor with gear box 16 rpm
92 — 4 fluorescent starters suit 4 — 80 w tubes
93 — 4 11 pin moulded bases for relays
94 — 5 B7G valve bases
95 — 4 skirted B9A valve bases
96 — 1 thermostat for fridge
97 — 1 infra red fire element 1000 watts
98 — 1 motorised stud switch (SH)
99 — 5 assorted ferrite shapes
100 — 3 ferrite magnets
101 — 1 2½ hours delay switch
102 — 1 9v mains power supply unit
103 — 1 6v mains power supply unit
104 — 1 4½v mains power supply unit
105 — 1 5 pin flex plug and panel socket
106 — 1 12v vibrating reed bleepers
107 — 5" speaker size radio cabinet with handle
108 — 5 different multi way push switches
109 — 10 ¼" spindle type volume controls
110 — 10 slider type volume controls
111 — 2 musical boxes (less keys)
112 — 1 heating pad 200 watts
113 — 1 fm front end with tuning condensor
114 — 1 1w amplifier Mullard 1172

With most items quantity buyers get good discounts and save on postage costs.

EX-G.P.O. TELEPHONES

Black heavy type	£5.50
Lightweight 746 type	£7.50
Ex-G.P.O. plug	£1.00
Ex-G.P.O. socket	£1.00

SOUND TO LIGHT UNIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form.

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 £16.50 or without case £15.00. post paid.

4/5A BATTERY CHARGER

Transformer and rectifier £3.95 & £1 post, 3 kits £12.

WALL MOUNTING ROOM THERMOSTAT

By Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0 — 30 c — 13 amp 250v contacts. Price £4.60. — 10 for £40.

BLEEPERS

6 or 12v battery or transformer operated, ideal for using in alarm circuits but particularly suitable for can and motor cycle alarms. These give a loud shrill note. Price 69p. 1000 for £345. Jap made.

PRESTEL UNITS

These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) — Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% — load regulation 1% from no load to full load — or full load to no load. Complete in heavy duty case — Models available: 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

25A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you wake — switch on lights to ward off intruders — have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50.

THIS MONTH'S SNIP

TOP OF THE POPS LIGHTING

if you use our disco switch ONLY £6.90

These have 12 x 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc. etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately one third of cost.

COMPUTER DESKS

Again available — Computer desks — size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 — you must collect — hundreds supplied to schools.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, 90% are unused componants.

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:

1 Framco motor with gear box
1 manual reversing & on/off switch
1 push to start switch
2 limit stop switches
1 circuit diag. of connections

£19.50 plus postage £2.50

J. BULL (Electrical) Ltd.

(Dept. EE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU.

Established 30 YEARS

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 day or night. Haywards Heath (0444) 454563. Bulk orders: phone for quote. Shop open 9.00 — 5.30. Mon to Fri, not Saturday.

VENNER TIME SWITCH

Ex-Electricity Board. Guaranteed 12 months.

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

EXTRACTOR FANS — MAINS OPERATED

Woods extractor.
5" — £5.75. Post £1.25.
6" — £6.95. Post £1.25.
5" Plannair extractor £6.50. Post £1.25.
4"x 4" Muffin 115v. £4.50. 230v. £5.75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER

by British Solartron, as used in best blow heaters. 3Kw £6.95 complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £2

Still available: £4.95 + £1.50 post. or have 3 for £16 p **2.5 Kw KIT**

ROCKER SWITCHES

Standard size fit 11.5 x 28 mm cut out. Single pole on/off — 15p each 1000 for £75. Single pole changeover 20p each — 1000 for £100. Single pole changeover with centre off — 25p each — 1000 for £125. Single pole on/off with neon — 36p — 1000 for £180.

ROCKER SWITCH DP/DT

15 amp 250 volts suitable for motor reversing etc. — 46p — 100 for £34.50. 1000 for £230.

MICRO SWITCHES

V3 type all 250 10 amp SpST 20p 1000 — £100 Spdt 30p 1000 — £150, very low tongue Spdt 40p 1000 for £200.

The AMSTRAD Stereo Tuner.

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio — easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are: long wave band 115 — 170 KHz, medium wave band 525 — 1650 KHz. FM band 87 — 108 MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board

Offered at a fraction of its cost: only £6.00 + £1.50 post + insurance

MINIATURE WAFER SWITCHES

2 pole, 2 way — 4 pole, 2 way — 3 pole, 3 way — 4 pole, 3 way — 2 pole, 4 way — 3 pole, 4 way — 2 pole, 6 way — 1 pole, 12 way.
All at 25p each or 10 for £2.00

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle — Price £3.45.
Ditto, but double ended £4.25.

MAINS MOTORS

We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — a complete mains operated kit, case included.

£11.95 plus £2.00 post.

OTHER POPULAR PROJECTS

R C Bridge Kit	£9.95
3 Channel Sound to Light — with fully prepared metal case	£14.95
Big Ear, listen through walls	£9.50
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch — fools friends and enemies alike	£1.95
3 — 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Radio stethoscope — fault finding aid	£4.80
Mug stop — emits piercing squark	£2.50
Morse Trainer — complete with key	£2.99
Drill control kit	£3.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
F M receiver kit — for surveillance or normal F M	£3.50
Insulation Tester — electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio — receives Medium Wave	£2.95
40 watt amp — hifi 20hz — 20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50

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EVERYDAY ELECTRONICS and computer PROJECTS

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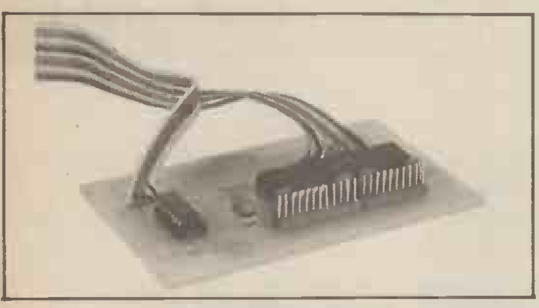
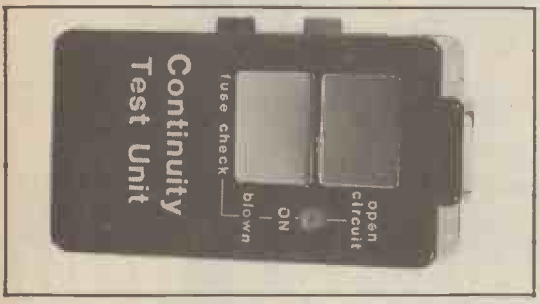
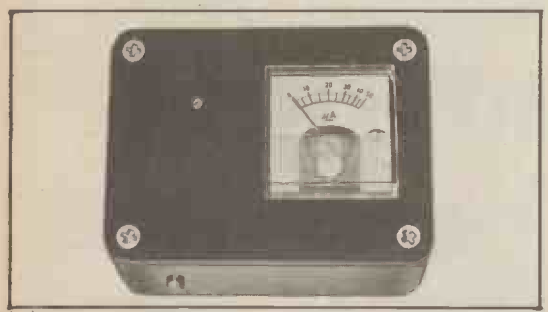
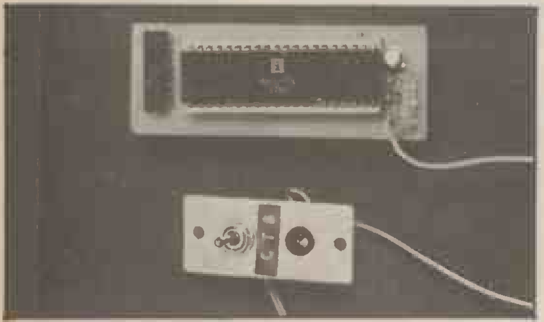
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .









PROJECTS

SERIES

FEATURES

Our August 1985 issue will be published on Friday, July 19. ***See page 399 for details.***

SUMMER SALE!!

All those people on the beach making Sandcastles – STOP – 'cos here are some really nice bargains. We're clearing stocks of last years offers at unbeatable prices . . . PLUS – all packs reduced . . . PLUS – a preview of new packs that will be featured later in the year!! All offers must end 31st August, so hurry hurry hurry!!! Minimum order value at these special sale prices is £10. Detail of all items can be found in earlier ads or send SAE for list.

PACKS

K524 Opto Pack £3.95 **£2.95**
K525 Preser Pack £6.75 **£3.95**
K528 Electrolytic Pack £3.95 **£3.20**
K531 Precision resistors £3.00 **£2.50**
K532 Relays £6.00 **£3.00**
K517 Transistors £2.75 **£1.95**
K523 Resistors £2.50 **£2.00**
K520 Switches £2.00 **£1.70**
K522 Copper clad board £1.00 **£0.70**
K530 Polyesters £3.95 **£2.95**
K518 Disc Ceramics £1.00 **£0.70**
K503 Wirewound Resistors £2.00 **£1.50**
K505 Pots £1.70 **£1.40**
W4700 Push button banks £2.95 **£2.00**
K526 Heatsinks £5.50 **£4.00**
K527 Hardware £4.00 **£3.00**

OTHER GOODS

"Crackshot" Joystick (Atari) £8.50 **£4.50**
BBC Joystick £9.50 **£5.50**
Analogue joystick £9.85 **£5.35**
"The Sensible 64" book £5.95 **£2.00**
Bimbox 6006 £2.95 **£2.00**
LP11 compartment tray £2.95 **£2.00**
Storage Bins £3.95 **£2.95**
Ferric Chloride £1.30 **£0.99**
SK1 Antex Kit £11.38 **£7.50**
Veroboxes, two tone grey:
825-21028 £3.38 **£2.50**
825-21029 £3.81 **£2.95**
825-21030 £4.28 **£3.30**
825-21031 £5.72 **£4.50**
Power/VU meter £1.00 **£0.60**
4.8V PCB Ni-Cad £0.99 **£0.70**
Single core Fibre Optic 20m coil £6.30 **£3.50**
Twin core Fibre Optic 20m coil £11.00 **£6.00**

PANELS

Z914 1W mono amp panel £1.50 **£1.00**
Z915 1W stereo amp panel £3.50 **£2.00**
Z916 AM tuner panel £1.50 **£1.00**
Z908 2×TDA1004 panel £3.00 **£1.50**
Z912 IF Panel £2.50 **£1.50**
Z910 RF/IF radio panel £2.50 **£1.50**
"Simon" panel untested **£1.50**
Z925 2 relays + triac £1.90 **£1.20**
Z926 relay + triac + SCR £1.85 **£1.15**
Z927 2×6V reeds £0.60 **£0.40**
Z922 Panel with 36p3w switch £9.50 **£4.50**

NEW PACKS

K534 SLEEVE PACK – wide selections of types and sizes – PVC, rubber, silicone, heatshrink, etc. in boxes from 1mm to 18mm, lengths 9mm to 100mm. Approx. 100 **£1.00**

K536 74 SERIES PACK – 'on board' chips for you to desolder – containing many LS and other types. Good mix.
40 **£1.85** 100 **£4.00**

K537 I.C. PACK – a mix of linear and logic chips, form 6 to 40 pin. All are new and marked, but some may not be full spec.
100 **£6.75** 250 **£14.00** *1000 **£45.00**
*mostly in tubes

K538 DIODE PACK – untested small signal diodes like IN4148 etc. at a price never before seen!!
1000 **£2.50** 10,000 **£20.00**

K539 LED PACK – not only round but many shaped leds in this pack In red, yellow, green, orange and clear. Fantastic mix.
100 **£5.95** 250 **£13.50**

K540 RESISTOR PACK – mostly 1/8, 1/4 and 1/2w, also some 1 & 2w in carbon, film, oxide etc. All have full length leads. Tolerances from 5 to 20%. Excellent range of values
500 **£2.50** 2500 **£11.00**

K535 SPRING PACK – approx 100 assorted compression, extension and torsion springs up to 22mm dia and 30mm long **£1.70**

NI-CAD CHARGER PANEL

177×114mm PCB with one massive Varta Deac 57×50mm Ø rated 7.2v 1000mAH and another smaller Deac 32×35mm Ø rated 3.6v 600mA. The price of these Ni-cad stacks new is over £20. Also on the panel is a mains input charger transformer with two separate secondaries wired via bridge rectifiers, smoothing capacitors and a relay to the output tags. The panel weighs 1kgm. All this for just **£6.00**.

1985 CATALOGUE

More components than ever before! With each copy there's discount vouchers, Bargain List, Wholesale Discount List, Bulk Buyers List, Order Form and Reply Paid Envelope. All for just **£1.00!!**

"SENSING & CONTROL PROJECTS FOR THE BBC MICRO"

Have you ever wondered what all those plugs and sockets on the back of the BBC micro are for? This book assumes no previous electic knowledge and no soldering is required, but guides the reader (pupil or teacher) from basic connexions of the user sockets, to quite complex projects. The author, an experienced teacher in this field, has provided lots of practical experiments, with ideas on how to follow up the basic principles. A complete kit of parts for all the experiments is also available. Book, 245×185mm 120pp **£5.95**. Kit **£29.95**

MOTORIZED GEARBOX

The unit has 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle, and a gearbox contained within the black ABS housing, reducing the final drive speed to approx 50rpm. Data Is supplied with the unit showing various options on driving the motors. Two new types of wheels can be supplied (the aluminium discs and smaller plastic wheels are now sold out). Type A has 7 spokes with a round black tyre and is 100mm dia. Type B is a solid heavy duty wheel 107mm dia with a flat rigid tyre 17mm wide.

PRICES: Gearbox with data sheets: **£5.95**
Wheel type A: **£0.70 ea**
Wheel type B: **£0.90 ea**

Our shop has enormous stock of components and is open 9-5.30 Mon-Sat. Come and see us!!

GREENWELD

All prices include VAT; just add 60p P&P. Min Access order £10, Sale goods £10 min. CWO value. Official orders from schools etc. welcome – min invoice charge £10.

443D Millbrook Road
Southampton SO1 0HX
Tel (0703) 772501/783740

BT STYLE PHONE CONNECTORS

NEW LOWER PRICES

Starter kit (includes Master, Secondary, 20m cable, line cord, clips, etc) all you need to rewire your phone – with instructions	9.50
Master (flush)	2.80
Master (surface)	2.80
Master (mini surface)	3.00
Secondary (flush)	2.00
Secondary (surface)	2.00
Secondary (mini surface)	2.20
Dual outlet adaptor	3.60
4 way line cord with plug to spade terminals	1.75
Extension Leads 5m 3.20 8m 3.60 20m	7.00
4 way line cord (per m)	20
Unapproved to BT connector	2.00
Plug in Extension Ringer	6.00
IDC Insertion Tool	30
Cable Clips (per 25)	30
NOTE: IDC normally supplied	

CMOS

4000	16	4028	45
4001	18	4040	49
4002	18	4043	42
4007	16	4046	60
4011	18	4047	56
4012	18	4049	32
4013	25	4050	35
4015	47	4060	55
4016	30	4069	18
4017	47	4070	18
4019	28	4071	18
4023	16	4077	20
4024	35	4081	16
4025	16	4093	35
4026	70	4511	48
4027	28	4514	1.00

LINEAR ICs

555	21	ML927	1.80
556	40	ML928	1.80
741	22	ML929	1.80
748	30	MM74C911	6.50
AD590	3.30	MM74C915	96
AY38910	3.90	MM74C922	4.90
CA3080	65	MM74C926	4.50
CA3130	85	NE567	1.25
CA3140	40	S566B	2.20
ICL7107	9.00	S576D	2.20
ICL7126	8.00	SAB0529	3.50
ICM7555	55	SAB0600	2.50
ICM8038	3.10	SL440	1.95
LF351	40	SL441	1.35
LF353	70	SL486	1.85
LF356	80	SL490	2.05
LM324	50	SP0256	4.15
LM334Z	85	TBA800	70
LM335Z	1.20	TBA810AS	90
LM339	40	TDA1024	1.20
LM348	55	TDA4290	1.98
LM358	48	TL061	40
LM380	1.20	TL062	72
LM381	1.40	TL064	1.30
LM382	1.10	TL071	45
LM386	88	TL072	70
LM1035	3.95	TL074	1.30
LM1458	34	TL081	35
LM2917	1.90	TL082	48
LM3900	68	TL084	1.00
LM3909	80	TL170	50
LM3911	1.75	TL507C	1.20
LM3914	2.65	TMS1121	8.50
LM3915	2.65	TMS1601	9.50
LM13600	1.10	UA2240	1.45
LS7210	4.75	ULN2003	75
LS7220	2.75	ULN2004	75
LS7225	2.60	ZN414	80
MF10C	2.97	ZN425	3.40
ML922	3.80	ZN427	5.70
ML924	2.50	ZN428	4.50
ML926	1.80	ZN1034E	1.80

OPTO

3mm red	9	5mm red	9
3mm green	12	5mm green	12
3mm yellow	12	5mm yellow	12
LED CLIPS	3	High Inf. red	28

Rectangular, square, arrow or triangular (flat face)
Red 15 Green 18 Yellow 18

Bicolour	65	Flashing LEDs	
Tricolour Red			50
Round	32	Red/	
Rectangular	45	Continuous	55
IL74/TIL111	55	MOC3020	1.10
ILQ74	1.80	MOC3040	1.50
ORP12	75	MEL11	35

Seven Segment LED Displays

DL704 .3 cc	75	4-Dig 1.8" cc	
FND500.5 cc	85	DIRECT DRIVE	
FND507.5 cc	85	Display	7.00

SWITCHES

Push to Make			16
Push to Break			25
Push on/off (3A mains)			50
Sub. Min. Toggle			
SPST	50	DPDT	65
DP Centre Off			89
Slider DPDT			15
DIL Switches:			
4-way	80	6-way	90
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AMSTRAD USER PORT

R.A.PENFOLD

ALTHOUGH the Amstrad CPC464 computer has enormous potential for expansion and is certainly a good machine as far as anyone interested in user add-ons is concerned, it lacks any real equivalent to the user ports found on the machines such as the BBC model B, Commodore 64, and VIC-20. These provide eight lines, each of which is individually programmable as an input or an output, plus a couple of handshake lines. Additionally, two 16-bit timer/counters are available, and these can be used to count input pulses or to divide the system clock to give a wide range of output frequencies. This is a feature which is very useful indeed, and which is exploited in many add-ons for the computers in question.

INTERFACE ADAPTORS

The device used to provide the user ports of the BBC model B and VIC-20 computers is the 6522 VIA (Versatile Interface Adaptor). The Commodore 64 has what is really a sort of improved version of the 6522, the 6526 CIA (Complex Interface Adaptor), but this is not available to amateur users.

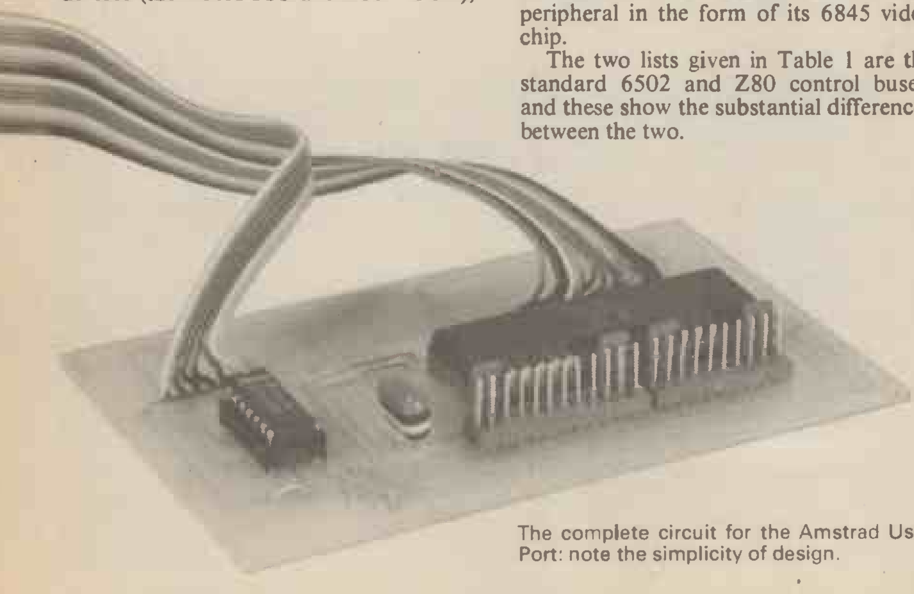
The 6522 is, of course, intended for use with the 6502 and 6800 families of microprocessors, whereas the Amstrad CPC464 computer is based on a Z80A. It would be possible to obtain similar facilities to those provided by the 6522 using a couple of Z80A peripheral devices (the Z80A PIO and Z80A CTC), but despite certain difficulties it is possible to interface 6500 and 6800 series peripherals to a Z80 or Z80A based computer.

Using a 6522 with a CPC464 is an attractive proposition as it gives an excellent range of facilities for a very modest cost. It should also enable most of the published designs for VIC-20/CBM64/BBC model B add-ons to be interfaced to the CPC464 with a little ingenuity. The unit described here is a remarkably simple 6522 interface for the CPC464.

CONTROL BUSES

The problems with interfacing a 6500 series peripheral to a Z80A-based system stem from the differences in the control buses. On the face of it there is also a problem in that a Z80A system normally has a clock frequency of about 4MHz whereas a standard 6522 has a maximum clock frequency parameter of just 1MHz. In practice this is not really a problem since the higher clock frequency of the Z80A is brought about by its different method of handling internal operations, and is not due to genuinely faster logic circuitry. This is demonstrated by the fact that standard (1MHz) 6500 and 6800 series peripherals can be made to operate with 4MHz Z80A systems, and it is not even necessary to resort to the higher speed "A" and "B" series 6500 and 6800 peripherals. As a matter of interest, the CPC464 has a built-in 6800 series peripheral in the form of its 6845 video chip.

The two lists given in Table 1 are the standard 6502 and Z80 control buses, and these show the substantial differences between the two.



The complete circuit for the Amstrad User Port: note the simplicity of design.

Table 1: CPU control lines

Z80	6502
$\overline{RD}$	R/W
$\overline{WR}$	
$\overline{IORQ}$	
$\overline{MEMRQ}$	
CLOCK	CLOCK
$\overline{RESET}$	$\overline{RESET}$
$\overline{M1}$	

There is no difficulty with the CLOCK and $\overline{RESET}$ lines which both seem to be compatible. There is no problem with the M1 line either, and when using a 6500 series peripheral this can simply be ignored. The main obstacle is the different read/write arrangement, with the 6502 having a single line which is taken low during read operations, while the Z80 has separate read and write lines which go low during read and write operations respectively.

The write line of the Z80 is actually a rough equivalent of the read/write line of the 6502, since both go low during write operations, and it can be used to drive the read/write input of a 6500 series peripheral. However, it is not always safe to just leave the read line unconnected, and it is advisable to gate both this line and the write one and use them to drive a chip select input of the 6500 series peripheral. This is done to ensure that the device is disabled except when a proper read or write operation is taking place, and avoids spurious read operations. These may not seem to be of any importance, but they could in fact result in status register flags being reset prematurely.

INPUT/OUTPUT

The 6502 has memory mapped input/output devices whereas the Z80 utilises a separate input/output map. The $\overline{IORQ}$ (input/output request) and $\overline{MEMRQ}$ (memory request) lines are used to provide the separate maps, with the $\overline{IORQ}$ line going low when an input/output device is accessed, and the $\overline{MEMRQ}$ line going low when a memory circuit is accessed. This different scheme of things is of no real consequence here, and the $\overline{IORQ}$ line is decoded by the address decoder, just as it is for any Z80 peripheral circuit. $\overline{MEMRQ}$ is just ignored.

THE CIRCUIT

The full circuit diagram of the interface is shown in Fig. 1.

The CPC464 has a very simple method of input/output mapping where taking one of the eight most significant address lines low activates a peripheral circuit. The eight least significant address lines are available if a peripheral circuit requires more than one address.

This is not the standard Z80 system of input/output mapping, but it is a practical approach which enables a minimal amount of address decoding to be used. Address line A10 is free for use with user add-ons, and in this circuit it is decoded with $\overline{IORQ}$ by 2-input NOR gate IC2d. The output of IC2d goes high and activates the positive chip select input of IC1 (the 6522) when A10 and $\overline{IORQ}$ are both low.

The other three gates of IC2 decode the read and write lines. IC2b produces a low output when either $\overline{RD}$ or $\overline{WR}$ are low, and it drives the negative chip select input of IC1.

Apart from IC2 and the supply decoupling capacitor C1, the only other component in the circuit is the 6522 itself. The data bus of the computer connects straight through to the data bus of IC1. The 6522 has sixteen registers and therefore has four register select inputs. These are driven from address lines A0 to A3, placing the registers at sixteen contiguous addresses. As considerably less than full address decoding is used, each register actually appears at a substantial number of addresses. However, it is advisable to use addresses from &F800 to &F80F to avoid unwanted operations of the internal hardware of the computer.

The $\overline{RESET}$ and CLOCK terminals are fed from the corresponding lines of the CPC464's "floppy disc" (expansion) port. Note that as the clock frequency is 4MHz rather than 1MHz, when the timers are used to divide the clock signal the output frequency is four times higher than would normally be the case. This is not a major drawback though, and the higher output frequency range could even be advantageous in some applications. It is not feasible to divide the clock by four so as to obtain a 1MHz clock signal for IC1 as this would upset the system timing during write operations, making it impossible to write data to IC1.

PB0 to PB7 are the eight data lines of IC1's port B, and CB1 plus CB2 are the two handshake lines. It is only this port that is available at the user port of the VIC-20, BBC model B, etc. In this case the eight data lines of port A (PA0 to PA7) and the two handshake lines (CA1 and CA2) are also available, giving a total of some 20 input-output lines.

The circuit requires a single 5 volt supply at a typical current consumption of well under 100 milliamps, and this can be drawn from the expansion port of the computer.

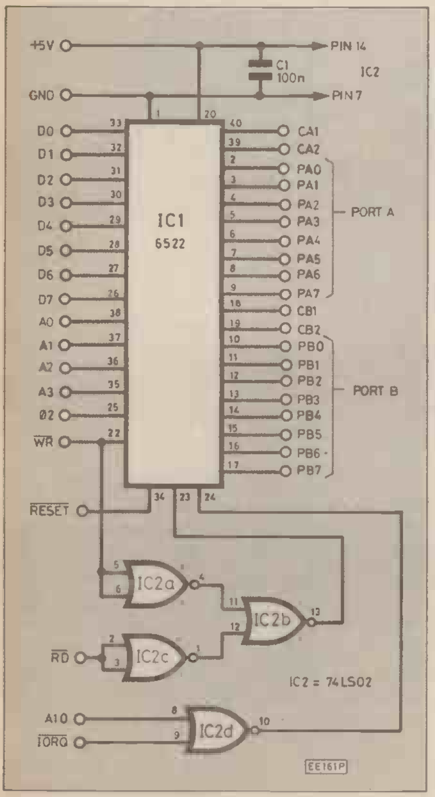


Fig. 1. User Port circuit diagram.

CONSTRUCTION

Details of the printed circuit board and component layout are given in Fig. 3. As IC1 is a MOS device and is also a fairly expensive type a (40 pin d.i.l.) integrated circuit holder for this component should be considered essential. Fit the other components including the cables and link-wires before fitting IC1 into place, and make quite sure it is fitted the right way round.

The connections to the computer are carried by a piece of 20-way ribbon cable about half a metre long. The free end of the cable is fitted with a 2 by 25-way 0·1 inch pitch edge connector using the method of connection shown in Figs. 2 and 3. The use of multicoloured ribbon cable is strongly recommended as it greatly reduces the risk of wiring errors. It is unlikely that a connector having a suitable polarising key will be available, but it would probably be possible for the constructor to fit one with a little ingenuity. Alternatively the top side of the connector can be clearly labelled as such.

On the prototype, simple 0·1 inch pitch printed-circuit mounting plugs are used to carry the port input and output connections (which include +5V and Gnd, giving a total of 22 terminals). The 22-way plug actually consists of one 10-way and one 12-way type butted together. Of course, any other type of 0·1 inch pitch connector should be equally suitable.

TESTING AND USE

Connect the unit to the "floppy disc" port of the computer prior to switching on. After switch-on the usual screen display should be obtained, and the computer should function normally. If there is any sign of a malfunction switch off at once and recheck the interface. As a quick test to determine whether or not the unit is functioning properly, try this command:

PRINT INP(&F800)

If all is well this should return a value of 255. Try wiring PB0 to ground and repeating this command. The value returned should then be 254.

The 6522 is a very complex device which has a large range of facilities. In this case the IRQ (interrupt request) output at pin 21 is not utilised, rendering some functions of the device defunct, but this still leaves a great many to master. Here there is only sufficient space available to cover a few 6522 basics, and anyone using this project would be well advised to obtain the data sheet which fully covers all aspects of the device.

Table 2 below lists all sixteen registers plus their primary addresses.

Table 2: 6522 VIA register addresses and functions.

Address	Function
&F800	Peripheral B (port B)
&F801	Peripheral A (port A)
&F802	Data Direction B
&F803	Data Direction A
&F804	Timer 1 Latch (low byte)
&F805	Timer 1 Latch (high byte)
&F806	Timer 1 Counter (low byte)
&F807	Timer 1 Counter (high byte)
&F808	Timer 2 Latch (low byte)
&F809	Timer 2 Latch (high byte)
&F80A	Shift Register
&F80B	Auxiliary Control
&F80C	Peripheral Control
&F80D	Interrupt Flags
&F80E	Interrupt Enable
&F80F	Port A (no handshaking)

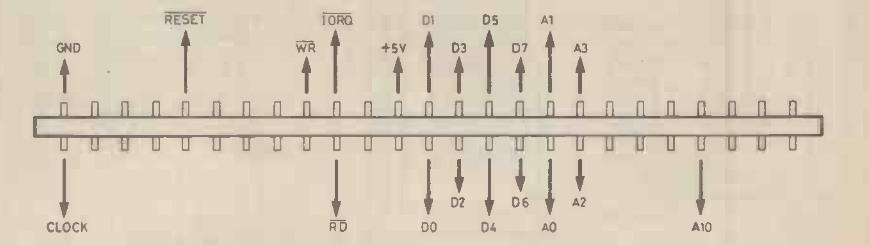


Fig. 2. Expansion port signals.

Obviously the most useful features of the device are the two eight bit input/output ports, and these are quite easy to understand. Each line can be set as an input or an output, and the function obtained depends on the state of the relevant bit of the appropriate data direction register.

COMPONENTS

See Shop Talk page 377

Capacitor
C1 100n polyester

Semiconductors
IC1 6522 VIA
IC2 74LS02

Miscellaneous
20-way ribbon cable; 2- by 25-way 0·1 inch pitch female edge connector; 40-pin d.i.l. i.c. holder; 14-pin d.i.l. i.c. holder; 12-way 0·1 inch pitch p.c.b. mounting plug; 10-way 0·1 inch pitch p.c.b. mounting plug; printed circuit board, available from the *EE PCB Service*, order code 8507-01.

Approx. cost Guidance only £12.00

Setting a bit to 0 sets the corresponding line as an input; setting it to 1 sets the line as an output. The reset pulse at switch-on sets all the registers to zero, and consequently all the lines are initially set as inputs.

If we required (say) PA0 to PA3 as outputs, and PA4 to PA7 as inputs, bits 0 to 3 of data direction register A would have to be set at 1, and bits 4 to 7 would have to be set to 0. This gives a value of 15 to be written to data direction register A, and this can be achieved from BASIC using the OUT instruction (i.e. OUT &F803,15). In most cases all eight lines of each port will be set to the same mode, which requires a value of 0 (all inputs) or 255 (all outputs).

PERIPHERAL REGISTERS

It is important to realise that the data direction registers only control the function of each data line, and that data for the ports is not written to or read from these addresses. It is written to or read from the appropriate peripheral register. For example, data for port B is written to peripheral register B at address &F800. The ports can be read from BASIC using the INP(X) function, as in the simple example given previously. All inputs have pull-up resistors and therefore go high if left floating. The CPC464 supports a bitwise AND function which can be used to mask any bits that are not of interest.

Many applications require handshaking to control the flow of data into and out of each port. These lines are controlled by the peripheral control register at &F80C. If we start with CA1, this has just two modes of operation, both of which are input modes. It can detect either high-to-low or low-to-high transitions. In other words it does not respond to fixed logic levels like the data lines, but it detects a transition from one logic state to the other. CA2 is more complex and has eight operating modes (four input and four output). When used as an input it also responds to transitions rather than fixed states. CA1 and CA2 are controlled by the four least significant bits of the peripheral control register, as detailed in Table 3. CB1 and CB2 are controlled in precisely the same way by the four most significant bits, and the decimal numbers in brackets are the equivalent values for CB1 and CB2.

When an input is activated it sets the approprate bit of the interrupt flag register, as shown below:

CA1 Bit 1 (2)
CA2 Bit 0 (1)
CB1 Bit 4 (16)
CB2 Bit 3 (8)

The number in brackets is the decimal value by which the value from the interrupt register is increased when that bit is set.

With the handshake input modes the flags are reset by reading from or writing

Fig. 3. Printed circuit board and component layout for the Amstrad User Port.

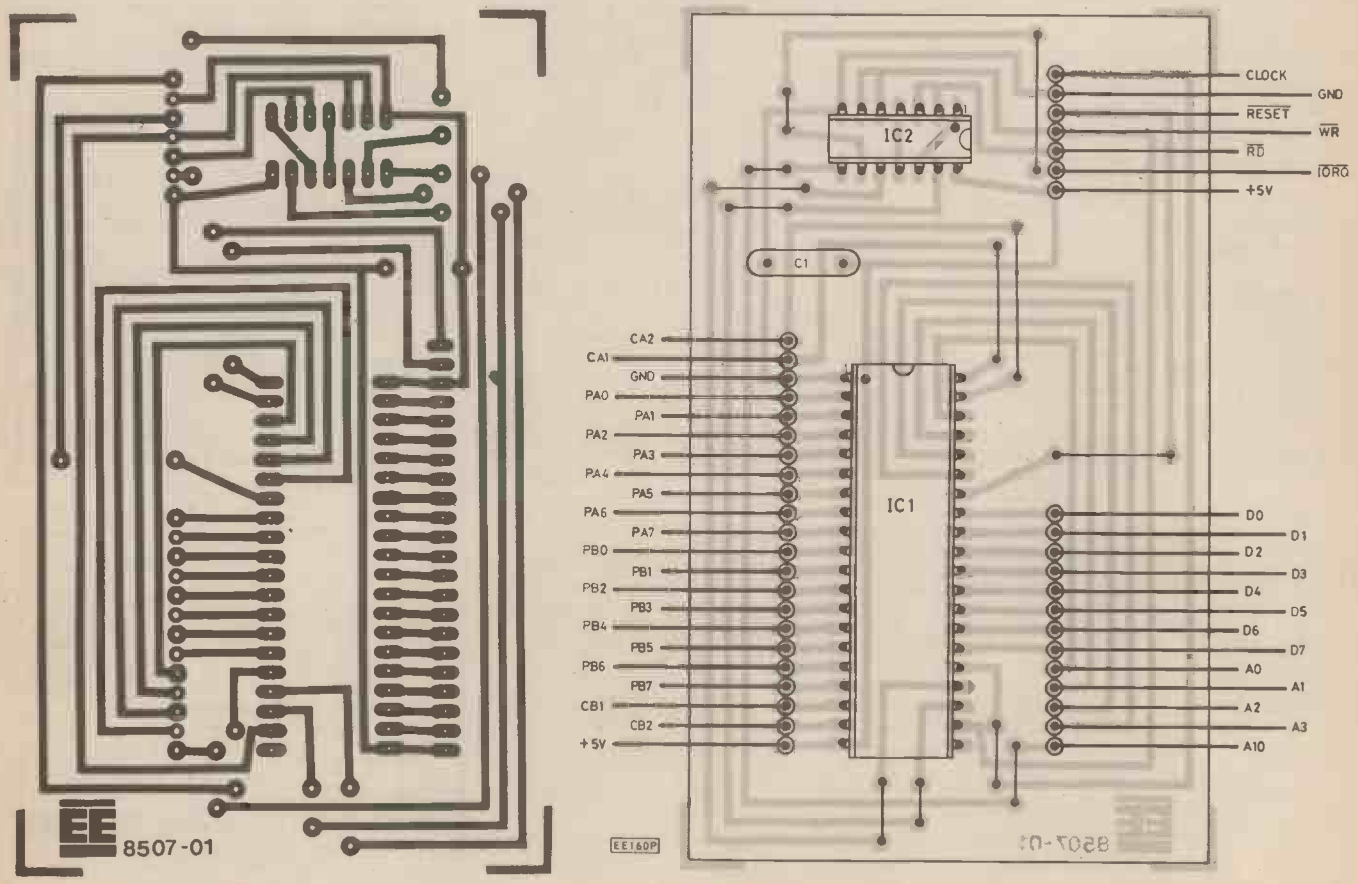


Table 3: Peripheral control register values for handshaking.

Binary/ Decimal Number	Operating Mode
0000/0 (0)	CA1 high-to-low handshake input
0001/1 (16)	CA1 low-to-high handshake input
0000/0 (0)	CA2 high-to-low handshake input
0010/2 (32)	CA2 high-to-low independent input
0100/4 (64)	CA2 low-to-high handshake input
0110/6 (96)	CA2 low-to-high independent input
1000/8 (128)	CA2 high-to-low handshake output
1010/10 (160)	CA2 high-to-low pulse output
1100/12 (192)	CA2 low output
1110/14 (224)	CA2 high output

to the appropriate port, or by writing 1 to the relevant bit of the interrupt register (and not, as one might have thought, writing 0 to the bit to be reset). This may seem to be a strange way of doing things, but it makes it easy to only reset the intended flag or flags. The independent input modes are different in that flags can only be reset using this second method, and are not affected by read or write operations to the ports.

OUTPUT MODES

Two of the output modes are used to simply set the output line continuously high or low, as required. The pulse output mode is a useful one which gives a brief negative pulse when data is written to or read from the appropriate peripheral register. The handshake output mode sets the line low when data is written to the relevant port, and it is reset to the high state by an active transition on the other handshake line of that port.

Of course, if you are using several handshake lines a single value must be written to the peripheral control register to set the required operating modes. This is just a matter of finding the value required to set each line to the required mode using the table above, and then the sum of these values is written to &F80C. As a quick check of a handshake line try this simple program:

```
5 OUT &F80C,0
10 PRINT INP(&F80D) AND 1
20 OUT &F801,0
30 FOR D=1 TO 100
40 NEXT
50 GOTO 10
```

When run this repeatedly prints the state of the CA2 flag down the left hand side of the screen, and resets it if necessary. CA2 is set to the high-to-low handshake mode. Therefore, readings of "0" are normally obtained, but each time CA2 is shorted to ground a single reading of "1" should be obtained from the computer.

Use of the timers really goes beyond the scope of this article, but as a quick check you can try these commands:

```
OUT &F80B,192
OUT &F804,208
OUT &F805,7
```

The first line sets timer 1 to the free running mode and enables output on PB7, while the next two lines write a value of 2000 to the timer 1 latches. The output frequency on PB7 is equal to 2000000 divided by the value written to timer 1, giving a 1kHz output with these values. However, by using different values it is possible to obtain frequencies from the low audio range through into the ultrasonic range. □

View of the User Port showing the p.c.b. mounting plugs and the ribbon cable connector to the computer.

CONTINUITY TESTER

A.R.WINSTANLEY

THE obvious method of determining the value of an unknown resistance is to employ an ohmeter set to the appropriate scale. However, quite often all that one may require is a simple indication of whether the circuit or component under test is an open or short circuit.

This particularly applies when testing suspect audio leads, fuses and printed circuit boards. A further disadvantage is that whilst trying to position multimeter test probes on the circuit, one must also observe the meter to read off the resistance.

This Continuity Test Unit is a device which generates an audio tone when it detects a short circuit or resistance up to 6·8kΩ or so. It is, therefore, considerably easier to apply the probes of the continuity test unit and listen for the tell-tale audio signal rather than use a less convenient multimeter which always seems to demand your constant attention!

FUSE CHECK

A special facility has been incorporated into the design which permits the unit to quickly and conveniently test the condition of all types of cartridge fuse, without the need to use test probes. This has proved most valuable.

Further details are given to enable you to perform simple tests on diodes and the majority of electrolytic capacitors, to enable you to obtain a quick go/no-go reading.

CIRCUIT DESCRIPTION

The circuit diagram appears in Fig. 1. There are two distinctive sections, each one being centred around an operational amplifier (op-amp).

IC1a and associated components form a simple comparator and it is this part of the device which detects for the presence of short circuits. R3 and R4, being of equal value, set the non-inverting input (pin 3) to half the supply voltage. Since R1 and R2 clamp the inverting input at three-quarters of the supply rail, the op-amp output is held low at roughly 0V, due to comparator action.

Current is able to sink through D1, which illuminates, and its associated current limiting resistor R5 into IC1a output, pin 1.

SK1 and SK2 are the two input sockets to the continuity test unit. Note that they are polarised, SK1 being positive and SK2 negative: this is relevant when testing diodes and capacitors but is otherwise not important.

The component under test is connected up through SK1 and SK2 and thus R2 will be shunted to 0V if a short circuit is present. This will mean that the voltage at the non-inverting input of IC1a will exceed that at the inverting terminal, and then the potential at pin 1 will rise to approximately the supply rail voltage.

The second op-amp, IC1b, is arranged as an astable oscillator which generates a square wave of roughly 4·7kHz. This drives a piezo-ceramic transducer, AWD 1, to produce a distinctive tone without undue battery consumption.

The oscillator is disabled when the output of IC1a is low. Conversely, the audible tone will be generated when a short circuit is present across SK1 and SK2.

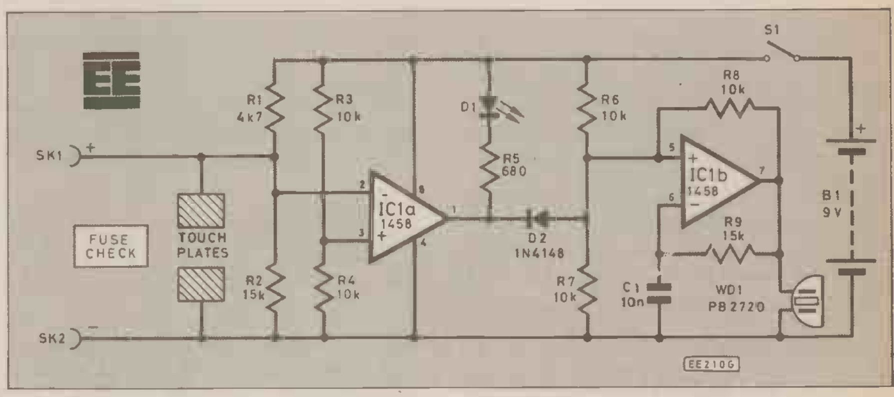


Fig. 1. Circuit diagram of the Continuity Tester.

In actual fact, any resistance up to about 6·8kΩ placed across R2 will cause the op-amp output to go high.

The l.e.d., D1, can be deemed to perform two functions. When power is applied by closing S1, the l.e.d. will light up, assuming that no short circuit is present across R2. In this mode, then, the l.e.d. acts as a power-on indicator.

If, however, this l.e.d. does not illuminate after switching on, then you should immediately check the condition of the battery B1. Thus the l.e.d. will also double as a simple battery condition indicator.

In fact, it was found that if the battery voltage dropped to 5V or less, the oscillator just started to operate. This gives an advanced warning that the battery is on its last legs!

The operational amplifiers used are similar to the universal 741 types. However, it is possible to obtain twin op-amp chips which incorporate two op-amps in an 8-pin d.i.l. package, this device being designated the 1458C, and this chip is used for IC1. A common rail supplies both op-amps at pins 8 (positive), and 4 (negative).

CONSTRUCTION

Assembly is a straightforward matter and the components are arranged on 0·1" matrix stripboard measuring 8 strips by 23 holes, see Fig. 2.

There are four breaks in the copper strips underneath the i.c., and these should be made using preferably a spot face cutter or hand-held twist drill of appropriate diameter.

To protect the integrated circuit from possible thermal damage during soldering, it is best to use an 8-pin d.i.l. socket. Then solder in the components in accordance with the diagram. In particular, observe correct polarity of the diode D2 and do not heat it for too long when soldering.

The prototype was constructed in an ABS box which measures 113 × 63 × 31mm. It is then possible to slot the component panel into the internal p.c.b. guides moulded inside the box, and so no mounting hardware is required for the stripboard.

The special fuse-checking facility incorporated into the prototype. This consisted of two rectangular touch pads bolted to the front panel with approximately 2mm between them. The touch pads, it will be seen, are effectively extensions of SK1 and SK2 and thus it becomes an easy matter to place suspect fuses across the pads to determine their condition. Of course, the audio tone will sound if the fuse is intact.

The case must be drilled to take the touch pads (if used), the l.e.d. and rocker switch. The l.e.d. can be affixed to the front using a transparent lens clip. The two 4mm sockets are mounted on the side of the box, having once made certain that they will not interfere with the touch pad mounting studs which protrude into the case.

At this stage you may wish to letter the case; this can be accomplished with rub-down lettering, followed by several light coats of protective lacquer.

AWD1, the piezo transducer, can simply be stuck to the inside of the removable panel with double-sided foam strip. This will be found to be perfectly adequate in holding the transducer firmly in place.

With construction complete, snap on a suitable battery (PP3), and then switch on at S1. The l.e.d. should illuminate. Shorting the touch pads or sockets should cause the l.e.d. to extinguish and the audio tone should be clearly heard. The unit is then complete and ready for use.

USING THE TESTER

The continuity test unit can immediately be used to check out the confusing terminals of rotary switches, breaks in copper tracks of printed circuit boards (not to mention heated rear window elements in cars) and also helps unravel connections in DIN audio leads.

It is also possible to perform simple tests on electrolytic capacitors. Connect the positive terminal to SK1 and the negative to SK2. The oscillator should sound for a period determined by the capacitance of the unit under test. A continued tone indicates a shorted capacitor or possibly excessive leakage current. No tone at all hints at an open circuit capacitor. Ensure that the capacitor is discharged to begin with. As a guide, a 1,500μF capacitor caused the tone to be heard for about nine seconds.

To check the polarisation of diodes, clip the diode to the test leads inserted into SK1 and SK2, note any results and then reverse the connections.

A tone heard both ways indicates a short circuited diode and again no tone at all would imply an open circuit: in both cases, of course, the diode can be considered unserviceable. If a tone is heard one way round but not the other, then, with the oscillator sounding, the anode of the diode is connected to SK1; also, the diode can be considered to be functioning normally.

The above information will hold true for both silicon and germanium diodes, as well as l.e.d.s. The forward current through the diode will be no more than 2mA and so there is no risk of damage in this respect. □

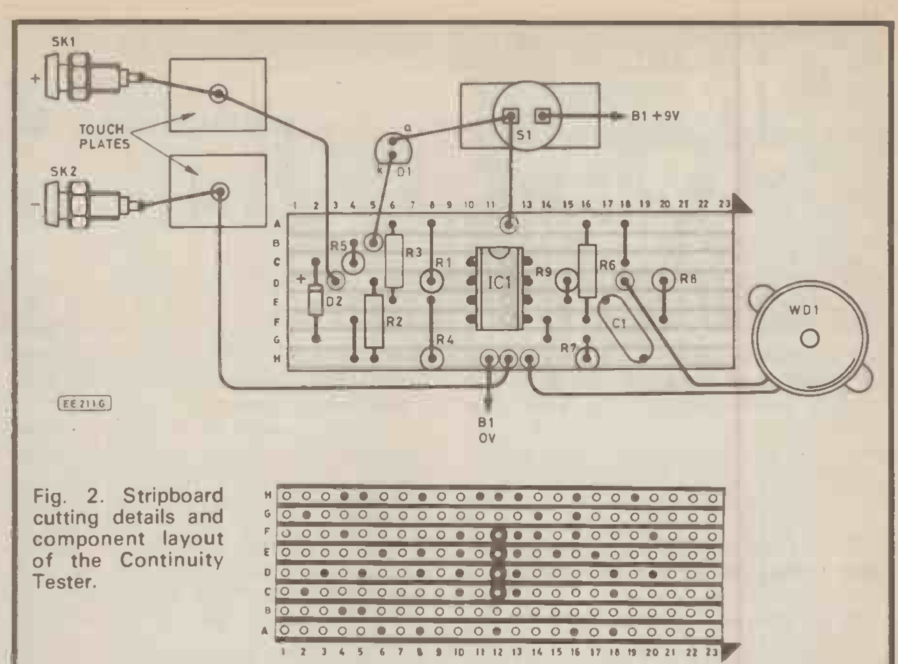


Fig. 2. Stripboard cutting details and component layout of the Continuity Tester.

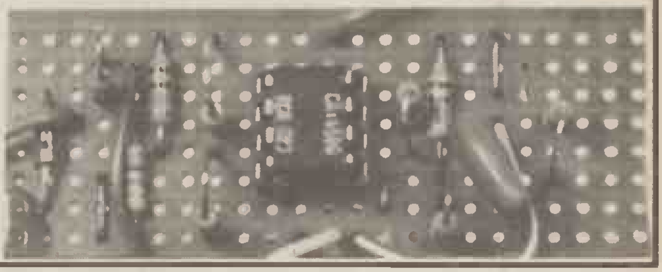


Photo illustrating the stripboard layout of the Continuity Tester.

COMPONENTS

Resistors
R1 4k7
R2 15k
R3,R4,
R6–R8 10k (five off)
R5 680
R9 15k
All resistors ¼W 5% carbon

Capacitor
C1 10n polyester

Semiconductors
D1 TIL220 0·2″ red l.e.d.
D2 1N4148 silicon diode
IC1 1458C twin op-amp

See Shop Talk page 377

Miscellaneous
S1 s.p.s.t. rocker switch; B1 9V PP3 battery and clip; AWD1 TOKO PB2720 piezo-ceramic transducer; SK1 red 4mm socket; SK2 black 4mm socket; 0·1″ matrix stripboard, 8 strips × 23 holes; ABS case, 113 × 63 × 31mm; rectangular touch pads, two off; 8-pin d.i.l. i.c. socket; transparent l.e.d. lens-clip; general-purpose hook-up wire; solder, etc.

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a regular feature for the Spectrum Owner...

by Mike Tooley BA

LAST MONTH we dealt with the circuitry and construction of a simple four-channel interface. This month we shall provide a few clues as to how this interface can be controlled from BASIC as well as describing some additional circuitry for driving external devices such as motors and a.c. lighting.

Using the Interface

The output interface (see Fig. 2, June *On Spec*) is mapped to decimal port address 191 (or 255 if IC2b has been omitted) and data can be sent to this address in order to activate the four external lines. The interface has been arranged so that each of the four output channels corresponds to one of the four least significant data bits; the state of channels A, B, C and D is, respectively, determined by data lines D0, D1, D2 and D3, as shown in Table 1.

It should also be noted that the channels are independent of one another as indicated by the "don't care" states.

If this is beginning to sound complicated, let's just consider a simple example. Suppose we wish to connect an audible alarm transducer to channel D and repeatedly pulse it "on" and "off" at a frequency of around 1Hz. To make things simple we will assume that all of the other channels should remain in an "off" state.

To turn channel D "on" leaving all of the other channels "off" we must output a decimal value of 8 (binary bit pattern 00001000) to port address 191. D4 will become illuminated and pin 1 (Q) of the output connector will then go "high" (approximately +5V) whilst pin 2 ($\overline{Q}$) will go "low" (approximately 0V).

Table 1. Relationship between data bits and output channels enabled

		State of data lines			
		D3	D2	D1	D0
Channel output enabled	A	X	X	X	1
	B	X	X	1	X
	C	X	1	X	X
	D	1	X	X	X

X = don't care.

To turn channel D off whilst all of the other channels remain off we must output a decimal value of 0 (binary bit pattern 00000000) to port address 191. D4 will become extinguished and pin 1 (Q) of the output connector will then go "low" (approximately 0V) whilst pin 2 ($\overline{Q}$) will be "high" (approximately +5V). To verify this "on"/"off" switching action, readers may like to try the following commands entered directly from the keyboard:

```
OUT 191,8
OUT 191,0
```

Each command should, of course, be followed by ENTER and D4 should confirm that channel D has been activated for the period between the first and second depression of the ENTER key.

In order to satisfy our requirement for pulsing the line "on" and "off" we need only place the foregoing commands within a simple program loop, not forgetting to include a short delay after each by means of an appropriate length PAUSE. (Note that a PAUSE statement will be overriden if a key is depressed). A suitable routine would be:

```
10 OUT 191,8
20 PAUSE 20
30 OUT 191,0
40 PAUSE 20
50 GO TO 10
```

The above program will, of course, continue for ever (or at least as long as power is applied to the Spectrum or BREAK is not depressed) and the user should thus be provided with a means of exit. This can be achieved by including some form of conditional statement along the lines of:

```
44 LET r$=INKEY$
48 IF r$="Q" THEN STOP
```

STOP may be replaced with GO TO, GO SUB, RETURN, or whatever else suits your own particular requirements.

For more information, readers should refer to our current "Spectrum Update" which provides a listing of a complete demonstration program for the four-channel output interface. This includes routines which will:

(a) toggle "on" and "off" any selected output line,
(b) produce a binary count sequence on the output lines,
(c) switch the lines "on" and "off" in a random manner, and
(d) operate as a four-channel sequencer.

Driving external circuitry

The four-channel output interface produces TTL-compatible output signals and thus, in many applications, a relay will be required for interfacing with external devices such as motors and lamps. Sensitive d.i.l. reed relays may be connected directly to the interface (these should be connected to the $\overline{Q}$ output rather than the Q output and the logical sense of the control bits inverted accordingly), and should have a coil resistance of between 450 and 600 ohms with an operating voltage of between 3·75V and 7V. Such relays can typically switch 240V a.c./100V d.c. at currents of up to about 500mA.

Where higher current 12V relays are to be used, the circuit of Fig. 1 should be employed. The coil resistance of the 12V relay should not be less than about 200 ohms in this particular arrangement. An alternative circuit is shown in Fig. 2. This arrangement uses a VMOS device and the 12V relay employed can have a coil resistance of as low as 50 ohms.

The circuit of Fig. 2 can be modified for use with a small d.c. motor connected in place of the relay, as shown in Fig. 3. The motor should be rated at 12V 500mA maximum (6W). It is important to note that, as with the previous two circuits, the 12V rail should *not* be derived from the Spectrum's own power supply!

Where a.c. mains is to be controlled, a solid-state relay is much to be preferred over a conventional electro-mechanical component. A typical solid-state relay (International Receiver D2W202F) will accept an input in the range 3V to 28V and exhibit an input resistance of 1,500 ohms. It may thus be connected directly to any output of the four-channel output interface without the need for any additional circuitry. The D2W202F will control a.c. voltages in the range 60V to 280V at up to 2A. Maximum off-state leakage current is 5mA and the device provides an isolation of up to 2,500V a.c. The pin connections of this relay are shown in Fig. 4.

Finally, there will be a number of applications in which some form of audible warning is required, the Spectrum's own BEEP command is obviously inadequate for such use and thus some form of external transducer will be required. For such applications a low-cost piezo-electric

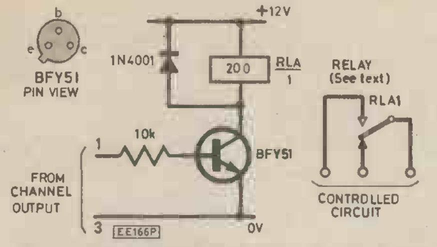


Fig. 1. Simple relay driver circuit: note that 200Ω is the minimum relay coil resistance.

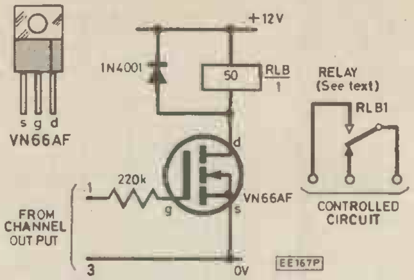


Fig. 2. Improved relay driver using a VMOS device—relay coil resistance may be as low as 50Ω.

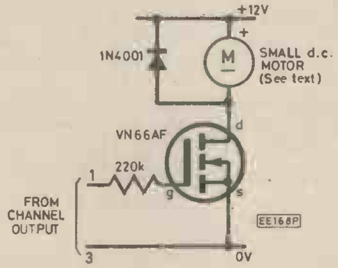


Fig. 3. Driver for a small d.c. motor.

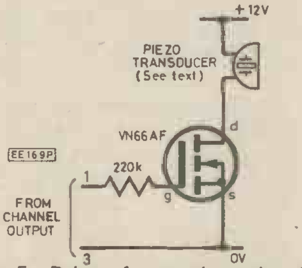


Fig. 5. Driver for a piezo-electric transducer.

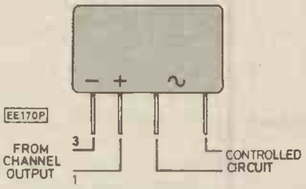


Fig. 4. Connections for the D2W202F solid-state relay.

transducer is recommended. This should be rated at 9V to 15V, 250mA maximum, and can be connected as shown in the arrangement of Fig. 5.

Making your own full-size keyboard

Even with the introduction of the "official" Spectrum-Plus upgrade kit, there will still be those (like me!) who find touch-typing on the Sinclair keyboard an impossibility, and most serious Spectrum users soon realise the need for a better keyboard.

The keyboard of the Spectrum-Plus is to the standard Spectrum keyboard what the Spectrum was to the ZX81, writes Andrew Moran of Shinfield Green, Reading. Andrew has sent in details of a simple, yet very effective, do-it-yourself keyboard.

Andrew's keyboard uses forty full-travel keys with standard Spectrum symbols printed on them. These can be obtained from Maplin Electronic Supplies, the key print, key top and key switch being sold as separate items (see pages 267 and 398 of the current Maplin catalogue).

The Spectrum keyboard uses a matrix of eight rows and five columns. A switch is placed at each row/column intersection and this may be either open (switch not depressed) or closed (switch depressed). The eight rows of the matrix are connected to the eight most significant address bus lines and each is addressed in turn by taking the relevant address line "low" whilst the others remain "high".

The five columns of the matrix are connected as data inputs to the ULA and are individually pulled high such that, if no keys are depressed, all five lines will be at logic 1. Whenever a key is depressed, however, the appropriate column input to the ULA will go "low" and thus the key may be read.

The keyboard arrangement is shown in Fig. 6 whilst Table 2 shows the correspondence between the key

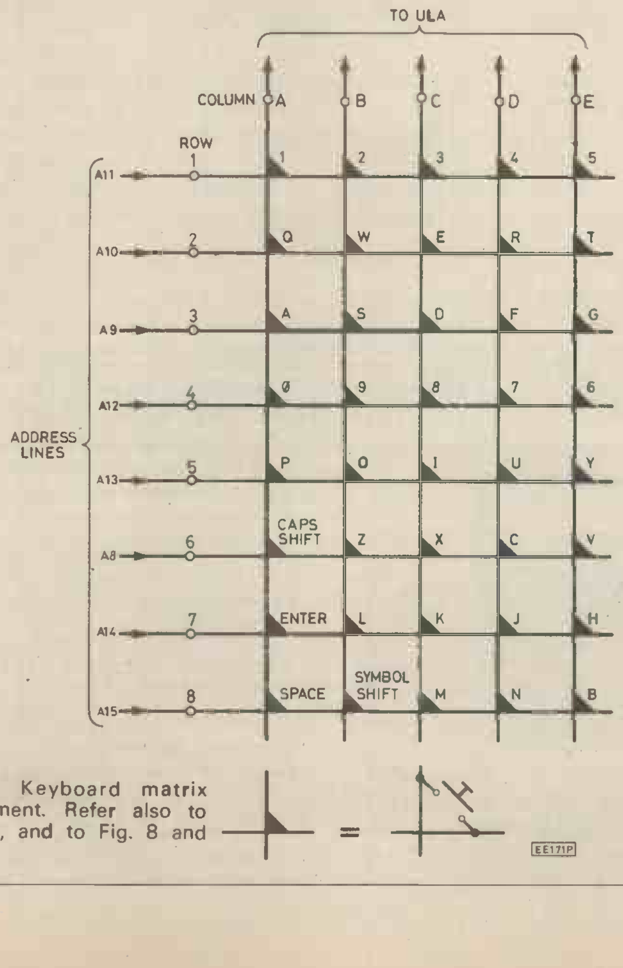


Fig. 6. Keyboard matrix arrangement. Refer also to the text, and to Fig. 8 and Table 2.

depressed and the selected row/column. Note that connecting row 3 with column E is equivalent to depressing the "G" key whilst connecting row 7 with column B will be equivalent to depressing "L".

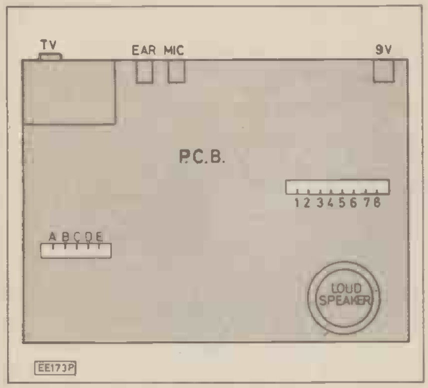


Fig. 7. Physical layout and labelling of keyboard connectors within the Spectrum.

Fig. 7 shows the physical layout of the keyboard connectors together with the labelling scheme adopted, whilst Fig. 8 shows the wiring of the new keyboard as viewed from the underside.

Key switches should be mounted on thin aluminium sheet, or similar material, drilled with a matrix of 0·5in. holes, the centres of which should be 19mm apart. Constructors should ensure that, if a metal base is used, adequate insulation is provided.

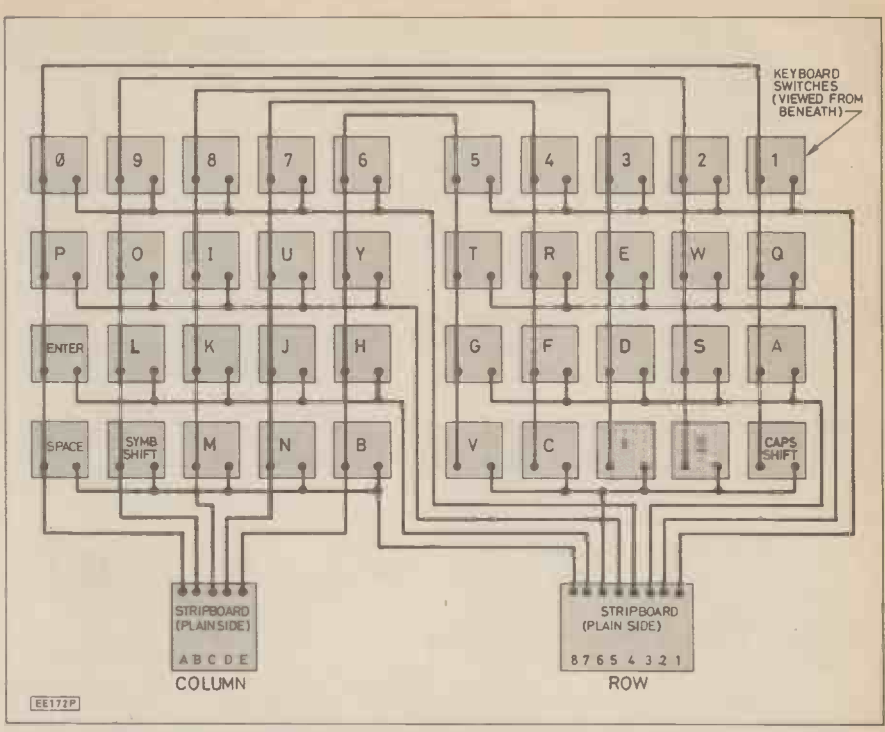


Fig. 8. Wiring of the keyswitches to the keyboard connectors. The rows connect to the upper byte of the address bus, and the columns to the ULA.

Table 2. Correspondence between keyboard rows, columns, and keys

Row	Column A	B	C	D	E	Row	Column E	D	C	B	A
1	1	2	3	4	5	4	6	7	8	9	0
2	Q	W	E	R	T	5	Y	U	I	O	P
3	A	S	D	F	G	7	H	J	K	L	ENTER
6	CAPS SHIFT	Z	X	C	V	8	B	N	M	SYMBOL SHIFT	SPACE

The ribbon cable leading to the keys should be terminated with two small pieces of Veroboard which may then be plugged directly into the existing p.c.b. keyboard connectors. It is, however, essential to ensure that the new keyboard is adequately mounted, using a sturdy enclosure of a suitable material. A sloping angle of about 11 degrees has been found to be the most ergonomic position for the keyboard.

Finally, the addition of the new keyboard is transparent to the Spectrum and thus no software modifications are required. Furthermore, no hardware add-ons are affected by this modification.

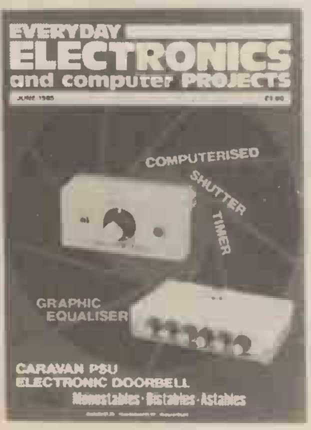
Any comments, queries, or suggestions for inclusion in *On Spec* should be sent to:

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

And don't forget to include a stamped addressed envelope if you would like a copy of our latest "Spectrum Update".

NEXT MONTH: We shall be taking a look at a simple joystick interface.

BACK NUMBERS and BINDERS



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NEW · NEW · NEW · NEW
PRODUCTS
NEW · NEW · NEW · NEW

VIDEOSAFE

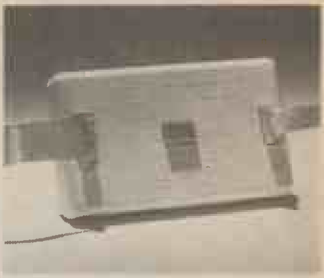
OF special interest to people who are continually harassed by the unauthorised used of their video machine, the latest anti-theft VHS video accessory from **Thorn EMI Ferguson** should be very popular. This deterrent applies particularly to the young who have a habit of tampering with the equipment when the parents are out of the house.

The Videosafe resembles a conventional video cassette but when armed and placed in a VHS recorder it will emit a 98 decibel audible alarm if the machine is moved in anyway or an attempt is made to eject the device.

The alarm is activated by locking the device with a key and a fifteen second delay allows time for it to be loaded into the recorder before it is armed. When deactivating, the cassette eject mechanism brings the device to the eject flap when it is then unlocked by the key, turning the alarm off and releasing it from the recorder.

Details of local stockists and prices may be obtained from:

Thorn EMI Ferguson Ltd.,
Dept EE, Cambridge House,
Great Cambridge Road,
Enfield, Middlesex,
EN1 1UL.



COLOUR GRAPHICS

DESIGNED specially to meet the demands of owners of the Apple IIc computer, the Peacock RGB Colour Module from **DMS Electronics** simply interconnects between the micro and any colour monitor to create enhanced colour graphics and coloured text.

Six d.i.p. switches on the front of the moulded case allow the user to select background and text colours, fringe-free and deliberately fringed colour graphics.

The module, which needs no separate power supply, works in lo-res, hi-res and double hi-res modes; plus, by using special circuitry, it is claimed that in "duochrome" mode it solves fine detail graphic display problems. It also allows full colour 80-column text on a normal RGB monitor.

A full colour leaflet is available giving full details of the Peacock RGB Colour Module, its capabilities and operation from:

DMS Electronics Ltd.,
Dept EE, Park House,
Kiveton Park Station,
Sheffield, S31 8PG.

ROBOTICS

THE Genesis programmable hydraulic robots from **Powertran Cybernetics** have provided many robotics researchers with a valuable insight into the workings and control of industrial robots. Now, they have launched Mark II versions of these excellent educational tools.

The Mark II Genesis P101 and P102 are a result of a policy of continued development rather than a radical redesign and represent detail improvements over the originals. In addition to the RS232 of the MkI versions, there's now a parallel I/O port to facilitate computer interface.

Despite many improvements, prices have remained at a reasonable level, and, both in construction and operation, the Genesis robots mirror industrial robots costing many thousands of pounds.

A detailed specification of the new Genesis Mark II robots is available from:

Powertran Cybernetics Ltd.,
Dept EE, Portway Industrial Estate,
Andover, Hampshire, SP10 3NN.

MINI DRILL

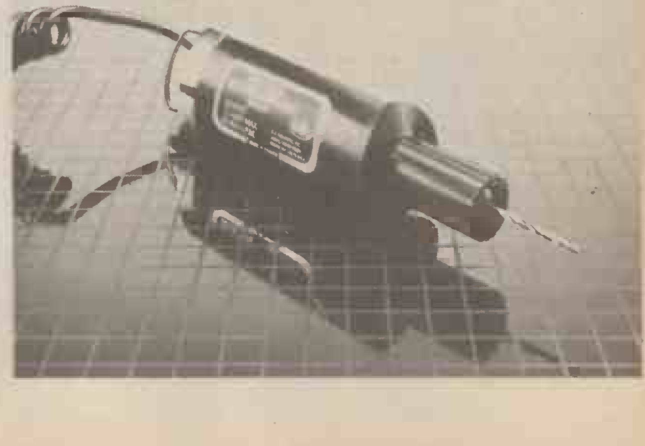
IDEAL for precision work, **OK Industries'** EDG-01 mini drill can be used with an assortment of bits, grinders, mandrels and drills and is very handy for p.c.b. prototype work. It takes shank sizes up to 3·2mm and the drill housing measures just 124mm long.

An optional stand enables the tool to be used as a drill press for accurate drilling. Other accessories include a grinder kit, cut-off wheels, end mills and slotting cutters.

The drill operates from 12V at 1·5A max., and runs at 20,000 r.p.m. Transformers are available for operating at 110V and 240V.

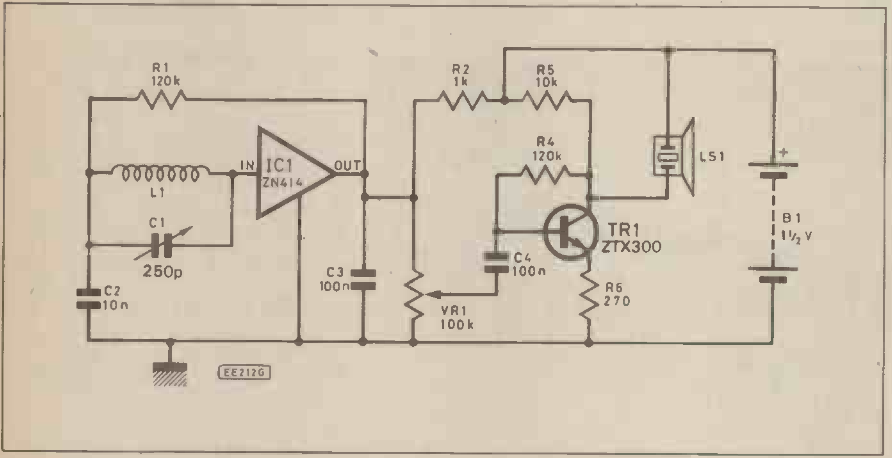
For more details and prices write to:

OK Industries UK Ltd.,
Dept EE, Dutton Lane,
Eastleigh, Hants,
SO5 4AA.



CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.



IF you're a regular reader and have not yet submitted an idea for Circuit Exchange, why not have a go now? We will pay £40.00 per page for any article published.

We are looking for original ideas which may be simple or complex, but most importantly are useful and practical. Areas of particular interest are ideas for car electronics, test gear designs, home projects and computer interfacing.

WHAT TO DO

Just send in your idea to our editorial offices, together with a declaration to the affect that it has been tried and tested, is the original work of the undersigned and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proved by us, but are included to stimulate further thought.

QUALITY

To help us to process articles which are offered for publication, all subject matter should conform to the usual practices of this journal. Special attention should be paid to circuit symbols and abbreviations and all diagrams should be on separate sheets, not in the text. Also manuscripts should be typed with wide margins and double line spacing or neatly hand written in the same fashion.

MATCHBOX RADIO

THIS simple little radio is a bit of a novelty as it can be constructed to fit into a matchbox. The common ZN414 three terminal i.c. forms the heart of the circuit and its output signal is amplified by the single transistor amplifier based around TR1. The output is capable of directly driving a crystal earphone.

The receiver is tuned via the L–C circuit comprising L1 and C1. L1 is a ferrite rod wound with about 80 turns of 30 s.w.g. enamelled copper wire.

R.M.B.,
Bridlington,
Yorkshire.

SIMPLE BANG-BANG SERVO

THIS circuit provides a simple and low cost method of servo control. It will accept a digital (4-bit) input via R1 to R4.

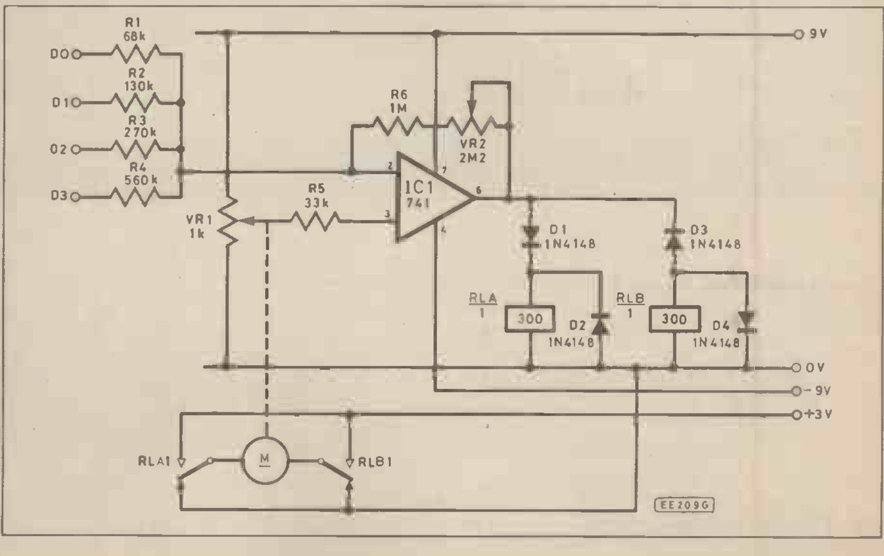
The voltage on pin 2 of the 741 op-amp (IC1) is derived from the summing junction, D0 to D3. If the voltage is the same as at pin 3 then the output voltage at pin 6 will be 0V. With this condition both relays will be unoperated.

If the voltage on pin 2 is taken higher than pin 3 then the output will become negative and RLB will operate. This will cause the motor to drive until a balance is reached via the feedback pot VR1.

Similarly, if the input (pin 2) is lower than pin 3 then the output will be positive, causing RLA to drive the motor until a balance is reached.

VR2 can be adjusted to vary the gain from 30 to 100, so that an error signal of 0·3 to 0·1 will switch the relays. Too much gain would cause hunting and too little gain reduced resolution. However resolution can be increased by using a 5 or 6-bit binary input.

W. A. Adam,
Kettering,
Northants.



Touch Switch Techniques

OWEN BISHOP

TOUCH CONTROLS are appearing nowa days on more and more electronic appliances, from pocket calculators and digital wristwatches to t.v. sets. The use of touch switches gives a neater appearance to the control panel and effects a considerable saving in space, both on the panel and inside the instrument case. Touch switches are no more expensive than the better grade of mechanical switch yet they are just as reliable, they are completely silent in operation and they are free from sparking and contact "bounce".

This article describes the principles of action of a field-effect transistor switch and how the function of conventional mechanical switches can be performed by a touch switch coupled to a simple digital circuit. Because the switch can operate from any d.c. supply between 3V and the maximum drain-source voltage of the transistor (25V for most f.e.t.s), it is fully compatible with either TTL or COS/MOS throughout their entire operating ranges.

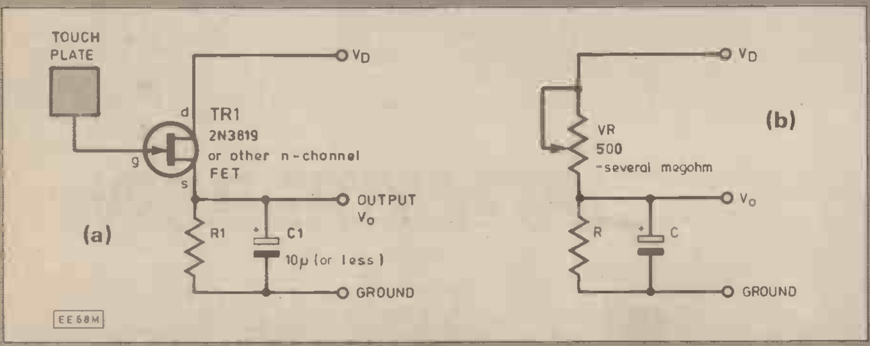
FET SWITCH

The basic switch circuit has very few components (Fig. 1a). The value of the capacitor is not critical, but should not be more than 47 microfarad. The circuit will work without a capacitor, but then its output voltage tends to be less steady. For all the circuits described here, 10 microfarad is a satisfactory value. The value of the resistor is between 270 ohm and 1kohm, depending on the supply voltage and whether the switch is to be coupled to TTL or to COSMOS. Values for special applications will be discussed later.

Before going on to the circuits let us see how the touch switch behaves. Readers may like to wire up the circuit in Fig. 1a using a 10μF capacitor (or a lesser value) and a 1kΩ resistor, with a supply voltage between 5V and 15V. Connect a voltmeter across the output terminals. The touch-plate can be a piece of metal foil about 2 cm squared, gripped in a crocodile clip—or even just the crocodile clip itself. As will be seen later, touch-plates can take many cheaply-constructed forms.

A f.e.t. can be thought of as a bar of n-type semiconductor material through which electrons can pass from source (s) to drain (d), when a potential difference exists between the two ends of the bar. The gate (g) consists of two regions of p-type material along the sides of the bar. These regions are connected electrically. In operation the potential of the n-type material adjacent to the n-p junction is several volts above that of the source, while the potential of the p-type material of the gate electrode is lower—often very close to that of source. Thus the n-p junction is reverse-biassed (like a non-conducting semiconductor diode) and a depletion zone extends on either side of the junction. The depletion zone extends across the n-type material and is wide enough to interfere with the passage of electrons from source to drain. The lower the gate potential the greater the reverse bias, the wider the depletion zone, and the more the passage of electrons is interfered with. If the potential of the gate is sufficiently low the electron flow can be cut off altogether. In this way the f.e.t. acts as a bar of material with variable resistance. By adjusting gate potential we are able to increase the resistance of the bar from approximately 500 ohm up to many megohms. When the gate and touch-plate are not in contact with any earthed conductor (which includes the reader), the potential of gate is slightly higher than that of the source, since it is situated between source and drain and gradually acquires a potential between 0V and that of the supply voltage.

Fig.1(a). Basic switch circuit. (b) Equivalent circuit.



BODY CURRENTS

However, the potentials we are referring to are measured with respect to the 0V terminal of the power supply. With respect to Earth, the figures are entirely different. The Earth has an electrical field around it which varies from time to time but is usually of the order of 100V per metre, increasing in a vertical direction. This means that when you are standing upright the field around your head is about 150V positive of the field around your feet! Electrons flow through your body tissues from your feet to your head and discharge positive ions in the air around your head. This current is exceedingly small, far too small to notice. The rate at which discharge can take place is very limited, even though the p.d. is considerable. Some electronic devices such as the CMOS i.c.s can be damaged by such high-voltage discharges. We are advised to Earth ourselves, the tools we use and the i.c.s and associated circuits before handling these devices.

LOCAL FIELD

The 2N3819 and similar junction field-effect transistors (j.f.e.t.s) are not damaged by such p.d.s. but their gate potential is appreciably affected by the small currents involved. Suppose the touch-plate circuit is mounted one metre above Earth. After a period of time it gradually acquires local field potential, which is about 100V. The potential at the source of the f.e.t. is about 100V, that of the drain about 105V (assuming a 5V supply), and the gate (and touch-plate) float at about 102V. Bring your finger close to the touch-plate and your body acts as a conductor joining a low-potential part of the field (around your feet—or the Earth itself if you are not wearing insulating footwear or standing on an insulating floor-covering), to a high-potential part around the touch-plate and your finger.

There is a local fall of potential in the region of the touch-plate. This affects the touch-plate and gate more than it affects the remainder of the circuit for these have low capacity and a loss of charge causes a relatively greater fall of potential. The result is that the gate potential falls with respect to the remainder of the circuit. This causes the depletion region to become wider, restricting the passage of current through the transistor. Reduction in current through R means that V_0 is reduced. If you held your finger there for many minutes the flow of charges and leakage at the gate eventually restores the equilibrium and V_0 rises again. However, we normally touch the plate only for an instant and this does not have time to happen. As you take your finger away, the situation is restored immediately and V_0 returns to its former level.

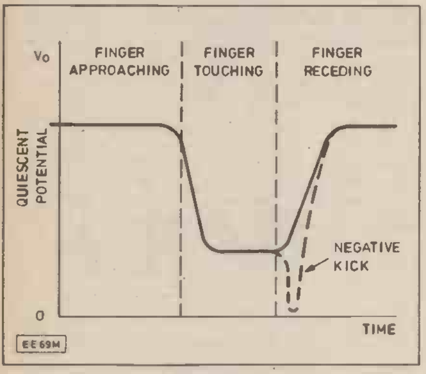


Fig. 2. How the output voltage changes.

From the fact that the switch operates without actual electrical contact between plate and earth we deduce that the conduction of electrons from earth to gate is not necessary. The effect is a capacitative one, between the touch-plate and the earthed finger of the operator. This effect is sufficient to produce the minute current, of the order of nanoamperes, needed to alter the gate potential. The mention of this capacitative effect introduces the second interesting point. The circuit operates in the manner so far described wherever it is placed. But if it is placed indoors where appliances are being operated from a.c. mains, an additional effect is observed, which turns out to be very useful for some special applications of the switch.

This effect may also be observed outdoors, provided the circuit is within a few metres of an a.c. mains power transmission line. Anyone who has ever touched a finger against the y-input of an oscilloscope operating on one of its more sensitive ranges will have noticed the 50Hz sine wave of small amplitude superimposed on the trace. This is due to alternating electrical potentials induced in the body as a result of the alternating magnetic fields surrounding the a.c.-carrying cables and apparatus in the room.

Indoors we are rarely far from such fields and though our body potential is, on average, at earth potential, it alternates slightly above and slightly below earth, at 50Hz. The capacitative action between touch-plate and finger is affected by this alternating potential in a way that is complex. It is additionally complicated by the depletion zone which acts as a non-conducting dielectric, turning the n-p junction into a capacitor, in series with the finger-plate capacitor. The capacitance of the n-p junction varies at 50Hz as the width of the depletion zone alternates in accord with the induced potentials. A complex situation, but the outcome is easy to demonstrate.

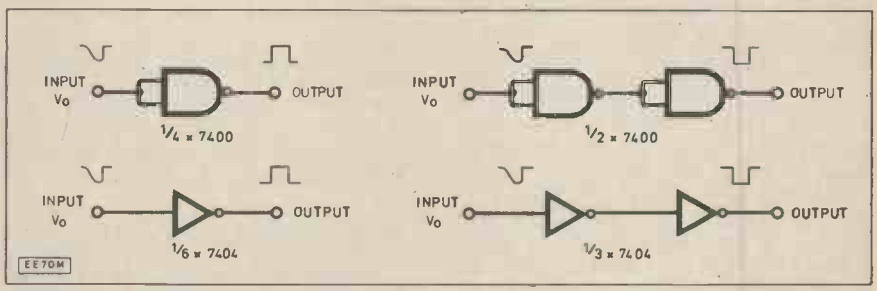
In an 'a.c. environment', V_0 falls as the finger approaches the plate, and remains at its low level for as long as the finger touches (or is close to) the plate. When the finger is removed, there is a rapid and large fall of potential at the gate; the depletion zone becomes very wide and practically cuts off the source-drain current. The effect is to give the f.e.t. very high resistance, and V_0 drops rapidly almost to zero volts. This is shown as a dashed line, labelled 'negative kick' in Fig. 2. This kick can be made use of in certain switching applications, but it must be remembered that this effect occurs only in an 'a.c. environment'.

OPERATING TTL

If the supply voltage is 5V and R=390 ohm the output from the switch drives a TTL NAND gate. This gives direct access to all the electronic devices employing TTL logic. If both inputs of a NAND gate (from a 7400) are connected to the switch, or if a INVERT gate is used (7404), as in Fig 3a, touching the plate causes the output of the gate to change from low to high. It remains high for as long as the plate is touched. Here we have a simple push-button action. To reverse this action we simply have to take this output and feed it to a second NAND or INVERT gate (Fig. 3b). The outputs from the TTL gates can be used to drive other logic i.c.s, and to power small lamps such as l.e.d.s. If the output is fed to a buffer gate such as the 7406 and 7416 (inverting) or 7407 and 7417 (non-inverting) drive currents of 30 or 40 mA can be obtained. For higher drive currents, the TTL gate and the driven device can be interfaced with a power transistor (Fig. 4). The main disadvantage of this type of connection between the switch and the TTL device is that the switching time is relatively slow. Thus, though the switch can drive several parallel NAND gates and can operate the J, K, clear and preset inputs of flip-flops (7472 etc) its output is not clean enough to operate the clock input of such devices.

A cleaner response is obtained if V_0 is fed to the inputs of a Schmitt trigger NAND (7413). This switches sharply to high output as V_0 falls below its negative-going threshold (approx 0·9V) and back to low output as V_0 rises past its positive-going threshold (approx 1·7V). If resistor R is 1kΩ, V_0 does not fall below the negative-going threshold until the finger is *removed* from the touch-plate, so there is no action on touching, and a high pulse from the Schmitt gate on release. This pulse has a duration much longer than the duration of the negative kick, for the gate output remains high until the *positive*-going threshold is exceeded. If a capacitor of fairly high value is used, V_0 takes several seconds to reach this value. This gives us a design for a push-switch which gives a clean pulse of predetermined length independently of the time the finger is in contact with the touch-plate (Fig. 5). If it is essential for the switch to operate on first contact, use a 390Ω resistor; the 'on' period will then be the period of actual contact, plus the delay time. If necessary the capacitor can be increased to 100μ or more to obtain extra long delay times.

Fig. 3. Push switch action. (a) Push on/release off (b) Push off/release on.



TOGGLE ACTION

The best way of achieving this is to use a TTL bistable latch constructed from two NAND gates (from 7400). To reset the latch a second touch switch may be employed. Touching one switch sets the latch one way, touching the other switch resets it. It is possible to use either output, so that the switches can supply high to

WE SHOW YOU HOW TOUCH SWITCHES *DON'T ACTUALLY NEED TO BE TOUCHED*

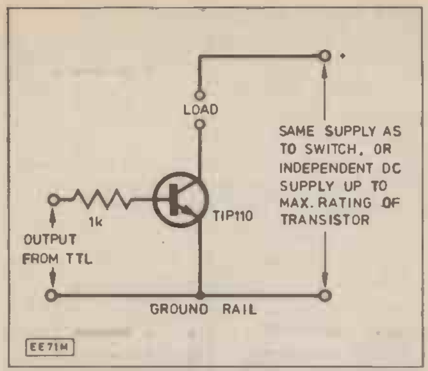


Fig. 4. Switching loads up to 1A from a TTL output.

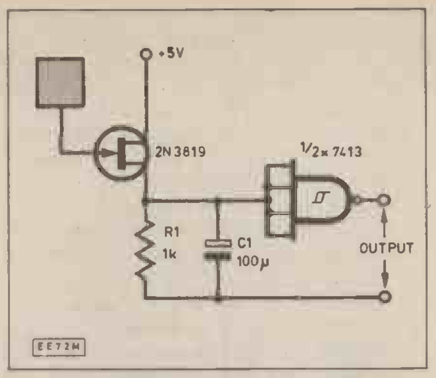


Fig. 5. Touch switch with delay.

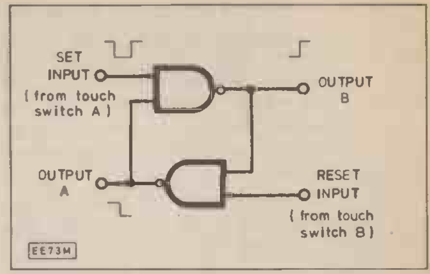


Fig. 6. Bistable latches for toggle action touch switch, using TTL.

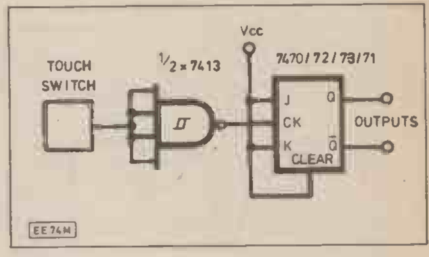


Fig. 7. Circuit for toggle action. The box does not represent a touch panel but the touch switch shown in Fig. 1.

some parts of the circuit and low to others as required.

To obtain toggle action with only one touch switch we employ a 7413 Schmitt followed by a J-K flip-flop, available singly as 7470 and 7472 or in pairs in 7473 and 7476. The circuit is shown in Fig. 7. Note that the capacitor should have a high value (between 33μ and 100μ), otherwise the flip-flop changes state when not switched, presumably due to spikes picked up by the f.e.t. and transmitted to the flip-flop by way of the Schmitt gate. This circuit produces a push-on/push-off action, the change-over taking place a second or so *after* the finger has been removed from the touch-plate.

OPERATING CMOS

All of the circuits described so far may be built from CMOS equivalents of the TTL devices mentioned. This makes it possible to employ this type of touch control in devices operating on voltages within the operating range—from 3V to 15V. The use of CMOS also brings about a significant reduction in the amount of power required for the control circuit. When triggering CMOS the resistor of the f.e.t. circuit should not be less than 1KΩ, for a lower value resistor produces a value of V_0 that is always below the 'high' threshold of CMOS gates and consequently changes in V_0 have no effect on the logic circuits. As mentioned in the previous section, the chief problem in triggering a J-K flip-flop is the slow rise and fall time of the f.e.t. switch output. As before, this can be overcome by using a Schmitt gate (CD4093B). Alternatively we may obtain the same effect by connecting 3 NAND gates (from a CD4011A) as shown in Fig. 8. The action of this depends on a characteristic of CMOS gates, that the threshold for change of state depends on how many inputs are held at high level when the other inputs change state. As V_0 falls, both inputs to gate A fall, but only one input to gate C falls, the other being held high by the output from gate B. Consequently gate A changes state a fraction of a second before gate C. The change of state of a means that both inputs to gate B are high, so that when C changes state a fraction of a second later the bistable as a whole can change to its other stable state. V_0 continues to fall, then rises again and the reverse action occurs, so that the bistable reverts to its original state. The effect is that a single contact on the touch switch causes the astable to change state and back again, generating a short sharp low pulse that will operate the clock input

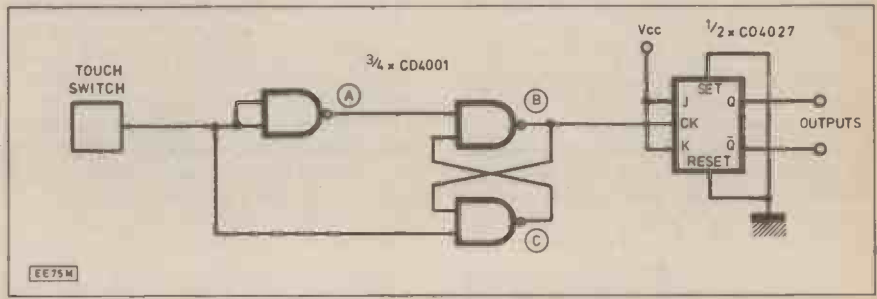


Fig. 8. Circuit for toggle action employing Schmitt trigger formed by CMOS NAND gates.

of a J-K flip-flop. To ensure that all changes are as rapid as possible, the change-over is made on a negative kick. A 2·7K resistor (R) in the touch-switch keeps V_0 high until the finger is removed and the negative kick occurs.

ANALOGUE SWITCHING

So far we have been concerned only with simple make-break switching functions. Though these cover many of our requirements there are many occasions on which we wish to switch a varying voltage. The CMOS range includes some devices which we can use for switching analogue signals under touch control. A very useful device is the CD4007, dual complementary pair and inverter. This versatile i.c. can be wired in various ways to produce either 3 inverters, or a 3-input NOR gate, or a 3-input NAND gate or several other logical devices, including the equivalent of a single-pole double-throw switch, capable of handling analogue signals. The pin connections for this application are shown in Fig. 9. The clock input is controlled by an astable, which is operated by two touch switches (Fig. 10). Depending on which switch was touched last, the output from the astable is high or low. If it is high there is a connection between pin 12 and pin 2. A signal fed into pin 12 will appear at pin 2, and conversely a signal fed to pin 2 will appear at pin 12, so this is a truly two-way connection. When the astable output goes low, the connection between the pins 12 and 2 is broken—or at least replaced with an impedance of the order of many megohms, so that it is effectively 'off'—and a low resistance (about 250 ohm) connection made between pins 12 and 4. Now signals can pass from pin 12 to pin 4 or the reverse. Thus using the circuit of Fig. 10 we can direct an analogue signal from one source to either of two destinations, or select signals from one of two sources. Signals voltages must be between V_{ss} and V_{DD}; the device transmits signals at frequencies up to 10MHz, so it is applicable to a very wide range of switching functions.

As a simple make-break (or single-pole single-throw) switch for analogue signals, the CD4007A can be used with one of its inputs grounded (say, pin 2) and the connection between pins 12 and 4 being made or broken according to the state of

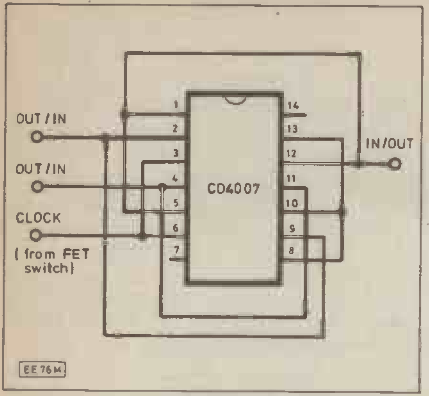


Fig. 9. Single-pole/double throw analogue switching using CMOS.

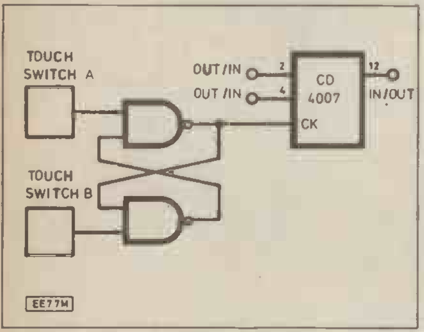


Fig. 10. Controlling the analogue switch of Fig. 9.

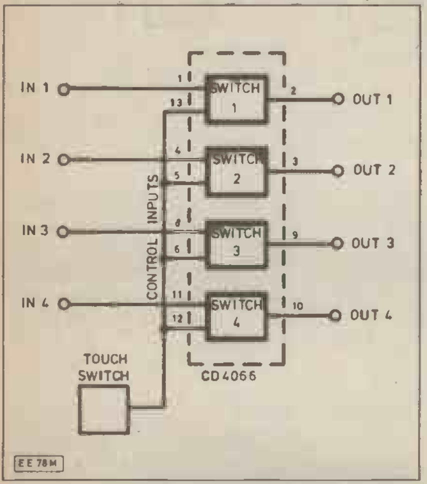


Fig. 11. Switching four channels simultaneously.

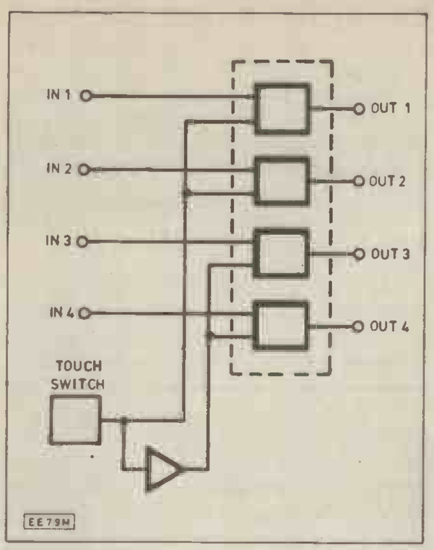


Fig. 12. Switching two channels on and two channels off simultaneously.

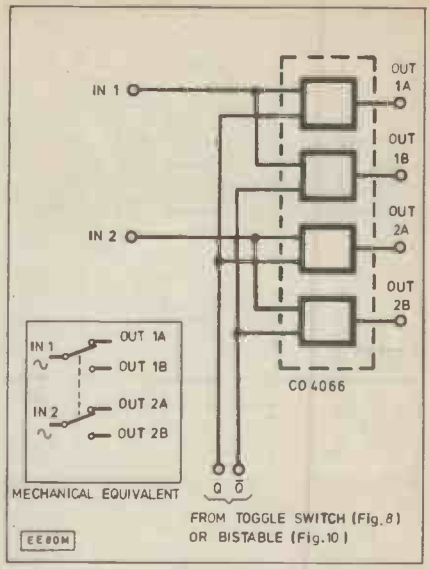


Fig. 13. Two-pole/two-way analogue switch.

the clock input—this clock input could be driven directly from the touch-switch if a simple push-button action was all that was required. For more complicated analogue switching we can use the CD4066 quadruple bilateral switch. This consists of four make-break switches in a single package, each with its own control input. Using this package we can design the touch-controlled equivalent of a multi-pole rotary switch, or a multi-contact relay. The possibilities are almost unlimited. By wiring the controls in parallel (Fig. 11) and operating them from a touch-switch (through a bistable if preferred), we can switch all four simultaneously. Thus four separate signals can be switched on or off using only one touch switch. If the i.c. is wired as in Fig. 12, we can switch some signals on, and others off simultaneously. If it is wired as in Fig. 13, we have a 2-pole 2-way switch.

More complex rotary functions require some additional circuitry unless one is willing to use separate touch-switches for controlling each of the inputs to the CD4066. A more sophisticated approach is to have a single touch switch which operates one step of a cycle each time it is touched. Fig. 14 shows a 1-pole 4-way switch. Each time the touch-plate is touched, a pulse is generated which causes the first flip-flop to change state. Together the two flip-flops form a binary counter which counts to 4 and then returns to zero.

The binary outputs from this counter are decoded by the NOR gates which in turn control the switches of the CD4066. The logic ensures that only one of these is on at any one time, so that in turn the four inputs are channelled to the output terminal (or one input can be channelled to any one of the four outputs). Such a circuit could be used for selecting programmes on audio circuits, or for feeding data from four points of a circuit to a single test-meter.

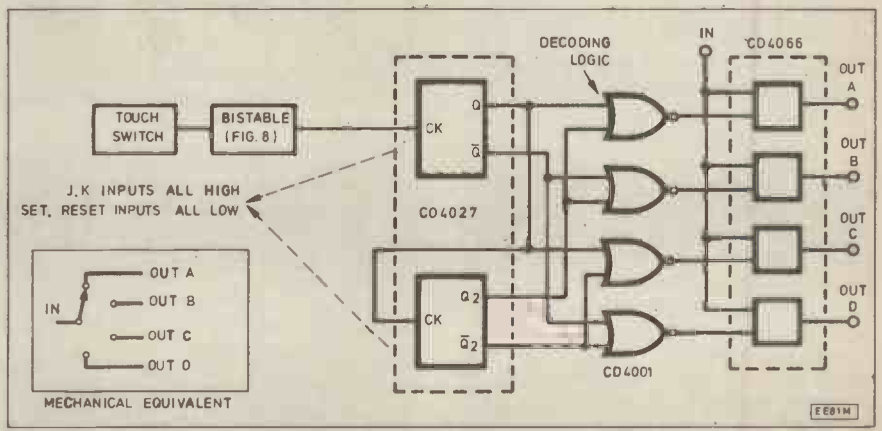


Fig. 14. A one-pole/four-way switch with sequential touch control.

By varying the decoding circuit we can provide for other combinations of 'on' and 'off' at each of the four stages of the switching cycle. Such a circuit may seem complicated, but in fact this requires only four i.c.s.

Additional switching functions can be provided at little extra cost. For example the decoding gates could control a second 4066, so giving 2-pole, 4-way control for a single additional i.c. By using additional J-K flip-flops and analogue switches there is virtually no limit to the range of switching functions that can be designed.

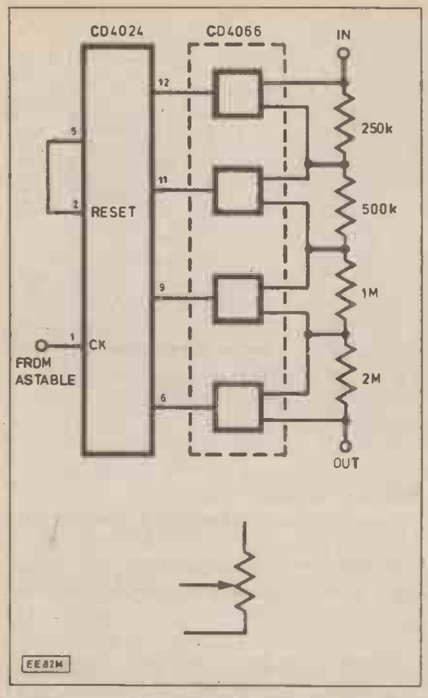


Fig. 15. Variable resistor of sixteen stages.

VARIABLE RESISTOR

To what extent is it worthwhile using touch-switches for types of control other than simple on-off switching? Having replaced all the push-buttons, toggle-switches and rotary switches by a set of neat touch-plates, it is tempting to try to replace the knobs of the variable resistors too. Fig. 15 shows how this can be done, using a modification of the circuit of Fig. 14. The two stage counter previously constructed from the CD4027 is replaced by a 7-stage counter, the CD4024. Only the first four stages are used in Fig. 5, the counter resetting automatically when it reaches a count of 16. The counter outputs are fed directly to the quad analogue switch (no need for decoding). As the binary count increases from zero to 15 the switches are operated in binary sequence to short-circuit the resistors. The effect is that the total resistance of the chain starts at 3·75MΩ and decreases in equal steps of 250kΩ each until it reaches zero—then returns to 3·75MΩ. This cycle requires 16 pushes on the touch-switch. The cost of this circuit is about 25 per cent more than that of a moulded-carbon potentiometer, and there is the disadvantage in some applications that it can only be altered in steps. On the credit side, there is no problem with track wear. Also the constructor can make up a variable resistor to total values suiting his own requirements—for example variable resistors of 3·75MΩ are not easily available, the largest common value being 1MΩ.

There are many variations on this system. A second CD4016 can be controlled by the same circuitry, to give a second variable resistor operating in tandem. Or, if four steps are adequate the single i.c. can be split to make two variable resistors, both controlled from the same pair of J-K flip-flops (a CD4027) at considerably less cost. Fig. 16 shows two tandem resistors, one of which decreases from 750kΩ to zero, while the other increases from zero to 1·5kΩ.

UP-DOWN ACTION

One snag of these circuits is that the cycle operates in only one direction. If one overshoots the desired setting, one has to press the button fifteen times to get back to the desired state. One way around this problem is to drive the counter from an astable, and to use an up-down counter. The astable delivers reliable stepping pulses at a convenient

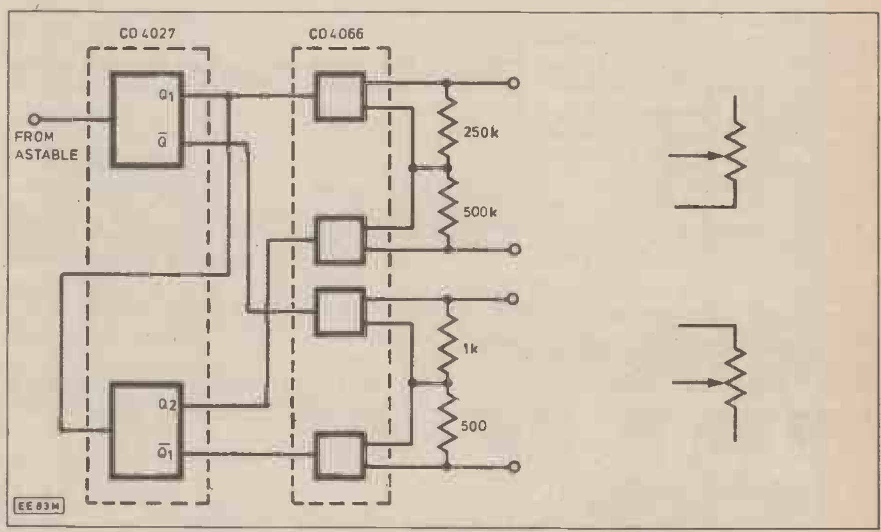


Fig. 16. Tandem variable resistor of four stages in opposite sense.

rate, and by means of two touch switches the operator controls the counter. In Fig. 17, the astable and the two control gates are all obtained from a single CD4011, so that this version is relatively easy to wire up and to operate. Touching one switch causes the counter to change state in one direction; touching the other switch makes it change state in the other direction; touching neither locks the counter; touching both (by mistake) makes the counter count down, the same result as touching switch a alone.

The variable resistors described above are capable of a change of total resistance in circuit. They may be used in a number of applications, including the feedback loop of an operational amplifier, when they can control the gain of the amplifier. They lack the wiper connection found on a mechanical variable resistor, whereby a potential divider can be constructed. It is easy to design a resistor chain and switching to various points along the chain under the control of touch-switches and the problem is left to the ingenuity of the reader. However, in an article of this kind it is not possible to anticipate the constraints on design that may arise in the varied kinds of device to which touch control may be applied. In modifying circuits for touch control, or in designing touch control circuits for new projects, the reader is advised to try out a prototype version of the control system, wired on a patch-board, before committing himself to a permanently wired circuit. The suitability of the design can then be assessed, and appropriate values of capacitors and resistors in the touch switch can be ascertained.

TOUCH PLATES

There are dozens of ways of making touch-plates, and the term 'plate' does not have to be taken too literally, for the touch-plate does not need to be a flat rec-

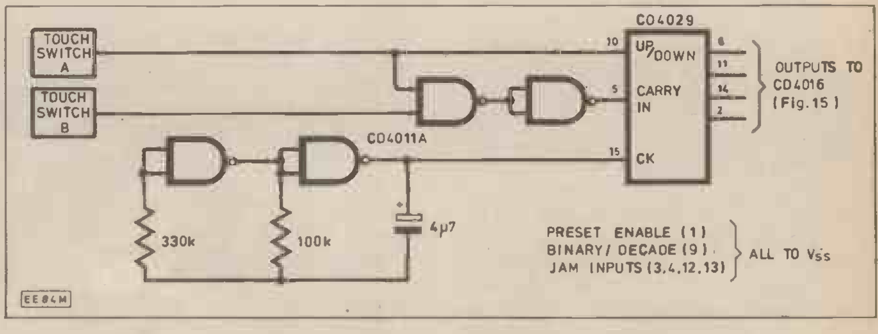


Fig. 17. Up/Down rotary switch

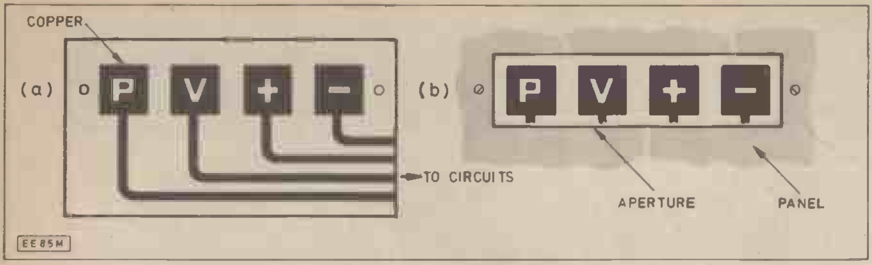


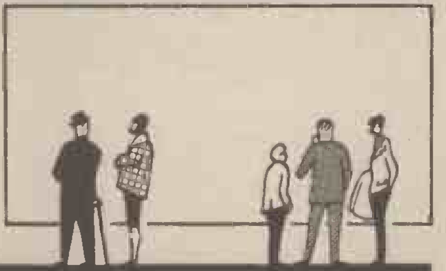
Fig. 18. Touch plate made by etching a copper-clad board.

tangular sheet. For instrument cases, a panel of touch-plates can be etched on copper-clad board, complete with leads to the edge of the board to which solder connection can be made. Then mounted, the edge of the board would be covered by the instrument case. If desired, the plates can be lettered during etching, to indicate their function. It is necessary to keep the plates well separated (not less than 10 mm gap between adjacent plates, and not less than 20 mm between centres) so as to obviate the possibility of triggering more than one switch with a single finger. Such a board can also be used back-to-front, as finger-to-metal contact is not necessary. Alternatively the board can be weatherproofed by covering it with thin plastic sheet, such as Fablon or Contact. In this way a decorative surface can replace a somewhat clumsy collection of knobs, buttons and switches. Thicker plastic seems to have little effect on operation. For example the plastic boxes in which photographic slides are returned from processing make ideal instrument cases. The touch-plates can be mounted on the *inner* surface of the box, yet be easily operated from outside. For real weatherproofing, put the device inside a Tupperware or similar polythene container. Touch-switches work very reliably through p.v.c. and similar plastics 1–2mm thick, provided that the touch plate is not smaller than about 20 mm square.

For other applications much smaller plates can be used. Drawing-pins make excellent touch-plates and can simply be pushed into a non-conducting material such as wood or plastic. Connection can be made by soldering to the points of the pins emerging from the other side. A very neat touch-plate array, having the appearance of a pocket calculator, can be made from a plastic slide-box. To make the array even more attractive, you can use plastic-covered pins in various colours to denote different control functions.

Some enthusiasts like to have the panel of their equipment covered with an impressive display of controls. Others may prefer the simple appearance that results from the use of touch switches. In fact, concealed beneath a covering of stick-on plastic sheet the touch switch may be completely invisible. For domestic appliances this may often be preferable, and for intruder-alarms hidden switches are invaluable. □

SHOP TALK



BY MIKE ABBOTT

Catalogues Received

The *1985 Midwich Catalogue* contains 116 pages of semiconductors (with pin-out information), connectors, microcomputers, printers, monitors, disc and tape sub-systems, power supplies, data sheets and books. Access and Barclaycards are accepted in payment of orders, and the catalogue itself is free of charge, available from: **Midwich, Gilray Road, Diss, Norfolk IP22 3EU.** ✆ **0379 4131.**

We have also received the *Spring 85 Cirkit Catalogue,* containing over 4000 different components, which makes it a must for the electronics hobbyist and the student. The stock profile is comprehensive; when sourcing difficult components and odds and ends my search often comes to an end in the *Cirkit Catalogue*. Quite a large section is devoted to inductors, and another to kits and modules. Data books are also available from **Cirkit Distribution Ltd., Park Lane, Broxbourne, Hertfordshire EN10 7NQ.** ✆ **0992 444111.** The *Cirkit Catalogue* is on sale in high street newsagents such as W.H. Smith, and may also be obtained directly from **Cirkit** for £1.15 (inclusive of VAT and p&p). Barclaycard and Access cards accepted.

CONSTRUCTIONAL PROJECTS

Amstrad User Port
The 6522 VIA i.c. for the *Amstrad User Port* is available from **Watford Electronics** (£3·40), **250 High St., Watford, Hertfordshire WD1 2AN.** ✆ **0923 40588.**

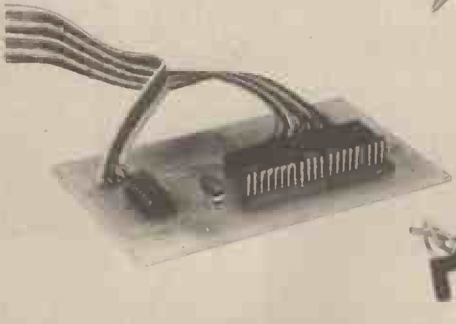
CB Field Strength Meter
The ferrite rod used in the *CB Field Strength Meter* is available from **Cirkit**, and so too is a suitable trimmer capacitor (5-60p trimmer will do). **Cirkit Ltd., Park Lane, Broxbourne, Hertfordshire EN10 7NQ.**

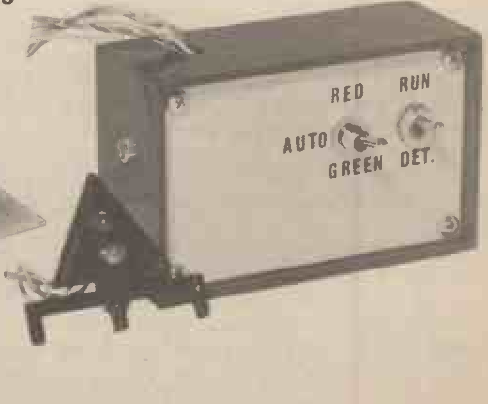
Continuity Tester
The touch pads for the *Continuity Tester* are available from **Maplin Electronics** (order code HY01B), **PO Box 3, Rayleigh, Essex SS6 8LR.** ✆ **0702 552911.** All major credit cards are accepted by **Maplin**, and an early telephone order quoting your credit card number will, in many cases, result in the postman dropping the components through your door the very next day.

Emergency Light Flasher
All the components used in the *Emergency Light Flasher* are commonplace, so you don't need my help.

Nascom Printer Handshake
There are no unusual components required for this handshake modification.

Train Signal Control
There should be no purchasing problems with the *Train Signal Controller*.





The Man Behind the Symbol

Nº1 INTRODUCTION

by Morgan Bradshaw

ELECTRONICS uses an internationally accepted world of symbols. Look at any advertisement or study the simplest circuit diagram in this magazine and you will be confronted with strange symbols of every shape. Magical signs used to signify basic units of physical quantity. Table 1 lists some of those in common use.

This series sets out to explain each symbol, and perhaps more important, something of the man who gave his name to it.

Although electronics is regarded as a modern science and hobby many of these units are named after pioneers scattered throughout the world whose accumulated research, often undertaken at great personal hardship, spans hundreds of years.

In the beginning, they discovered mysterious sparks, unexplained phenomena or strange electrical effects, each pioneer in turn receiving inspiration from predecessors and contemporaries with many years passing before their discoveries were put to practical use.

ATTRACTION

Take the word electronics itself, for that we must go back in time to ancient Greece. To the ladies of Greece passing time by decorating their spinning wheels with amber, found on shores in the Far North. They observed that the amber when contacting the threads would draw the threads to itself as they separated from the wool, and then push them away.

The Greek word for amber was elektron, from the verb *elkein* to attract. This phenomenon was observed and noted by several of the great Greek philosophers, the foremost of these being Thales of Miletus (640BC–548BC).

To find the first man to use the word "electricity", we have to jump two thousand years to the early 1600's and to the reign of "Good Queen Bess", Elizabeth the First of England, who was persuaded by her physician, William Gilbert, to attend a demonstration of a frictional electric machine based upon the power of amber to attract. This power he called electricity.

Gilbert died in 1603 and was buried in the chancel near the Church of Holy Trinity, Colchester and the inscription refers to his book concerning the magnet: *De Magnete*. He had also constructed many models and instruments which he bequeathed to the College of Physicians but they were all consumed by the Great Fire of London 1666.

It was soon realised that the crackling and sparking of Gilbert's electric machine were the same phenomena, on a minute scale, as thunder and lightning, but how to prove it?

KITE FLYER FINDS KEY

One of the first to try was the fifteenth child of an English immigrant; born in Boston, Massachusetts in the year 1706, this was the well known American statesman and signatory to the Declaration of Independence—philosopher Benjamin Franklin.

His historic but dangerous experiment trying to capture electricity from the sky occurred during a thunderstorm in the summer of 1752, when accompanied by his small son, he flew a kite with an iron spike in the tail and held the end of the kite string with an iron door key. During the storm, he saw that sparks sprang from the key to his wrist, what he didn't realise, of course, was that if the lightning had actually struck the kite he would have been killed.

The study of natural phenomena had to take second place to his other activities; he served as American Ambassador to France, but he came to the conclusion that thunderstorms were simply the levelling of opposed electrical potentials, between one cloud and another or between a cloud and earth.

It was Franklin who introduced the positive and negative signs for electric charges, realising there are two kinds which neutralise each other.

Next month we move from America to 18th century Italy and the Scientist Alessandro Volta, after whom the volt, the measurement of electrical potential is named.

Table 1. Fundamental Unit

Unit Symbols	Name of Unit	Physical Quantity
A	Ampere	Electric current
C	Coulomb	Electric charge
V	Volt	Electric potential
F	Farad	Electric capacitance
Ω	Ohm	Electric resistance
W	Watt	Power
Hz	Hertz	Frequency
Wb	Weber	Magnetic flux
T	Tesla	Magnetic flux density
Oe	Oersted	Magnetic field strength
H	Henry	Inductance

These basic units are often inconveniently large or small and the units are prefixed with the following symbols:

p smallest	Pico	÷ 1,000,000 million
n ↑	nano	÷ 1,000 million
µ	micro	÷ 1 million
m	milli	÷ 1,000
k	kilo	× 1,000
M ↓	mega	× 1 million
G largest	giga	× 1,000 million

Hence 5kV = 5,000 volts: or 5mV = 0·005 volt.

Benjamin Franklin

DOWN TO EARTH

BY GEORGE HYLTON

ALTHOUGH germanium transistors have been almost completely supplanted by silicon ones they can still be useful.

LEAKAGE CURRENT

There are, it is true, many ways in which silicon is a better transistor material than germanium—perhaps the most important is that silicon transistors and diodes have much lower leakage currents. They are so low that many users are unaware of their existence. If you apply an ohmmeter to the collector and emitter terminals of a small silicon transistor, leaving the base unconnected, the meter will read infinity. Do the same to a germanium transistor and you get a resistance reading which may be quite low.

What is happening is that the ohmmeter's internal battery is driving a leakage current through the transistor. Even at room temperature a small germanium transistor may have a collector-emitter leakage of a few milliamps, and at high temperatures this increases alarmingly.

When germanium transistors are likely to get hot, elaborate precautions against dangerous increases in leakage have to be taken. Even then, you are fighting a losing battle. A germanium transistor dies when its internal temperature exceeds about 90°C. Silicon will stand 150°C.

LOW TURN-ON

So what's good about germanium? One thing is that germanium transistors can work from very low voltages. To turn on a silicon transistor it's necessary to apply a base-emitter voltage of at least 500mV.

For germanium the typical voltage is 250mV and some transistors, like the once ubiquitous Mullard OC71, turned on at as little as 100mV. Occasionally it is required to operate transistors from a low voltage supply (e.g. the output of a single solar cell) and in this case germanium still has its uses.

SIMPLIFIED AMPLIFIER

In more ordinary circumstances, the low base-emitter turn-on voltage can be used to simplify audio amplifier circuitry. In Fig. 1, the complementary output pair (TR1, TR2) is operated without bias. The crossover distortion which results can be reduced to tolerable amounts by negative feedback via R4.

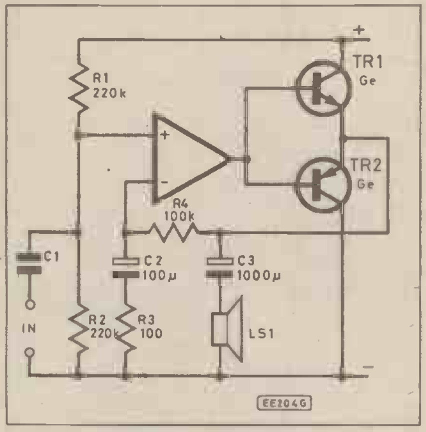


Fig. 1. Simple audio amplifier using germanium transistor complementary output pair.

When the supply voltage is low, a germanium complementary output pair can deliver appreciably more audio power than a silicon pair. This is because very little drive voltage is wasted in the base-emitter junctions of the output pair. For silicon this wastage will be at least 700mV. For germanium it may be only 300mV. Thus, if the battery voltage is 3V, the peak outputs are, for silicon, 2·3V and for germanium 2·75V. Since peak power output is proportional to the square of the voltage, in this case germanium gives about a third more power.

Suitable complementary transistors for low voltage operation are AD161, AD162. These are power transistors designed for mounting on heat sinks. If the alternative small transistors (for example, AC187 and AC188) are used, they should be provided with cooling clips.

DIODES

If a transistor's collector is connected to its base (Fig. 2) it becomes a diode with the lowest possible working voltage drop. Such things are useful in circuits designed to protect equipment from accidental reversed battery connections.

If polarity is correct a good germanium "diode" wastes less voltage than a silicon one. Also, most germanium audio transistor base-emitter junctions will withstand much greater reverse voltages than silicon ones, which may break down at 6V and allow reverse current to flow.

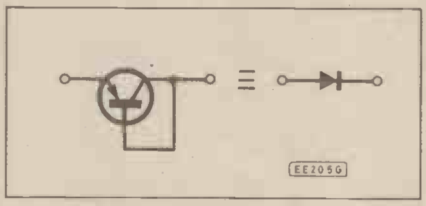


Fig. 2. Connecting a transistor's base direct to its collector creates a very low voltage-drop "diode".

FREQUENCY RESPONSE

The silicon transistors commonly used in audio amplifiers are actually capable of working at radio frequencies. This can be a nuisance. If radio frequency signals stray into audio circuits they can cause noise. If an audio circuit has high gain at radio frequencies it can become unstable (oscillate) as a result of stray feedback at a high frequency.

Germanium audio transistors, on the other hand, have poor high-frequency performance. Indeed, the problem is to get enough gain at the higher audio frequencies.

LOW-PASS FILTER

Inserting a germanium transistor stage fairly early in an audio amplifier introduces a low-pass filtering effect which can sometimes help in avoiding these troubles.

Germanium is generally too noisy for use in very low level stages, but can often be designed into a second stage. With care, temperature effects can be minimised.

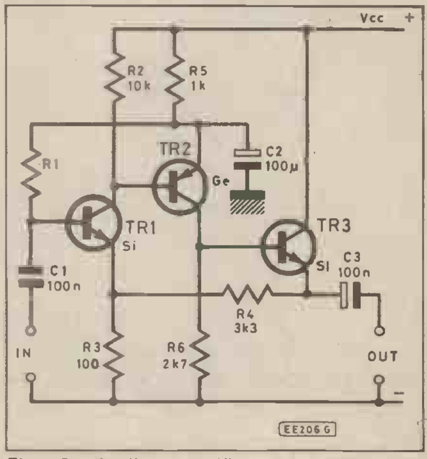


Fig. 3. Audio amplifier incorporating a germanium transistor stage to introduce low-pass filtering; this reduces the chance of oscillation caused by high-frequency feedback.

Fig. 3 shows a general purpose low-level audio amplifier with a fixed gain and low-impedance output. The gain is approximately R4/R3, and is about 30 with the values shown. R1 should be selected to set the voltage across R5 to about one-third of the battery voltage (Vcc).

TOO EXPENSIVE

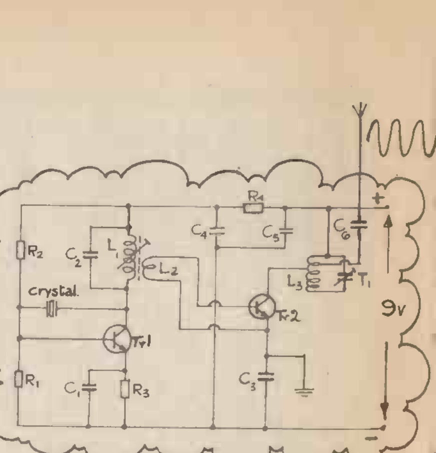
You may wonder why, if germanium transistors are so useful, they are not still made. One reason is that the traditional methods of manufacture are too expensive. It would be impossible to make germanium transistors for the same price as mass-produced silicon ones.

FUNTRONICS WITH RADIO CONTROL

PART 3 FINAL PART of Series 1

Series 1 has set out to give the beginner an understanding of R/C by developing the most basic Tx/Rx combo. Series 2 will develop a multi-channel Tx/Rx using a new model for Rx.

by Thakery



TRANSMITTER

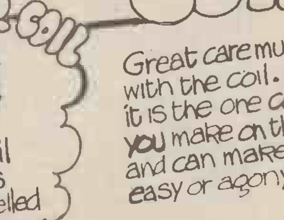
COILS

RECEIVER COIL

10mm dia coil
15 turns
24 SWG enamelled wire

Great care must be taken with the coil. Remember it is the one component you make on the circuit and can make the tuning easy or agony.

TRANSMITTER COILS

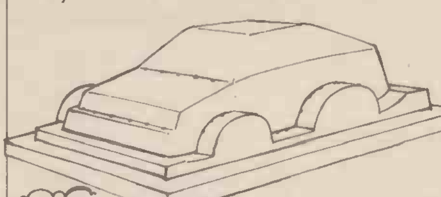


Core: 5mm Dia x 15mm long. High frequency grade core.
L_1 = 15 turns
L_2 = 5 turns
Both windings use 32 SWG enamelled wire

15 mm inside diameter.
22 mm long
11 turns
18 SWG enamelled wire.

WOODEN FORMER

The only practical way of making the body is by forming a plastic sheet over a wooden form shaped to the INSIDE size of the body



The principle of vacuum forming

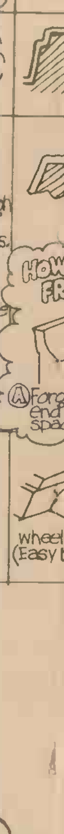
A plastic sheet heated to soft state is sucked over the FORMER by means of a VACUUM created between the plastic sheet and FORMER.

You can choose from a varity of materials to make the FORMER but MAHOGANY is generally the most available and easy to form.

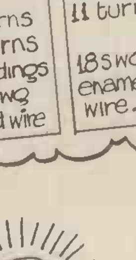
Your model can follow the shape offered by the series or you may wish to create your own shape but whatever you decide you must follow some rules for the best results...

SOME RULES

1. Every face going in a VERTICAL direction must have at least a 5° angle.
2. There's only one way to achieve sharpness in detail—drill a hole about 1mm in diameter through the former where a sharp corner occurs. The former may be too deep for the conventional twist drill so an alternative is employed in the shape of 16 to 18 gauge PIANO WIRE with one end formed to a point.
3. Remember you will have to trim the shell taken from the vacuum former so be careful how you extend the former beyond the body shape

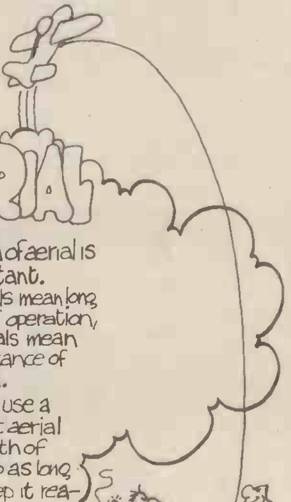


TUNING



If you don't happen to have a wavemeter or oscilloscope then find a 6V. lamp bulb and put it across the output as your initial load. The circuit is tuned when the bulb is brightest.

The AERIAL

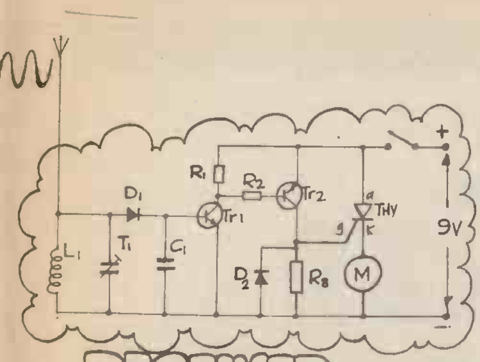


The length of aerial is very important. Longe aerials mean long distance of operation, Short aerials mean short distance of operation. It's best to use a telescopic aerial but a length of wire will do as long as you keep it reasonably straight.

SERIES 2

Series 2 will expand the circuits to multi channel control and with a simpler method of switching on the motor. Using the THYRISTOR or a RELAY in place of R3 is the most interesting but a power transistor in place of Tr2 would make the circuit more simple.

One channel will reverse polarity of the motor enabling your model to reverse and, with special treatment to one wheel, move in a circular path.



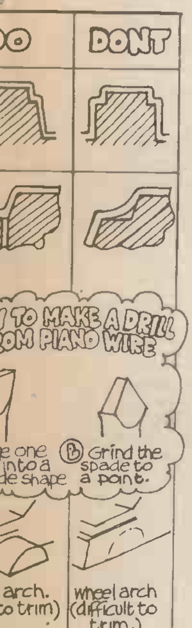
RECEIVER

COMPONENT LIST (Rx)

	VALUE
R1	3·3K
R2	1K
R3	1K
T1	30pF TRIMMER
D1	Point contact detector type
D2	1N4001
Tr1	BC109
Tr2	AC128
C1	2nF
Thyristor	BT101
Motor	3·0 to 6·0V operating range ·070A 5000rpm No Load conditions.
Board	20x16 holes, 0·15 matrix

COMPONENT LIST (Tx)

	VALUE
R1	56K
R2	15K
R3	100 ohms
R4	100 ohms
T1	80pF TRIMMER
Tr1	2N2221A
Tr2	2N2219A with 'Heat sink'
C1	10nF ceramic disc.
C2	39pF
C3	2nF ceramic disc
C4	10nF ceramic disc
C5	5nF ceramic disc
C6	1nF
Crystal	27·025MHz and holder (Try the nearest value you've got before buying one)
Board	20x20 holes, 0·15 matrix.



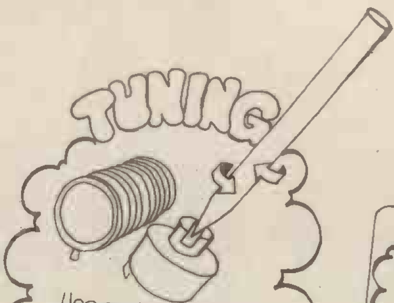
HOW TO GET A SHELL FROM YOUR FORMER

First, phone around until you find a model maker with a vacuum forming machine and stress that you've already made the former. If the model maker is prepared to accommodate you for a charge make the most of it. It may not be a large charge, especially if he's already setting-up for his own formers and is able to fit yours in at the same time.

Think of making the 'Base' and 'Receiver' by vac-forming

Most workshops are very busy so offer to knock out the former from the plastic shell.

TUNING



Use a plastic screwdriver for tuning the capacitor or coil. A metal screwdriver will cause endless frustration due to aerial effect

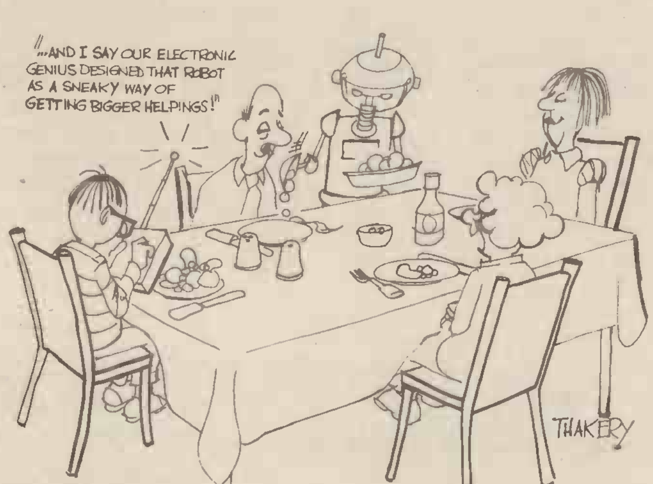
LINK-UP

Link-up the letters to form a chain of words related to electronics.

START→				I	M	P	E	R	F
T	C	A	R	A	V	N	O	I	E
O	R	F	A	W	S	H	M	T	C
O	T	A	N	E	F	F	O	T	R
R	A	I	T	R	E	I	D	N	O
	U	T	O	T	R	A	N	S	D
	C	E	P	S	R	O	T	C	U
	T	R	O	R	A	D	I	O	M
		A	D	A	R	R	E	T	E
		R	S	C	O	P	E		

WORD	CLUE
_ _ P _ _ _ _ _ _ _ N	NOT IDEAL CRYSTAL
_ A _ _ _ O _	VARIATION OF C
_ A W _ _ _ _ _ _ _ O N	MICROWAVE TUBE DEVICE
_ _ F F _ _ _ _ _ _ R	TRANSDUCER
_ U T O _ _ _ _ _ _ R	MAGNETIC AMPLIFIER
S P E C _ _ _ _ _ _ R	... INFRA-RED REGION
_ A _ _ _ _ _ _ E	... SCREEN

Solutions on page 384



TRAIN SIGNAL CONTROLLER

A.P. DONLEAVY

THIS ARTICLE describes the construction of a system for controlling the signals of a model train set. The signal lights are coupled to the power supply of the train set, so that the train will not advance if the lights are at red. The setting of the signals may be automatic, manual, or done by detectors placed on the track; the last way is used to prevent one train from entering a zone in which there is already another train.

Although the complete circuitry is relatively uncomplicated, the constructor may decide for himself how much he wants to build since the various functions are not interdependent.

CIRCUIT OPERATION

The signal lights used are a red and a green l.e.d., D1 and D2. D1 (red) is driven by a *pnp* transistor TR1, and D2 (green) is driven by TR2, an *npn* type—refer to Fig. 1. IC1 is a CD4093, quad dual input NAND Schmidt trigger. One of these gates, IC1a, is connected as an oscillator in a standard circuit, in which the period of oscillation is determined by the values of R3 and C1, about 4 seconds for the values chosen.

With S1 in the centre position, the oscillator runs freely, and the oscillation is transmitted via IC1b, used as a buffer, to the bases of TR1 and TR2. When the output of IC1b is high, TR1 is turned off and TR2 is turned on, hence D1 (red) is off and D2 (green) is alight. When IC1b output is low D1 is alight and D2 is off. Manual control of the lights is achieved using S1. When S1 is in the "green" position, the input, pin 13 of IC1b, is held low, so the output pin 11 goes high, irrespective of the state of the other input, pin 12. The green l.e.d. D2 remains permanently lit with S1 in this position. With S1 in the "red" position the output pin 3 remains high. Hence both inputs of IC1b are high so the output pin 11 goes low, thus turning off D2 and turning on D1. R1 and R2 are pull-up resistors to keep the corresponding inputs high when not otherwise switched by S1.

The third method of control of the lights is automatic detection of the train as it passes the lights, causing them to go from green to red. This simulates the real situation where a train passing into a zone changes the signals to red. On coming out of the zone the train is detected and the signal returns to green. Hence two trains should never be in the same zone at the same time.

The detectors used in this project are miniature reed relays, which are normally-open switches. The passing train, which has a magnet attached underneath, causes the relay to momentarily close and make contact. The two relays are connected to the circuitry of IC1c and IC1d. These gates are connected in a bistable arrangement. Relay 1 (S3), on making contact will cause pin 10 to go high and pin 4 to go low. These two outputs will remain in this state until changed by S4 making contact. If S2 is closed and S1 in the centre position, then the states of the outputs of IC1c, IC1d determine which l.e.d. is alight. S3 should be placed near to the signal lights. On passing S3 pin 4 goes low and causes D1 to light. When the train then passes S4, the l.e.d. D2 lights.

The stop/go control of the train, corresponding to the status of the signals, is done using TR3 and CSR1. When the lights are green TR3 (*npn*) is turned on; this in turn turns on the triac, since the emitter of TR3 draws its current from the gate of CSR1. R7 is used to limit the triac gate current to about 6mA. When the signals are red, TR3 is off, and CSR1 does not conduct, hence the circuit of the supply current to the train is broken.

It is assumed that the supply to the train comes from a rectified and unsmoothed a.c. supply. The triac would be unable to control the train if the power were to be supplied from a battery, since there would be no periods of zero current to allow the once-triggered triac to turn off again.

The use of the triac has two advantages. Firstly it conducts in both directions, so the control is still effective if the train direction is reversed. Secondly, the speed control potentiometer remains effective.

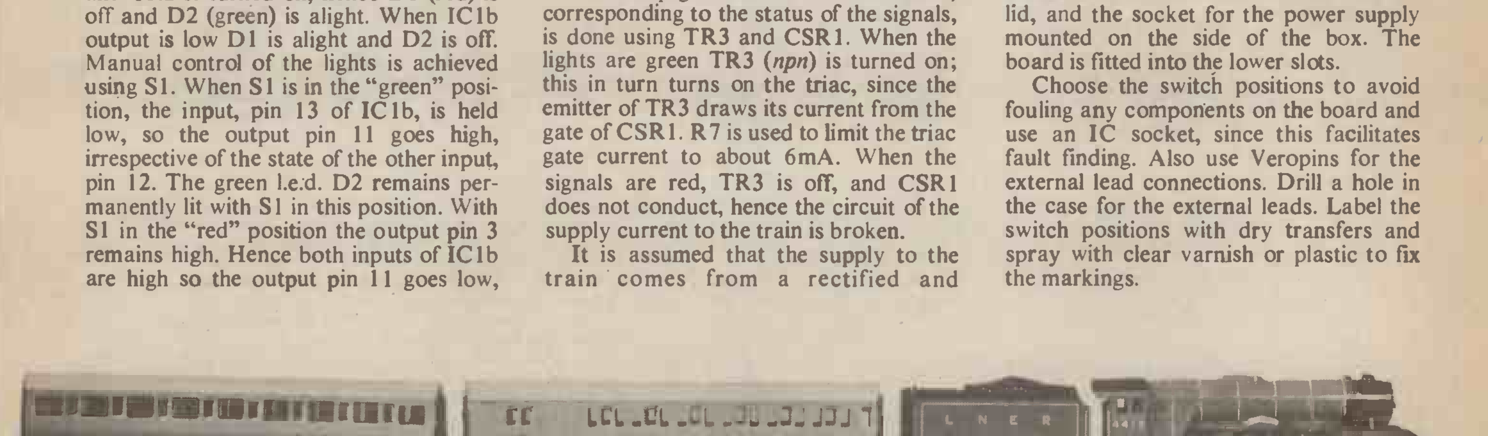
CIRCUIT OPTIONS

The constructor may well decide not to use all the possibilities of this project. The simplest form would be a free-running set of signal lights. In this case, all the circuitry associated with S1, TR3, CSR1 and IC1c, IC1d, can be omitted. Manual control of the lights would require the inclusion of S1. The other circuitry can be added as required.

CONSTRUCTION

The circuit was built on a piece of 0·1 inch pitch Veroboard (31 holes × 10 strips). The size is chosen to suit the mounting slots of the box used, which is an inexpensive plastic type size 85mm × 56mm × 34mm external dimensions. Fig. 2 shows the topside components layout and the underside breaks in the copper tracks. The switches are mounted on the lid, and the socket for the power supply mounted on the side of the box. The board is fitted into the lower slots.

Choose the switch positions to avoid fouling any components on the board and use an IC socket, since this facilitates fault finding. Also use Veropins for the external lead connections. Drill a hole in the case for the external leads. Label the switch positions with dry transfers and spray with clear varnish or plastic to fix the markings.



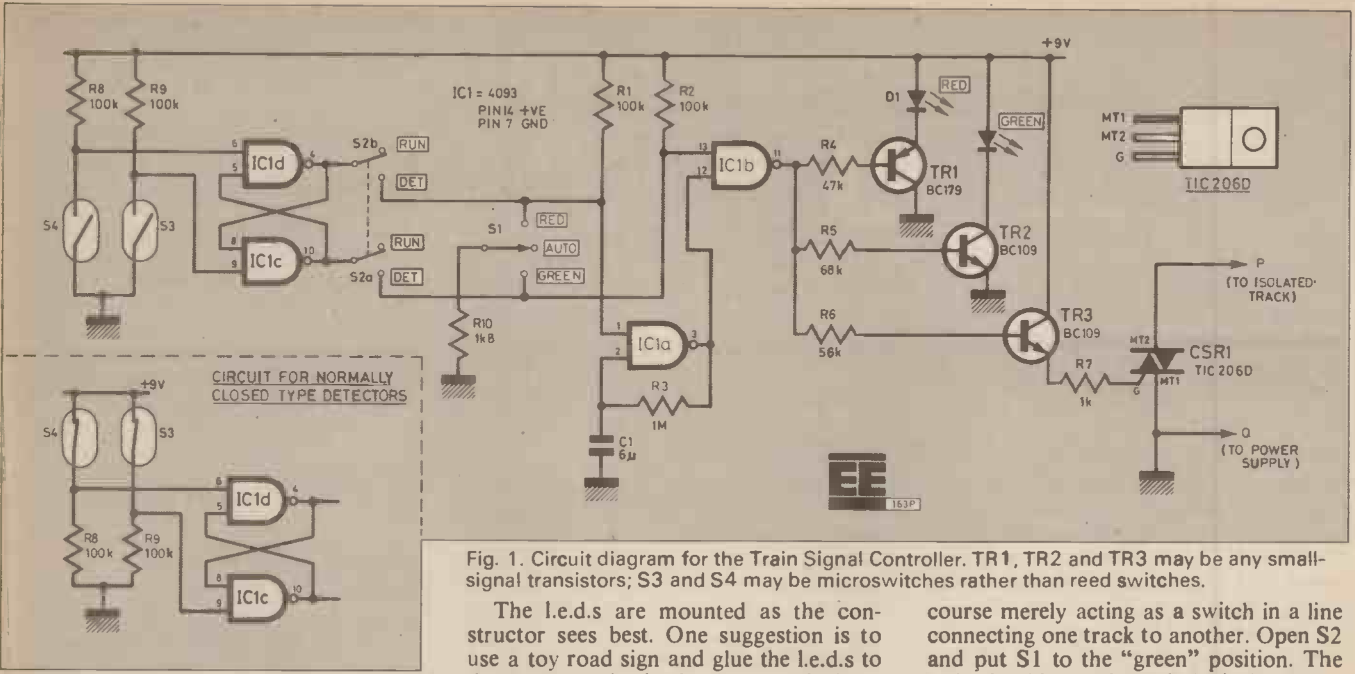


Fig. 1. Circuit diagram for the Train Signal Controller. TR1, TR2 and TR3 may be any small-signal transistors; S3 and S4 may be microswitches rather than reed switches.

The l.e.d.s are mounted as the constructor sees best. One suggestion is to use a toy road sign and glue the l.e.d.s to the top, cut the leads short, and close-wrap the three supply wires round the stem to the base.

The reed relays may be glued to the sleepers. Bring the connecting wires under the lines or the baseboard (if used).

IN USE

The electrical arrangement for the layout is shown in Fig. 3. It will be necessary to take single sections of track and isolate *one* of these lines with a plastic isolating clip at either end. Power to this isolated section of track is fed via MT2 and MT1 of the triac. The triac is of course merely acting as a switch in a line connecting one track to another. Open S2 and put S1 to the "green" position. The train should pass through the isolated section without a change of speed in either direction. If the train slows down on entering the isolated section, then reverse the connections P and Q and the problem should disappear. (Note this is not the same effect as reversing the current). When the lights are at red, the train should stop in the isolated section.

The first relay should be placed just beyond the isolated line, far enough away to stop the train from changing the lights before all its wheels are out of this section. The second relay may be placed anywhere further along the track but for safety it should be distanced at least the

COMPONENTS

Resistors

R1, R2, R8, R9	100k (4 off)
R3	1M
R4	47k
R5	68k
R6	56k
R7	1k
R10	1k8

All $\frac{1}{4}$W ±5%

Capacitor

C1	6µ 15V tantalum

See Shop Talk page 377

Semiconductors

D1	red l.e.d.
D2	green l.e.d.
TR1	BC179
TR2, TR3	BC109 (2 off)
CSR1	TIC206
IC1	CD4093

Miscellaneous

S1	single-pole two-way centre-zero switch.
S2	d.p.d.t. toggle switch.
S3, S4	min. reed switches. (2 off)

0.1 inch matrix stripboard size 10 strips by 31 holes; case—e.g. MB2 type; small magnet for operating reed switches; plastic road sign; interconnecting wire.

Approx. cost Guidance only £10.50

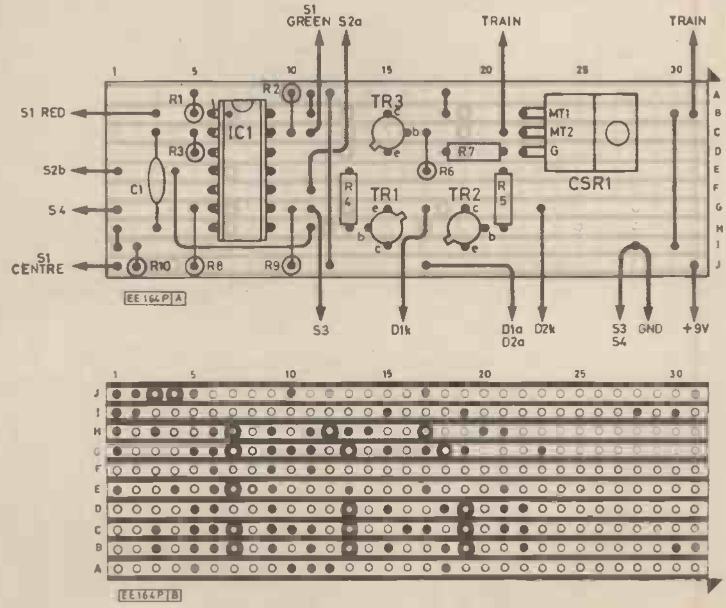


Fig. 2. Component layout and stripboard drilling details. The two off-board connection, labelled "Train", correspond to points "P" and "Q" in Fig. 1.

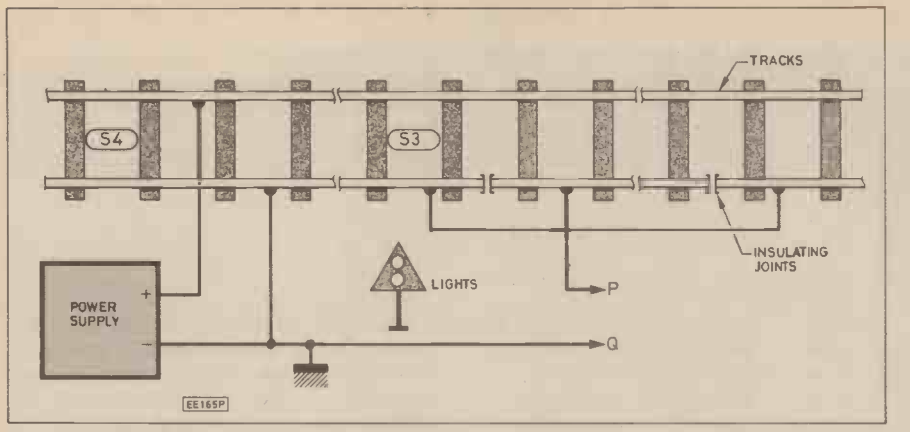


Fig. 3. Track layout and guide to the positioning of the reed switches.

length of the longest train plus carriages likely to be used.

When using the detectors with S2 set to "Detect", S1 should be in the centre position. The situation of the lights may be temporarily overridden by switching S1 as required. R10 prevents a short circuit to ground of the outputs of IC1c and IC1d when this override is used.

POWER SUPPLY

The prototype used a 9 volt mains adaptor for the power supply (not supplying the train of course). The voltage is not critical and any supply between 4·5 and 15 volts will work, though it may be necessary to adjust the values of R4 and R5 to obtain a current of about 20mA for the l.e.d.s. Using the train power supply will probably not be satisfactory since there will be far too much "noise" and the voltage will vary with the speed setting, causing the intensity of the lights to change.

COMPONENTS

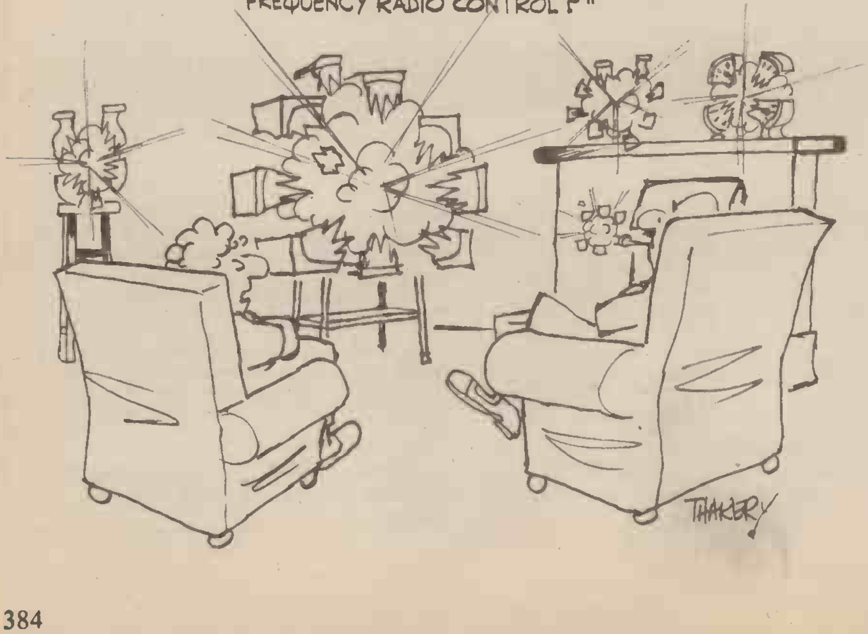
TR1 may be any small-signal *pnp* transistor. Similarly TR2 and TR3 may be any small-signal *npn* transistors. If another triac is used, then R6 may need to be adjusted to give the correct gate current. The reed relays provide a simple way of detecting the train. However a small magnet must be glued to the underside of the locomotive (or a truck) to cause the relay to close as the train passes. The magnet used in the prototype was an "office" magnet used for holding notices against a board or wall.

Alternative types of detectors could be used, for example, a microswitch, a photo-detector, or a photoresistor. If a microswitch is used the train would need to make mechanical contact with the switch. If a photo-detector is used, then it should be fixed onto the track so that the light is interrupted by the train passing overhead. In this case the photo-detector acts as a "normally closed" switch, so the input circuit should be modified slightly as shown in Fig. 1. R8 and R9 may need to be altered to suit the type of photo-detector used.

The lights used could also be miniature (6 volt) bulbs instead of l.e.d.s. Such bulbs take about 60mA, so the values of R4 and R5 should be lower (try 10k). □

FUNTRONICS ANSWERS

"DID YOU SAY OUR SON IS UPSTAIRS EXPERIMENTING WITH *SUPER* ULTRA HIGH FREQUENCY RADIO CONTROL ?"



LINK-UP

Link-up the letters to form a chain of words related to electronics.

				I	M	P	E	R	F
T	C	A	R	A	V	N	O	I	E
O	R	F	A	W	S	H	M	T	C
O	T	A	N	E	F	F	O	T	R
R	A	I	T	R	E	I	D	N	O
	U	T	O	T	R	A	N	S	D
	C	E	P	S	R	O	T	C	U
	T	R	O	R	A	D	I	O	M
		A	D	A	R	R	E	T	E
		R	S	C	O	P	E		

WORD	CLUE
IMPERFECTION	NOT IDEAL CRYSTAL
VARACTOR	VARIATION OF C
FAWSHMOTRON	MICROWAVE TUBE DEVICE
DIFFERENTIATOR	TRANSDUCER
AUTOTRANSDUCTOR	MAGNETIC AMPLIFIER
SPECTRORADIOMETER	... INFRA-RED REGION
RADARSCOPE	... SCREEN

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Food For Thought

If you are interested in the history of sound and broadcasting, and have a few hours in a weekday to spare, call in at the National Sound Archive just up the road from the Science Museum in Kensington. They have just finished taping interviews with literally dozens of people with something to say about the early days of sound and broadcasting.

There's Derek Chinnery, Controller BBC Radio 1; Arthur Haddy, Technical Director of Decca right from the early days; George Martin, sometime Beatles producer; Duncan MacEwan, BBC Radio Engineering; Eric Simms, wildlife recording; Kenneth Wilkinson of Decca and Ken Townsend of Abbey Road. It would take you over 60 hours to listen to them all in the NSA's booths. You can take notes but not make tape copies. The plan now is to extend the project further up towards the present.

Favourite Story

My favourite story comes from Doreen Walker, wife of electronics genius Alan Blumlein who was killed in the war testing secret radar. Blumlein was obviously the archetypal inventor. When stuck with a problem he would think only of finding a solution.

One evening when Blumlein was mentally stuck he and his wife were invited out to dinner with friends. Throughout the whole meal Alan doodled on a napkin, juggling formulae and equations. He took no notice of anyone, said nothing and ate like an automaton.

At the end of the meal everyone went through for coffee, but Alan still stayed in his mental shell. Suddenly he broke out, asking his wife loudly across the room "Doreen, WHEN are we going to eat?"

Save It

Now here's a puzzle, with no prizes other than perhaps it will save someone, somewhere some real problems. Sorry, but only those familiar with Psion's *Xchange* multi-tasking program will be able to enter.

This program package offers a back-up facility so that you can copy precious data files from one disc drive to the other. If you are running the program try it. Copy a file from drive A to B, following the prompts.

On my Apricot with hard disc, the copy routine works, but curiously fast. After a while, with suspicions aroused, I collected together all my back-up files and (in DOS) ran a directory listing. All back-ups had the correct headers and history, but all were of zero bytes length! Explanations, even if related to my stupidity, gratefully received.

But meanwhile, anyone else with a pile of back-up data discs, from whatever program they are running, might like to try running a directory check on byte length.

Finally, what could be another useful computer tip. Psion is the company which wrote some of the best software for Sinclair computers. They sold around a quarter of a million copies of *Vu-file,* a simple data base program that runs on the Spectrum. People use it to catalogue addresses, memberships, files and stock.

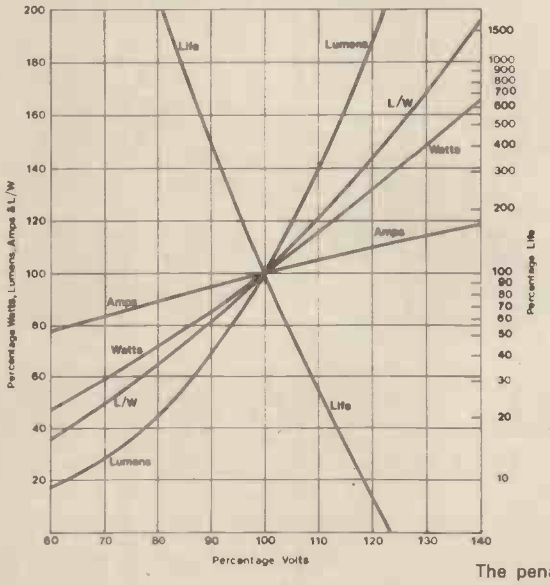
Because *Vu-file* runs on the 48K Spectrum, solely out of RAM, it can look up any entry in quite literally less than one second. The snag, of course, is that it can't search files which overflow the Sinclair memory. For that you need a much more sophisticated program, like *Archive*, which is part of Psion's *Xchange*.

Press Reception

At a press reception, I asked Psion whether there was compatibility between *Vu-file* and *Xchange*. There isn't. But in response to my request/challenge Psion have now written a transfer routine which means that anyone who has laboriously keyed data into a *Vu-file* data base can now export it to *Archive* down a simple hard wire connection.

They are still not sure whether to sell the program or offer transfers as a service.

VARIATION IN WATTS, LUMENS, AMPS, L/W AND LIFE OF LAMPS WITH VARIATION IN VOLTAGE



Voltage Shock

A few years ago I wrote in this column about fluctuations in mains voltage. By law the electricity boards are allowed to let mains voltage vary by plus or minus 6 per cent of the nominal 240V which is now standard for Britain. That means 14·4V either way.

Many readers reported wide variations, through the day and night. This is because the voltage falls as industrial or domestic load increases, and voltage rises when there is less demand. But often there is a clear pattern of consistent excess voltage or consistent low voltage. There is good reason for this. And the effects can be quite surprising.

Even though they are very thick, the mains power cables have resistance, just like any other electric wire. So voltage is lost on a long run. If you live a long way from the local sub-station transformer, then you are at the end of long run and your voltage will be low.

Because the electricity boards cannot let anyone's voltage drop more than 6 per cent, they have to push out enough voltage from the substation to keep even distant homes above the legal threshold. This means that homes nearer the sub-station, on short runs with low resistance, get consistently high voltage. Does it matter? Yes.

Electronic equipment will usually function happily within the 12 per cent, or 25V swing. This is because they have a stabilized power supply which, within reasonable limits, provides the low voltage circuits with exactly the right voltage. But simple electric equipment, like fires and lamps are not stabilized. So they consume more power when the voltage is up and less when the voltage is down.

In simple terms you get more light and heat if your voltage is high than you do if the voltage is low. And of course you pay for it because electricity is metered by watts of power consumed per hour, and this is directly dependent on voltage.

But much more important, is the effect that high voltages have on lamp life. I found out, quite by chance, that Thorn-EMI had done some work ten years ago on the relationship between lamp life and supply voltage. Look at the attached graph.

If supply voltage is just 5 per cent up then lamp life is halved. So if your mains is running at 252V, instead of 240V, any lamp in use is burning out at twice the predicted speed.

During the miners' strike I consistently logged high voltages in warm weather. The Electricity Board said this had nothing to do with the miners' strike. It was quite routine. If so, then I now know why my bulbs burn out faster than expected.

If you live a long way from a sub-station, and your supply voltage is consistently 5 per cent or 12V down, then your lamps will last twice as long. The penalty of course is that you will get less light and it will be rather redish in hue.

A few years ago, before the whole country was standardized on a nominal 240V, it was possible to buy 250V bulbs. These would last around twice as long when used in a 240V area. Some people used to deliberately buy them for just this reason. But I haven't seen any in the shops for years.

Perhaps it is just that 250V bulbs are now packaged as long-life lamps and sold at a premium price!

CURRAH MICROSPEECH Review...

MICHAEL TOOLEY BA

IT IS UNUSUAL, and also somewhat gratifying, to be asked to review a product which you have already been using for some time. Such was the case with the Currah Microspeech unit which I originally purchased last year with the intention of "livening-up" some of my BASIC programs. Currah are not alone in the Spectrum speech synthesis market and thus it was not without some careful thought that I eventually decided upon the Currah unit for my own use.

Most of today's personal computers are, with differing degrees of success, able to emit a variety of bleeps and tones. Some are even capable of producing sounds which can claim to be music, albeit limited to one or two octaves in range. Other micros offer not only 'music' but sound effects as well. These, no doubt, are calculated to delight the Space-invaders fan at the expense of those of us equipped with more sensitive auditory nerves!

The next logical stage in the production of sound by personal computers has, therefore, to be concerned with the production of a reasonable facsimile of human speech. Whilst there are several methods by which speech can be produced by a computer, the General Instruments SP-0256 chip has undoubtedly had the biggest impact in the low-cost speech synthesis market. This device has justifiably earned immense popularity and provides a flexible solution to the provision of speech output by means of allophone generation.

THE ALLOPHONE SET

Allophones are simply the constituent sounds of which a complete spoken word is composed. Furthermore, we can adequately synthesise nearly all of our vocabulary of many thousands of words using just sixty, or so, basic allophones. Currah Microspeech is capable of reproducing 58 allophones and 4 pauses of various lengths. These allophones are then strung together in order to produce complete words. The word "was", for example, is synthesised by stringing together the three separate allophones "w", "o" and "z". From this simple example it should be apparent that, in speech synthesis, we are primarily concerned with how words sound, not how they are spelt!

The allophone set is sub-divided as follows:—

1. Phonetic allophones comprising all single characters a to z but with the exception of "x" and "q".
2. Double vowel allophones such as (ee) in "see".
3. Strong phonetic allophones used at the start of words or where particular emphasis is required such as (ggg) as in "big".
4. Complex allophones such as (ck) as in "clock" and (sh) as in "ship".
5. Four pauses which differ in length from very short (apostrophe) to very long (full stop).

For the technically minded, each allophone is represented by a byte in which the least significant six bits (bits 0 to 5) are used to represent the particular allophone code (0 to 63 decimal). Bit 6 is used to denote intonation (the allophone is intoned up when bit six is set to 1) and bit 7 is always set to zero. If all of this sounds over complex it really isn't! Putting together your own words and phrases is extremely easy and takes only a few minutes to master thanks to the syntactic checks that the Currah unit carries out before it generates the speech code directly from your BASIC program statements.

Suppose, for example, that you wish to incorporate a simple greeting at the start of your program. The following line of BASIC would suffice:—

```
10 LET s$="He(ll)(oo)J(ay)mz":
PAUSE 1
```

This line outputs the phrase, "Hello James" using the reserved variable, s$. Where the user wishes to check the syntax of his speech strings before running the program this can be carried out by typing:—

```
PRINT s$
```

In our previous example this would result in:—

```
*e(ll)(oo)J(ay)mz
```

The asterisk shows that the phrase has been accepted as syntactically correct and that it has been converted into speech code. Where a phrase is not correct a question mark is generated to show the location of the error within the phrase. Complete phrase libraries can be easily built up and stored as arrays within the program to be output as and when desired.

The Currah Microspeech unit stores its speech code in a high-memory buffer until it is ready to be output. The buffer is initialised on power-up to a length of 256 bytes (this can be extended later if desired) and operates on a "First-In-First-Out" (FIFO) basis. Consequently, in a 16k machine RAMTOP is lowered to 32343 whilst in a 48k machine RAMTOP is lowered to 65111. The buffer can easily be extended by simply CLEARing more space, e.g. CLEAR 65000 makes RAMTOP point to 65000 and the buffer will now have a total capacity of 367 bytes (this may not sound a lot but would typically represent around a minute's worth of speech!).

HARDWARE

The Currah Microspeech unit is housed in a very neat enclosure measuring just 75mm × 70mm × 17mm. The unit mates directly with the expansion connector at the rear of the Spectrum and extends horizontally rather than vertically. No further expansion of the Spectrum bus is provided for and thus this unit must be the last in any series of expansion modules. The unit fits both the Spectrum and Spectrum Plus. A unit is also available for the CBM64.

Besides the bus expansion, two further connections to the Spectrum are required.

One of these is taken to the TV output socket via a phono connector and the other is taken to the EAR connector via a 3·5mm jack plug. (This latter connection permits output of sounds other than speech.) The phono plug at the end of the original TV lead is then connected to a socket in the Microspeech unit.

MANUAL

The manual is very neatly presented and contains a total of 24 pages. Unlike many similar booklets, it is both eminently readable and just the right size for handy reference. Sections are devoted to, setting up the unit, forming simple words and phrases, the allophone set, intonation and phrase libraries, the speech buffer, and using machine code. In addition, six useful appendices are included covering such topics as, decimal and hex codes and using the unit with Sinclair Microdrives.

SOFTWARE

Although the Microspeech unit requires no separately loaded software interpreter (this is resident in ROM) Currah supply a demonstration cassette with the unit. One side of the cassette contains a tutorial program whilst the other is a simple adventure game with speech.

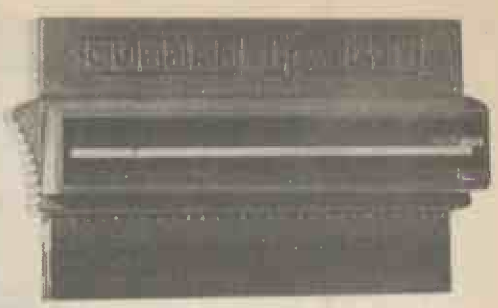
The tutorial program comprises five separate sections, the first of which is simply an animated drawing showing how the Microspeech unit should be connected to the Spectrum. This, however, must be regarded as something of a gimmick since the user has hopefully already done this before loading the software! Indeed, to stop the tape and then connect the unit would be tempting fate since expansion modules should *never* be connected whilst power is applied. In any event, the connecting information printed on the Microspeech packaging is perfectly adequate.

The next section of the tutorial package invites the user to enter allophones directly from the keyboard and they are then output via the TV loudspeaker. The user is then tested on what he has learned with the program asking for the correct form for each allophone. If correct, the allophone is output, if not you are invited to try again or pass on to the next (in which case the correct solution is supplied). A similarly organised section follows on intonation and finally the topic of using allophones within string arrays is introduced.

The reverse side of the cassette contains an adventure game entitled Mystic Tower. This game is played in three levels and involves a search for "mystical" objects. Whilst the connoisseur of adventure games will almost certainly be unimpressed with this game, it does however show how speech can add an exciting new dimension to such programs. Indeed, it is a shame that so few games programs are available with speech. This, hopefully, will change as the market becomes more sophisticated.

IN USE

The first surprise when using the Currah Microspeech unit is that, from power up, the keyboard becomes "voiced" (i.e. as each key is hit its function is spoken!). This, I found, is far from



This handy item is the Microslot, it allows the user to connect two peripherals at a time to the Spectrum's user port; price reduced when purchased together with the microspeech unit. Details from Welwyn Systems (address below)

being just a gimmick since it allows one to type merrily away at the Spectrum's keyboard without having to constantly refer to the TV display to see whether one has hit the right keys (always a problem with the Spectrum's keyboard!). This considerably speeds up program entry.

If the keyvoices become monotonous, or when a tape LOAD is being performed, it is possible to disable the keyvoices by simply entering:—

LET keys=0

To turn on the keyvoices once more one simply enters:—

LET keys=1

The keys may also be disabled and enabled from within a program by simply assigning the reserved variable, keys, a value of 0 or 1 respectively. The reason for disabling the keys during a LOAD is that a continuous, and somewhat annoying, "e" allophone is output resulting from the leading "e" of the ENTER key. (One can, of course, simply turn down the volume of the TV receiver!)

Currah Microspeech is fully compatible with the Sinclair Interface 1 and Microdrives but is *not* compatible with Watford Electronics Spectrum disk operating system, SP-DOS. One further disadvantage of the Microspeech unit should be mentioned. Due to the sound mixing process, slight patterning of the TV display occurs. This, however, is more noticeable when large areas of "strong" colours are displayed and does not greatly degrade the TV picture.

CONCLUSION

The Currah Microspeech unit is a first rate accessory that can be thoroughly recommended. Its ease of use, both in terms of installation and access from BASIC, make it extremely attractive. Furthermore, the built in modulator, which provides sound and speech direct from the television receiver, must be a decisive factor in its favour.

Currah Microspeech costs £21.95 including VAT and p&p, and is available from: Welwyn Systems, Bedlington, Northumberland, NE22 7AA.

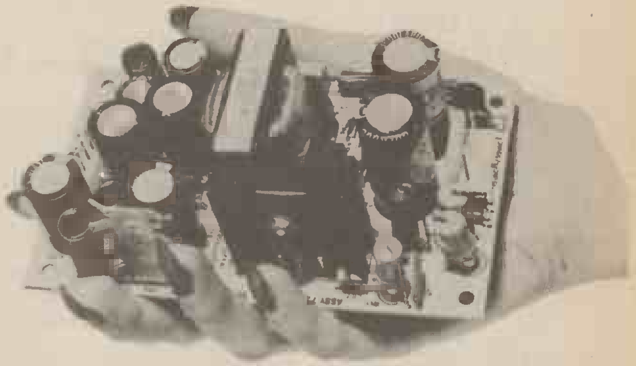
EVERYDAY news ... from the world of

"THE WEEK"

THE All Electronic/ECIF Show, now in its eleventh year, has become Britain's largest industrial happening and its organisers hope to see it develop into the largest electronics show in the world.

And develop it certainly has. The show, held at London's Olympia in May (now known as "The Week"), boasts a total of 1,114 exhibitors and incorporates four major events: The All Electronic/ECIF Show, Circuit Technology, Electronic Product Design and Fibre-Optics.

Claims to importance of this event seem well justified by the wide range of exhibitors, including many of the household names from the electronics world. "The Week" was also attended by hundreds of VIPs, such as trade ministers, scientists and educationalists.



"IT WERE THIS BIG, IT WERE"

We have all heard the fisherman's claims to the biggest catch. At this year's show there was no shortage of such claims (most of them justified), with launches of the smallest, largest, first or unique product.

Featured at the show was the "world's smallest" switch mode power supply, available from Gresham Powerdyne Ltd. (above). The Littelfuse Tracor (below) from Picofuse™ is the world's smallest fuse. Now available taped and on reel for use with automatic insertion equipment, it comes with 5,000 fuses per reel. Also ammo-packs of 1,000 are available.

JAPAN v. AMERICA

The two greatest chip producing nations are undoubtably America and Japan, but when it comes to selling them it seems that Japan wins hands down. Out of the five largest semiconductor houses from Japan, four were represented under their own name; yet of the American biggest five, only one had a stand at the show.

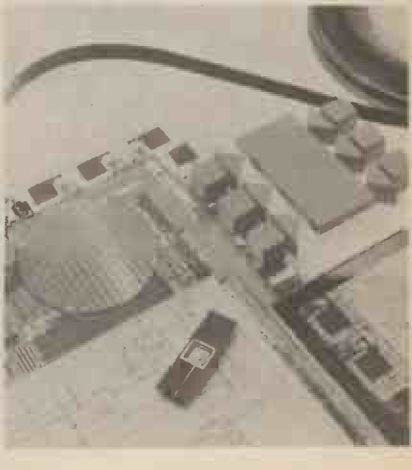
Never-the-less, there was an abundance of chips from hundreds of sources. Whether it was a million 32-bit processors or a single transistor there was a dealer trying to sell them. This in itself is something of a problem. It would take at least a week to get round all the stands—most people had a day.

CHIPS AND OPTICS

Probably the greatest advance in electronics over the last year, has been in the field of memory products and optical technology. This was reflected by the growth in the number of "Fibre Optic Exhibitors" and the general expansion of the All Electronics Show.

There were many innovations in these fields launched at the show, including the "first ever" CMOS SRAM to combine low power (0·5μA) and fast access (45nS). The picture (right) shows a typical MOS LSI chip from the Sprague solid state range.

The picture (left) is a meteorological picture imaged by LASER and developed by heat alone, using 3M dry silver film. It seems that LASERs and fibre optic technology are finding new applications all the time. I wonder when Fibre Optics will become the main event.



UNDER SURVEILLANCE

In more than a hundred Norwegian banks, customers at cashiers' counters are now under the continuous surveillance of a video recording system developed by National Elektro A/S of Oslo in association with Bell & Howell, UK.

Featuring enhanced image resolution, not only is it possible to identify individuals but it is even possible to see such details as the value of currency notes being passed over during a transaction.

At the heart of the system is a heavy duty JVC U-format video recorder specially modified to record single pictures without loss of quality sometimes associated with time-lapse recordings. Because only single pictures are recorded, one cassette is sufficient to cover a ten-hour business day even at the fastest time-lapse speed of five pictures per second. At the slowest speed the recording time is 32 days.

In a typical bank installation, every cashier's counter is individually covered by a monochrome surveillance camera and, by means of a switching unit, the output of each camera is transferred in sequence to the video recorder. This then records a single picture with the time and date superimposed.

The resulting video tape contains a succession of these pictures, obtained from each camera. Subsequently, if there has been an incident calling for investigation, the recorder is used in a fast search mode to locate the relevant section of the tape.

TEACHER TRAINING

The aim of a one-week course entitled Electronic Applications for Teachers, *being run by the University of Salford, is to provide teachers who have some basic knowledge of semiconductor electronics with the opportunity to study the subject in greater depth. The material covered will be adequate for the electronics option of the JMB "A" Level Physics syllabus.*

Participants' time will be divided equally between lectures and laboratory work. Many of the circuits studied should prove useful as the basis for a range of school projects up to "A" level, while practical circuits suitable for school laboratory work will also be investigated.

The Electronic Applications for Teachers *course will run from 15 to 19 July and further information may be obtained from:* ***Dr E. A. Flinn, Salford University, The Conference Office, Maxwell Building, Salford, M5 4WT.***

The Board of INMOS International Plc has appointed Douglas Stevenson a Chief Executive Officer of the Company.

Coup in America

A successful sortie into the ultra-competitive American software market has been achieved by a British software house. Kewill Systems of Walton-on-Thames, has secured twelve prestigious contracts and now plans to open an additional office in the States.

This achievement is all the more remarkable at a time when the US software scene is overflowing and casualties are rife. The company's coup is almost the software equivalent of taking micro-chips to Silicon Valley.

EFFECTS DISC

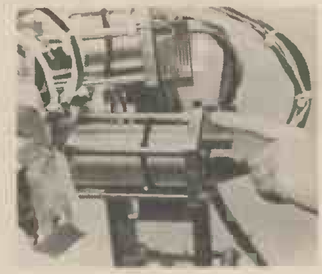
BBC Radio have produced their first compact disc of sound effects for in-house use. The disc is a "pilot" for evaluation by the sound effects service.

Effects are an important facet of programme making, both in Radio and TV, and 100,000 discs are issued on loan annually via the Sound Effects Centre. At present, the BBC uses 7in. $33\frac{1}{3}$ r.p.m. discs for its stereo recordings, with up to seven minutes material on each side. The Compact Disc is an attractive alternative as it can have more than an hour's worth of material, four times as much as a 7in. disc, with a longer life and better quality.

The Sound Effect CD has been pressed by Nimbus Records, the only UK manufacturing plant. Digital equipment was used to make digital recordings for three quarters of the playing time.

The new record features backgrounds such as sea wash, rivers and city skyline, as well as new recordings of bicycles, dentistry, babies and natural history subjects. There are also some percussive "spot" effects which are usually difficult to put on to an analogue disc.

Demonstrating that with the new sensors fitted, even a child can "teach" a robot.



Touch Sensitive Robot

Touch sensors are the latest innovation to be added to the range of Neptune robots manufactured by Cybernetic Applications of Andover.

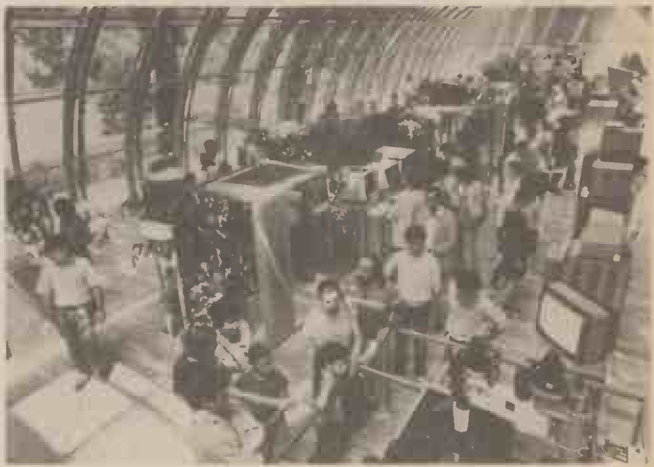
First described in our sister magazine PRACTICAL ELECTRONICS (see Sept '84-Mar '85), the addition of "touch pads" enables featherlight control, so that, when linked to a computer, precise positioning can be designated manually memorised and repeated as many times as required.

"These sensors work on the same principle as leading a bull by a ring through its nose", says Dick Becker (Managing Director), referring to both the powerful hydraulics and sensitivity involved in his robots.

EVERYDAY news

An adventure in information technology.

EXHIBIT



DESIGNED to bring the world of Information Technology (IT) and computers to the broadest possible audience, particularly the young, the "IBM EXHIBIT Roadshow" will be exhibiting in the gardens of the Yorkshire Museum, York during July (9.30a.m.–8.30p.m.).

Created in Milan by IBM Italy to an unusual architectural design by Renzo Piano (one of the originators of the Georges Pompidou Centre, Paris), the EXHIBIT pavilion is housed in a transparent tunnel of polycarbonate pyramids, supported by a semi-circular framework of beechwood with aluminium joints. It is designed to stand in natural parkland settings close to city centres.

The EXHIBIT show features many different aspects of information technology and gives a wide range of demonstrations including how silicon chips are made from pure crystal; how laser and holography is used in supermarket check-outs; how computers can be used to draw on a display screen and how they can aid deaf children to improve their speech.

Also on display are three-dimensional graphics, a device that can read and write three million characters a second and a robot that picks out counterfeit coins from the genuine article.

The sole purpose of EXHIBIT is educational and entry is entirely FREE of charge. Up to 45 temporary summer jobs, with specialist IBM training, will be created for local students acting as demonstration staff.

Following high-level discussions in Peking, agreement has been reached between Radio Tele Luxembourg and the Ministry of Radio and Television of the People's Republic of China over major areas of co-operation.

Mr Gust Grass, Director General of RTL, and Mr Kong Mai, Minister of Radio and Television, signed formal agreements over rights to music publishing; sales of European and British TV and radio commercials; and distribution of radio and TV programmes.

Primary Competition for Schools

A national competition to encourage primary school children to develop closer links with the local industrial and economic community is being sponsored by the Department of Trade and Industry.

With cash prizes totalling almost £4,000, the competition is being organised by the Schools Curriculum Industry Project (SCIP). The winners will be the school with the best project for involving local industry in the curriculum.

Most primary schools in the UK should have received letters, from the DTI and SCIP, about the competition and details of how to obtain a free book entitled Schools and Industry 5–13. *The book gives examples of what can be done and how to go about it.*

VIDEO SHOPPING

The Co-op has become Britain's first major retailer to develop an interactive video system for in-store use. It allows shoppers to choose from a wide range of information about microwave cooking at the touch of a television screen.

The basis of the system is a software package designed by Convergent Communications, used in conjunction with a touch-screen monitor and Phillips Professional Laser-Vision player. Two separate programs are stored on the system's single video disc: one designed to supply shoppers with facts about microwave cooking and microwave ovens; the other for use as an aid to staff training in microwave product sales.

Launched under the title of the Homemaker Microwave Advice Centre, the first unit has been installed at United Co-operatives' Talke hypermarket, near Stoke-on-Trent.

British Telecom Research Laboratories' work on optical fibres has won the Queen's Award for Technological Achievement.

The award goes to the Optical Materials and Low Loss Fibre section at Martlesham Heath, Suffolk.

LIFE LINE

Up to 250 medical patients waiting for organ transplants will be in constant touch with their hospitals through Life Page, a new service provided free by British Telecom Radiopaging. Under the scheme, patients waiting for heart, kidneys, liver and other organ transplants will be issued with standard BT radiopagers through transplant unit administrations.

The idea of the Life Page scheme was conceived by BT after studying the success of a similar scheme run by independent radiopaging companies in the United States.

The scheme will be administered by National Health Service organ transplant units in all parts of the country. Unit administrators from about 50 hospitals will be providing radiopagers to those patients most likely to need them. Once these patients have had their operations, the radiopagers will be passed on to new patients.

Mr. Trevor Harvey, general manager of British Telecom Radiopaging, said: *"We are delighted that the National Health Service was able to accept the Life Page scheme on behalf of transplant units through the UK, and that the units themselves have responded so enthusiastically."*

In the largest OEM deal so far signed by Acorn, Reuters is buying their microcomputer technology valued at almost £1M to enhance its international Reuter Monitor network.

The deal, the first to come out of Acorn's newly created Business Division, is for a low cost microprocessor specially developed to Reuters' specification.

CB FIELD STRENGTH METER

T.R. de Vaux Balbirnie

SIMPLE, HANDY AND INEXPENSIVE

THE Field Strength Meter, together with the SWR meter, rank as the two most useful test instruments in C.B. work. Although the SWR meter ensures maximum power output from the antenna, the field strength meter shows where this power goes. Any directional effects may be detected and adjustments to the position and alignment of the antenna made to correct them.

The prototype meter operates up to about 25 metres from the antenna so the effects of buildings, guttering and other obstructions may be readily analysed. This instrument is equally useful in mobile work for setting the aerial to give the desired radiation pattern. Since the meter is powered by the incoming signal, no battery is required.

Although designed primarily for C.B. applications, this project is also suitable for setting model control transmitters for maximum output since both C.B. and model control equipment operate at approximately the same frequency.

CIRCUIT DESCRIPTION

The circuit for the C.B. Field Strength Meter is shown in Fig. 1. It is similar to an old-fashioned *crystal set* but has a sensitive meter in place of the headphones.

The aerial receives a signal from the transmitter antenna nearby. Tuning is effected by L1 and C1 and the selected signal passed on to L2. The signal is demodulated by D1 (that is, the negative parts of the waveform are removed). The positive parts of the waveform then flow through the meter M1 and the reading given is related to the strength of the incoming signal. C2 tends to charge up on the peaks and increase the readings given.

To keep construction costs down, the two coils L1 and L2 are home-wound and the tuning capacitor, C1, is a trimmer rather than a knob-operated component. The latter type would be slightly more convenient but much more expensive. The meter chosen for the prototype was a miniature 50 microamp meter of the type specified in the parts list. The circuit would work with a less sensitive meter but the operating range would be reduced.

CONSTRUCTION starts here

Most of the circuit is built on a piece of miniature tag board (2 rows of 10 tags). This is cut slightly large then filed to fit the runners of the plastic case *tightly*. The ferrite rod will probably have to be cut or snapped from a larger piece (use a grindstone if possible). Ferrite is a hard and brittle material so be prepared for a tricky job. The actual length and diameter are not particularly critical.

The ferrite rod is mounted on the reverse (that is, the non-tag) side of the circuit panel (see Fig. 2). The rubber grommets are a tight fit on the rod and the copper wire (connecting wire with the insulation removed will do) pulled tightly over the grooves of the grommets. The ends are passed through holes and soldered to the tags on the other side. The grommets provide some resilience as well as giving clearance for winding L1 and L2 later.

C1 is mounted on the panel so that when in position the adjustment screw will protrude through a hole in the front of the case. When mounting D1, take care over its polarity. If this is wrong then the meter will tend to read the wrong way. Leave 10cm wires for the meter and aerial connections.

The windings are next formed on the ferrite rod. Fig. 2 shows the details. Although 22 s.w.g. enamelled copper wire was used in the prototype, the thickness is not thought to be critical. Plastic insulated single strand connecting wire would probably serve. L1 consists of 4 turns and this number *is* critical. L2 consists of 4 turns also but here there is room for experiment later. If enamelled wire is used, it is advisable to buy the self-fluxing type whose insulation does not need scraping off.

The hole for the meter may be made by drilling a circle of small holes then carefully breaking out the plastic. The meter covers up any irregularities so the hole need not be very neat.

A hole needs to be drilled for the adjustment screw of C1. To find the position for this, the circuit panel should be placed in the runners of the box slightly too high. If the lid is now offered up in position, the head of the adjustment screw will scratch the inside of the lid sufficiently to mark it. The hole should be drilled a little larger than the screw so this will be a loose fit in the lid.

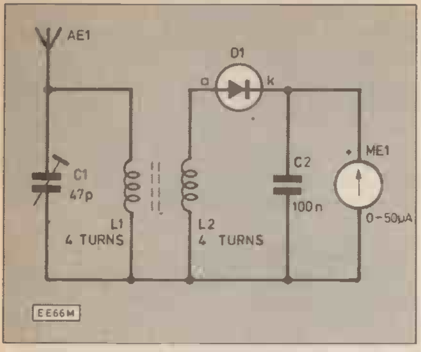


Fig. 1. Circuit diagram. Look, no battery!

COMPONENTS

Semiconductor
D1 OA90/91 germanium signal diode

Capacitors
C1 47/50p trimmer
C2 100n disc ceramic

Miscellaneous
50μA moving coil panel meter (Maplin "Quick Fit Meter").
Telescopic aerial length approximately 900mm.
Tag board: 2 rows of 10 tags.
Ferrite rod: diameter 8/10mm, length approximately 50mm.
2 off grommets to fit ferrite rod.
Wire for L1/L2—see text.
Plastic case type MB1, approximate internal dimensions 76 x 56 x 35mm.
Solder tag, solder, connecting wire.

Approx. cost Guidance only £7.00

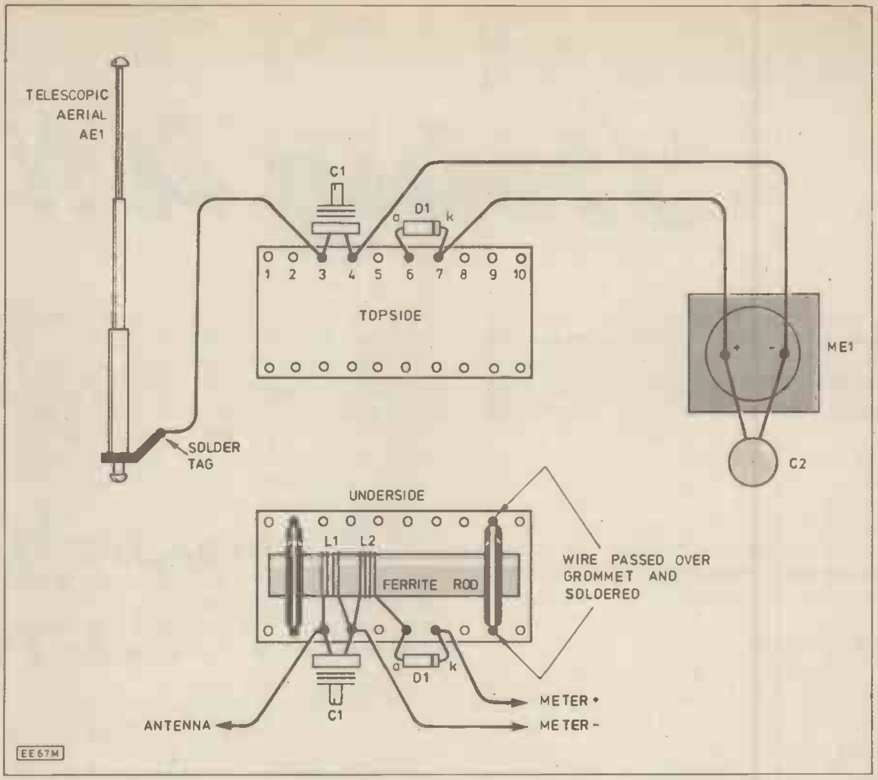
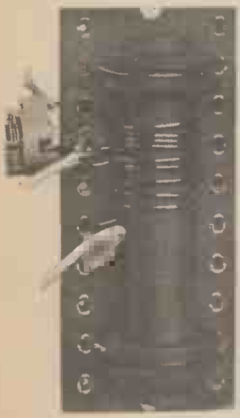
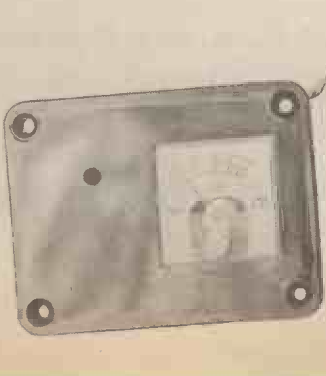
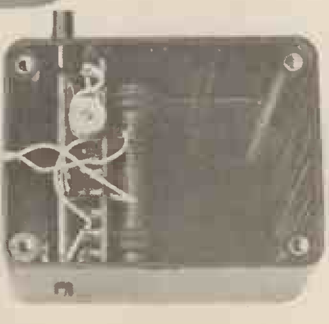


Fig. 2. Construction on tag-board, and wiring. The ferrite rod may be 'snapped' to the required length if a groove is cut in it first.

The telescopic aerial is mounted in the manner shown in the photograph. Do not be tempted to bolt it direct to the top of the case since this method would be very weak. The method shown, as well as being strong, also effectively shortens the antenna when the project is not in use. A solder tag is needed at the base of the aerial to make the connection to the circuit panel.







TESTING AND ADJUSTING

With the circuit panel in position and the lid on the case, check that C1 is free to rotate using a small screwdriver. Switch the transmitter to a free channel and keep the microphone keyed by means of a rubber band.

Erect the aerial on the field strength meter and stand with the instrument approximately 5 metres from the transmitter antenna. The meter is unlikely to show much deflection without tuning C1. Do this until the highest reading is indicated. If the reading goes off the scale of M1 move back a little.

If no reading is obtained, despite adjusting C1 through a full 360°, then first check for wiring errors. If there are none, check the number of turns on L1 and make slight alterations. Try one more and one fewer turn.

If you wish to obtain greatest range from your instrument you may spend some time adjusting the coil L2 and also C2. The windings may eventually be locked using a little glue. The prototype gave a reading of about 5 microamps at approximately 25 metres from the antenna delivering 4 watts.

You might wish to remove the scale of the meter and make a new one labelled *Field Strength*, although this was not thought worthwhile in the case of the prototype.

The meter is now ready for use. If ever readings are too high then either move back a little or collapse the aerial slightly. □

Actually Doing it!!

IN THIS, our new regular item called *Actually Doing It* we come to the rescue of the often overlooked absolute beginner to the hobby of building electronic instruments. The constructor's precept is simple, and that is to procure the specified components and connect them together as per the circuit diagram. The p.c.b. (printed circuit board) does most of this for you, whilst instrument wiring does the rest. That's the theory. The objective of *Actually Doing It* is to show you the practice.

HAVE A GO

To some extent this hobby is a victim of its own success, in that outsiders are deterred from having a go by the sight of smart professional boxes with shiny spun aluminium knobs. This is not evidence of technical elitism but of evolution, for the circuits are much the same as those that were once stuffed inside homely tobacco tins and plywood boxes.

Most of the projects published in *EE* are dead easy to build. It is finding out why they don't work afterwards that takes the time. For the beginner the trouble is usually caused by a wiring, or component insertion error, or equally often, by a "dry joint." If it's any comfort, for the veteran home constructor, failure to work first time is usually caused by exactly the same things.

When something is built and does not work, the experienced hobbyist will know what to suspect first; and so, eventually we will be using this column to expose the secrets of "debugging". But logically, we must first seek to master that most basic art—*soldering*. Learn to do this proficiently and you'll have all the fewer perplexing bugs to hunt down on the big day.

HARMLESS PRACTISE SOLDERING

There is but one way to learn to solder properly, and that is to practise, *and practise*. Get yourself a piece of Veroboard and a reel of 22 s.w.g. tinned copper wire, and, of course, a soldering iron. Snip off *one hundred* lengths of wire of about 30mm each and bend them as shown in Fig. 1, to be inserted as random links around the piece of stripboard (Veroboard). You are now almost ready for a solo practise flight. I say *almost*, because you will need something to hold the stripboard firm whilst applying the soldering iron (you will need both hands free), and the photograph shows a typical vice available for this purpose. If you are inventive, and reluctant to spend big money at this stage, rig something up with a pair of pliers and an elastic band, or with a clothes peg (Fig. 2).

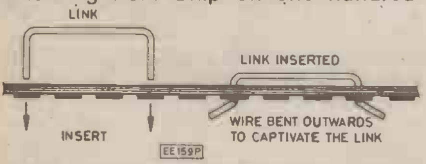


Fig. 1. Forming and inserting practise solder links.

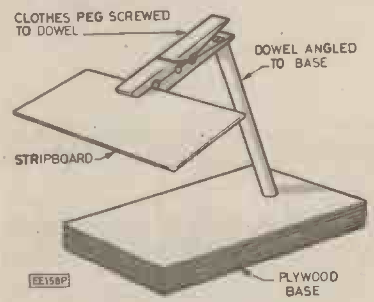


Fig. 2. A makeshift vice.

A typical mini vice.

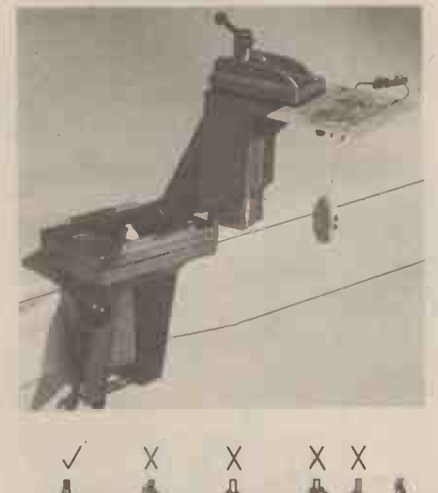


Fig. 3. Identifying poor joints on either stripboard or p.c.b.

This will prove good spiritual training.

Basically, a good solder joint is shiny and symmetrical, and curves gently into the two surfaces it is supposed to connect. Fig. 3 indicates how the "gentle curve" results when thorough "wetting" has taken place due to heat from the soldering iron activating the flux in the multicore solder.

HOW MUCH SOLDER?

The amount of solder you should feed into a joint is a matter only of common sense. Remember, the primary purpose of the joint is to create electrical contact, but it must have mechanical strength too, because components usually have no other means of support. Fig. 4 should help you to identify the correct amount of solder to apply. The application of too much solder can result in a joint that looks the same as one in which inadequate wetting of the track has taken place. In the case of too much solder, though, the bulbous appearance of the joint is caused by the fact that the solder has run out of copper track to spread out on.

Fig. 4. Apply the correct amount of solder.

CAUSES OF BAD WETTING

If you experience bad wetting despite all attempts to overcome it, you will probably find that either your stripboard (or p.c.b.) has been lying around for some time, or likewise your components (or tinned copper wire), so that they have become tarnished. The oxydisation that inhibits wetting may not be particularly visible, and yes indeed, it *can* afflict even tinned surfaces. There is only one escape route. Clean all offending surfaces with an abrasive.

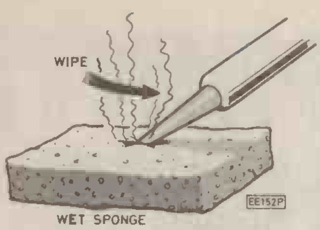
TEMPERATURE

Another way to improve wetting and good flux activation is to use a hotter iron. A hotter iron (370°C or greater) allows, indeed *necessitates* faster soldering. A cooler temperature setting is suitable whilst you are developing the basic skill, but a higher temperature setting will allow you to acquire that ultimate polish. The day should come when, in a crisis, your soldering is above suspicion. □

Mike Abbott

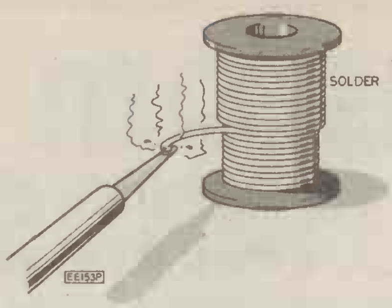
1

Clean the soldering iron bit thoroughly. Wet sponge is ideal.



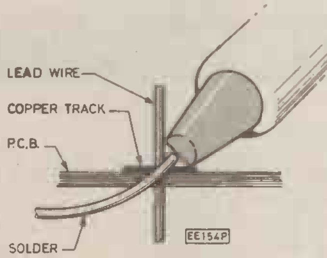
2

Tin the soldering iron tip, wetting it just enough to encourage heat transfer from the bit to the copper track and component lead. The idea is that when you make the joint the bit should carry a film of solder to form a heat conducting bridge to the work, not that the bit should carry enough molten solder to make the joint itself. Fresh solder should be applied at the time, for this purpose.

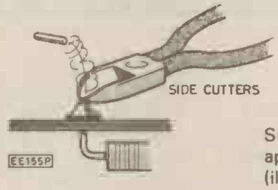


3

Apply the iron to the joint so that its flat surface (a beginner's iron should have one) forms a triangle between copper track and the perpendicular component lead. It is essential that the soldering iron bit imparts heat to both the track and the lead simultaneously. The moment contact is made, gently push some 22 s.w.g. multicore solder into the flat surface of the bit, encouraging molten solder to fill the "triangle" and flow on around the whole joint. If you are doing it right, the whole process should take about two seconds. Just keep practising on those links until you're happy. Only fresh solder will leave behind a shiny joint, especially if it is applied with smart, positive actions.



4



Snip off the excess leads to make it easier to approach other joints. Using side-cutters (illustrated) cut off just flush with the edge of the solder. Do not snip the solder itself, and be sure the joint has solidified first before disturbing it.

Fig. 5. The four steps to a good solder joint.

COUNTER INTELLIGENCE

BY PAUL YOUNG

Computer Evolution

Only those readers who were around during World War II will remember that erudite and entertaining radio programme called *The Brains Trust*. It consisted of a panel of four members, usually, Professor C. E. Joad, Aldous Huxley, Commander Campbell and Sir Malcolm Sargent. They endeavoured to answer questions on every conceivable subject, not boring political questions, but questions like, "Do you dream in colour or black and white", and is there any truth in the legend of, "The moving coffins in the Barbados vaults?"

Quite often their answers were so hilarious that the rest of the team were helpless with laughter, as for example when Commander Campbell said he knew a bald headed man whose head used to steam every time he ate marmalade!! Alas, they don't make 'em like that any more.

What prompted this sudden flow of memories from forty years ago, was simply this. Reading a periodical the other day, I read the bare unamplified statement that Alan Turing was the inventor of the computer, I immediately thought of what Professor Joad, with his extremely logical mind, would have said. He would have said, since he invariably commenced his answers in this way, "It all depends what you mean by a computer." These are my sentiments exactly, first you must define a computer.

In the beginning we had the static ones, such as Stonehenge, probably constructed around 2000 B.C.—inventor unknown. Recently some peasants in outer Mongolia found what they took to be a bunch of old ivory chopsticks but scientists say were part of a mathematical system and date it about 1000 B.C.—inventor unknown.

This brings us to the manually operated ones such as the Abacus. They have been around for a very long time, precise date and inventor unknown, and are still in use today in some parts of Russia, China and Japan (and even some UK Chinese Restaurants—Ed.).

To illustrate how adept some users of the Abacus are, just after the last war, a duel took place between a Japanese clerk in the Ministry, named Matsuzake and an American Sergeant named Tom Wood, who was using the latest electro mechanical desk calculator. Matsuzake and his Abacus beat him hands down, much to everone's delight.

At this point, I must mention another early type of computer, the slide rule. This was invented by William Oughtred, Rector of Albury (1575–1660). He also introduced the symbol "X" for multiplication.

This brings us to Charles Babbage, born in 1792, and his analytical engine. Many regard him as the true father of the computer. Unfortunately it was a hundred years ahead of its time and the gearing so complicated that no mechanic could make it.

Mechanical Computer

Only one other person ever understood it, and that was Augusta Ada Countess of Lovelace, only child of Lord Byron. He was worried that she might turn out to be a poet. He need not have worried, not only was she a brilliant mathematician, she was dazzlingly beautiful as well. She realised what Babbage was trying to do and fell in love with him on the spot. So cheer up all you lovelorn computer buffs, all you have to do, is find an Ada.

Poor Babbage died in 1871, a disappointed man, unable to get his computer built. He might have been consoled if he had realised that with his publications and Lady Lovelace's notes, they had between them laid the foundation of the first generation of digital computers, or number crunchers, to use the vernacular.

We now come to inventors like William Seward Burroughs and Dorr E. Felt who between them built the first practical calculating machine that had a print out. Although by the beginning of the twentieth century Babbage had become a forgotten man, engineers who studied his notes realised that although his invention was wonderful it was pointless to continue with mechanical computers and at last work was started on the electronic ones.

We must now mention two Americans, John Prosper Eckert and John William Mauchly, who are credited with the invention of the ENIAC which stands for Electronic Numerical Integrator and Calculator. This was commenced in 1943, and finished in 1946 and is therefore among the earliest electronic computers.

Code breaker

Finally we arrive at Alan Mathison Turing, he played a vital role in the development of the Colossus, a code breaking computer which was operational in 1943 and helped to break the German *Enigma* code. It is important to note the shortcomings of these early computers, for example, the ENIAC had 18,000 valves. It needed 160 Kilowatts of power and the heat dissipation was a major headache. Perhaps the worst problem was caused by valve failure, more time was spent in detecting and changing valves than in calculating. The final step only came after three Americans, John Bardeen, Walter Houser Brattain, and William Bradford Shockley invented the transistor.

So I am sure readers, you will now understand why I echo Cyril Joad's trademark, "It all depends what you mean by"

NASCOM PRINTER HANDSHAKE

G.D.SOUTHERN

RECENTLY A QUME Sprint 5 serial driven printer was borrowed to print out software from a Nascom 2 computer. The Qume could be run at 300 baud continuously without the printer buffer overflowing, but at this speed printout was achieved somewhat slowly. As the Nascom in its basic form also has a 1200 baud capability, an investigation was started to see if the Nascom could be made to respond to the "Clear To Send" (CTS) signal from the printer without software modifications or the use of port "bit".

At the beginning of the print operation the printer raises "clear to send" from approximately −12 volts to +12 volts to signify that the device is ready to receive data. When the printer buffer is full, the printer returns CTS from +12 volts to −12 volts informing the sending device to stop data transmission.

THE NASCOM SERIAL PORT

Both the Nascom 1 and 2 utilise a 6402 UART (Universal Asynchronous Receiver Transmitter) serial I/O device. On investigation it was discovered that when the input buffer of the UART is empty, the voltage level on pin 22, which represents a status signal "Transmitter Buffer Register Empty (TBRE)", goes to a high level (greater than 2·4 volts). Thus a low level would indicate to the microprocessor that a data byte was still in the transmitter buffer register and so it must wait until TBRE goes high before loading another character in to the UART.

On the Nascom, TBRE is connected to the data bus line 6. In order to allow normal operation of the data bus, TBRE is a tri-state output which can only be sampled when a low level (less than 0·8 volts) is placed on UART pin 16, the "Status Flag Disable" (SFD) connection. A low level will allow the system microprocessor to read the UART port status.

SOFTWARE METHOD

A simple software flow chart is shown in Fig. 1, illustrating how the microprocessor would wait for TBRE to go high. Loop 1 in Fig. 1 reads the status word from the UART and checks bit 6 (which represents TBRE). If bit 6 is zero, the status word is read again, and the whole process repeated until a high level (non-zero) is read on bit 6. The software is now flagged that the UART transmitter buffer register is empty and waiting for the next character to be loaded into the buffer register.

Loop 1 could be extended to check not only bit 6 of the UART status port, but also to check a "bit" of another port to examine the status of the CTS signal from the printer. However, it was considered that an easier method would be to hardware gate the CTS signal with bit 6 of port 2, thus eliminating any software modifications.

HARDWARE METHOD

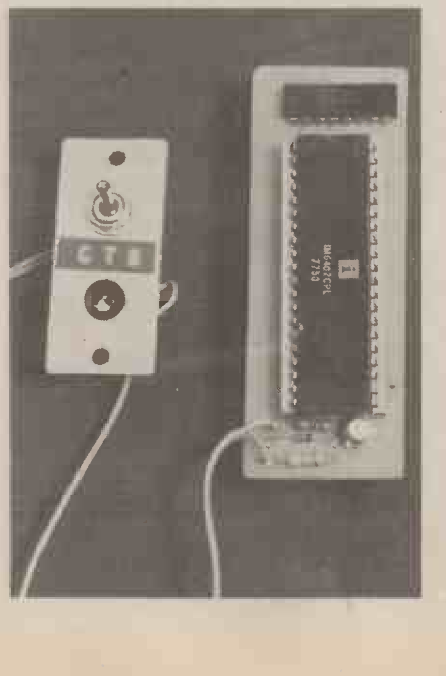
Reference to the circuit diagram (Fig. 2) shows that the RS232 CTS signal is applied to the base of transistor TR1. Resistor R1 limits the base current of TR1 and diode D1 clamps the negative voltage swing to approximately −0.7 volts (remember RS232 switches between +12 and −12 volts). The inverted CTS signal at the collector of TR1 now conforms to TTL levels and is connected to the select input of multiplexer IC1. The operation of IC1 can be explained by reference to the truth table in Table 1.

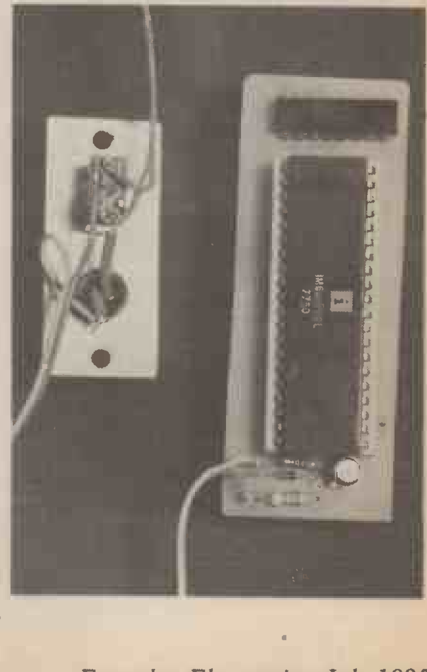
Pin 22 of the UART is disconnected from the data bus line D6 and connected to the I_0 input line of the multiplexer IC1. Data line D6 is hence connected to output Z of IC1. Input I_1 of the multiplexer is tied to ground.

Software reads the status word from port 2 by setting SFD low. SFD now not only enables the output of the UART but also enables the output of the multiplexer IC1 via the enable signal (pin 15). If the CTS signal from the printer is high, the output of TR1 will be low, thus selecting the I_0 input on IC1.

Output Z of IC1 will be equal to the status condition of TBRE. If CTS from the printer goes low, the select input on IC1 will go high thus selecting input I_1. As I_1 is tied to ground, output Z of IC1 will be low. So when the software is checking the UART status word, bit 6 will reflect the condition of CTS from the printer and TBRE from the UART. A data character will only be loaded into the UART if CTS and TBRE are both high.

Switch S1 selects printer or cassette operation. The l.e.d. D2 indicates that CTS is high.





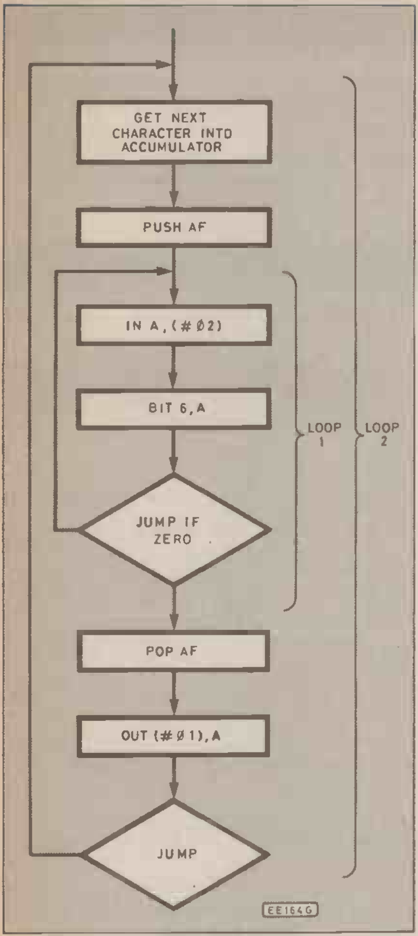


Fig. 1. Flow chart illustrating software detection of "buffer register empty".

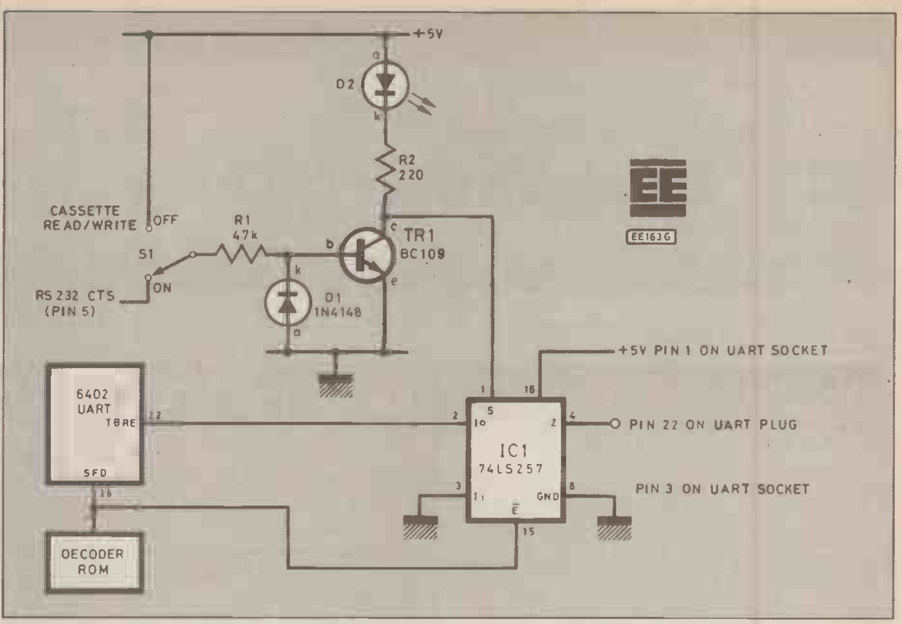


Fig. 2. Complete circuit diagram of the printer handshake modification.

Table 1: function table for 74LS257

$\overline{E}$ (SFD)	S ($\overline{CTS}$)	$I_{\emptyset}$ (TBRE)	I_1	Z
H	X	X	L	OFF
L	H	X	L	L
L	L	L	L	L
L	L	H	L	H

Note: L = low, H = high, X = don't care.

ASSEMBLY

The UART is removed from the Nascom p.c. board. A small printed circuit board is assembled containing the components shown in the circuit diagram (Fig. 2). A forty pin wire-wrap socket is soldered to this board to contain the UART, as shown in Fig. 3 and the photographs. The socket pins are cut to approximately half-an-inch long and carefully soldered to a 40 pin header plug.

Note that pin 22 is cut back to the board and a separate lead taken from pin 22 on the header plug to the position marked on the board. □

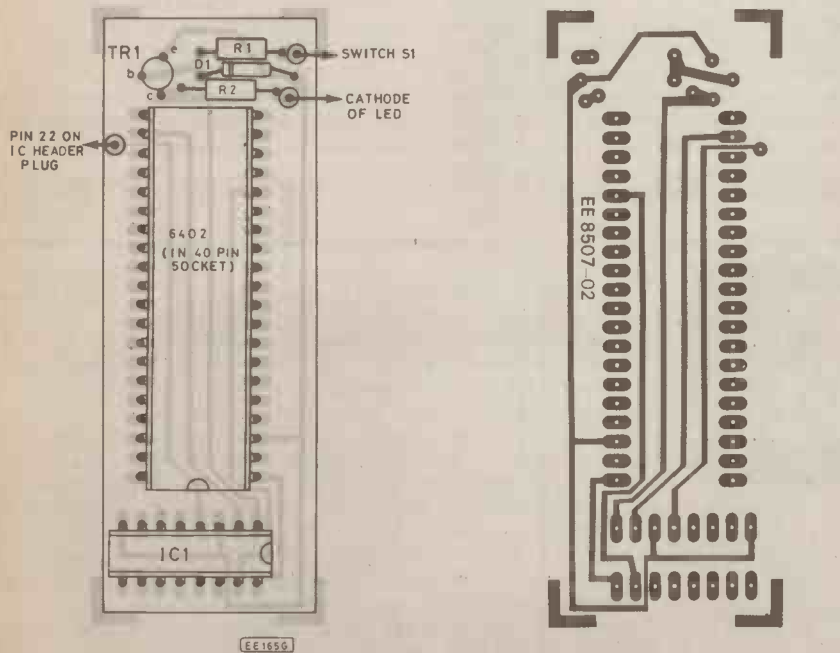


Fig. 3. Component layout and p.c.b. design. The p.c.b. is available from the *EE PCB Service*, order code 8507–02.

COMPONENTS

See Shop Talk page 377

Resistors
R1 47k
R2 220
Both $\frac{1}{8}$ Watt, 5%, carbon film

Semiconductors
IC1 74LS257
TR1 BC109
D1 1N4148
D2 5mm l.e.d.

Miscellaneous
Printed circuit board: single-sided, size 80 × 30mm: *EE PCB Service*, order code 8507–02.
40 pin wire-wrap i.c. socket; 40 pin i.c. header plug.
s.p.d.t. switch

Approx. cost Guidance only **£7.00**

CIRCUIT EXCHANGE

This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part the original work of the sender and that it has not been offered for publication elsewhere.

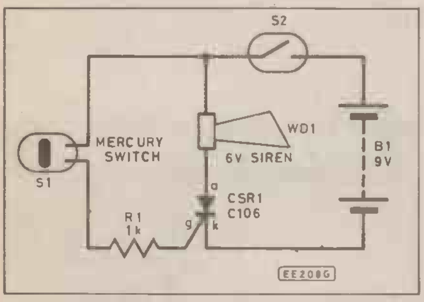
MERCURY SWITCH BICYCLE ALARM

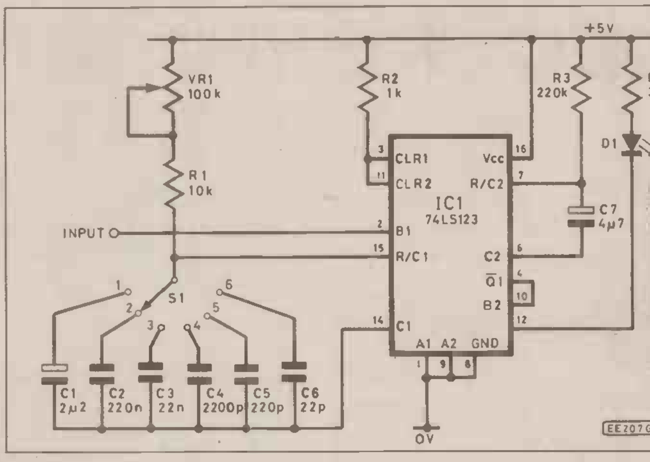
This is a very simple, yet very effective bicycle alarm which relies upon a mercury switch (S1) to trigger a thyristor (CSR1). This then sounds the siren (WD1) hopefully scaring off or attracting attention to the would-be thief. To turn the alarm on or off a reed switch (S2) is used, since a magnet to activate it can be carried around very easily, and the thief cannot turn the alarm off.

The device can be mounted in a small plastics box, with a PP3, 9V battery for power. The reed switch is glued to the lid of the box and the box is then placed in the bicycle's saddle bag so that the mercury switch is nearly horizontal.

Although designed mainly for use with bicycles, this little circuit could be used in a variety of other applications. One such application is the protection of home electrical products such as videos etc.

M. James,
Lincoln.





SWITCH POSITION	RANGE
1	10Hz - 100Hz
2	100Hz - 1KHz
3	1KHz - 10KHz
4	10KHz - 100KHz
5	100KHz - 1MHz
6	1MHz - 10MHz

MONOSTABLE FREQUENCY METER

The circuit, shown above, is for a simple frequency measuring device, based on a 74LS123 dual monostable. This is a retriggerable type, and it is this feature that is used to measure the periodic time of an input waveform, and give an indication of frequency.

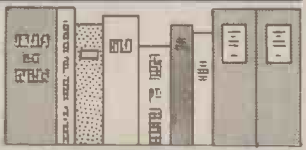
The signal is fed to the B input of the first monostable. Its time constant depends upon the setting of the potentiometer, VR1, and the value of capacitor selected by the rotary switch, S1. If the time constant is longer than the periodic time of the input signal, then this monostable is constantly retriggered. If it is shorter, then the mono, times out, switching the Q output high. This then triggers the second monostable, which turns on the l.e.d.

In practice, the potentiometer, VR1 is set to the middle of its travel, and the rotary switch used to step down the frequency ranges, until the l.e.d. lights. The pot. is then adjusted until a point is reached where this indicator just comes on. By reading off a calibrated scale against the potentiometer setting, the frequency can be measured.

Accuracy depends upon initial setting up, and capacitor tolerances. By selecting these on test, frequency measurement to within 5% is possible. This is perfectly satisfactory for use with most digital circuits, where clock signals are usually multiples of each other, e.g. a half or a quarter.

Paul Thompson,
Lennoxtown,
Glasgow.

BOOK REVIEWS



USBORNE INTRODUCTION TO ELECTRONICS

Author Pam Beasant
Price £4.50 hardback, £2.25 paperback
Size 240 × 170mm. 48 pages
Publisher Usborne Publishing Ltd
ISBN 0 86020 809 5

Usborne Introductions are always bright, readable and well-presented, and Pam Beasant's *Introduction to Electronics* is no exception. The material is arranged so that the beginner can actually build circuits almost immediately—so that understanding comes from doing, rather than reading.

This emphasis on knowing *how,* prior to knowing *that,* is central to the Usborne approach, and this kind of knowledge is particularly appropriate to the science of electronics.

There are simple circuits here which can be built at once on Veroboard, so that the beginner can become familiar immediately with standard electronic components. However, where theoretical points are explained, the description is sometimes cursory or badly-worded. The material at the end of the book is useful: the history of electronics is outlined, and there are practical hints on building and testing circuits; and the more important of the laws of electronics are given.

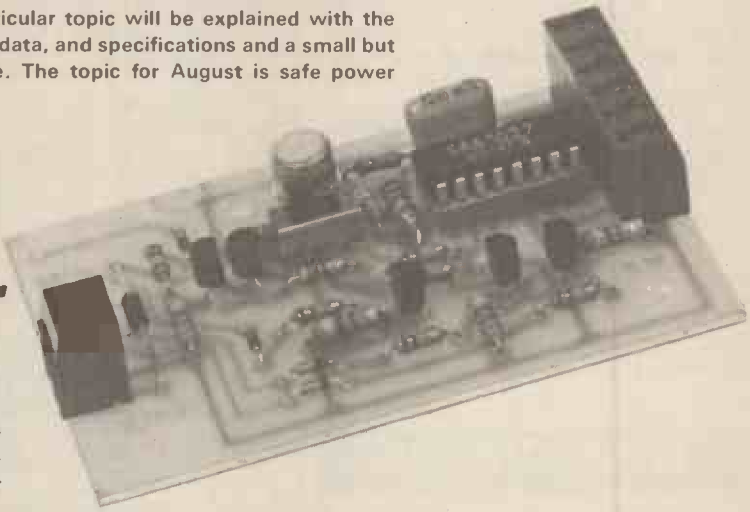
This is a good back-up to schoolwork. The approach is modern and bright, and designed to provoke questions. The use of colour, and the excellent layout and design of the material will attract the interest of any newcomer to this most important subject.

D.A.B.

AUGUST FEATURES...

ELECTRONIC BUILDING BLOCKS

A new series with a new look at electronic construction and design. Each month a particular topic will be explained with the help of plenty of diagrams, data, and specifications and a small but essential dose of formulae. The topic for August is safe power supplies from the mains.



STEPPING MOTORS
Stepper Motor Interface

Stepping motors explained, plus a useful constructional project which allows precise controlled movement from almost any computer user port.

TREMOLO/VIBRATO UNIT

Providing two different musical effects which can be used individually or together this unit incorporates a compander noise reduction circuit to give a 10kHz bandwidth with good signal to noise ratio.

TRI STATE THERMOMETER

An electronic thermometer which uses coloured l.e.d.s for "see-at-a-glance" temperature checking.

Computer Club Mystery

EVERYDAY ELECTRONICS and computer PROJECTS

AUGUST 1985 ISSUE ON SALE FRIDAY, JULY 19

EMERGENCY LIGHT FLASHER

M.G. ARGENT

With summer coming there's increased motoring and that means a greater possibility of car break-down, however small. This project will provide a very eye catching warning to other drivers of your lame vehicle around the bend!

To make it as practical as possible, it has been designed around the plentiful 555 timer and uses easily obtainable components. It will also fold up to take a minimum of boot space—so important on holidays.

THE CIRCUIT

The circuit in Fig. 1 can be split into two almost identical sections. IC1 is a conventional astable (free running) multivibrator and its output (pin 3) drives TR1 via R3 which will turn on and light LP1. The purpose of TR1 is to provide an increase in available current to drive the lamp. IC1 pin 3 also, via R4, turns on TR2 which turns *off* TR3 making sure that LP2 will not light. When the output of IC1 changes, i.e. goes to the low output state, TR1 will turn off and extinguish LP1 and the reverse will happen to TR2 and TR3 causing LP2 to light. So what we end up with is two alternately flashing lamps.

The second section around IC2 works in the same way, only this time there is a slight difference in the value of R7 causing a marginally faster flashing rate.

When the four lamps are positioned as in Fig. 4 a very effective overall flashing of four lamps occurs, causing the intended eye-catching warning. The 12V supply is derived from the car battery, which can be via the ever popular cigar lighter or simply hooked directly onto the car battery via a pair of large croc. clips. (This last method will require an in-line 3 amp fuse.) D1 is shown on the circuit

COMPONENTS

Resistors

R1,R2,R6	15k (3 off)
R3,R4,R5,R8,R9, R10	1k (6 off)
R7	12k

All resistors ¼W 5%

Capacitors

C1,C3	15µ/16V elect (2 off)
C2,C4	10n (2 off)

See Shop Talk page 377

Semiconductors

D1	1N4001
TR1,TR3,TR4, TR6	BFY51 (4 off)
TR2,TR5	BC108 (2 off)
IC1,IC2	555 timer (2 off)

Miscellaneous

LP1–4	12V car indicator lamps (4 off)

Veroboard 20 strips by 34 holes on 0·1in. matrix. Two-core flex as required for connection to car battery. Three pieces of rod to make the tripod, and one small plastic box.

Approx. cost Guidance only **£15.00**

Fig. 2. Veroboard layout.

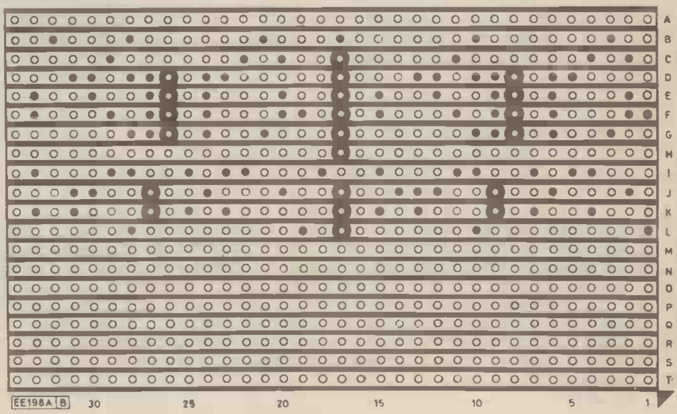
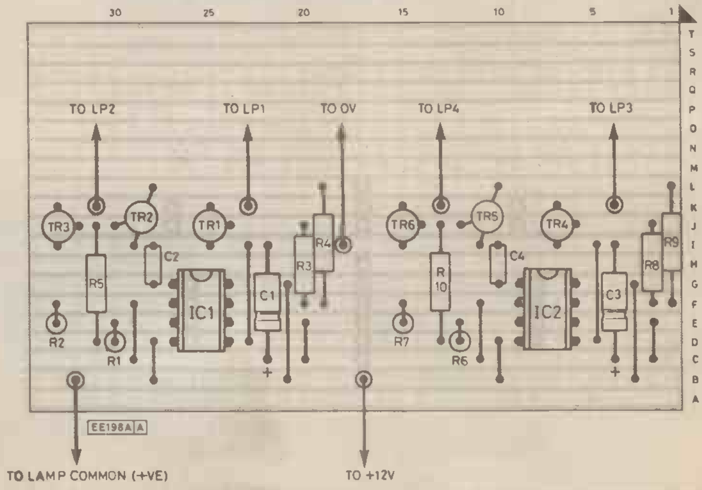


Fig. 3. Component layout.



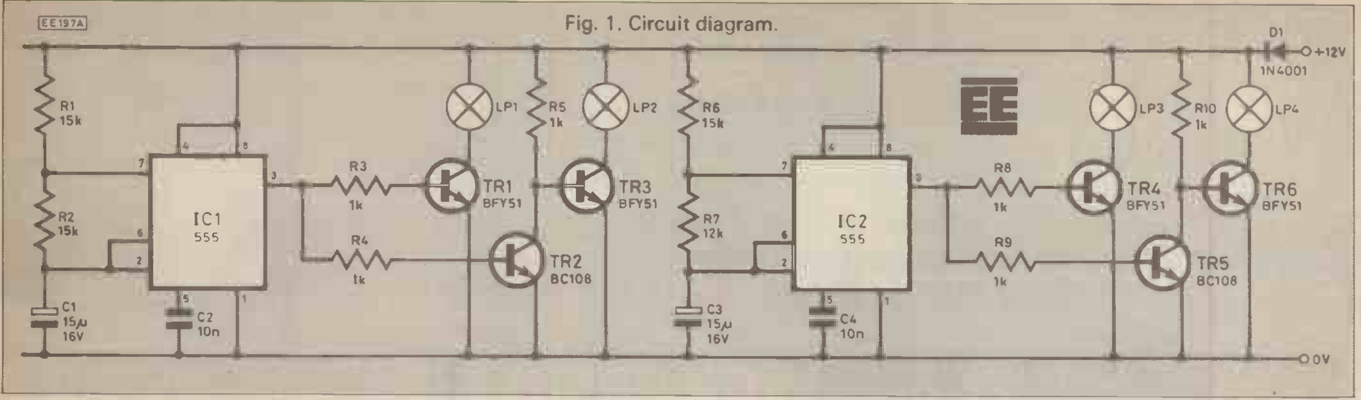


Fig. 1. Circuit diagram.

diagram and is optional: it is useful to avoid any damage resulting from connecting the 12V the wrong way round.

CONSTRUCTION

All the electronics in the prototype were housed in a small plastic box, and were assembled on a piece of Veroboard consisting of 20 copper strips by 34 holes of 0·1in. matrix. The tracks that need to be cut (using a Verocutter or a small drill) are shown in Fig. 2 and the component layout is shown in Fig. 3. This layout is not at all critical and may be altered to suit the box that will be used to house the electronics.

The tripod stand was made out of surplus metal curtain rail which many of us have around at home. The pivot used at the top of the tripod was a plastic "nut and bolt" type fitment from self-assembly cabinets. All these parts are available from d.i.y. stores. The metal legs of the tripod were used as the common lamp supply (+12V). Make sure that they *do not* touch the metal body of the car when in use!

TESTING

After checking the electronics assembly for accuracy, connect up to the 12V supply via a 3 amp fuse. All being well, the lamps will flash. If not, check that pin 3 of each i.c. switches between 0V and +12V repeatedly. Temporarily shorting the emitter and collector of the transistor driving the non-working lamp will light the respective lamp, suggesting that there is a fault around the transistor. □

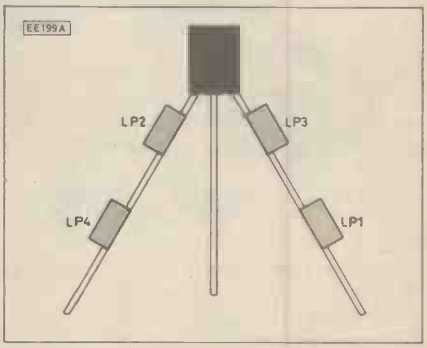


Fig. 4. General tripod assembly.

NEW · NEW · NEW · NEW
PRODUCTS
NEW · NEW · NEW · NEW

COMPUTER COMMUNICATION

If you're a home computer user and have been waiting for a low cost modem, this might be the one for you. It's fully approved for use with British Telecom equipment and an interface pack makes it compatible with most home micros.

It operates with standard or TTL level RS 232/243 signals via an interface that will support a split Baud rate. A simple three-position switch selects full or half-duplex operation.

In full duplex, the modem transmits at 75 Baud and receives at 1200 Baud. When in half duplex mode it sends and receives at 1200 Baud.

The unit is battery powered with four AA size batteries offering up to fifty hours use. Connections from the modem are made via a five-pin DIN socket.

The **Protek** 1200 Modem is available from Protek Computing Ltd. at a special price for EE readers. The complete package including: modem, interface, cable and software is available for £39.95 or £49.95 for the Amstrad version. For more details contact:

Protek Computing Ltd.,
Dept. EE, 1A Young Square,
Brucefield Ind. Park,
Livingstone, West Lothian.

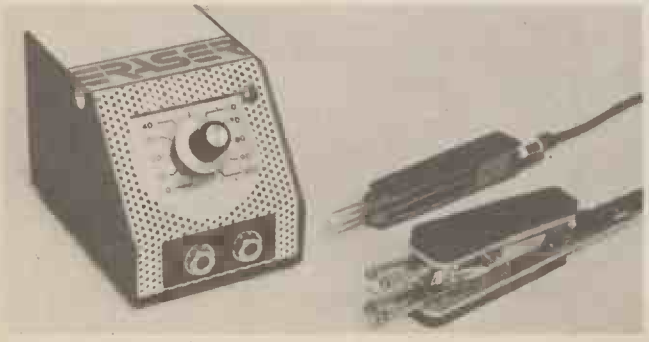
NO PROBLEM FOR STRIPPERS

Probably of more interest to the professional but worth a mention, is the new thermal wire stripper from **Rush**. The new model, MT-1, uses a positive tweezer action to cleanly strip insulation from wires without danger to the conductor.

The tool is especially useful for stripping problem wire such as Teflon and PTFE and will strip wire between 0·82 and 0·002 sq.mm.

Heating for the element is supplied from a self contained power pack which gives a low voltage-high current supply. Temperature is infinitely variable by the turn of a knob.

Rush Wire Strippers,
Dept. EE, Unit M,
Hunting Gate,
Andover, SP10 3LU.



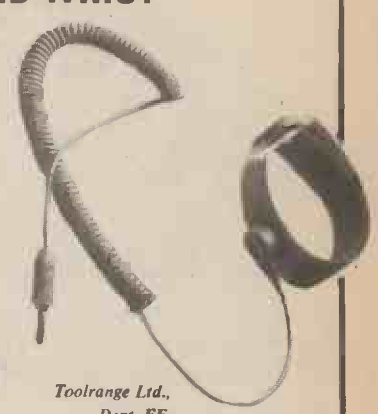
STRAPPED WRIST

If you're prone to static and suffer from blown chips, then you deserve a strapped wrist.

These wrist bands are part of a comprehensive range of antistatic aids from **Toolrange**. The new design shown here comes complete with a coiled earth wire and together with the D-type adjustable buckle, is said to offer a new dimension to operator comfort.

A banana plug connection at one end of the wire provides a secure earth and a press-stud at the other allows a clip on-clip off arrangement to the wrist strap.

Details of this and other products in the range are all in the latest catalogue available from:



Toolrange Ltd.,
Dept. EE,
Upton Road,
Reading,
Berks., RG3 4JA.

PUT IT IN A BOX

Made in Great Britain, a new case from **West Sussex Instruments Ltd.** This should be of interest to many hobbyists who construct ba..ery operated equipment.

It's moulded in three parts in ABS plastic and has a separate battery compartment capable of accepting up to two PP3 batteries.

At only £2.40 it should prove to be very popular.

For more details contact:

West Sussex Instruments Ltd.,
Dept. EE,
12A Coronation Buildings
Brougham Road,
Worthing,
West Sussex,
BN11 2NW.

TESTING TRIP

A new addition to the West Sussex range of instruments is the WSI RCCB Tester. As with all their instruments it comes complete with robust carrying case, mains lead and 13A plug.

The meter has a large 12·7mm l.c.d. and a neon indication of earth continuity and line connection before testing.

Test currents are in the range, 2·5 to 500mA and offer a 2% accuracy. The tripping current can be selected to be injected at 0 degrees or 180 degrees cycle.

It costs £79.50 and more details are available from:

West Sussex Instruments.
(See above.)

SOLITONS ...Too fast for Electronics

George Hylton...

BACK in the 19th century, John Scott Russell, a British engineer, was riding by a canal-side when he noticed something that intrigued him. It was a wave. But no ordinary wave. It moved steadily along the canal, mile after mile, and it was quite alone. No ripples in front of it, and none behind. Russell, in describing it, called it a solitary wave.

In time, the mathematicians got to work and discovered how solitary waves can propagate, not just in water, but in other media. It turned out that many impulse-like phenomena can be treated mathematically as if they were solitary waves. Even sub-atomic particles can behave like these waves.

SOLITON COMMUNICATION

Re-named solitons for short, solitary waves are now engaging the attention of communications engineers. Light waves can exist in soliton form, and recently it was discovered that they could be manufactured in the laboratory with a soliton laser. What interests communications engineers is the extreme shortness of a soliton. The light pulse that emerges from a soliton laser is measured not in microseconds, or nanoseconds or even picoseconds, but in femtoseconds. A femtosecond is a thousand-million-millionth of second. An optical soliton might have a duration of 50 femtoseconds.

By using soliton light impulses instead of ordinary ones, optical cables should be able to carry vastly increased traffic. At present the shortest light pulses last for about a nanosecond (a thousand-millionth of a second). Solitons should be at least a thousand times faster. So on the face of things there seems to be a prospect of at least a thousand-fold increase in traffic capacity.

UNUSUAL PROPERTIES

There are, however, snags. Low-loss optical cables capable of carrying solitons do not yet exist. Ordinary optical cables just won't do the job. A striking feature of soliton pulses is that they stay 'sharp'. They don't spread out like ordinary pulses, as they travel along a glass fibre. But in order to propagate at all, there must be an interplay between the soliton and the glass. Solitons are a bit like supersonic booms, shock waves. Both are high-power impulses which maintain their shape by changing the characteristics of whatever medium they are travelling through. In the case of an optical soliton in a glass fibre, the refractive index of the glass must be changed by the soliton. This calls not only for high intensity light, but for glass with unusual optical properties. The properties needed have been calculated, and it should be possible to make the required glass. That leaves several other problems.

One such problem is the making of soliton lasers that are capable of reliable operation in cable networks. The original soliton laser was large and cumbersome. What's needed is a cheap semiconductor alternative. The Royal Society recently made a grant to a Scottish university to construct such a device.

The high power needed to keep a soliton going is not going to be much of a problem. What matters is the concentration of energy, the intensity of the light. In a modern optical cable the light is confined to a very small channel down the middle of the fibre. In this small space, powers of a few watts will be sufficient to produce intense enough illumination.

What happens when the attenuation of the cable reduces the light intensity to the level where soliton propagation becomes impossible? The research laboratory of British Telecom have done a computer simulation which shows that although the soliton pulse does then broaden, it doesn't broaden all that much. So high data rates should still be possible.

ELECTRONICS TOO SLOW

So far, so good. But now comes a different problem. If information is conveyed by solitons at, say, a million million bits per second, how can it be handled at the receiving end? Electronics as we know it can't do the job. The present speed limit of logic circuits is around a thousand million bits per second (1G B/s). This might conceivably be increased, say tenfold, by using more advanced chips and devices. But there are physically insurmountable barriers to a thousandfold increase, which is what's needed.

The likely answer will be to abandon electronics as too slow and turn to optical devices. It might be possible to make optical switches work at the required speeds. The optical logic would share out the incoming soliton bitstream to a number of receivers, effectively reducing the bit rate speed to what the slow, old-fashioned technology, electronics, could handle.

PLEASE TAKE NOTE

Immersion Heater Controller *(April 85)*

In the *Components List* RTH1, 2, 3, 4 should be ignored. These thermistors are R15, 16, 17, 18 respectively. The RS part number for RLB should read: 348–403.

Two connections are not shown in the circuit diagram. These are from S1a position 1 (CANCEL) to +Ve, and from cathodes D6–10 to 0V.

A track break is missing from the stripboard layout of Fig. 2, which should be located at matrix position 35*K*.

PCB SERVICE

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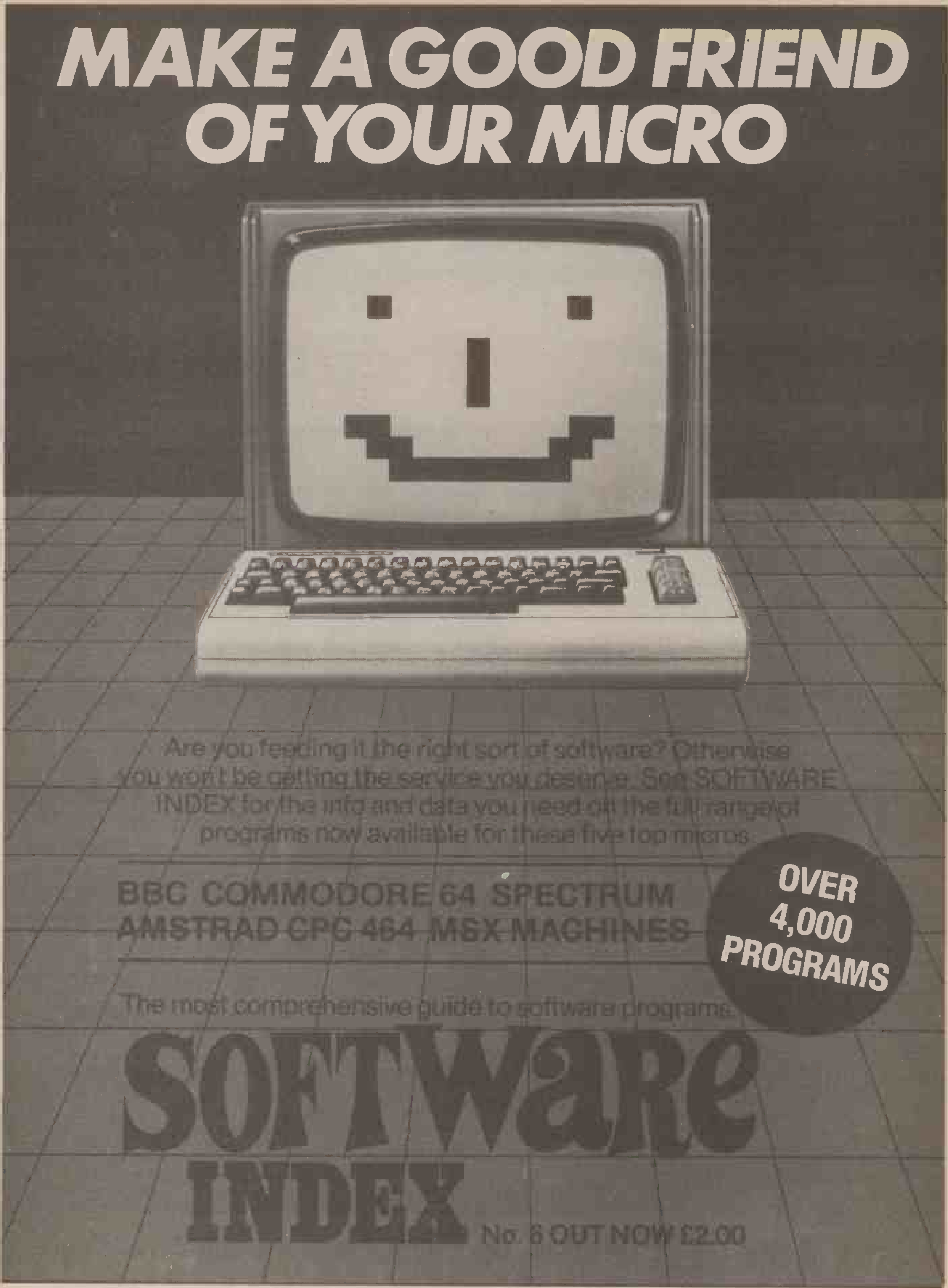
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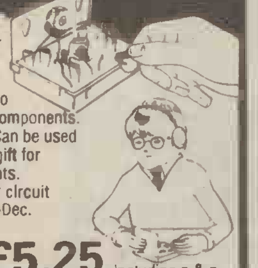

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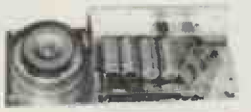

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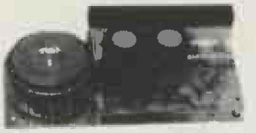

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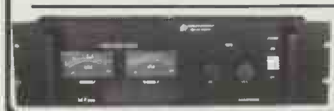

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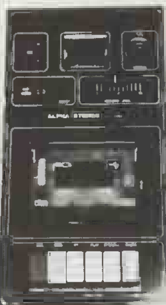

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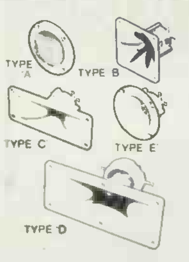

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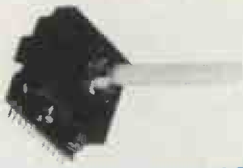

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Top Ten Kits

THIS/LAST MONTH		DESCRIPTION	CODE	PRICE	BOOK
1.	(–)	Live-Wire Detector	LK63T	£2.95	14 XA14Q
2.	(1)	75W Mosfet Amp.	LW51F	£15.95	Best E&MM
3.	(2)	Partylite	LW93B	£10.95	Best E&MM
4.	(4)	Car Burglar Alarm	LW78K	£7.49	4 XA04E
5.	(9)	U/sonic Intrudr Dtctr	LW83E	£10.95	4 XA04E
6.	(10)	Computadrum	LK52G	£9.95	12 XA12N
7.	(8)	Light Pen	LK51F	£10.95	12 XA12N
8.	(11)	Syntom Drum Synth.	LW86T	£12.95	Best E&MM
9.	(7)	8W Amplifier	LW36P	£4.95	Catalogue
10.	(6)	ZX81 I/O Port	LW76H	£10.49	4 XA04E

Over 100 other kits also available. All kits supplied with instructions. The descriptions above are necessarily short. Please ensure you know exactly what the kit is and what it comprises before ordering, by checking the appropriate Project Book mentioned in the list above.

- May be used by any computer with RS232 facility.
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