EVERYDAY
ELECTRONICS
and ELECTRONICS MONTHLY

SEPTEMBER 1986 £1·10

INFRA-RED BEAM ALARM

SCRATCH BLANKER

FREEZER FAILURE ALARM

SIMPLE PRINTER BUFFER

Newcomers Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

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

1. 5 – 13 amp ring main junction boxes
2. 5 – 13 amp ring main spur boxes
4. 5 – surface mounting switches suitably insulated for mains voltage
5. 3 – electrical switches intermediate type, will also replace 1 or 2 way switches, white flush mounting
7. 4 – in flex line switches with neons
9. 2 – mains transformers with 6V 1A secondaries
10. 2 – mains transformers with 12V $\frac{1}{2}$A secondaries
11. 1 – extension speaker cabinet for 6$\frac{1}{2}$" speaker
13. 12 – glass reed switches
17. 2 – ultra transmitters and 2 receivers with circuit
19. 2 – light dependent resistors
25. 4 – wafer switches – 6p 2 way, 4p 3 way, 2p 6 way, 2p 5 way, 1p 12 way small one hold fixing and good length $\frac{1}{4}$ spindle your choice
28. 1 – 6 digit counter mains voltage
30. 2 – Nicad battery chargers
31. 1 – key switch with key
33. 2 – aerosol cans of ICI Dry Lubricant
34. 96 – 1 metre lengths colour-coded connecting wire
39. 1 – long and medium wave tuner kit
41. 8 – rocker switch 10 amp mains SPST
45. 1 – 24 hour time switch mains operated (s.h.)
48. 2 – 6V operated reed switch relays
49. 10 – neon valves – make good night lights
50. 2 – 12V DC or 24V AC, 3 CO relays
51. 1 – 12V 2 CO miniature relay very sensitive
52. 1 – 12V 4 CO miniature relay
53. 2 – mains operated relays 3 × 8 amp changeover (s.h.)
54. 10 – rows of 32 gold plated IC sockets (total 320 sockets)
55. 1 – locking mechanism with 2 keys
56. 1 – miniature uniselector with circuit for electric jigsaw puzzle
60. 5 – ferrite rods 4" × 5/16" diameter aerials
61. 4 – ferrite slab aerials with L & M wave coils
63. 1 – Mullard thyristor trigger module
64. 10 – assorted knobs $\frac{1}{4}$ spindles
65. 5 – different thermostats, mainly bi-metal types
66. 1 – magnetic brake – stops rotation instantly
67. 1 – low pressure 3 level switch can be mouth operated
69. 2 – 25 watt pots 8 ohm
70. 2 – 25 watt pots 1000 ohm
71. 4 – wire wound pots – 18, 33, 50 and 100 ohm your choice
72. 1 – 1250 watt dimmer Ultra ref SE20
77. 1 – time reminder adjustable 1-60 mins clockwork
81. 2 – 30A panel mounting slyslok fuses
85. 1 – mains shaded pole motor $\frac{3}{4}$" stack – $\frac{1}{4}$ shaft
89. 1 – mains motor with gear box 1 rev per 24 hours
91. 2 – mains motors with gear box 16 rpm
96. 1 – thermostat for fridge
98. 1 – motorised stud switch (s.h.)
101. 1 – 2$\frac{1}{2}$ hours delay switch
103. 1 – mains power supply unit – 6V DC
104. 1 – mains power supply unit – 4$\frac{1}{2}$V DC
105. 1 – 5 pin flex plug and panel socket
107. 1 – 5" speaker size radio cabinet with handle
110. 10 – slider type volume controls
111. 2 – musical boxes (less keys)
112. 1 – heating pad 200 watts mains
113. 1 – FM front end with tuning condenser and data
114. 1 – 1W amplifier Mullard 1172
115. 1 – wall mounting thermostat 24V
118. 1 – teak effect extension 5" speaker cabinet
120. 2 – p.c. boards with 2 amp full wave and 17 other recs.
121. 4 – push push switches for table lamps etc.
122. 10 – mtrs twin screened flex white p.v.c. outer
123. 100 – staples for thin flex
124. 25 – clear plastic lenses 1$\frac{1}{2}$ diameter
127. 4 – pilot bulb lamp metal clip on type
128. 10 – very fine drills for pcbs etc
129. 4 – extra thin screw drivers for instruments
132. 2 – plastic boxes with windows, ideal for interrupted beam switch
134. 10 – model aircraft motor – require no on/off switch, just spin to start
136. 2 – car radio speakers 5" round 4 ohm made for Radiomobile
137. 1 – 6$\frac{1}{2}$" 4 ohm 10 watt speaker and 3" tweeter
139. 10 – 4 BA spanners 1 end open, other end closed
145. 2 – 4 reed relay kits 3V coil normally open or c/o if magnets added
146. 20 – pilot bulbs 6.5V.3A Philips
147. 1 – secret switch kit with data
149. 4 – socket covers (protect inquisitive little fingers) for twin 13A
152. 1 – air or gas shut off valve – clockwork operated
153. 1 – air or gas shut off valve – thermostat operated
154. 1 – 12V drip proof relay – ideal for car jobs
155. 3 – varicap push button tuners with knobs
158. 5 – 12 way connector blocks 2A 250V
159. 3 – 12 way connector blocks 25A 250V
162. 1 – 13A fused and switched spur for surface mounting or can be removed from box for flush mounting
163. 3 – 13A sockets good British make but brown
169. 4 – short wave air spaced trimmers 2-30f
171. 1 – shocking coil kit with data – have fun with this
172. 10 – 12V 6W bulbs Philips m.e.s.
178. 3 – oblong amber indicators with lilliputs 12V
180. 6 – round amber indicators with neons 240V
181. 100 – p.v.c. grommets $\frac{3}{8}$ hole size
182. 1 – short wave tuning condenser 50 pf with $\frac{1}{4}$" spindle
184. 1 – three gang tuning condenser each section 500 pf with trimmers and good length $\frac{1}{4}$" spindle
188. 1 – plastic box sloping metal front, 16 × 95mm average depth 45mm
    2 – double pole 20 amp 250V flush mounting switch – white
191. 6 – B.C. lamp holder adaptors white
193. 6 – 5 amp 3 pin flush sockets brown
195. 5 – B.C. lampholders brown bakelite threaded entry
196. 1 – in flex simmerstat for electric blanket soldering iron etc.
197. 2 – thermostats, spindle setting – adjustable range for ovens etc.
199. 1 – mains operated solenoid with plunger 1" travel
200. 1 – 10 digit switch pad for telephones etc.
201. 8 – computer keyboard switches with knobs, pcb or vero mounting
208. 20 – mtres 80 ohm, standard type co-ax off white
211. 1 – electric clock mains driven, always right time – not cased
216. 1 – stereo pre-amp Mullard EP9001
232. 2 – 12V solenoids, small with plunger
236. 1 – mains transformer 9V 1 amp secondary C core construction
241. 1 – car door speaker (very flat) 6$\frac{1}{2}$" 15 ohm made for Radiomobile
242. 2 – speakers 6" × 4" 4 ohm 5 watt made for Radiomobile
243. 2 – speakers 6" × 4" 16 ohm 5 watt made for Radiomobile
244. 1 – mains motor with gear-box very small, toothed output 1 rpm
245. 4 – standard size pots, $\frac{1}{2}$ meg with dp switch
249. 1 – 13A switched socket on double plate with fused spur for water heater
266. 2 – mains transformers 9V $\frac{1}{2}$A secondary split primary so ok also for 115V
267. 1 – mains transformers 15V 1A secondary p.c.b. mounting
289. 50 3.5V torch bulbs
290. 3 7" reel to reel tape spools
291. 1 ten turns 3 watt pot $\frac{1}{4}$" spindle 100 ohm
292. 5 two plate brown bakelite ceiling roses
293. 50 silicon diodes mixed unmarked
294. 50 Germanium transistors mixed and unmarked
295. 10 round pointer knobs $\frac{1}{4}$ spindle
296. 3 car cigar lighter socket plugs
297. 1 cover for 24hr time switch ref BD45
298. 2 15 amp round pin plugs brown bakelite
300. 1 mains solenoid with plunger compact type
301. 10 ceramic magnets Mullard 1" × 3/8 × 5/16
303. 1 12 pole 3 way ceramic wave charge switch
304. 1 stereo amp 1 watt per channel
305. 1 tubular dynamic microphone with desk rest
306. 1 module, speaker & battery to make musical card
307. 5 thermal fuses 15 amp woods metal
308. 1 T.V. turret tuner (black & white T.V.)
309. 12 adaptable legended knobs $\frac{1}{4}$" spindle
310. 2 oven thermostats
311. 1 Clare Elliot sealed relay 12V
312. 1 pressure pad switch 24 × 18 (Trigger Mat)
313. 5 sub miniature micro switches
314. 1 12" 8 watt min fluorescent tube white
315. 1 6" 4 watt min fluorescent tube white
316. 1 round pin kettle plug with moulded on lead

MULLARD UNILEX AMPLIFIERS

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

CAR STARTER/CHARGER KIT

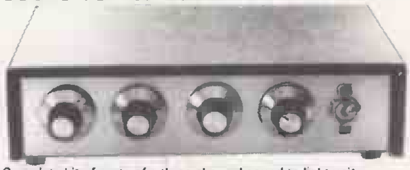
Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 or without case £15.00 post paid.

Ex-Electricity Board. Guaranteed 12 months.

VENNER TIME SWITCH

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 24hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

SOUND TO LIGHT UNIT



Complete kit of parts of 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 $\frac{1}{4}$" 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.

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3$\frac{1}{2}$" long by 3" dia. They have a good length of $\frac{1}{4}$" spindle –
1/10 hp £3.45
1/8 hp £5.75. 1/6 hp £7.50

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. A beautiful unit at £2.50

THIS MONTH'S SNIP

is a Prestel Unit, brand new and complete except for some ICs, also we understand tested, so should work OK directly the missing chips are fitted. Supplied complete with handbook and keypad at only £5. It's a bargain that should not be missed, even if you don't want to use it for its original purpose, It has wonderful spares value: you will have a long low case, ideal if you plan to make something which has a lot of controls, such a case could easily cost you £5. You will have a modem; more and more telephone/computer operations are being performed and this modem could set you going. Price £5 plus £1 post.

GOODS ARE ON APPROVAL

these notes are often hastily written and technical information sheets are seldom available about the items we have to describe, also advertisements sometimes go to press without our having a chance to correct any mistakes, however, everything we sell is supplied on the understanding that if it is not suitable for your project you may return it within 7 days for credit. If there was a definite error of description in our copy then we will pay postage. If not, then you pay the postage. Note this offer applies to kits, but only if construction is not started.

FANS & BLOWERS

Woods extractors
5" £5 + £1.25 post. 6" £6 + £1.50 post
4" × 4" Muffin equipment cooling fan 115V £2.00
4" × 4" Muffin equipment cooling fan 230/240V £5.95
5" Plannair extractor £5.50
9" Extractor or blower 115V supplied with 230 to 115V adaptor £9.50 + £2 post.
All above are ex computers but guaranteed 12 months.
10" × 3" Tangential Blower. New. Very quiet – supplied with 230 to 115V adaptor on use two in series to give long blow £2.00 + £1.50 post or £4.00 + £2.00 post for two.

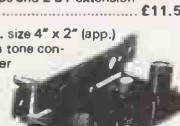
IONISER KIT

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.

TELEPHONE BITS

Master socket (has surge arrestor – ringing condenser etc) and takes B.T. plug £3.95
Extension socket £2.95
Dual adaptors (2 from one socket) £3.95
Cord terminating with B.T. plug 3 metres £2.95
Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 BT extension sockets £11.50

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



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

J & N BULL ELECTRICAL

Dept. E.E., 128 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QL

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

OVER 400 GIFTS YOU CAN CHOOSE FROM

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

TWO POUNDERS*

2P2 –Wall mounting thermostat, high precision with mercury switch and thermometer
2P3 –Variable and reversible 8-12v psu for model control
2P4 –24 volt psu with separate channels for stereo made for Mullard UNILEX
2P6 –100W mains to 115V auto-transformer with voltage tappings
2P8 –Mains motor with gear box and variable speed selector. Series wound so suitable for further speed control
2P9 –Time and set switch. Boxed, glass fronted and with knobs. Controls up to 15 amps. Ideal to program electric heaters
2P10 –12 volt 5 amp mains transformer – low volt winding on separate bobbin and easy to remove to convert to lower voltages for higher currents
2P11 –Power amp module Mullard Unilex EP9000 (note stereo pre-amp module Unilex 9001 is BD216
2P12 –Disk or Tape precision motor – has balanced rotor and is reversible 230v mains operated 1500 rpm
2P14 –Mug Stop kit – when thrown emits piercing squawk
2P15 –Interrupted Beam kit for burglar alarms, counters, etc.
2P17 –2 rev pr minute mains driven motor with gear box, ideal to operate mirror ball
2P18 –Liquid/gas shut off valve mains solenoid operated
2P19 –Disco switch-motor drives 6 or more 10 amp change over micro switches supplied ready for mains operation
2P20 –20 metres extension lead, 2 core – ideal most Black and Decker garden tools etc.
2P21 –10 watt amplifier, Mullard module reference 1173
2P22 –Motor driven switch 20 secs on or off after push
2P26 –Counter resettable mains operated 3 digit
2P27 –Goodmans Speaker 6 inch round 8ohm 12 watt
2P28 –Drill Pump – always useful couples to any make portable drill
2P31 –4 metres 98 way interconnecting wire easy to strip
2P32 –Hot Wire amp meter – 4$\frac{1}{2}$ round surface mounting 0–10A – old but working and definitely a bit of history
2P34 –Solenoid Air Valve mains operated
2P35 –Battery charger kit comprising mains transformer, full wave rectifier and meter, suitable for charging 6v or 12v
2P38 –200 R.P.M. Geared Mains Motor 1" stack quite powerful, definitely large enough to drive a rotating aerial or a tumbler for polishing stones etc.
2P43 –Small type blower or extractor fan, motor inset so very compact, 230V
2P46 –Our famous drill control kit complete and with prepared case.
2P49 –Fire Alarm break glass switch in heavy cast case
2P51 –Stereo Headphone amplifier, with pre-amp
2P55 –Mains motor, extra powerful has 1$\frac{1}{2}$" stack and good length of spindle
2P62 –1 pair Goodmans 15 ohm speakers for Unilox
2P63 –1 5Kv 20 mA mains transformer ex-equipment
2P64 –1 five bladed fan 6$\frac{1}{2}$" with mains motor
2P66 –1 2Kw tangential heater 115v easily convertible for 230V
2P67 –1 12v–0–12v 2 amp mains transformer
2P68 –1 15v–0–15v 2 amp mains transformer
2P69 –1 250v–0–250v 60 mA & 86.3v 5A mains transformer + 50p post
2P70 –1 E.M.I. tape motor two speed and reversible
2P72 –1 115v Muffin fan 4" × 4" approx. (s.h.)
2P75 –1 2 hour timer, plugs into 13A socket
2P76 –1 audax tweeter partner to 5P26 speaker
2P82 –9v–0–9v 2 amp mains transformer
2P84 –Modem board with press keys for telephone redialler
2P85 –20v–0–20v $\frac{1}{2}$A Mains transformer
2P88 –Sangamo 24 hr time switch 20 amp (s.h.)
2P89 –120 min. time switch with knob
2P90 –90 min. time switch with edgewise engraved controller
2P92 –Bailey & Macky pressure switch 15 p.s.i.
2P94 –Telephone handset for EE home telephone circuit

£5 POUNDERS*

1. 12 volt submersible pump complete with a tap which when brought over the basin switches on the pump and when pushed back switches off, an ideal caravan unit.
2. Sound to light kit complete in case suitable for up to 750 watts.
3. Silent sentinel ultra sonic transmitter and receive kit, complete.
5. 250 watt Isolating transformer to make your service bench safe, has voltage adj. taps, also as it has a 115V tapping it can be used to safely operate American or other 115V equipment which is often only insulated to 115V. Please add £3 postage if you can't collect as this is a heavy item.
6. 12V alarm bell with heavy 6" gong, suitable for outside if protected from direct rainfall. Ex GPO but in perfect order and guaranteed.
12. Equipment cooling fan – minin snail type mains operated.
13. Ping pong ball blower – or for any job that requires a powerful stream of air – ex computer. Collect or add £21 post.

5P15 –Uniselector 5 pole, 25 way 50 volt coil
5P18 –motor driven water pump as fitted to many washing machines
5P20 –2 kits, matchbox size, surveilance transmitter and FM receiver
5P23 –miniature (appr. 2$\frac{1}{2}$" wide) tangential blow heater, 1·2kw
5P24 –$\frac{1}{4}$hp motor, ex computer, 230V, mains operation 1450rpm. If not collect add £3 post
5P25 –special effects lighting switch. Up to 8 channels of lamps can be on or off for varying time periods
5P26 –Audax woofer 8" 8ohm 35 watt
5P27 –cartridge player 12V, has high quality stereo amplifier
5P28 –gear pump, mains motor driven with inlet and outlet pipe connectors
5P32 –large mains operated push or pull solenoid. Heavy so add £1.50 post
5P34 –24V 5A toroidal mains transformer
5P35 –modem board from telephone auto dialler, complete with keypad and all ICs
5P37 –24 hour time switch, 2 on/offs and clockwork reserve, ex Elec. Board loading up to 50A. Add £1 post
5P41 –5" extractor fan, very quiet runner (s.h.), gntd 12 mths.
5P51 –200 watt auto transformer, toroidal wound and encapsulated 230–115V
5P58 –Amstrad AM/FM stgereo tuner with connection diagram

LIGHT CHASER KIT motor driven switch bank with connection diagram, used in connection with 4 sets of xmas lights makes a very eye catching display for home, shop or disco, only £5 ref 5P56.

VALVE PRE AMP described in the Aug E.T.I. it's a very interesting circuit if you intend trying it, we can supply many of the parts

mains transformer 250–0–250 + 6·3V our ref	2P69 + £1 post
B9A valve bases 4 for £1	BD95
Double tag strips 3 lengths £2	2P100
Toggle switches dpst and 4p 4 way rotary switch	BD394
1 meg single gang pot 4 for £1	BD391
100 + 100μf 320V electrolytic 2 for £1	BD392
4μf 300V 4 for £1	BD393

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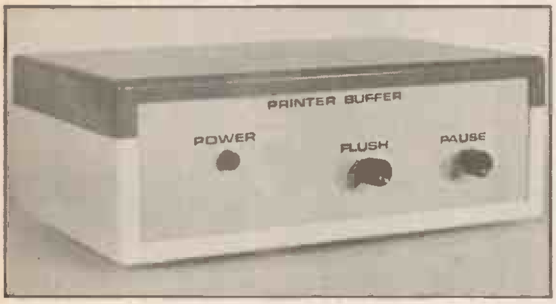
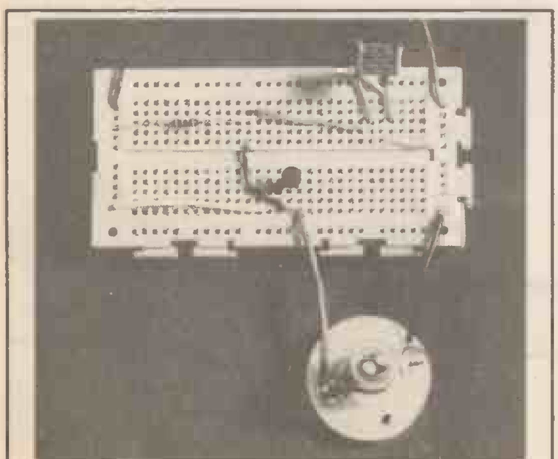
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .





Projects

Series

Features

Our October 1986 issue will be published on Friday, 19 September. See page 481 for details.

E.E. PROJECT KITS

MAGENTA

Full Kits Inc. PCBs, or veroboard, hardware, electronics, cases (unless stated). Less batteries.
If you do not have the issue of E.E. which includes the project – you will need to order the instruction reprint as an extra – 70p each. Reprints available separately 70p each + p&p 80p.

THIS MONTH'S KITS
SAE or 'phone for prices

BATTERY TESTER Aug 86	£6.85
TILT ALARM July 86	£7.45
HEADPHONE MIXER July 86	£27.69
CARAVAN BATTERY MONITOR July 86	£16.35
SQUEEKIE CONTINUITY TESTER July 86	£3.35
ELECTRONIC SCARECROW July 86	£8.45
VOX BOX AMP July 86	£12.73
EXPLORING ELECTRONICS 1/2	£9.99
PERCUSSION SYNTH June 86	£28.98
LIGHT PEN (less case) June 86	£5.80
PERSONAL RADIO June 86	£10.98
WATCHDOG June 86	£7.85
MINI STROBE May 86	£12.49
PA AMPLIFIER May 86	£23.77
LOGIC SWITCH May 86	£14.22
AUTO FIRING JOYSTICK May 86	£11.29
STEREO REVERB Apr 86	£23.98
VERSATILE PSU Apr 86	£22.39
CIRCLE CHASER Apr 86	£19.98
FREELOADER Apr 86	£7.70
STEPPER MOTOR DRIVER Apr 86	£4.66
BBC MIDI INTERFACE Mar 86	£25.34
INTERVAL TIMER Mar 86	£17.11
STEREO HI-FI PRE-AMP	£44.62
MAINS TESTER & FUSE FINDER Mar 86	£7.98
FUNCTION GENERATOR Feb 86	£22.53
POWER SUPPLY FOR ABOVE	£7.26
TOUCH CONTROLLER Feb 86	£11.67
pH TRANSDUCER (less Probe) Feb 86	£22.01
LIGHT EFFECTS/GAMES UNIT Feb 86	£10.37
SPECTRUM OUTPUT PORT Feb 86	£10.21
HEADLIGHT ONE SHOT Feb 86	£10.69
DPORT Jan 86	£6.80
TACHOMETER Jan 86	£23.40
MAIN DELAY SWITCH left case Jan 86	£17.93
ONE CHIP ALARM Jan 86	£7.90
MUSICAL DOOR BELL Jan 86	£16.98
TTL LOGIC PROBE Dec 85	£8.59
DIGITAL CAPACITANCE METER Dec 85	£35.98
DIODE/TRANSISTOR TESTER Dec 85	£15.98
UNIVERSAL LCR BRIDGE Nov 85	£23.49
FLUX DENSITY TRANSDUCER Nov 85	£26.15
FLASHING PUMPKIN less case Nov 85	£3.82
SQUEAKING BAT less case Nov 85	£8.63
SCREAMING MASK less case Nov 85	£9.99
STRAIN GAUGE AMPLIFIER Oct 85	£25.46
SIMPLE AUDIO GENERATOR Oct 85	£2.59
SOLDERING IRON POWER CONTROLLER Oct 85	£4.72
VOLTAGE REGULATOR Sept 85	£6.78
PERSONAL STEREO P.S.U. Sept 85	£8.99
R.I.A.A. PRE-AMP Sept 85	£14.49
CARAVAN ALARM Sept 85	£9.37
FRIDGE ALARM Sept 85	£6.82
SEMI-CONDUCTOR TEMP. SENSOR Sept 85	£18.93
RESISTANCE THERMOMETER Sept 85 Less Probe	£18.83
PLATINUM PROBE Extra	£22.00
LOW COST POWER SUPPLY UNIT Aug 85	£16.72
TRI-STATE THERMOMETER (Batt) Aug 85	£6.05
TREMOLO/VIBRATO Aug 85	£34.48
STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£13.99
1035 STEPPER MOTOR EXTRA	£14.50
OPTIONAL POWER SUPPLY PARTS	£4.67
CONTINUITY TESTER July 85	£5.37
TRAIN SIGNAL CONTROLLER July 85	£8.78
AMSTRAD USER PORT July 85	£15.33
ACROSS THE RIVER June 85	£17.97
ELECTRONIC DOORBELL June 85	£6.55
GRAPHIC EQUALISER June 85	£23.33
AUTO PHASE May 85	£16.39
INSULATION TESTER Apr 85	£16.96
LOAD SIMPLIFIER Feb 85	£16.98
SOLID STATE REVERB Feb 85	£39.98
GAMES TIMER Jan 85	£7.63
SPECTRUM AMPLIFIER Jan 85	£5.98
TV AERIAL PRE-AMP Dec 84	£12.36
Optional PSU 12V £2.03	240V £9.86
MINI WORKSHOP POWER SUPPLY Dec 84	£34.98
DOOR CHIME Dec 84	£14.91
BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£28.77
PROXIMITY ALARM Nov 84	£17.98
MAINS CABLE DETECTOR Oct 84	£4.39
MICRO MEMORY SYNTHESISER Oct 84	£47.98
DRILL SPEED CONTROLLER Oct 84	£6.89
GUITAR HEAD PHONE AMPLIFIER Sept 84	£6.38
SOUND OPERATED FLASH less lead Sept 84	£5.91
TEMPERATURE INTERFACE FOR BBC Aug 84	£19.70
CAR RADIO BOOSTER Aug 84	£13.87
CAR LIGHTS WARNING July 84	£7.99
VARICAP AM RADIO May 84	£10.43
EXPERIMENTAL POWER SUPPLY May 84	£18.72
SIMPLE LOOP BURGLAR ALARM May 84	£13.62
MASTERMIND TIMER May 84	£5.44
FUSE/DIODE CHECKER Apr 84	£3.45
QUASI STEREO ADAPTOR Apr 84	£10.90
DIGITAL MULTIMETER add on for BBC Micro Mar 84	£24.98
NI-CAD BATTERY CHARGER Mar 84	£9.85
REVERSING BLEEPER Mar 84	£6.78
PIPE FINDER Mar 84	£3.60
IONISER Feb 84	£23.98
ZX81 EPROM PROGRAMMER Feb 84	£14.48
SIGNAL TRACER Feb 84	£14.89
CAR LIGHT WARNING Feb 84	£3.76
GUITAR TUNER Jan 84	£17.73
BIOLOGICAL AMPLIFIER Jan 84	£19.16
CONTINUITY TESTER Dec 83	£9.99
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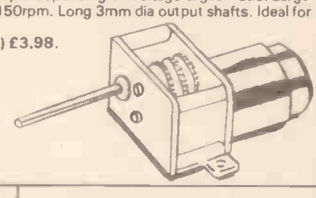

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Phone: Wimborne (0202) 881749

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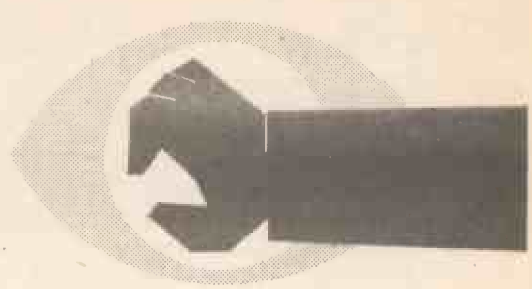
INFRA-RED BEAM ALARM



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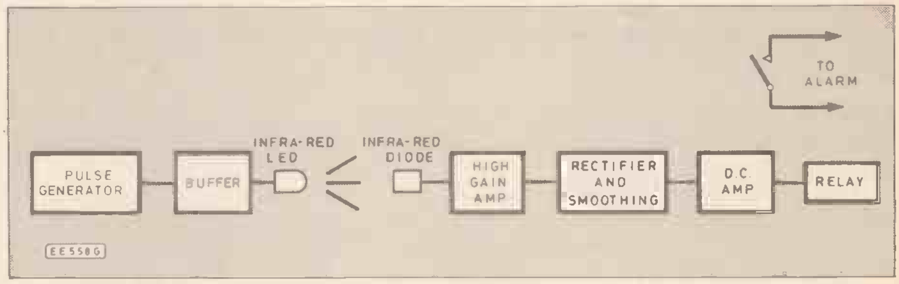


Fig. 1. Block diagram of the IR Beam Alarm.

IN THE late sixties and early seventies broken beam infra-red alarms were popular in television spy series and the like, usually with the hero defeating the alarm by avoiding the beam or shining an infra-torch onto the receiving sensor. Infra-red alarms are no longer the technological marvels that they once were, and are now regarded as relatively mundane pieces of electronics. They have moved on from those early days though, and are no longer restricted to use over very short distances, such as across a corridor. It was this short operating range which made the early types so easy to defeat. Although an infra-red beam is invisible to the human eye, the transmitting and receiving devices are not, and can be difficult to conceal really effectively. Once an intruder has detected the presence of the beam it is not difficult to avoid it.

Using modern devices and techniques it is possible to produce designs which will operate over much longer distances. In fact systems of this type are no longer restricted to spanning a doorway, or even a room, and they can be used out-of-doors over quite long distances if desired. Units of this type are often referred to as "infra-red fences". The system described here is designed to operate in conjunction with an existing burglar alarm system, and it can be constructed at quite low cost. An operating range of at least ten metres is possible, and by simply modifying the value of one resistor in order to increase the output power of the transmitter it is possible to boost the range to 50 metres or more.

OPERATING PRINCIPLE

The obvious arrangement for a broken beam alarm is to have a light source aimed at a suitable sensor, with a simple circuit to detect the presence or absence of any significant output from the sensor. In practice this does not work very well as it is difficult to provide a strong enough light beam to reliably switch the sensor between two distinct output levels. The infra-red beam tends to become swamped by the background infra-red level.

The easiest way around this problem is to use a set-up of the type outlined in the block diagram of Fig. 1. Instead of using a continuous infra red beam, the special l.e.d. which generates the infra-red signal is pulsed on and off at a fairly high frequency (usually in the range 1 to 100kHz). The l.e.d. is driven from the pulse generator via a buffer stage which enables high l.e.d. currents to be provided. The drive signal is not usually a squarewave, but instead a short pulsed waveform is used. The general idea is to have the l.e.d. switched on for (say) ten per cent of the time so that a very high l.e.d. current can be used, but the average l.e.d. current is kept down to a safe level. For instance, with the l.e.d. pulsed at 500mA with a signal having a 1 to 9 mark-space ratio, the average l.e.d. current would only be 50mA (which is quite safe for a large l.e.d.).

There are several types of device which could be utilized as the sensor at the receiver, but the most common type for this application is a large area photodiode. These offer good sensitivity plus a reasonably wide bandwidth. This second factor is an important one as the received signal is not a continuous beam, but a series of narrow pulses. Although the pulses might be at a frequency of (say) 10kHz, the narrowness of the pulses results in most of the component frequencies being at much higher frequencies, and the system must have a bandwidth of at least ten times the fundamental input frequency in order to respond to the input pulses properly and make full use of the power economy at the transmitter.

Although reasonably sensitive, the output signal from the sensor diode is not likely to be particularly strong, and it could well be less than a millivolt r.m.s. However, as it is a pulse signal it is easily amplified to a more suitable level using ordinary audio type amplifier stages. Because a.c. coupling can be used there is no problem with drift or changes in the ambient infra-red level causing spurious triggering of the unit.

The amplified signal is rectified and smoothed to produce a d.c. signal that is roughly proportional to the strength of the received signal. When the beam is not broken, the received signal is strong and a strong d.c. output is produced by this circuit. This signal is used to drive a d.c. amplifier which in turn activates a relay. If the beam is broken, the d.c. signal rapidly subsides and the relay switches off. A pair of normally open relay contacts are wired into the burglar alarm circuit. Although the

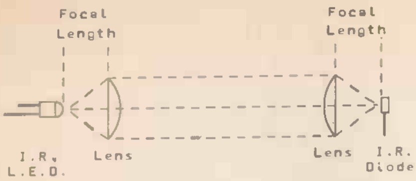


Fig. 2. Simple lens system.

contacts are called normally open types, in this circuit the relay is normally switched on, and it cuts off when the beam is broken. The relay contacts are thus effectively normally closed types, and are wired into the usual loop of normally closed switches in the main alarm circuit. This arrangement is fail-safe in that a failure in the alarm circuit will almost certainly result in the relay switching off, and the main alarm being activated.

OPTICS

Although the range of a system of this type is much greater than a simple d.c. circuit, it is still difficult to obtain reliable operation at much more than two or three metres. It might be possible to refine the circuits to obtain some improvement, but a much better way of tackling the problem is to add an optical system. By focusing the output from the transmitter into a tight beam the usual fall off in strength as the range is increased is avoided. In practice there is some reduction in beam strength as range is increased due to imperfections in the focusing system and consequent spread of the beam, and the fact that air is not totally transparent. Even with quite a simple and inexpensive lens to focus the beam this can boost the range of the system by a factor of five or more. A lens at the receiver can be used to further boost the range by a similar factor.

Ordinary glass lenses, mirror lenses, or a combination of the two can be used in this application, but in its most basic (double-ended) form the lens system is as shown in Fig. 2.

At the transmitting end a plano-convex lens is used to focus the output from the l.e.d. into a narrow beam. Optically the receiving end of the system is just the opposite of the transmitter, with another plano-convex lens gathering up the output from the transmitter over a relatively large area, and then concentrating the received energy onto the infra-red sensor diode. For optimum results the l.e.d. and detector diode must be quite accurately aligned behind their respective lenses, and they must be the correct distance from their lenses. The optimum spacing is equal to the focal length of the lens. You do not get something for nothing in the world of physics, and the price that has to be paid for the improvement in range is the highly directional nature of both the transmitter and the receiver. The practical result of this is that the system has to be carefully set up and mounted in a stable fashion if it is to function at all; but optical alignment of the equipment is not excessively difficult.

In the past there has been a problem for the home constructor with an arrangement such as this in that it has been difficult to obtain suitable lenses, and they have been quite expensive once located. Fortunately, suitable plastic lenses can now be obtained at low cost, making a project of this type perfectly feasible as a constructional project. Although in normal optical terms the quality of the lenses is, to say the least, extremely poor, image quality is unimportant in this context. The lenses need do nothing more than roughly focus the infra-red signal in order to give a large improvement in performance.

TRANSMITTER CIRCUIT

The transmitter uses few components, as will be apparent from the circuit diagram which appears in Fig. 3.

IC1 forms the basis of the unit, and this is the low power CMOS version of the well known 555 timer. It operates here in a form of astable (oscillator) circuit, but it is not quite the standard configuration as steering diode D1 has been included. Normally this type of circuit operates by first charging timing capacitor C2 to two-thirds of the supply potential via both R1 and R2, and during this time the output at pin 3 goes high. C2 is then discharged by way of R2 and an internal switching transistor of the integrated circuit until the charge falls to one-third of the supply voltage. The cycle then starts again with C2 charging via R1 and R2. The output of IC1 goes low during the discharge period.

In Fig. 3, TR1 is a VMOS transistor, and it switches on the infra-red l.e.d. D2 when the output of IC1 goes high and forward biases TR1's gate. In the standard 555 astable circuit the period during which the output goes high is longer than the time it spends in the low state, since C2 charges via both R1 and R2, but only discharges through R2. This is the opposite of what we require, as it results in the l.e.d. being switched on for more than 50 per cent of the time, rather than the ten per cent or thereabouts that is required. Diode D1 provides a simple solution by bypassing R2 during the charge portion of each cycle. The charge time is then controlled by R1, and the discharge time is determined by R2. By making R2 about ten times higher in value than R1 the required output waveform with a mark space ratio of about 1 to 10 is obtained. The oscillator operates at a frequency of about 3kHz.

Little current is consumed by the oscillator circuit, and TR1 requires no significant drive current. The current drawn from the battery supply is therefore little more than the average l.e.d. current, which comes to just over one milliamp. This low level of power consumption makes battery operation a practical proposition even if the unit is left operating for long periods of time, which is quite likely in a burglar alarm application. Each set of HP7 size cells should be capable of powering the unit continuously for well over a month, or using the unit around ten hours a day the batteries would only need replacement at approximately three monthly intervals.

RECEIVER CIRCUIT

The full circuit diagram of the receiver unit is shown in Fig. 4. D3 is the detector diode, and this is reverse biased by R4. A small leakage current flows through D3, and the leakage level is dependent on the infra-red level received by D3. The pulses of infra-red energy from the transmitter therefore cause small pulses or current to flow through R4 and D3, generating small voltage variations which are coupled by C4 to the input of the high gain amplifier. The latter is a straightforward three stage common emitter circuit which has capacitive coupling between all three stages. The full gain of all three stages is not required, and R12 introduces a large amount of feedback to TR4 in order to reduce its voltage gain to a more suitable level. The voltage gain of the circuit is still well in excess of 80dB (10,000 times). The detector diode incorporates an infra-red filter which largely prevents problems with ambient light sources swamping the received signal. Tungsten lamps powered from the mains can generate a significant 100Hz infra-red signal, but the coupling capacitors in the amplifier have been given low values so that they provide some attenuation at 100Hz and reduce the risk of mains lighting holding the unit in the unactivated state.

Socket SK1 enables the output of the amplifier to be monitored using a crystal earphone or high impedance headphones. This is helpful when setting up the sytem as

Fig. 3. Transmitter circuit diagram.

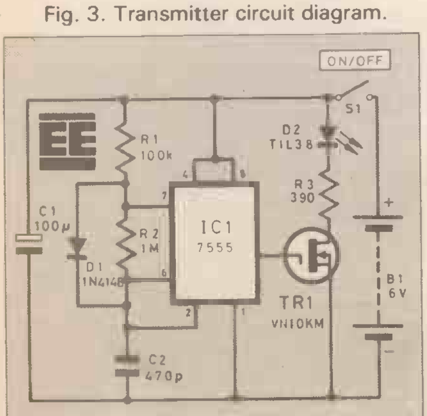
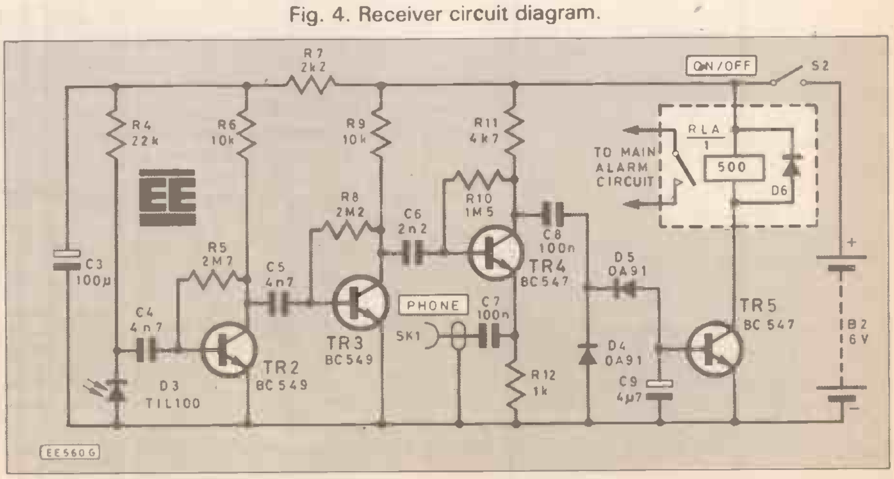


Fig. 4. Receiver circuit diagram.



it enables the strength of the received signal to be gauged, making it much easier to set up the sytem for optimum reliability.

The output from TR4 is coupled to a conventional rectifier and smoothing circuit. The value of C9 controls the time taken for the d.c. signal to decay to the point where the relay cuts off once the beam has been broken, and this time must be kept to just a fraction of a second so that the relay always cuts off before the person breaking the beam moves on and the signal is restored. On the other hand, a very short decay time could reduce reliability and cause spurious triggering of the unit. A decay time of about 100ms seems to be a good compromise.

It is not possible to design the unit to have a very low stand-by current comsumption as the relay will remain activated except for any brief occasions when the beam is broken. However, a relay which has a very low current consumption can be used, and the fact that the voltage and current ratings of the contacts are very low is not a problem in this application where only minute power levels are involved. The total current consumption of the unit is about ten milliamps or so. This will give around 100 hours of operation from HP7 size batteries, and rechargeable Nicad cells probably represent the most practical power source. Alternatively, four HP2 size batteries would be capable of powering the unit continuously for about one month, or for over two months with around ten hours use per day. Of course, if preferred, either or both units can be powered from mains power supply units that supply a well smoothed output at around five to six volts.

Note that protection diode D6 is an integral part of the relay which is a minia-

COMPONENTS

See **Shop Talk** page 485

TRANSMITTER

Resistors

R1	100k
R2	1M
R3	390

All 0·25W 5% carbon

Capacitors

C1	100μ radial elect. 10V
C2	470p ceramic plate

Semiconductors

IC1	ICM7555 CMOS timer
TR1	VN10KM VMOS transistor
D1	1N4148 silicon diode
D2	TIL38 5mm IR l.e.d.

Miscellaneous

S1	SPST miniature toggle switch
B1	6 volt (4 × HP7 size cells)

Plastic case about 150 × 100 × 60mm; Printed circuit board (available from the *EE PCB Service*, order code EE536); 30mm diameter lens with 80mm focal length (Maplin); 8 pin d.i.l. i.c. socket; battery holder for 4 × HP7 size cells; PP3 style battery connector; wire and solder

RECEIVER

Resistors

R4	22k
R5	2M7
R6,9	10k (2 off)
R7	2k2
R8	2M2
R10	1M5
R11	4k7
R12	1k

All 0·25W 5% carbon

Capacitors

C3	100μ radial elect. 10V
C4,5	4n7 polyester layer (2 off)
C6	2n2 polyester layer
C7,8	100n polyester layer (2 off)
C9	4μ7 radial elect. 63V

Semiconductors

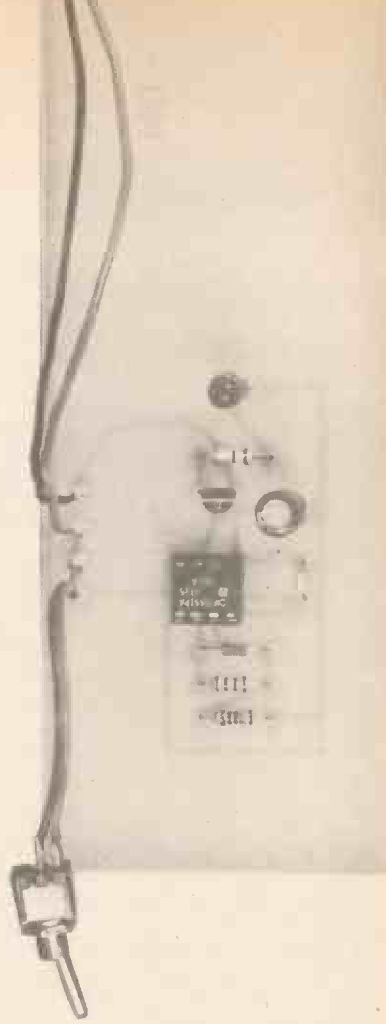
TR2,3	BC549 silicon *npn* (2 off)
TR4,5	BC547 silicon *npn* (2 off)
D3	TIL100 IR detector diode
D4,5	OA91 germanium diodes (2 off)
D6	Part of relay

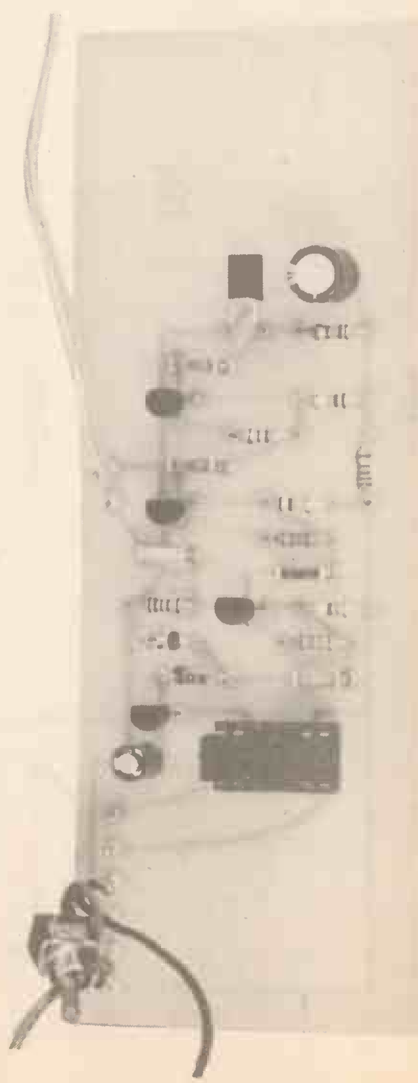
Miscellaneous

S2	SPST miniature toggle switch
RLA1	5V, 500 ohm coil, 14 pin d.i.l. package with normally open contacts and protection diode.
SK1	3·5mm jack socket
B2	6 volt (4 × HP7 size cells)

Plastic case about 150 × 100 × 60mm; printed circuit board (available from the *EE PCB Service*, order code EE537); 30mm diameter lens with 80mm focal length; battery holder for 4 × HP7 size cells; PP3 style battery connector; 14 pin d.i.l. i.c. socket; wire and solder, etc.

COMPONENTS approximate cost £22·50





ture type in a form of 14 pin d.i.l. encapsulation.

CONSTRUCTION

Starting with construction of the transmitter, details of the printed circuit board are shown in Fig. 5. Although the board may seem to be rather over-size, it is in fact designed to fit into the guide rails which are moulded into the specified case. It fits into the pair of rails nearest the back of the case with its component side facing forwards. Of course, there is plenty of space on the board for mounting holes, and if a different case is used there should be no difficulty in mounting the board satisfactorily.

The board itself is easy to construct, and although IC1 is a CMOS device, it has built-in protection circuits which render the usual anti-static handling precautions unnecessary. It is, nevertheless, advisable to use a socket for IC1. The leads of D2 should be trimmed quite short so that it does not protrude too far above the board. This is important because the distance from the

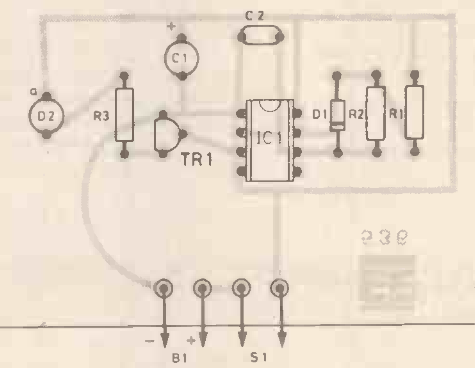
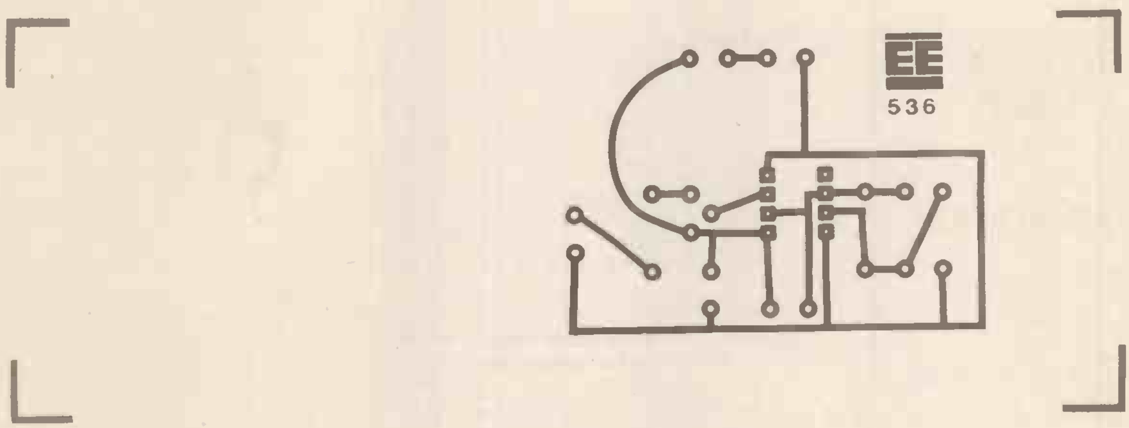


Fig. 5. Printed circuit board layout and wiring of the transmitter.



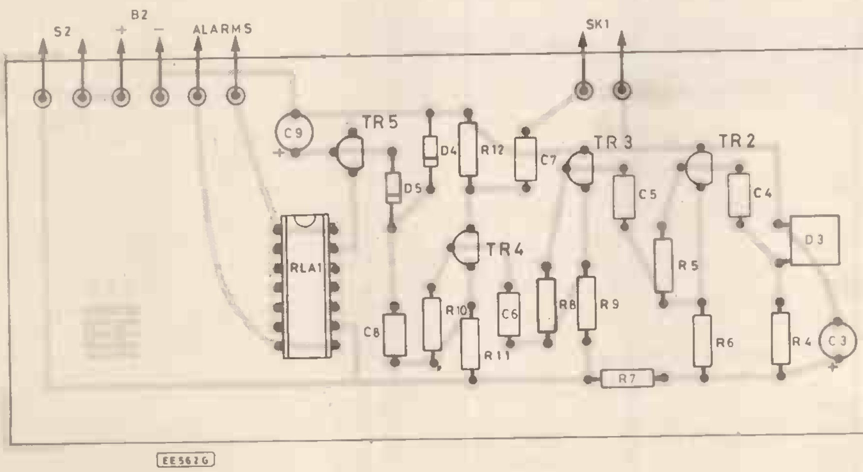
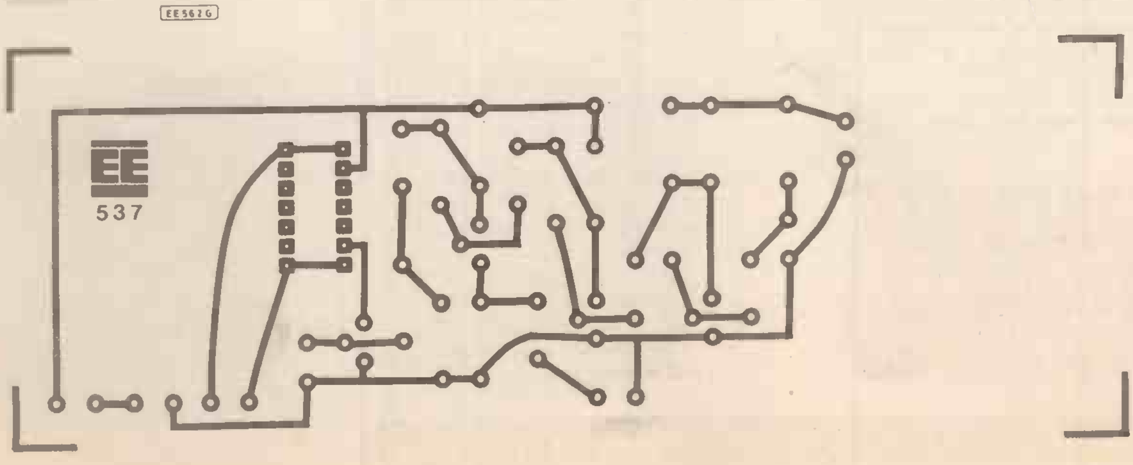


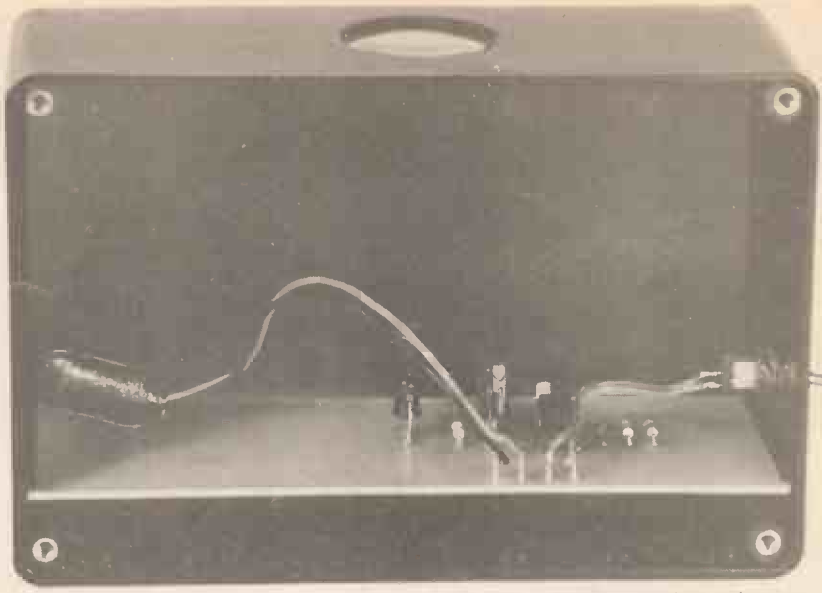
Fig. 6. Printed circuit board layout and wiring of the receiver.

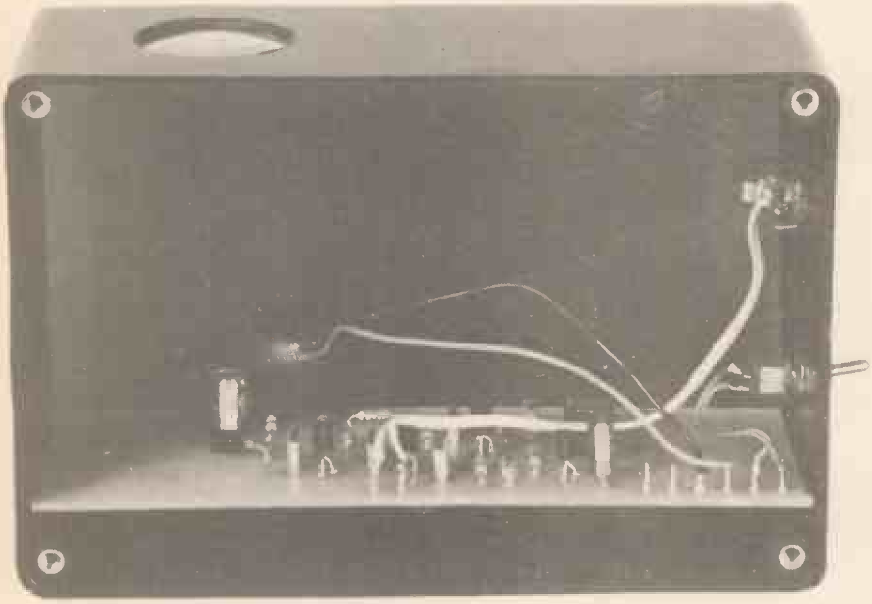


lens to D2 will be inadequate if the leads are left too long, giving a mediocre level of performance.

The lens is mounted on the front of the case, and it must be accurately positioned directly in front of D2. A large offset would impair the performance of the system and would give a peak response that would be well away from a rightangle to the front panel, making it relatively difficult to set up the finished units properly. A 30 millimetre diameter cutout is required for the lens, and this can be produced by first drilling a central hole of around 10 millimetres in diameter and then enlarging it to the required size using a reamer.

The lens has a rim which enables it to be glued in place on the rear face of the front panel using any good general purpose adhesive, but be careful to avoid smearing adhesive over the main part of the lens. There is a slight problem in mounting the lens in that some of the printed circuit guide rails moulded into the case tend to get in the way. These can be carefully cut away using a small modelling knife, or the lens can be mounted on the front surface of the case (which will not look as neat).





Switch S1 is mounted on one of the end panels, and then the unit is completed by wiring S1 to the board and adding the battery connector. If the unit is powered by four HP7 size cells fitted in a plastic battery holder, connection to the holder is via an ordinary PP3 type battery clip.

Construction of the receiver is along much the same lines as that of the transmitter. Details of the printed circuit board are shown in Fig. 6. The leadout wires of D3 are bent at right angles so that its sensitive surface (the large one which does not carry the type number) faces forwards towards the lens. The SFH205 is a suitable alternative to the TIL100, and the sensitive surface of this device is the curved one.

Diodes D4 and D5 are the germanium type, and these are much more vulnerable to damage by heat then silicon devices. Therefore, when soldering these in place the bit should not be kept on the joint for any longer than is absolutely necessary. The relay has a 14 pin d.i.l. encapsulation, but the middle three pins in each row are missing. The printed circuit board has all 14 holes drilled so that the relay can easily be mounted in a 14 pin d.i.l. socket if desired.

IN USE

Initially the units should be tested at quite short range as they are then quite easily aligned. However, even at short range the system is still highly directional, and they will need to be aimed accurately in order to obtain proper operation. Things are very much easier if a crystal earphone is used to monitor the output from SK1, as the fairly high pitched tone from the receiver should be audible when the two units are even badly aligned, and adjustment of the receiver's orientation enables the volume of the tone to be peaked. If the clipping level is reached there will be no further increases in volume if a stronger input signal is obtained, but there will be a noticeable drop in the background "hiss" level.

Setting up the sysem over a distance of several metres or more is a little more difficult, and the main problem is ensuring that the transmitter is aimed at the point where the receiver is situated. The receiver only has to be slightly outside the main beam in order to reduce the strength of the received signal to a totally inadequate level. The receiver can be used as a sort of field strength monitor to detect the precise direction of the beam, and the orientation of the transmitter can be adjusted by trial and error to home in the beam on the desired point. Alternatively, where possible it is easier if the transmitter can be aimed in the right general direction, and the receiver is then moved to a point within the beam. Try to get the units set up so that a strong signal is picked up at the receiver, as this gives optimum reliability.

The distance from each photocell to its lens is slightly less than the 80 millimetre optimum, but this only marginally reduces the maximum operating range, and has the advantage of making the system slightly less directional and easier to set up. A reliable operating range of 10 metres or more should be possible, and this can be considerably boosted by reducing the value of R3. This resistor can be made as low as 4Ω7 in value, giving a pulse current of around 500 milliamps. This will increase the current consumption of the transmitter though (to about 50 milliamps with R3 at 4Ω7), and R3 should not therefore be any lower in value than is really necessary. □

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Comdex

I spent a few days in Georgia talking modems with Hayes; the privately owned US company which has quietly succeeded in bringing some order into the chaos of computer communications and electronic mail. The Hayes protocol has become a *de facto* standard. More on modems and Hayes protocol in a future month; it's a story on its own. While in Atlanta I visited Comdex, the computer trade's exhibition and conference held at the World Congress Centre. Some snippets are worth passing on.

Film company Polaroid has cleverly stolen a march on the US computer industry with an offer to recover data from floppy discs which have been damaged by misuse. Most magnetic media companies will replace a faulty floppy, but they baulk if the disc has been mistreated. In any case you have still lost the data, which is usually far more valuable than the disc.

Polaroid now offers a Data Rescue Service in America. Anyone who has bought a Polaroid disc and damaged it can return it to the company. At no cost, and usually within 48 hours, Polaroid retrieves as much data as possible, copies it onto a new disc and posts it back to the owner.

Actually this isn't all that clever. Floppy discs are only circular sheets of magnetic tape. The trick is to find a solvent which will shift sticky materials from the disc surface but not break down the resin which binds the oxide to the plastics base film. Polaroid, who make the discs—or in the past has bought in from other manufacturers—is obviously in the best possible position to know the best solvent. As a publicity stunt Polaroid challenged the US computer press to try and find a way of contaminating a disc so that data was irretrievably lost. They tried everything from chilli sauce to ice cream. Polaroid cleaned it all off. The only loss was two per cent of data destroyed when one journalist made holes in the disc by stapling it to the sleeve. So far Polaroid isn't running the scheme in the UK.

Big Blue Rules

Main impression at Comdex was that IBM rules the roost. Apple weren't there at all. Only Atari and Commodore, with the Amiga, were putting up a struggle against total domination of the PC industry by Big Blue.

The new IBM PC convertible lap-top, which will sell for 2000 dollars, used controversial new technology for the screen. IBM promises 8 hours operation from a single charge of the built-in nickel cadmium batteries. The only way to achieve this is with a passive screen of liquid crystal, which modifies reflected light instead of generating its own.

The PC convertible screen is a dot matrix display capable of resolving 25 lines of 80 characters each or a graphics image built up from 640 by 200 individual picture elements or pixels. All l.c.d.s suffer from the same problem; the image has low contrast, and the text appears as dark grey on a light grey background. Room light reflects off the glass front of the screen and degrades contrast even further.

But IBM believes it has solved the problem of glare and stray reflections. Conventional screens use a sandwich of two glass or plastics sheets, a thin sheet to contain the liquid crystal fluid and a thick sheet to protect the thin under-layer. It is the air gap in between which causes odd reflection effects in ambient light. The IBM lap-top screen uses a single layer of transparent, flexible plastics. The l.c.d. fluid backs directly on to this, so the screen is soft to the touch. It deforms when pressed and the image disappears where it is touched. Although this does not matter, because there is normally no need to touch the screen, IBM acknowledges that if someone prods the screen with a sharp object the plastic will puncture and the l.c.d. material ooze out.

CD ROM

Sony believes that CD ROM, the new technology which relies on a laser-read 12cm compact disc to store 600 megabytes of data instead of an hour of music, will be a consumer product by the end of the year. Sony began pressing CD ROMs at its US factory in Terre Haute, Indiana, in May. The company has also now started to sell CD ROM drives in bulk to other manufacturers for incorporation in home computers.

There are two types of Sony CD ROM drive. The CDU 5002 fits neatly into the slot in a computer which is normally used for a floppy disc drive. The CDU 100 is a stand-alone unit which plugs into the rear of a computer to offer an extra source of data. Sony is charging manufacturers a trade price of around 300 dollars for the CDU 5002 and 400 dollars for the CDU 100. An extra circuit board must be fitted inside the computer, but the extra cost to end user should still be well below 1000 dollars. For this premium on the price of a conventional computer, the customer will be able to read data from an optical disc as well as read and record with magnetic discs.

The stumbling block so far has been industry agreement on how a home computer will search through the data stored on a CD ROM. Although there is now a standard called CDI (CD Interactive Media) for the method of recording data on the disc so that it can be retrieved by any player, there is still no agreement on a protocol for searching through the retrieved data. In an effort to break the deadlock with market force and create a standard Sony has signed a joint venture deal with software company Knowledgeset of Monterey, California.

The joint venture, to be called Publishers Data Service Corporation, PDSC, will offer publishing companies a one-stop service. Sony's factory in Indiana will order and format the publisher's data, for instance, an encyclopaedia, and transfer it to digital tape. The same factory will then use this tape to produce a master disc from which CD ROMs are duplicated.

Knowledgeset will provide a retrieval program called KRS (Knowledge Retrieval System) so that a home or business computer can search through the data on the disc. KRS is compatible with any IBM PC. The joint venture promises a four week turnround, from raw data to finished CD ROMs ready for sale. The Indiana plant can press up to 1·5 million discs a month. They can be either music or data discs.

Towering Inferno

Finally a warning. If you ever visit a Comdex show, don't whatever you do mention the word "fire", let alone shout it.

When the MGM hotel in Las Vegas went up in flames it was during a Comdex show. This year at Atlanta in Georgia the delegates were getting decidedly twitchy by the time they left the peanut state.

Both the Omni and Marriott Marquis hotels in Atlanta have those scarey glass lifts which run on vertical tracks up the outside of the walls. And this year both had fire scares. At the Omni hotel one of the lifts caught fire at 2am. When the fire alarms sounded no one took it seriously, until they started coughing on the kind of smoke which only a burning electric motor can generate.

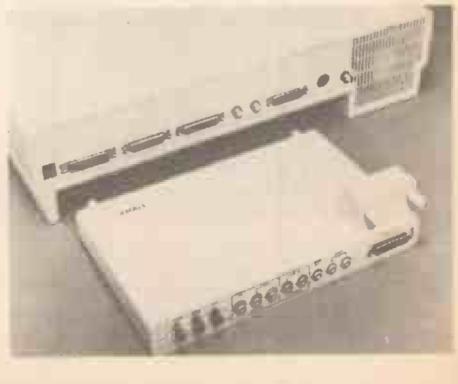
At the Marquis the next day things were even more dramatic. All three of the lifts serving the 47 floors of bedrooms which overlook the biggest atrium in the world suddenly stopped dead. They then descended at high speed to the bottom floor.

Alarm bells rang on each landing and flashing lights told guests to use the stairs. Having heard about the Omni smoke they did, and weren't seen again for an hour. Later I pieced together what had happened.

Sensibly the hotel designers built smoke detectors into the lift system at engine room level, down in the basement. One whiff of smoke and the whole things shuts down. Unfortunately, the hotel staff like to gather in the basement to puff on a few cigarettes, of one kind or another, and shoot the breeze about life in general.

"They aren't supposed to do it, but they do," a hotel receptionist confided, in between hoping I was having a nice day. Once the crafty smokers are caught, the lifts go up again. Unfortunately this is little consolation to anyone who has just started out on a 47 floor hike down the stairs. They do not have such a nice day. The Marquis management has not yet thought of a way of telling people on the stairs that the fire is out and the lifts are working. Maybe by next year's Comdex!

Amiga can hook up to a video source with Genlock—but can it compete with IBM?



a regular feature for the Spectrum Owner...

by Mike Tooley BA

Alien zapping freaks! Build your own Custom Joystick

THIS month we shall follow the theme introduced last month by taking a brief look at the RAM chips used in the Spectrum. We shall also be introducing another of the Spectrum's system variables and showing how readers can make their own "custom designed" joysticks.

RAM chips

From last month's memory map, readers will see that the Spectrum's memory is divided into ROM (addresses from 0 to 16383 decimal) and RAM (addresses from 16384 to 65535 decimal). The latter address space is, in fact, populated by two types of dynamic RAM; the lower 16K being provided by eight 16K × 1 bit chips (4116, or equivalent) whilst the upper 32K is provided by eight 32K × 1 bit chips (4532, or equivalent).

The pin-outs for the Spectrum's RAM chips are shown in Fig. 1. Readers should note that the 4116 (which are now somewhat elderly) require no less than THREE separate supply rails! The 4532 devices are, thankfully, a little more up to date and only require a single +5V rail. The reason for the use of two different RAM types is simply that the Spectrum started life as a 16K machine and only later became available as (or expandable to) a full 64K machine.

At the time that the Issue 2 Spectrum emerged, full-specification 32K and 64K RAM devices were rather expensive. Doubtless it was for this reason that the RAM devices fitted in the upper 32K of the early 48K RAM machines were "failed" 64K devices in which just one half was "good"! These chips were coded with an "H" or an "L" and appropriate links provided on the p.c.b. Naturally, ALL chips in the 32K block MUST be of the same type; either all "H" or all "L"!

It seems likely that, on later issue Spectrums, the upper 32K may be populated by fully functional 64K RAM chips of which only half is actually put to use. With a little thought someone might even have managed to "page-in" the unused 32K. So, if you have had a go at this, why not drop me a line so that I can pass on the relevant information.

REPDEL

This month we put the REPDEL system variable under the microscope. REPDEL is at a decimal address of 23561 and it contains the time delay (in fiftieths of a second) that a key must be held down before it begins to repeat. Whilst REPDEL is normally initialised to 35 (giving a delay of 35/50 sec) the value can be readily changed by simply poking a byte into 23561.

To produce a delay of exactly 1 second, for example, we would need to make the value in REPDEL equal to 50. This can be achieved by a statement of the form:

```
POKE 23561,50
```

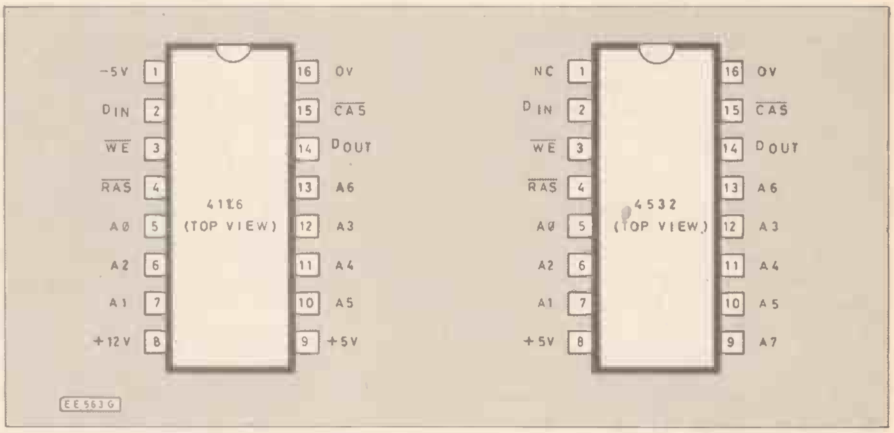


Fig. 1. Spectrum RAM pin connections for the 4116 and the 4532. Note that the 4116 requires three separate power supplies!

Readers would be forgiven for thinking that POKEing REPDEL with a value of zero would produce no delay at all. This, however, is not the case! Surprisingly, POKEing REPDEL with 0 results in the longest rather than the shortest possible delay. The reason for this apparent anomoly is simply that the Spectrum's operating system decrements the value contained in REPDEL until it reaches zero before exiting the key repeat delay loop. When POKEd with zero, REPDEL first decrements to 255 (i.e. −1) and thus the delay loop is repeated a total of 256 times.

DIY Joystick

Several readers have accused me of taking a rather more serious approach to computing on the Spectrum than is really warranted by what has become accepted primarily as a "games" machine. To redress the balance here is a little project to warm the cockles of the hearts of all inveterate games players!

Most arcade games are greatly improved when using a good quality joystick. With this in mind, and having tried a number of commercially available joysticks with only moderate success, I recently set about producing my own "custom joystick".

Whilst hardened games addicts may disagree, my own preference is for a joystick with very light but positive directional control used by the right hand with an entirely separate "fire" button operated by the left thumb. Furthermore, my "ideal" unit would be "hand-held" rather than having to rest on a flat surface.

Circuit

The circuit diagram of the joystick is shown in Fig. 1. The four direction switches, S1 to S4, are microswitches mounted on a "professional" joystick assembly.

Figs. 2 and 3 respectively show the circuit and internal wiring of the joystick. The four direction switches, S1 to S4, are the microswitches. The switches provided on this unit are single-pole changeover types and, in this application, only the "make" (normally open) contacts are employed.

The exterior view of the prototype joystick, showing the control layout, is depicted in Fig. 4. Readers will doubtless wish to vary the layout to suit their own individual requirements. The Spectrum joystick connector (pin view) is shown in Fig. 5. This is an "Atari standard" 9-pin D-connector in which pins 5, 7 and 9 are unused and simply left disconnected.

Auto-fire unit

For "alien zapping freaks", Fig. 6 shows a further enhancement of the custom joystick which provides automatic operation of the fire button at a rate determined by the setting of VR1.

This circuit uses a 555 timer running in astable mode coupled to the joystick unit by means of an opto-isolator. This latter component is simply a standard single-transistor low-cost type housed in a conventional 6-pin d.i.l. plastic package.

The prototype auto-fire circuit was built in a separate plastic case (identical to that used for the joystick unit) and the supply derived from an internal PP3 9V battery. The prototype auto-fire unit was coupled to the joystick box using a short length of twin flex terminated with two 1mm plugs. Whilst this arrangement will prove quite satisfactory for occasional use, some constructors will undoubtedly want to mount the auto-fire unit within the joystick housing. This should not present too great a problem however, since space is very much at a premium, careful attention will have to be paid to layout. Good luck—and happy "zapping"!

CUSTOM JOYSTICK WITH AUTO FIRE

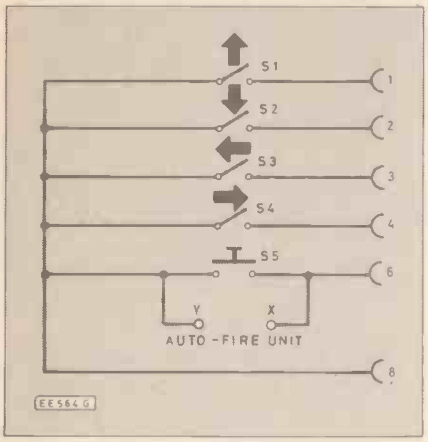


Fig. 2. Circuit diagram for the joystick.

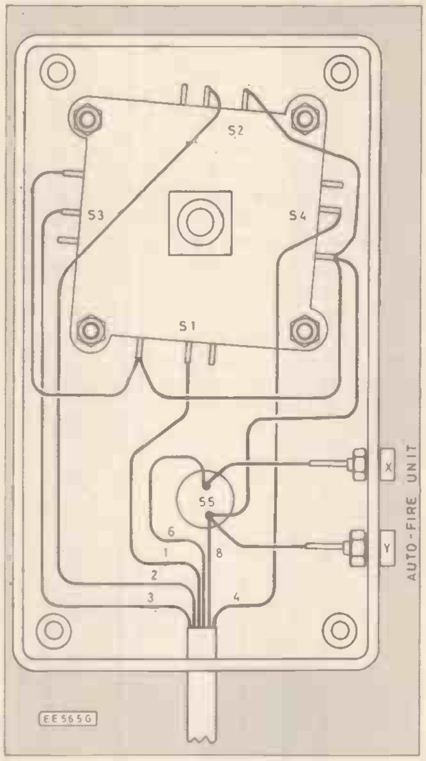


Fig. 3. Joystick internal construction and wiring.

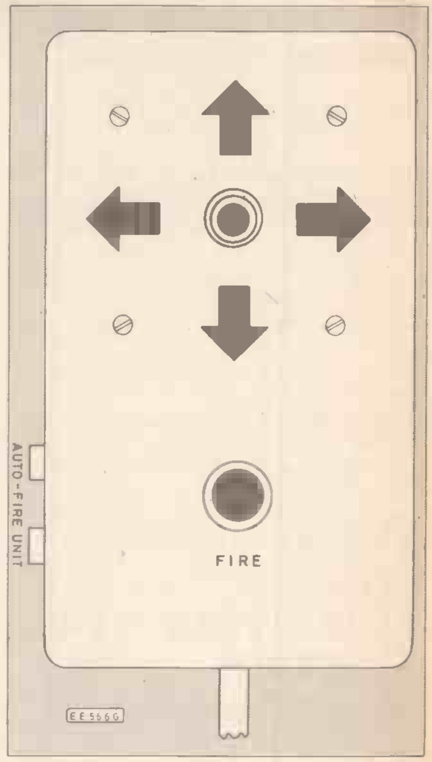


Fig. 4. Control layout of the joystick.

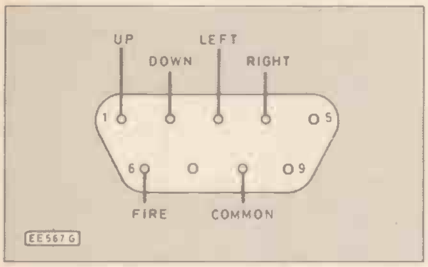


Fig. 5. Standard joystick interface connections (pin view).

COMPONENTS

Joystick Components

Plastic case (approx. 110mm × 60mm × 30mm); joystick switch assembly (S1 to S4); momentary normally open push-button switch (S5); sockets (2 × 1mm); 9-way D-connector (to suit joystick interface); 6-way flexible cable (approx. 1m).

Auto Fire Components

See Shop Talk page 485

Resistors
- R1 10k
- R2 10k
- R3 270
- All 0·25W ±5%

Potentiometer
- VR1 100k linear carbon

Capacitors
- C1 10μ p.c. elect. 16V
- C2 100μ p.c. elect. 16V

Semiconductors
- IC1 555
- IC2 Opto-isolator (see text)

Approx. cost Guidance only **£12**

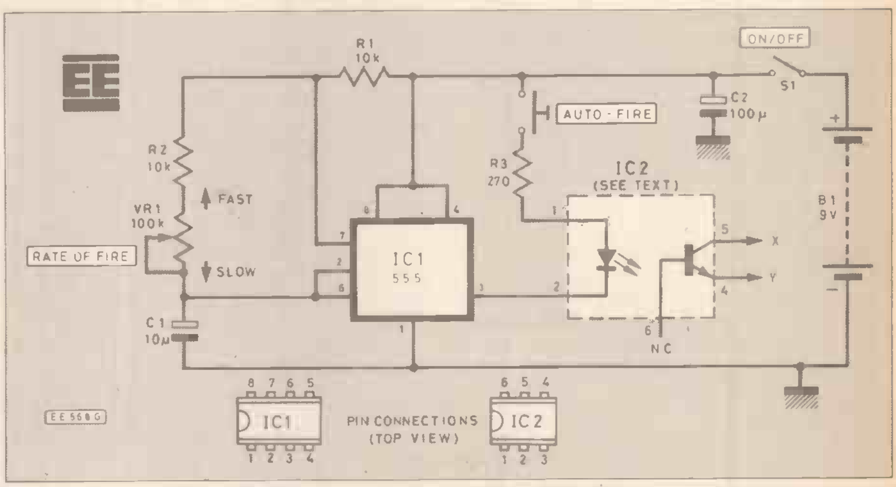


Fig. 6. Circuit diagram for the auto-fire unit.

If you have any comments or suggestions for inclusion in *On Spec*, please send them to:
Mike Tooley,
Department of Technology,
Brooklands Technical College,
Heath Road,
WEYBRIDGE,
Surrey, KT13 8TT
P.S. Don't forget to include a large (A4 size) stamped addressed envelope if you would like to receive a copy of our "Update"!

Next Month

Next month we shall be reviewing some enhanced interpreters for the Spectrum and describing the construction of an "infallible" reset switch. This handy unit allows users to recover from BASIC and machine code program crashes without having to erase the entire contents of the Spectrum's memory. See you next month!

Robot Roundup

NIGEL CLARK

MECHANICAL SERVANT

THE DREAM of the mechanical servant has been around for a long time, fostered by growing automation in industry and the imagination of a large number of writers, particularly in science fiction. The difficulties encountered so far in making the dream reality have hardly dented the belief that it is possible to make a mechanical human.

For the majority of people anything that falls short of the ideal cannot be called a robot and expectations are high that it can be achieved with the might of the "miracle" microchip. A brief look at what can be achieved with the present technology and knowledge is sufficient to show that mechanical humans are a long way from becoming a fact. However, there is still a lot happening in the world of robots and the aim of this new regular feature is to reflect the trends in what is called the "personal" end of the market.

It is always useful to start with a definition of the area to be covered. Personal robots can be a problem in that everyone knows when they see one but trying to set down criteria can be difficult. This column will try to concentrate on devices which can be programmed either directly from an on-board processor or indirectly from a host computer. I use the term program loosely to include instructions given to toys, like *George Compurobot*, through a keypad.

A simpler way of finding out what will be covered here is to split the available machines into three categories—arms, buggies or turtles and toys.

ARMS

Arms come in all shapes and sizes. Most are used in education and are usually smaller, cheaper versions of their industrial cousins with prices ranging to a maximum of about £4,000. There are two types, articulated and Scara. The articulated are the dinosaur-like devices which operate in the vertical plane, whereas the Scara, which stands for Selective Compliance Assembly Robot Arm, works in the horizontal.

Within these two catagories there are many different versions with prices usually depending on their complexity. The degrees of freedom, which govern their flexibility, vary from three to six with the usual number being five.

In terms of the human body they are waist, shoulder, elbow and two wrist

The Ogre servo-assisted arm.

movements, rotation and up and down or pitch. The sixth degree is a sideways movement of the wrist or yaw. In addition there is an end effector, usually a gripper which is sometimes included in the number of degrees of freedom. Most grippers are two-fingered pinchers but there are three-fingered versions and some machines can take other devices.

The drive systems are equally, if not more, varied. The older models use stepper motors and nylon cord transmission systems. Steppers have the advantage that they can be instructed to move a certain number of steps without feedback to assess when the required movement has been completed. They are slower, however, than the now more popular d.c. servos, which do need feedback.

Scaras, such as the *Cepek* from **Reekie Technology** or the *Ivax* from **Feedback Instruments**, are mostly powered by d.c. motors with a toothed belt drive, nylon cord having been found to slip. Articulated arms go in for more exotic systems such as the servo-driven screw drives of the *Ogre*, the servo powered screw-driven pistons of **Remcon's Teachrobot** or the oil hydraulic system of Feedback's HRA 933 and 934.

Positional feedback is usually obtained by optical encoders which use light reflecting from a disc on which there are black and white stripes.

Most can be obtained in kit form or fully built, the advantage of the kits, apart from their being cheaper, is that a detailed knowledge of the device can be obtained as it is built. They come complete with software for operating the system either by way of their own processors or from popular micros like the BBC B or increasingly the IBM PC.

Most manufacturers, like **LJ Electronics**, maker of the *Atlas*, or **Cybernetic Applications**, maker of among others the *Neptune* and *Serpent*, consider that their arms are only part of a total robot system and have built-up work cells to show how their arms can be used in a manufacturing environment. They include conveyor belts and sorting and storing systems. Cybernetic has recently gone a stage further by including a milling machine on which small items can be made which are then checked and sorted by the rest of the system.

Although there have been some problems in the market recently with **Colne**

Seymour Papert, reported to be the "father" of the turtle language—LOGO.

Even a child can teach a Neptune robot, when fitted with touch sensors.

Robotics being liquidated and **Powertran Cybernetics** assimilated into its parent company, Feedback Instruments, there are still a number of new developments.

Maker of the *Ogre*, **L. W. Staines**, is planning to launch a two-armed robot called *Troll*. It is based on the same robust technology as the Ogre and its two arms can perform tasks together. Recently a new name has appeared, **Spectravideo**. Already well-known for its computer peripherals, this company has announced a new low-cost four-axis arm with three clip-on end effectors.

BUGGIES

Buggies or turtles are small mobile computer peripherals which initially were designed to help in education, particularly the teaching of maths where abstract concepts could be made physical. The turtle name came from the innovatory work of an American, Seymour Papert, who wrote the language which they mostly use, LOGO, and used it to control small turtles on a screen before the mobiles were considered.

The devices are usually two wheeled, using stepper or servo motors, with a pen which can be raised or lowered to draw diagrams under the control of a computer.

There have been casualties here as well. **Valiant Designs** produced an infra-red controlled turtle which proved very popular but the company has since closed.

One of the earliest companies, however, is still around. **Jessop Micro Electronics** with its creatively-named *Jessop Turtle*, which looks like an upturned mixing bowl, is still selling steadily.

Here again manufacturers are finding that having a robot is not sufficient and two of the newer companies have developed a large amount of support material. **Clwyd Technics**' school-designed *Trekker* comes with programs and documentation for a range of school courses in which the mobile can assist learning and has been well received. *Zero* from **IGR** has bump and sound sensors and a line follower and the company is hoping to move out of education with some specially-written games.

TOYS

At the cheaper end of the market are the "toys". Personal robots hit the headlines in this country about two years ago when **Androbot**'s *Topo* was launched with the expectation that RB Robot's RB5X would follow soon. Despite all the ballyhoo it quickly became apparent that they were little more than expensive, more than £1,000, toys and they failed to sell.

The companies which went for more reasonably-priced toys, like **Tomy** of the US, proved more successful. Tomy robots can, with some persuasion, react to speech, be programmed in a simple way and are mobile, like George, the Compurobot. The company is now importing the *Petster* range, which has similar capabilities, but instead of looking like miniature R2D2s they resemble furry toy cats, the ultimate in cuddly robots.

The three-way split, however, leaves out two areas which do not fit easily into any category, the Heros and kits. Lego, Fischertechnik and more recently Meccano, are providing packages which though appearing to be toys allow quite sophisticated devices to be constructed.

A buggy can be built from **Lego** which can be controlled by a switch panel or by a computer. **Fischertechnik** has recently expanded its range of computing kits to include a simple arm and **Meccano** has been assessing the market.

All have attracted interest from the education market because of their relatively low cost and flexibility and increasing amounts of software are being written for them.

There is also a set of kits from **Milton Bradley** which though they are more obviously aimed at the toy market their movements can be controlled by a simple keypad and can give an easy introduction to many robotic concepts.

The Heros are much more complex, being intended for higher levels of education. When *Topo* was receiving much attention *Hero 1* was also included as an example of how personal robots were developing, mainly because it was mobile and had a vaguely similar shape.

However, that was the end of the similarities. Hero had been designed with education in mind and had many more facilities than Topo. It had an on-board processor, with possibility of expansion, light, sound and movement sensors and a rangefinder, a four-axis arm, speech and a comprehensive robotics course based around it.

Made in the US by Zenith/Heathkit it is imported by **Maplin Electronic Supplies** and is still selling for about £2,200 ready-built or £1,200 in kit. Recently its upgraded version, the *Hero 2000* became available in this country with far larger ROM and RAM, improved speech and a five-axis arm selling for £2,200 plus VAT for the kit.

THE CHALLENGE

Robots have a long way to go before they match the ultimate fantasy but developments are being made all the time. As BP discovered when it held two "Build-A-Robot" contests for schools and youth organisations, there is plenty of original thought around.

After its first contest, in which a block had to be found and collected in the shortest possible time, the organisers thought they would make the second one more difficult. A machine had to be built which would fetch a drink on request. It was thought this might prove too difficult, until the results were seen.

A similar "impossible" challenge has been set by Dr John Billingsley of Portsmouth Polytechnic—the building of a robot ping-pong player or Robat. That followed his Micromouse challenge which attracted interest from all over the world, lately in Japan.

The first prototype Robat machines have been seen and some have developed an efficient hand-eye co-ordination and been able to hit the ball. The next stage is to impart some direction to the resulting hit.

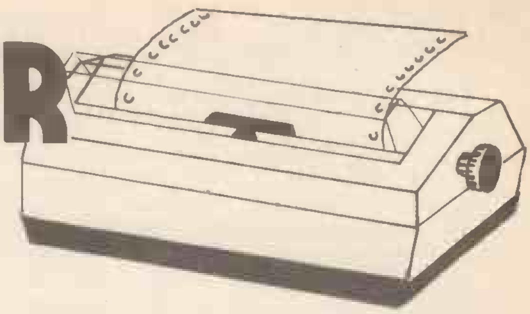
The big stumbling block to any form of "human" robot is the development of an intelligence. How to react quickly to all the inputs which can be received through a series of accurate sensors or spoken instructions is a limiting factor in all robots. There is plenty of work going on around the world in the area of artificial intelligence and Britain is one of the leaders in the field.

The world of personal robots is wide-ranging and fascinating and I intend to cover it thoroughly. If you have any points you wish to make or any new products or developments which you think should have a wider audience I can be contacted through the magazine.

The Valiant infra red sensitive turtle—now defunct.

The now famous Hero 1 marketed in the UK by Maplin.

SIMPLE PRINTER BUFFER



W. HUNTER

An invaluable addition to any computer/printer set-up with a Centronics interface

A PRINTER buffer is one of those items which you will not miss until you've used one. Any serious computer user will find the circuit described here is really useful. (However we do not recommend this project to readers who have not built other projects successfully.) It allows the continuation of data or text entry whilst the previous letter, account, listing or what-have-you is printed out.

The commonest printer interface amongst cheaper printers and microcomputers is the Centronics Parallel Interface. It is available on the ubiquitous Epson range of printers, which can be driven by almost any computer. The printer buffer described in this article uses the Centronics Interface and has been designed for simplicity in construction and application. It fits between the printer cable from the computer and the printer itself. Whenever the computer wishes to send text to the printer, the buffer will accept the text as fast as the computer will transmit it, and then feed it slowly to the printer. The computer transmission will be at very high speed since the parallel interface is not constrained by a fixed Baud rate.

The buffer can accept text until its memory is full—that is 16K characters, at which stage it signals to the computer to stop. Meanwhile the buffer is feeding text out to the printer at the printer's maximum acceptance rate. Depending on the printer it might be 100 characters per second (cps) for a matrix printer down to 12 cps for a daisy wheel printer. Very often, the buffer's 16K memory will be enough to accept all the computer's output at one go, freeing the computer for use in only a few seconds. The printer itself will be occupied for minutes as the buffer feeds out the full text at the printer's own speed. If the computer attempts to output more than the buffer can hold, it is halted at the moment the buffer is full. The buffer will then demand more text from the computer at the rate that the old text is sent to the printer.

CIRCUIT

The heart of the buffer is the Motorola 6802 central processing unit (CPU) shown in Fig. 1. It is almost identical to the long-running 6800 but the 6802 offers the advantage of an on-board oscillator, simplifying the circuit. The CPU executes a program that is held in the 2716 which is a 2K byte EPROM. The 6802 CPU can access the computer and the printer through the 6821 parallel interface adaptor (PIA). This remarkably cheap device has its peripheral lines divided into two sets, known as Port A and Port B. Each set comprises eight data lines for either input or output, and two control lines for handshaking. In this design, port A is used as an input from the computer whilst port B is the output to the printer. The PIA must be configured correctly to perform the startup sequence at switch-on.

COMPONENTS

See Shop Talk page 485

Resistors

R1,R6	10k (2 off)
R2 to R5	4k7 (4 off)
¼W ±10%	

Capacitors

C1	47μ elect. 12V
C2,C3	33p (2 off)
C4	10n
C5 to C8	100n (4 off)
C9	470μ elect. 16V

Semiconductors

IC1	MC6802 CPU
IC2	MC6821 PIA
IC3	2716 EPROM
IC4,IC5	6264P RAM (2 off)
IC6	74LS00 Quad NAND Gate
IC7	74LS02 Quad NOR Gate
IC8	7805 +5V regulator
D1	OA202
D2–D5	1A Rectifier bridge

Miscellaneous

S1, S2	Miniature panel mounting push button switches (2 off)
T1	Mains transformer, 3VA rating, 7 to 9 volt output
FS1	Mains fuse in fuseholder, panel mounting
SK1	Centronics type 36 way socket (IEEE-488)
PL1	Centronics type 36 way plug, cable or IDC.
X1	4MHz crystal

Case, minimum size approximately 180 × 120 × 65mm; ribbon cable; double sided p.c.b. see Shop Talk; connectors, etc.

Approx. cost Guidance only £31

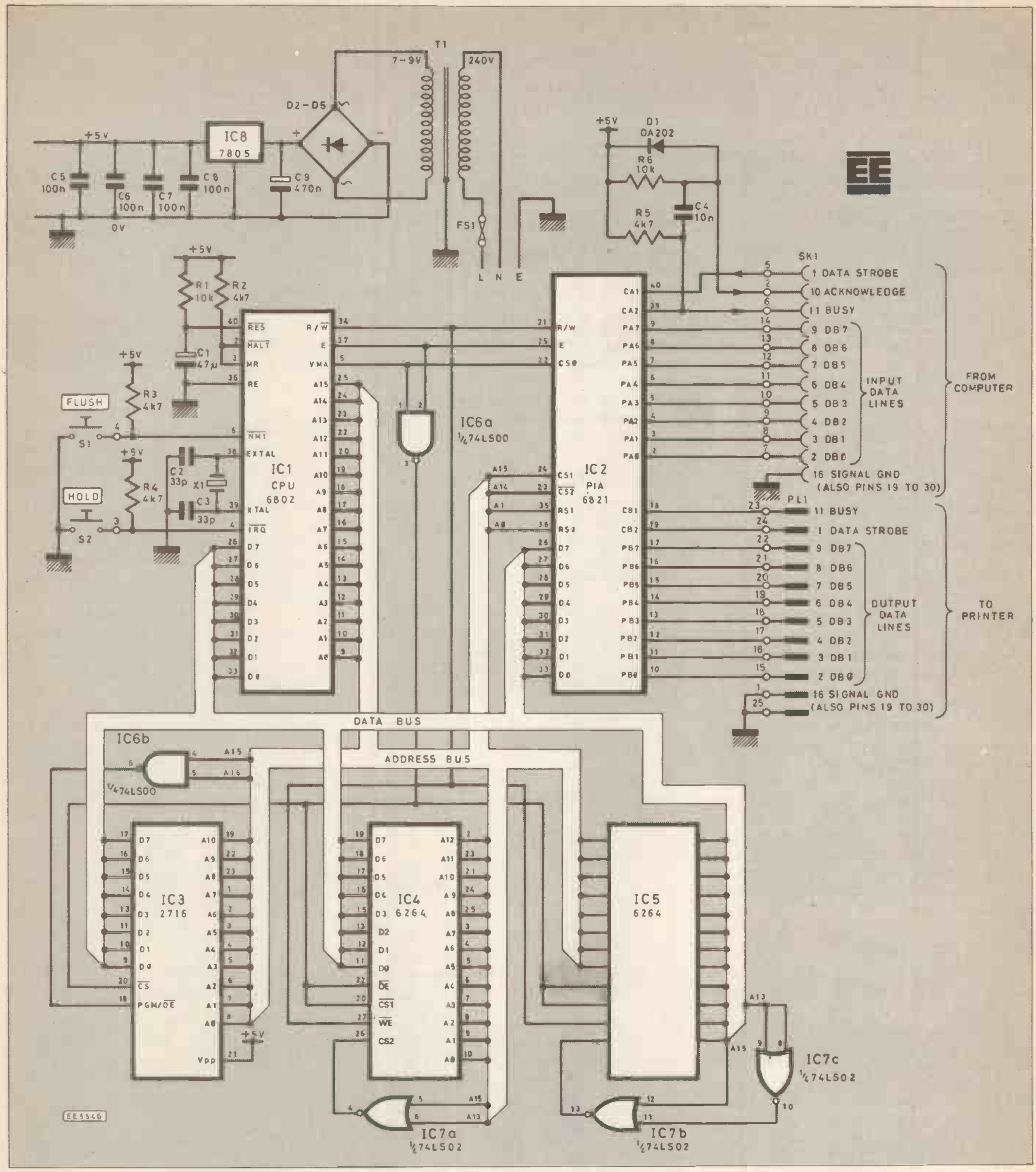


Fig. 1. Complete circuit diagram of the Printer Buffer.

Memory (i.e. RAM) is available in many different types of integrated circuits these days. The 6264 chips used in this design are part of the family known as "Byte-wide" memory chips, since they have eight parallel data lines. With these chips a byte of data can be read from one chip in one access cycle, making design simpler than with other types.

Each of the 6264 chips will hold 8K bytes, making a limit of 16K characters of text in the buffer. However the circuit and EPROM program are designed so that the buffer will run with only one memory chip if necessary, in case a constructor wishes to keep the initial costs to a bare minimum.

The only remaining logic circuits are the NAND and NOR gates which are used for the decoding, shown in Fig. 2. In order to cover reset and interrupt vectors, the EPROM is decoded to the top of the memory map, occupying $F800 to $FFFF. The RAM is placed at the lowest addresses, the first (and possibly only) RAM chip being at $0000 to $1FFF, and the second at $2000 to $3FFF. This leaves plenty of space for the PIA, which only requires four addresses—these are available at $8000 to $8003. Those readers familiar with address decoding will realise that the locations given are not the only locations which could be used. In fact the PIA occupies all addresses from $8000 to $BFFF, but there is no advantage in refining the decoding further for this project.

HANDSHAKING

The Centronics parallel interface uses a system called "handshaking" in order to pass data from one device to another (see Fig. 3). Handshaking prevents the sending device (the source) from transmitting data too fast for the receiving device (the target) to deal with. At the start of transmission,

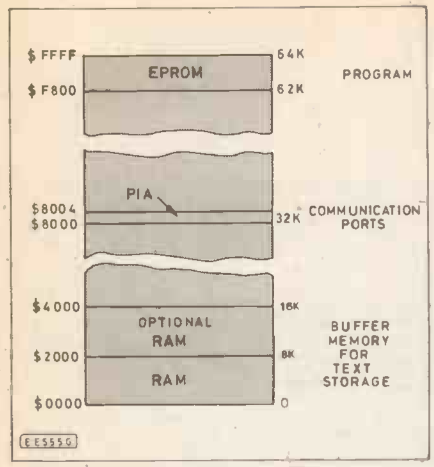


Fig. 2. Decoding of address space.

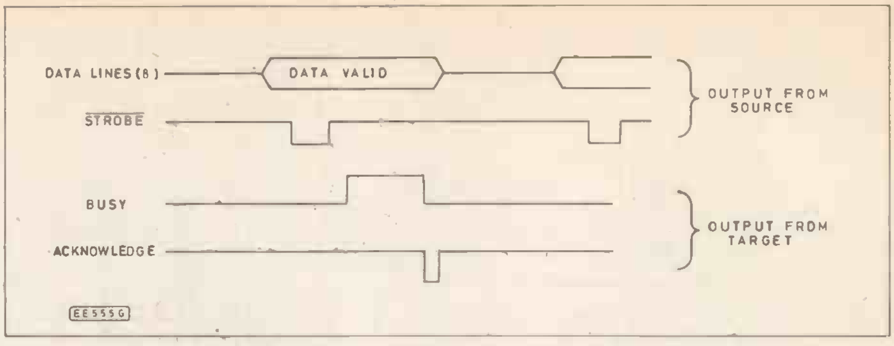


Fig. 3. Interface handshake timing diagram.

the source puts one byte of data on the eight parallel data lines. It then signals to the target that valid data is held on the lines, by sending a pulse called a strobe to the target. Since the data lines are all occupied, the strobe has to be sent on a separate line which is called the Strobe line. The source will now wait until the target has had time to read the data byte. The target signals that is has received the data, by putting a "high" voltage (i.e. 5V) on yet another line—the Busy line.

As soon as the source reads a high on the Busy line, it terminates its strobe pulse, if it hasn't already done so. The target now processes the data (i.e. prints or saves it) and then signals to the source that it is ready for another data byte. It does this by dropping the voltage on the Busy line back to zero. The Centronics interface provides for two types of target reply line. The Busy line can be replaced or assisted by an Acknowledge line. Some computers use only one or the other of these two lines. This design provides both, so it will interface with any computer with a Centronics interface.

ACKNOWLEDGE

The Acknowledge line is held high normally, and when a byte of data has been read by the target, a short pulse to zero volts "acknowledges" the data. The source can then move on to the next byte. The width of the acknowledge pulse is not critical, and in this design a pulse of roughly 20 microseconds is produced. The pulse comes from a falling edge on the Busy line, through a 10 nanofarad capacitor, and signals that the buffer is ready to receive new data. If the buffer is full, the Busy line remains high and so there is no negative edge and no Acknowledge pulse, until space is available again.

Handshaking sounds complicated, but it achieves the fastest possible data transfer between variable speed machines. The interface needs two handshake lines (the Strobe and the Busy lines) to work, and these are just what the PIA provides. Port A and Port B each have two "control lines" in addition to the eight data lines. Remember that the PIA has to act as a target for the computer, and as a source for the printer. Control line CA1 is therefore a Strobe input, and CA2 is a Busy output for the target side of the PIA. Control line CB2 is a Strobe output and CB1 is a Busy input when the PIA is a source to the printer.

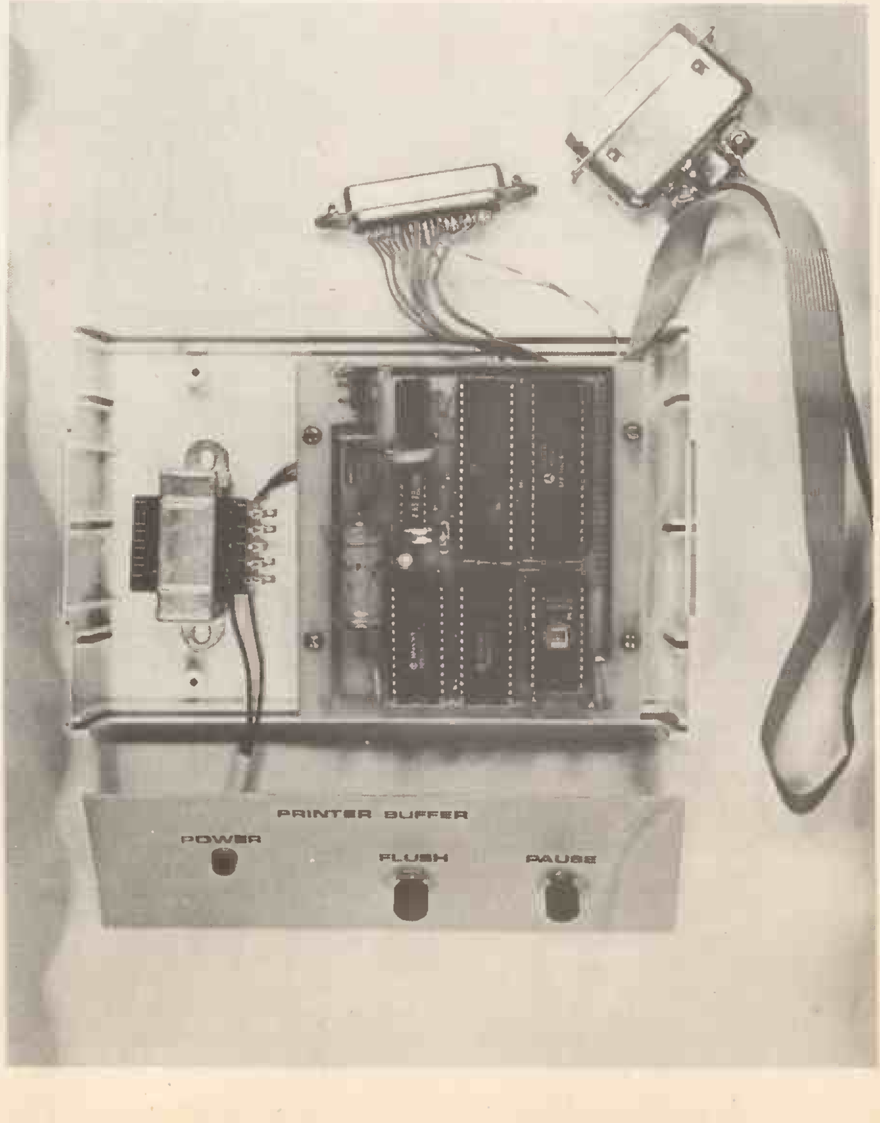
The beauty of the Centronics interface is that when the buffer is temporarily full it can halt the computer's output, until space becomes available. This is achieved by holding the Busy line high. Similarly if the printer runs out of paper, it will halt output from the buffer in the same way.

FUNCTION SWITCHES

Two function switches are provided —Hold and Flush. To keep the circuit simple, these switches are linked to the two interrupt lines of the CPU. A low on the Interrupt Request line (IRQ) will send the CPU off into a section of program which either suspends output to the printer, or resumes output if it is already suspended. The Non-Maskable Interrupt line (NMI) will divert the CPU to terminate output immediately and then reset its pointers to effectively clear its memory. This is useful if printing needs to be stopped for some reason.

PROGRAM

The program is held in EPROM and executed by the CPU. During normal operation, the program continually circulates through two routines, TRYIN and TRYOUT. One acquires data from the computer and the other despatches data to the printer —subject always to the limitations of buffer memory size and printer speed. Two pointers are used by the routines, DATEND points to the byte most recently stored in memory and DATBEG points to the byte most recently output (the next higher address is the next byte for output, i.e. the Data Beginning).



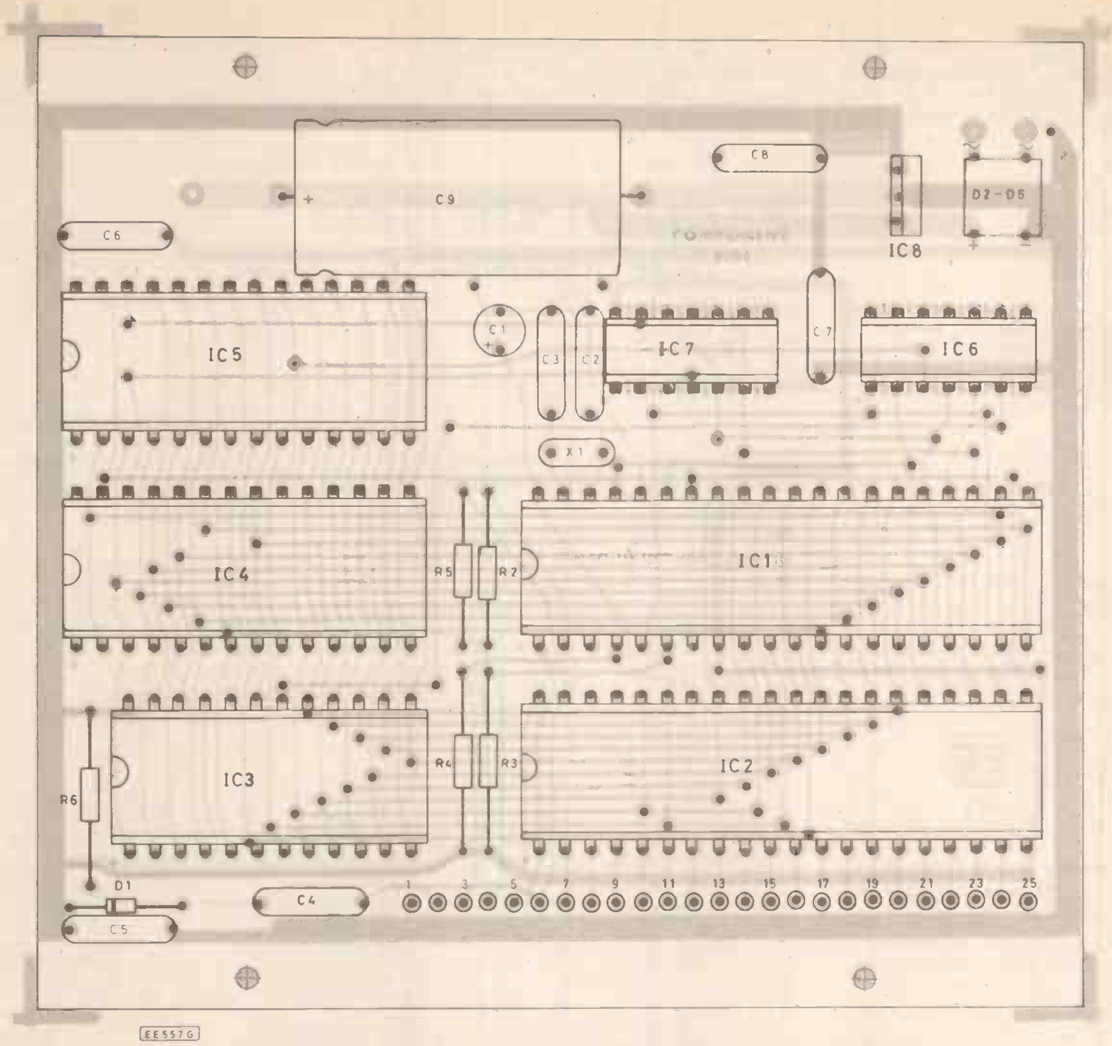


Fig. 4. Double-sided p.c.b. layout and wiring.

While TRYIN is executed, the index register (IXR) points to the next available storage location. Subroutine INDAT puts the Busy line low and checks the input port (at PIAIN) to see if a data strobe has latched the CA1 flag (bit 7 of PIAIN). If it has, the routine reads a data byte from the port and then puts the Busy line high again. TRYIN now stores the data byte, updates IXR and saves it in DATEND for the next round. Note that if no data strobe is detected or if memory is full, the pointer DATEND is not updated by IXR, so the current location is preserved for another try.

TRYOUT alternates with TRYIN and attempts to feed data to the printer. After loading the accumulator (A) with the next data byte (if there is data in memory), OUTDAT is called. This subroutine checks whether the previous output has been received and acknowledged by the printer (CB1, bit 7). If so, the new data is output via port B (PIAOUT). Finally the pointer DATBEG is updated. It can be seen that TRYOUT will not send new data if there is none to send, or if the previous byte has not been acknowledged. This latter condition causes a slight hiccup for the first byte, since there was no previous byte to be acknowledged in this case. FLAG1 allows OUTDAT to circumvent the acknowledge condition for the first byte after power-on. The subroutine labelled STROBE provides the requisite handshaking pulses for OUTDAT.

When power is switched on, the reset line is held low for about 500ms by the resistor and capacitor on the line. The reset vector takes the CPU to an initialisation routine. First the stack pointer is set to point to the top of the stack area, then the PIA is set up appropriately with port A as an input and port B as output. CA1 and CB1 are set up to trigger on negative edges for handshaking. The memory at $2000 is tested to find if the second RAM chip is fitted and the appropriate value ($2000 for 8K, $4000 for 16K) is stored in MEMEND. The pointers DATBEG and DATEND are intialised to the start of buffer memory, above the stack at $007F. Eventually the main loop of TRYIN—TRYOUT—TRYIN, etc is started.

The interrupt vectors NMI and IRQ are used by the control buttons for Hold and Flush. The NMI routine simply resets the stack then jumps into the initialisation routine beyond the PIA set up section. This is to avoid the possibility of an inadvertent strobe to the printer if the PIA was set up anew. An interrupt request (IRQ) can cause the processor to run one of two routines, since the Hold button has a toggle action. The routine which is to be run is pointed to by IRQV2. Initially this is the routine called IRQR1 and it is this routine that halts printing. The first action taken by IRQR1 is to put the Busy line high to stop output from the computer. It then goes into a 40ms delay to ensure that the Hold switch has stopped bouncing.

Although the processor sets an interrupt mask when it receives an interrupt request, it is possible for a second interrupt request to be latched and acted upon when the interrupt mask is cleared. IRQR1 gets around this by indicating that the IRQ routine has been run by setting a flag IRQFLG. This allows it to ignore a second interrupt. Finally, IRQR1 adjusts IRQV2 to point to IRQR2 (the other interrupt request routine) and then enters the wait state. On the next press of the Hold button, the processor exits from the wait state and executes IRQR2. This allows printing to continue, by resuming the program at the point where it left off to service the first press of the Hold button. Thus no data can be lost by the Hold action.

CONSTRUCTION

Construction of the printer buffer should present no problems. The power supply consists of a small transformer mounted separately in the case, driving a full wave bridge rectifier and smoothing capacitor. A fuse should be fitted in the mains input lead to the transformer, for safety. The d.c. supply is regulated at five volts by a 7805 positive regulator. Since current consumption is only 200mA, power loss in the regulator should not require a heat sink to be fitted unless the transformer produces excessive voltage. The power supply components are mounted on the printed circuit board (p.c.b.). It is suggested that all the integrated circuits (apart from the regulator) should be mounted in d.i.l. sockets. This not only protects against destruction by high soldering temperatures, but also assists greatly if a component is faulty.

Before mounting any components on the p.c.b. connect all the pin throughs and solder on both sides of the double sided board—there are 73 of these. A few components also require soldering on both sides of the board. The p.c.b. track masters are not shown as this board is not recommended for home manufacture—see Shop Talk for a supplier. When the board has been constructed, the power supply regulation can be checked before any expensive integrated circuits are plugged in. Connection to the computer is through a Centronics socket mounted on the back panel of the case. Separate wires or ribbon cable can be

PRINTER BUFFER SOFTWARE

```
                * SYSTEM EQUATES

8000            PIAIN   EQU     $8000      Inout PIA
8002            PIAOUT  EQU     $8002      Outout PIA
0080            MEMST   EQU     $0080      Start of buffer RAM
007F            STACK   EQU     MEMST-1    Top of stack

                * SYSTEM VARIABLES

0000                    ORG     $0

0000            MEMEND  RMB     2          Last available RAM adors
0002            DATBEG  RMB     2          Address of data start
0004            DATEND  RMB     2          Address of data end
0006            FLAG    RMB     1          Data transferred flag
0007            FLAG1   RMB     1          First data byte flag
0008            IRQFLG  RMB     1          Interrupt request flag
0009            IRQV2   RMB     2          IRQ soft vector

                * RESET AND INTERRUPT VECTORS

FFF8                    ORG     $FFF8

FFF8 F8 81      IRQV    FDB     IRQJMP
FFFA F8 B9      SWIV    FDB     SWIR
FFFC F8 B0      NMIV    FDB     NMIR
FFFE F8 00      RESET   FDB     START

                ***************************
                *
                * PROGRAM STARTS HERE

F800                    ORG     $F800

F800 8E 00 7F   START   LDS     #STACK
F803 BD F8 C1           JSR     INIT
F806 0E         START1  CLI

                * MAIN ROUTINE
                *

                * Check for data and outout if any

F807 DE 02      TRYOUT  LDX     DATBEG     Get addrs of start of data
F809 9C 04              CPX     DATEND     Any data in memory?
F80B 27 0F              BEQ     TRYIN      Branch if none
F80D A6 00              LDA A   0,X        Get data
F80F BD F8 51           JSR     OUTDAT     Send data
F812 7D 00 06           TST     FLAG       Test if data sent
F815 27 05              BEQ     TRYIN
F817 BD F8 78           JSR     INCRX      Update pointer
F81A DF 02              STX     DATBEG     Save it

                * Check buffer and inout data if space available

F81C DE 04      TRYIN   LDX     DATEND     Point to last data byte
F81E BD F8 78           JSR     INCRX      Update pointer
F821 9C 02              CPX     DATBEG
F823 27 E2              BEQ     TRYOUT     RAM full
F825 BD F8 38           JSR     INDAT      Look for inout
F828 7D 00 06           TST     FLAG       Test if data inout
F82B 27 DA              BEQ     TRYOUT
F82D DE 04              LDX     DATEND
F82F A7 00              STA A   0,X        Save data
F831 BD F8 78           JSR     INCRX      Update pointer
F834 DF 04              STX     DATEND     Save pointer
F836 20 CF              BRA     TRYOUT

                * READ INPUT PORT AND GET DATA IF ANY
                *

F838 C6 34      INDAT   LDA B   #$34
F83A F7 80 01           STA B   PIAIN+1    Put IBZ lo
F83D 7F 00 06           CLR     FLAG
F840 7D 80 01           TST     PIAIN+1    Check for strobe
F843 2A 0B              BPL     INDAT2
F845 7C 00 06           INC     FLAG       Indicate data available
F848 B6 80 00           LDA A   PIAIN      Get data
F84B C6 3C              LDA B   #$3C
F84D F7 80 01           STA B   PIAIN+1    Put IBZ hi
F850 39         INDAT2  RTS

                * DATA OUTPUT ROUTINE
                *

F851 7D 00 07   OUTDAT  TST     FLAG1      First byte since switch on?
F854 26 05              BNE     OUTD1
F856 7D 80 03           TST     PIAOUT+1   Check for printer acknowledge
F859 2A 0C              BPL     OUTD2      No acknowledge
F85B 7F 00 07   OUTD1   CLR     FLAG1      Indicate first byte sent
F85E F6 80 02           LDA B   PIAOUT     Clear busy flag
F861 B7 80 02           STA A   PIAOUT     Send data
F864 7E F8 6B           JMP     STROBE     Output STROBE pulse
F867 7F 00 06   OUTD2   CLR     FLAG
F86A 39                 RTS
```

```
                * STROBE HANDSHAKE LINES
                *

                * Strobe output port

F86B C6 34      STROBE  LDA B   #$34
F86D F7 80 03           STA B   PIAOUT+1   Put data strobe low
F870 C6 3C              LDA B   #$3C
F872 F7 80 03           STA B   PIAOUT+1   Put data srobe high
F875 D7 06              STA B   FLAG
F877 39                 RTS

                * INCREMENT X FOR LOOP MEMORY

F878 08         INCRX   INX
F879 9C 00              CPX     MEMEND     REACHED END+1
F87B 26 03              BNE     INCRX1
F87D CE 00 80           LDX     #MEMST     IF SO. START OVER
F880 39         INCRX1  RTS

                * INTERRUPT ROUTINES
                *

F881 DE 09      IRQJMP  LDX     IRQV2      Get address of IRQ routine
F883 6E 00              JMP     0,X        Jump to it

                * Stop printing and wait

F885 C6 3C      IRQR1   LDA B   #$3C
F887 F7 80 01           STA B   PIAIN+1    Put IBZ Hi
F88A 8D 2E              BSR     DELAY      Delay for switch debounce
F88C 7D 00 08           TST     IRQFLG     This routine been done?
F88F 26 01              BNE     IRQ11      Branch if not done
F891 3B                 RTI                Unwind second IRQ
F892 7F 00 08   IRQ11   CLR     IRQFLG     Flag routine done-print stopped
F895 0E                 CLI                Enable next IRQ
F896 CE F8 9D           LDX     #IRQR2     Reset vectors to
F899 DF 09              STX     IRQV2      point to other IRQ routine
F89B 3E                 WAI                Wait for interrupt
F89C 3B                 RTI                Return to main proç

                * Restart printing

F89D 8D 1B      IRQR2   BSR     DELAY
F89F 7D 00 08           TST     IRQFLG
F8A2 27 01              BEQ     IRQ12
F8A4 3B                 RTI
F8A5 86 FF      IRQ12   LDA A   #$FF       Flag - printing restarted
F8A7 97 08              STA A   IRQFLG
F8A9 0E                 CLI
F8AA CE F8 85           LDX     #IRQR1
F8AD DF 09              STX     IRQV2
F8AF 3B                 RTI

                * NON-MASKABLE INTERRUPT ROUTINE
                *
F8B0 8E 00 7F   NMIR    LDS     #STACK     Restore stack
F8B3 BD F8 E0           JSR     INIT1      Re-init RAM pointers
F8B6 7E F8 06           JMP     START1     Begin again

                * SOFTWARE INTERRUPT ROUTINE
                *

F8B9 3B         SWIR    RTI                Not implemented

                * DELAY ROUTINE
                *

F8BA CE 13 88   DELAY   LDX     #5000      40mS delay
F8BD 09         DEL1    DEX
F8BE 26 FD              BNE     DEL1
F8C0 39                 RTS

                * INITIALISE PIA AND FIND MEMORY SIZE
                *

F8C1 7F 80 01   INIT    CLR     PIAIN+1    Select DDR's
F8C4 7F 80 03           CLR     PIAOUT+1
F8C7 7F 80 00           CLR     PIAIN      Make inputs
F8CA 86 FF              LDA A   #$FF
F8CC B7 80 02           STA A   PIAOUT     Make outputs
F8CF 86 3C              LDA A   #$3C       Set up for handshake
F8D1 B7 80 03           STA A   PIAOUT+1
F8D4 B7 80 01           STA A   PIAIN+1
F8D7 B6 80 00           LDA A   PIAIN      Clear handshake flags
F8DA B6 80 02           LDA A   PIAOUT
F8DD BD F8 F8           JSR     TSTMEM     Find memory size
F8E0 86 FF      INIT1   LDA A   #$FF
F8E2 97 07              STA A   FLAG1      Set first byte flag
F8E4 97 08              STA A   IRQFLG     Set IRQ flag
F8E6 CE 00 80           LDX     #MEMST
F8E9 DF 02              STX     DATBEG     Initialise data start pointer
F8EB DF 04              STX     DATEND     Initialise data end pointer
F8ED CE F8 85           LDX     #IRQR1
F8F0 DF 09              STX     IRQV2      Set up interrupt pointer
F8F2 86 34              LDA A   #$34
F8F4 B7 80 01           STA A   PIAIN+1    Put IBZ low
F8F7 39                 RTS
```

continued . . .

PRINTER BUFFER SOFTWARE—continued

```
                   * Find size of RAM available
                   *
F8F8 86 AA         TSTMEM  LDA A   #$AA
F8FA CE 20 00              LDX     #$2000    Last addrs +1 in first RAM
F8FD A7 00                 STA A   0,X       Try storing data
F8FF A1 00                 CMP A   0,X       Test if stored
F901 26 03                 BNE     TSTM1
F903 CE 40 00              LDX     #$4000    Last address +1 in oot RAM
F906 DF 00         TSTM1   STX     MEMEND    Save address
F908 39                    RTS
```

```
SYMBOL TABLE

DATBEG 0002   DATEND 0004   DEL1    F88D   DELAY  F88A   FLAG   0006
FLAG1  0007   INCRX  F876   INCRX1  F880   INDAT  F838   INDAT2 F850
INIT   F8C1   INIT1  F8E0   IRQ11   F892   IRQ12  F8A5   IRQFLG 0008
IRQJMP F881   IRQR1  F885   IRQR2   F89D   IRQV   FFF8   IRQV1  0009
MEMEND 0000   MEMST  0080   NMIF    F8B0   NMIV   FFFC   OUTD1  F858
OUTD2  F867   OUTDAT F851   PIAIN   8000   PIAOUT 8002   RESET  FFFE
STACK  007F   START  F800   START1  F806   STROBE F86B   SWIR   F829
SWIV   FFFA   TRYIN  F81C   TRYOUT  F807   TSTM1  F906   TSTMEM F8F8
```

used to connect this socket to pads on the p.c.b. Output from the buffer to the printer is through a ribbon cable soldered direct to pads on the p.c.b. at one end, and terminating in a Centronics plug at the other end. This plug should be either an insulation displacement type or soldered, with a cover. The ribbon cable to it should be clamped on the back panel and lead out through a slot or recess. Two push button switches are mounted on the front panel for the Flush and Hold functions. □

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.

CAR WARNING OF THINGS LEFT ON

EVERY car owner knows the horrible feeling; you find you have left something on, and return to the car to find a flat battery. This circuit overcomes that problem on my Volvo, and has done so for about two years.

Take a typical journey. Get in, switch on and start, stop, switch off, after having put the sidelights on during the journey. The result is a buzzer sounding and a pilot light on to say what's left on. Switch off the lights and all is well.

If you want to leave them on for parking, flip a toggle switch and the buzzer stops. Come back again after parking with lights on, switch on, and the buzzer sounds to remind you to put the switch back to the original position.

Diodes D1, D2, D3 and D4 form an OR gate. Any one of the sensed circuits switched on produces 12V to relay RLA and (via S1 in the SET position) the buzzer. If ignition is off, the buzzer and RLA have an "earth" return via lamp LP5; the buzzer sounds and the relay energises.

The relay contact RLA1 provides an earth return for indicators LP1, LP2, LP3, and LP4 via diodes D5, D6, D7, and D8. The appropriate indicator lights up. Diodes D5, D6, D7, and D8 are needed to prevent incorrect indications via the low d.c. resistances to earth of other sensed circuits.

If ignition is on, neither the buzzer nor RLA sees an earth return, as IGN is at 12V. The buzzer is silent, and no indicators light up. In a "parking with lights" situation, IGN is an earth return via LP5, and the junction of D1, D2, D3, and D4 is at 12V. Relay RLA is energised, so the appropriate indicator is on.

Putting S1 to CANCEL silences the buzzer. When the car is started again, IGN becomes 12V; with S1 to CANCEL, this connects the buzzer between 12V and earth. It sounds, as a reminder to set S1 back to SET.

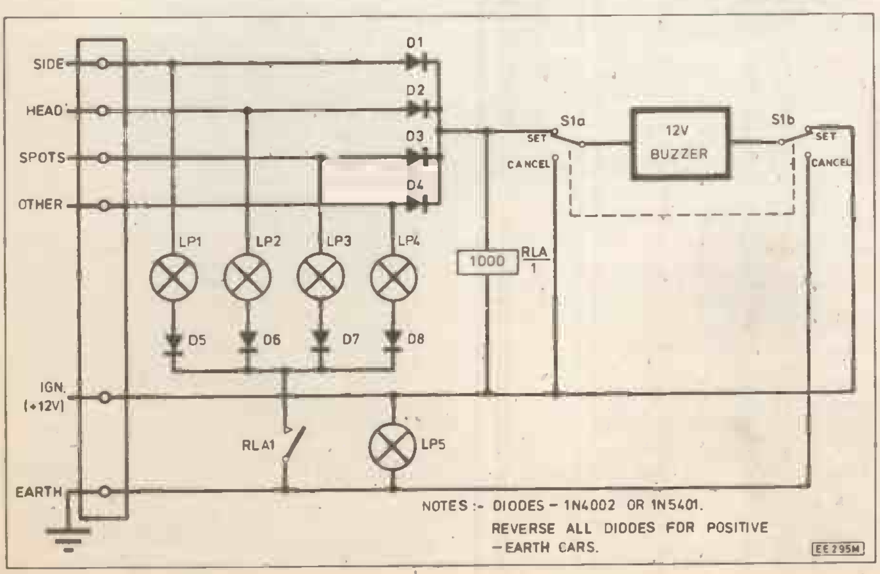
Lamp LP5 may not be necessary. All that is required is a permanent low-resistance connection between IGN and earth. On my Volvo, three added instrument illumination lamps provide this path.

Components are not critical. The circuit diagram shows suggested types. Indicators LP1, LP2, LP3, and LP4 are car accessory shop 12V indicators, any colour you fancy. The diodes can be any 1A 400V type. The relay can be any small 12V component with a coil resistance over 1000 ohms. Don't use car accessory relays, they take too much coil current. The buzzer can be any small 12V type.

The indicators and the toggle switch are mounted on a small accessory panel. The rest goes on a small p.c.b. behind the dash. The IGN input comes from any live line fed via the ignition switch.

The sensed points can normally be picked up by "tee-in" car accessory connectors near the switches of the sensed circuits. I sense side lights, headlights, spot lights, and a rear screen heater which is not fed via the ignition switch. Sense what you like; the circuit can have as many OR gate diodes and indicator lamps as you like.

C. Waltham,
Southampton.



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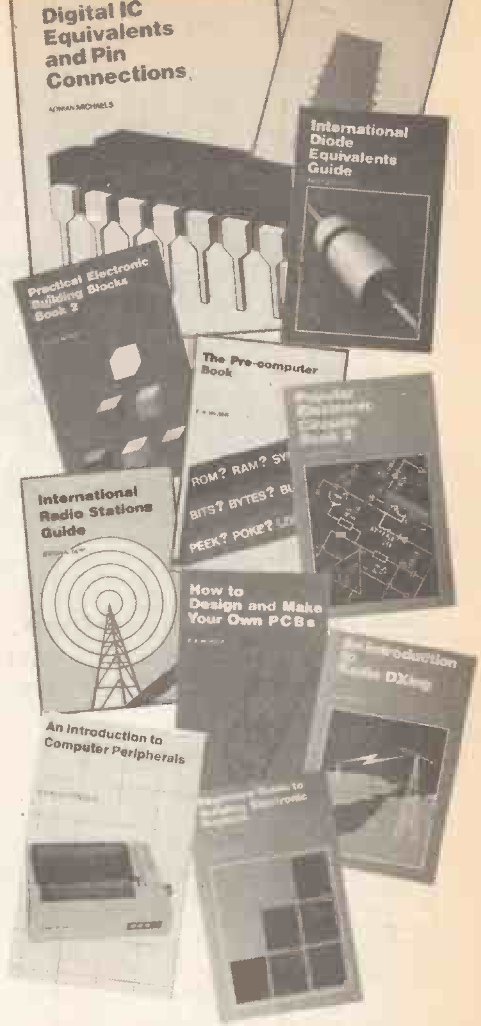
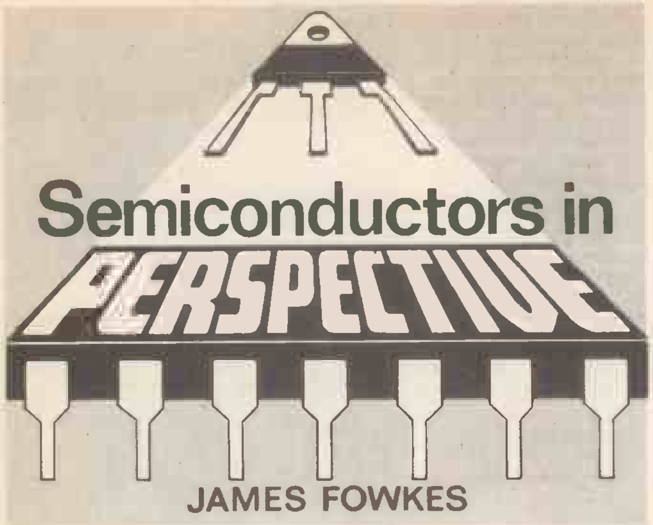




Semiconductors in PERSPECTIVE

JAMES FOWKES

SIGNIFICANT DATES

1835 Munck Roschenschold: Rectifying action in solids.
1906 Carborundum and Catswhisker was developed.
1924 Lossev Experiments with Point-Contacts and zincite with carborundum.
1930 Wilson and Mott published *The Physical Theory of Conduction of Solids.*
1945 J. Bardeen and W. H. Brittain began work on *Control of Surface Charge Density,* . . . and in . . .
1948 published, *The Transistor, a Semiconductor Triode.*
1949 Bell Telephone Laboratories announce the *p-n* junction Transistor.

THERE are still people who remember hearing "2LO calling" on a crystal and catswhisker radio. More correctly known as the crystal detector, it was one of a number of devices used to "rectify" an alternating current signal.

Other devices, in order of importance, were: The Coherer, the Electrolytic, and the Magnetic detector; The Thermionic Valve; and, much later, the Transistor.

Here we are only concerned with crystal detectors, the more common of which, again in historical format, are:

Bornite and Zincite
Zincite and Tellurium
Carborundum and Steel
Galena and Tellurium
Copper Pyrites and Tellurium
Germanium and Copper
Iron Pyrites and Silicon
Several others worthy of mention are:
Cassiterite, Graphite, Hertzite, Malachite, and Molebdenite; but the possibilities are endless.

Even a piece of common coal can rectify—or the inner and outer cones of a coal-gas flame.

Since only germanium and silicon appear to have survived common usage into the 20th century we will ignore all the others.

They possess a peculiar property where, when placed in contact with a foreign body, a current will flow much more easily in one direction than the other. This, in turn, changes a modulated pulse of radio-frequency voltage into a cumulative unidirectional current—which may be utilised to reproduce audio-frequencies from an earpiece or other electromechanism.

The property is only present where impurities exist in the crystal. Discovered by accident, it is variously described as rectification, detection, or demodulation. Potentiometric biasing may be used to select the straighter part of the characterstic curve; or a capacitor/resistor combination, so as to utilise the incoming signal.

The Greeks first spoke of "spirit" particles in 400BC and their electrostatic experiments with amber (Elektra) are well-known.

Experiments with rectifiers, however, did not begin until about 1835AD; then, around the turn of the century the silicon carbide rectifier was developed; commonly known as carborundum and catswhisker, this was the first use of silicon.

Shortly after the First World War, experiments began with silicon point-contact diodes. Ideal for u.h.f. detection, they were electrically similar to the thermionic valve, which was now fast replacing the crystal and catswhisker.

Germanium oxide can be obtained from the flue-ash resulting from burning common coal.

The advent of another war made miniaturisation a priority. Owing to material shortages, both germanium and silicon were used; the latter being less frequency-conscious. (In Germany brass wire was substituted for the copper used in radios due to a shortage of the latter caused by allied bombardment.)

The instability of the catswhisker led to the study of "doping"—adding impurities to the junction—and conductivity was found to improve across the resultant alloy. Doping creates either a surplus or a deficiency of electrons in the crystal lattice. The former is referred to as the donor *n*, while the latter is called an acceptor *p*.

When *p* and *n* atoms bond together in a co-valent, or homogenous, union an energy exchange occurs as the two materials try to equalise, leaving a depleted area known as the "space-charge" region. An area of stress builds up in this region and is referred to as the *p-n* junction. "Forming" a junction is a continuous process, so that the junction may become a chemically "single" crystal.

Since each side of the junction is of opposite polarity, it follows that it must possess capacitance. The extent of this capacitance has considerable influence on determination of the upper frequency limits.

Negative electrons have to be "balanced" by positive holes. (A hole is an atom lacking an electron and, therefore, carrying a positive charge.) Where the electrons greatly outnumber positive holes the crystal is referred to as *n* type.

If positive holes predominate the structure is called *p* type.

The point-contact's catswhisker is pointed so as to concentrate the electric field. The same principle is applied to the lightning conductor.

Study concentrated on the effect of surface charges after the Second World War, and use of an electrolyte in contact with the surface of semiconductor material led to an additional electrode placed close to the first.

Soon afterwards, the Bell Laboratories announced the *p-n* junction transistor. (This was named after TRANSfer + reSISTOR = Transistor.) Which side of the junction the second contact is placed determines whether the resultant transistor will be *pnp* or *npn*.

The three transistor electrodes are called the emitter, the base, and the collector. Application of a forward bias between the emitter and base will cause holes (or electrons, depending on transistor type) to be emitted from the emitter into the space-charge region (the base). And a reverse bias applied from the collector to base will permit the collector to collect.

Direction of current flow has long been confused with the ambiguities of "current flow" and "electron flow"—the one in direct contradiction to the other.

With the arrival of crystal "chemistry"—a branch of quantum mechanics—new, and yet more confusing terms have evolved. Current flow by hole movement; forward current, reverse current, saturation current, leakage current, and now *p-n* or *n-p* junctions!

INTEGRATED

Soon two or more transistors were to be found embodied in the same envelope. (This was no new event, for in the wartime German "people's" set four thermionic valves shared the same glass case.)

Transistor-pairs soon followed; the "Darlington pair" and the "Super-alpha pair" soon led to logic blocks and gating circuits, and to diode-transistor combinations (DTL). Then, to obtain greater speed, the transistor-transistor (TTL) logic series evolved—and the integrated circuit was born.

Since the semiconductor industry concentrated on business processing and personal computers, integrated circuit development slowed down. Thermionic valves and other components were expensive in comparison with circuit wiring; whereas in semiconductors, chip area and wiring limit costs.

The advent of VLSI (very large scale integration) brought denser bulk memories, concentrating 256,000 ECL (emitter-coupled logic) devices onto a "chip" smaller than a baby's finger-nail, but with wide-ranging applications for solving design problems throughout the fields of physics and engineering.

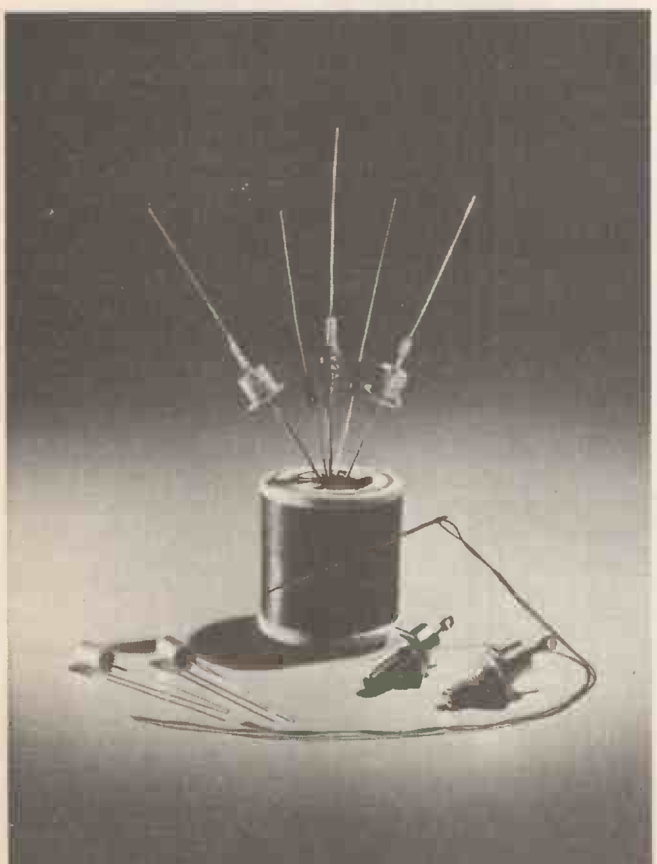
The Government-sponsored Alvey directorate recently announced a £63 million, three year, research programme to a number of the larger manufacturers' research groups, to develop VLSI, which relies on a lithographic process. After the three years they move on to the next but one "chip" generation—up to 10 million components on a single chip. One project will be to develop an advanced 1·25 micron CMOS (CMOS stands for complementary metal-oxide semiconductor), using a double level metal process involving VLSI.

By applying the laws of quantum physics, computer study of molecules large enough to be of biological significance has produced stable silicon compounds, called "polysilenes", in which silicon atoms bond together. These silicon-silicon bonds form a "living" tissue which will make the "biological chip" possible. New laws, both social and ethical, will be needed then to govern its use.

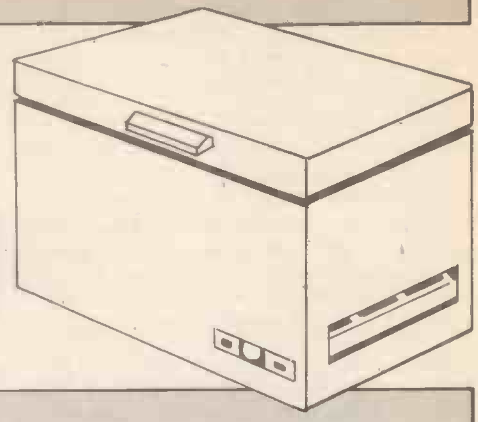
Devices such as those proposed will make the home computer seem a simple mechanism compared even with the calculators in use today.

That simple crystal might well be termed our building block to the future . . . □

A range of modern semiconductor diodes.



FREEZER FAILURE ALARM



W. HUNTER

Provides an audible warning of freezer failure

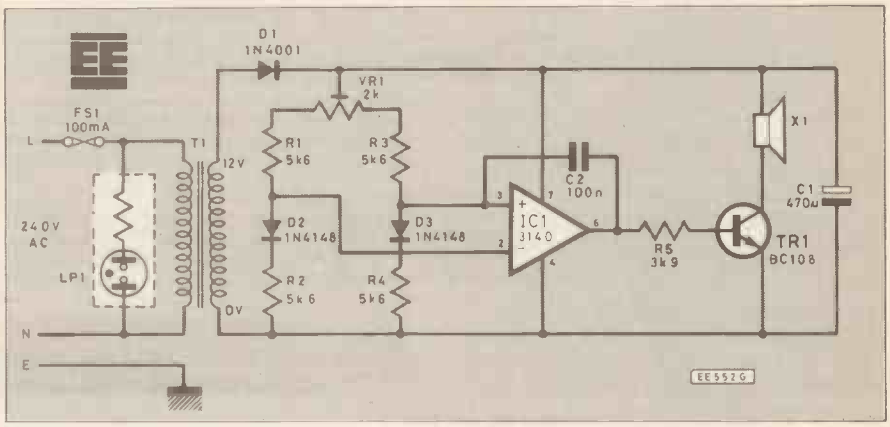


Fig. 2. Complete circuit diagram of the Freezer Failure Alarm.

A DOMESTIC freezer is a very reliable piece of household equipment and generally runs for many years with no trouble at all. If a fault occurs, then there is usually time to get the machine repaired before the food is spoiled, providing the freezer is kept shut and the repair man is called in immediately. But what happens if the freezer is in an out of the way place like the garage when the fault occurs, and it is not noticed for some time? This happened to the author recently and he was left with a large amount of thawing food which had to be used up quickly before it spoiled. This prompted the design and construction of the freezer failure alarm described in this article.

BASIS OF OPERATION

The circuit described here uses a silicon diode as the temperature sensor, and measures the voltage across the diode which changes as the temperature of the diode changes. The forward voltage of a silicon signal diode will depend upon the particular diode type, but it is usually around 0·7 volts. This voltage falls by about 2mV for every Centigrade degree rise in temperature, and this is known as the temperature coefficient of the diode. Using this property, the diode can be used as a temperature measuring device. Fig. 1 shows the principle of the circuit used in the alarm.

The sensor diode D1 along with R2 forms one arm of a bridge circuit. The other arms are made up of R1, R3, and D2 plus R4. If all the resistors are of the same value, then the bridge will be in balance when the forward voltage drop of the two diodes is equal. Assuming that the two diodes have identical characteristics, then the bridge will be in balance if the two diodes are at the same temperature, and the voltmeter will read zero. If D1 is now cooled, then the voltage across it will increase by approximately 2mV for each Centigrade degree, the bridge will be unbalanced, and the meter will show a positive reading.

CIRCUIT

In Fig. 2 the circuit of the alarm is shown. The voltmeter is replaced by an op-amp which amplifies the difference in the voltage between the arms of the bridge. Because the amplifier has no d.c. feedback its gain is extremely high, and its output will switch from low to high with the slightest imbalance in the bridge. The output of the amplifier then drives the base of TR1 which in turn causes the audible warning device to sound. Variable resistor VR1 is used to balance the bridge when the sensor diode is at the required temperature. Capacitor C2 is required to make the amplifier switch on rapidly. It supplies positive feedback to a.c. signals so that as the output voltage begins

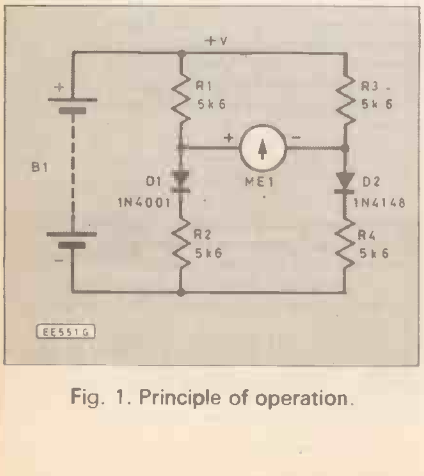


Fig. 1. Principle of operation.

to change, this is fed back to the positive input and speeds up the transition. The circuit requires very little current, and is supplied by half-wave rectifying the 12V from the transformer and smoothing with capacitor C1.

CONSTRUCTION

The circuit was built on a printed circuit board, the layout of which is shown in Fig. 3. The circuit board is mounted in a diecast box. All components are mounted on the board except the audible warning device—which is mounted on the outside of the box—and the sensor diode.

The diode is soldered to a pair of fine twisted wires and sleeved to protect the connections. The sleeve, which covers the diode itself, not only gives physical protection to the diode but also gives some thermal insulation, so that the diode does not warm up too quickly. This prevents the alarm from going off when the freezer door is opened, but will allow the diode to warm up sufficiently quickly if the freezer should fail.

The audible warning device (X1) was screwed onto the outside of the box in the author's alarm, but could be mounted remotely from the alarm and connected to the main unit with a long lead if required. The warning device uses a very small current, so there should be no appreciable voltage drop unless the connecting lead is very long or the wire is very thin. In the prototype X1 was a piezo ceramic device obtained from Verospeed (type SM2), but virtually any similar device could be used as long as it is rated for use at 15–20 volts.

COMPONENTS

See Shop Talk page 485

Resistors

R1,R4	5k6 (4 off)
R5	3k9

Capacitors

C1	470μ elect. 40V
C2	100n

Semiconductors

D1	1N4001
D2,D3	1N4148 (2 off)
IC1	3140 op. amp.
TR1	BC108

Miscellaneous

XI	Audible warning device (15 to 20V operation)
T1	12V 1·5VA mains transformer
LP1	Mains neon indicator
FS1	20mm mains fuseholder and 100mA fuse

Diecast case, 113 × 63 × 31mm; p.c.b. available from the *EE PCB Service*, order code 534; connecting wire (see text), sleeving (see text), fixings, etc.

Approx. cost Guidance only £7.50

TESTING

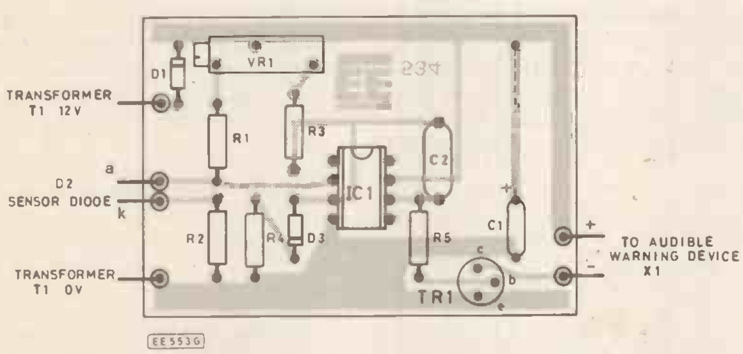
Once the circuit has been built and checked, it can be tested. This is easily done by switching on with both diodes at room temperature, and adjusting VR1 until the alarm sounds, then back-off VR1 until the alarm just stops. If D2 is now warmed up by holding above a hot soldering iron (take care not to touch the diode with the iron or it may crack) the alarm should begin to sound. If VR1 does not have enough adjustment to either switch the alarm on or off then the bridge must be well off balance. This may be due to an error in construction or a component that is faulty. It is a simple matter to check the components with a meter to ascertain where the fault lies.

When the circuit has been tested, the sensor diode can be put in the freezer, and the connecting wires brought out over the door seal at a convenient point. If the wires are thin (use 7/0·1mm wire), then the seal of the freezer will not be impaired.

The diode should be left in the freezer for at least fifteen minutes to allow it and the sleeving to cool to the surrounding temperature before the alarm is adjusted. During this time the alarm should be switched on and the box lid closed to allow the diode in the other side of the bridge, D3, to reach its working temperature. This is necessary because the bridge circuit compares the voltages across the diodes, and cooling D3 has the same effect as warming D2. The potentiometer should, of course, be adjusted so that the alarm is not sounding during this wait. After this time the alarm can be adjusted in the same way as it was during testing. The alarm is now ready for use and the box can be closed up.

RELIABILITY

Because of the simplicity of the circuit, it should be very reliable and should give no trouble, but for peace of mind it might be worthwhile testing the alarm once or twice a year. This may be done by removing the sensor from the freezer and checking that the alarm sounds after a small delay. This also provides an opportunity to check the calibration of the alarm. The author's alarm has been in use for more than six months and has given no trouble apart from a small recalibration when it was tested at four months. The adjustment required was very small and would not have caused any problem had the freezer failed. □



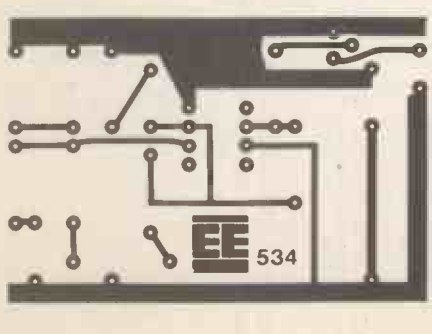


Fig. 3. Printed circuit board design and component layout and wiring. Make sure the anode of the sensor diode is connected to the upper pin. T1 should be connected to the mains via a fuse and mounted in an earthed metal case.

exploring electronics

OWEN BISHOP

Part 3 Another transistor switch

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

THIS month we build another circuit based on a simple transistor switch. This circuit introduces you to ideas that are very important in circuit design—the idea of the *potential divider* and the idea of *feedback*. It also introduces another kind of semiconductor device, the *light-dependent resistor*.

POTENTIAL DIVIDERS

Sum of resistors R_1 and $R_2 = R$ (Fig. 3.1a).

Potential across AC (V_{AC}) is $V_{AC} = IR = I(R_1 + R_2)$ so $I = V_{AC}/R$

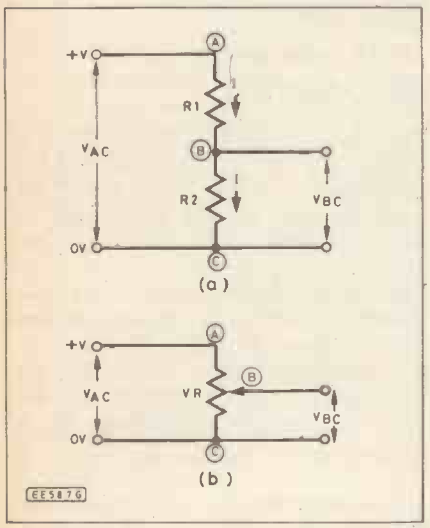


Fig. 3.1. Potential divider arrangements.

Potential across BC (V_{BC}) is $V_{BC} = IR_2$

$$= \frac{V_{AC}}{R} \times R_2 = V_{AC}\left(\frac{R_2}{R}\right)$$

The potential across AB is divided, and a fraction of it (R_2/R) appears across BC.

This assumes that we draw no current from point B. If a small current is drawn, there will be little change, but if a large current is drawn the potential across BC may fall greatly.

In Fig. 3.1b V_{BC} can have *any* value between zero and V_{AC}, depending on the position of the wiper of the variable resistor, VR

LIGHT DEPENDENT RESISTOR

The light dependent resistor (l.d.r.) is a resistor made from a semiconducting material such as cadmium sulphide. When light falls on it, the energy of the absorbed light causes additional electrons to be set free. This provides more charge carriers, so current can flow more readily. The effect of this is that the resistance of the material decreases. The brighter the light, the lower the resistance. Its resistance may fall from 10 megohms in darkness to as low as 20 ohms in bright light.

The light dependent resistor (l.d.r.) is also known as a *photoconductive cell*.

ELECTRONIC CANDLE

The electronic candle to be described is a novelty to amuse your family and friends. The "candle" has an electric lamp instead of a wick. When you strike a match and hold it close to the lamp, the lamp lights. When you blow, the lamp goes out. The candle works best in a dimly lit room.

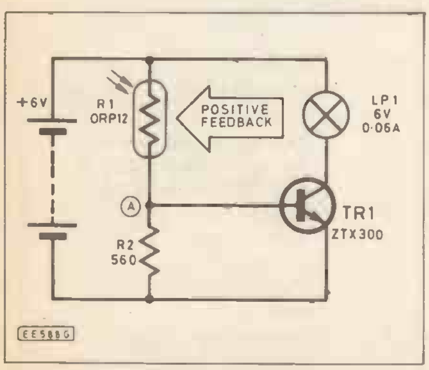
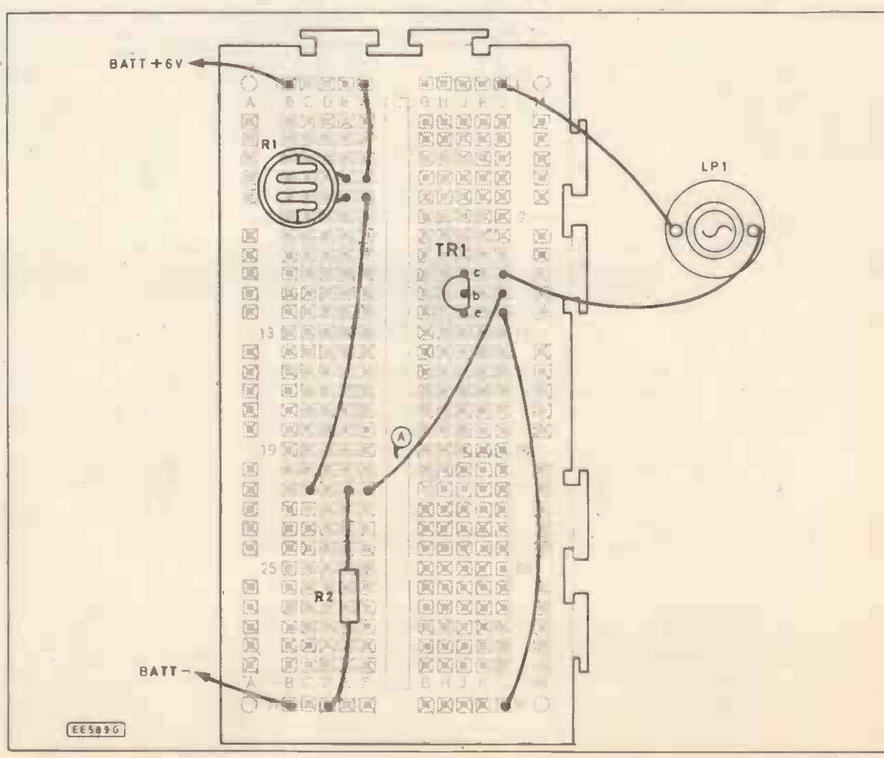
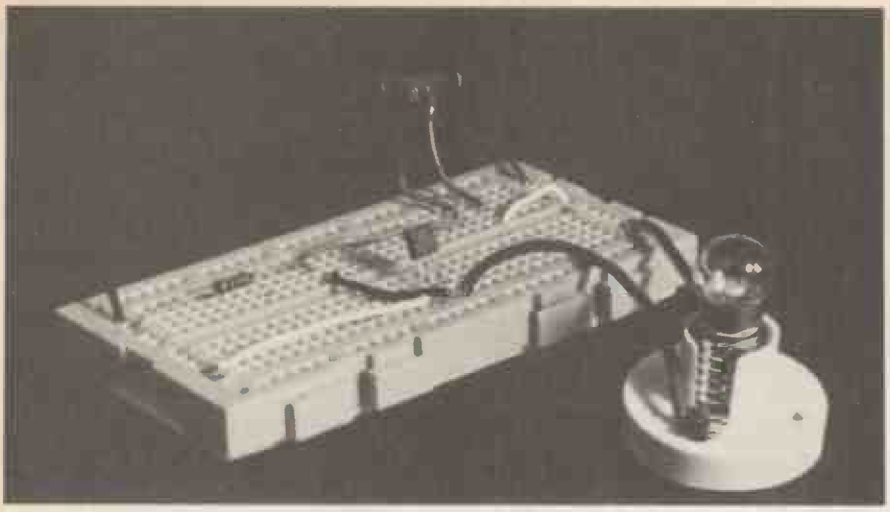


Fig. 3.2. Circuit diagram for an "Electronic Candle". The practical layout is shown opposite.





COMPONENTS

Resistors

R1	MKY7C38E or ORP12 light-dependent resistor
R2	560

Transistor
ZTX300 *npn* junction transistor

Miscellaneous
LP1 6V 0·06A lamp in holder; materials for making candle and concealing circuit if required; breadboard, e.g. Verobloc.

Approx. cost
Guidance only **£5**

HOW IT WORKS

The lamp is turned on and off by a transistor used as a switch. The base current to the transistor comes from a *potential divider*. This is made up of R1 and R2 (Fig. 3.2). One of the resistors (R1) in the potential divider is a *light dependent resistor*. In the dark this has a resistance of several hundred kilohms. As the amount of light falling on it is increased, its resistance decreases. In bright light it has a resistance of only about 100 ohms. In the dark the potential at *A* is low, almost zero volts. No base current goes to TR1, so TR1 is off and the lamp is dark. If we shine a light on R1 (or hold a burning match near to it), its resistance falls. The potential at *A* rises and base current flows to TR1. The transistor is turned on, and the lamp lights. In the electronic candle, the lamp and l.d.r. (light dependent resistor) are close together. The light from the lamp keeps the resistance of R1 low, so once turned on the lamp stays on. Even when we take the match away, the lamp stays on. To the uninitiated it appears that when we "light" the candle, using a match, it stays lit just like an ordinary candle. The "signal" from this circuit is the light coming from the lamp. Part of this signal is fed back to the l.d.r. The way the circuit is arranged ensures that light from the lamp keeps the lamp switched on. Conversely, absence of light from the lamp keeps the lamp switched off. This is positive feedback.

The electronic candle has a small shutter of card which rocks sideways and partly covers the l.d.r. when we blow on the candle. This partly breaks the beam of light between the lamp and l.d.r. As this hapens the resistance of R1 increases sharply, the potential at A falls and TR1 is turned off. The lamp goes out. Now, even though we have stopped blowing, the amount of light reaching R1 from the surroundings is not enough to turn on the lamp again. Just like an ordinary candle, it stays out when it has been blown out. The unit can be built up and tested as shown in Fig. 3.2.

CONSTRUCTION

There is a lot of scope for your imagination in making this circuit look like a real candle. The drawing (Fig. 3.3) shows one way of doing it, but there are lots of other equally good ways.

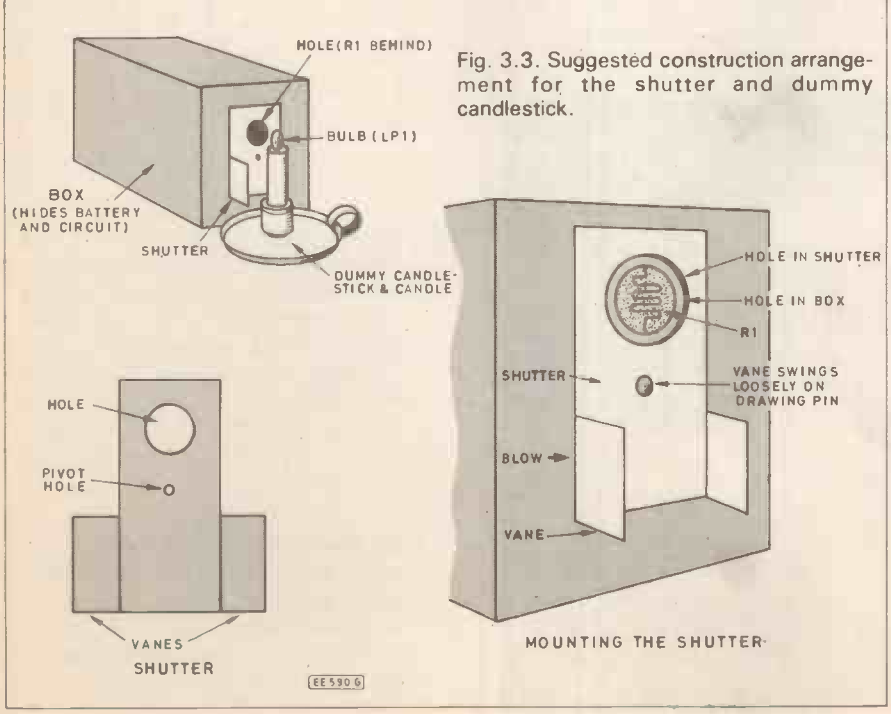


Fig. 3.3. Suggested construction arrangement for the shutter and dummy candlestick.

FEEDBACK

Most electronic circuits have some kind of *output signal*. The output signal may be sound, movement, electric current, or (as in this month's circuit) light. A small part of this signal may be taken and *fed back* to the circuit from which it came. The signal fed back is used to modify the output of the circuit.

Feedback may be positive or negative. If it is positive, an increase in the output signal leads to a further increase in output signal (until it reaches its maximum). If it is negative, an increase in output signal leads to a decrease in output signal (until it is zero or reaches a stable level).

This month's circuit shows positive feedback. We shall discuss negative feedback in later issues.

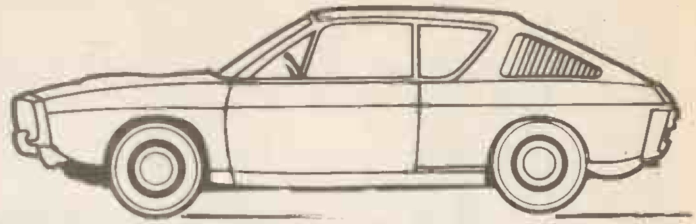
Next Month: Using a Thermistor.

You will Need . . .

R1	Thermistor, type VA1040 (or any similar type with a resistance of about 150 ohms at 25°C
VR1	Variable resistor 1k
LP1	Filament lamp 6V 0·06A with holder
D1	TIL209 or similar light emitting diode
B1	Battery—box with four 1·5V cells

Breadboard (e.g. Verobloc); pointer-knob for VR1.

CAR TIMER



D. BUTLER

Don't choke your car or collect parking tickets. The choice is yours!

THE Car Timer project was originally designed as a "choke-on" reminder for cars which do not have any such indication. However, other applications can easily be found, as the circuit is a timer with an alarm. The timer is fully adjustable, as is the alarm note, it consumes little power and occupies a modest amount of space.

CIRCUIT DESCRIPTION

The timer is formed around IC1 (Fig. 1), a 4060 14-stage ripple counter and oscillator. Components R1, R2 and C1 set the oscillator frequency, hence the timing period. The reset pin (pin 12) is provided with a pulse every time the supply is connected by the action of C2 and R3. In this way the timer is always initiated at the same point. The timer is activated by applying +12V to the supply line. Particular ways of achieving this will be considered later. The actual timing period is adjusted by connecting an oscillator output to the alarm circuit described below.

PIEZO ALARM CIRCUIT

The alarm circuit produces a twin tone which may be modified by changing components C3, R5 and C4, R6. The transducer (WD1) is a ceramic piezo-electric element which generates tones when a 3V peak square wave is applied. Rigid mounting methods ensure maximum volume levels, which is necessary in the environment of a car. The element has no moving parts, is robust and consumes little power.

A final mention should be made of diode D1, which protects the circuit from reversal of power connections.

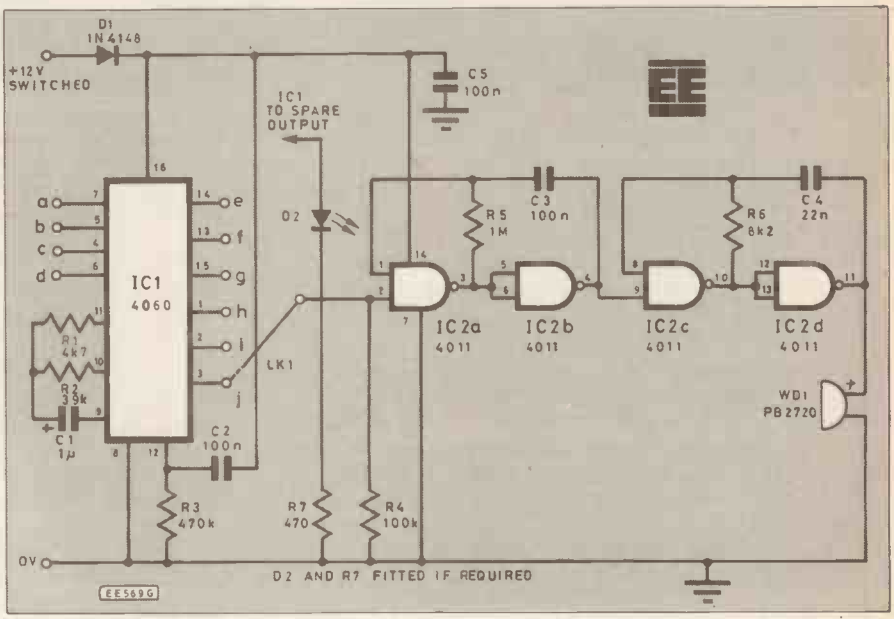
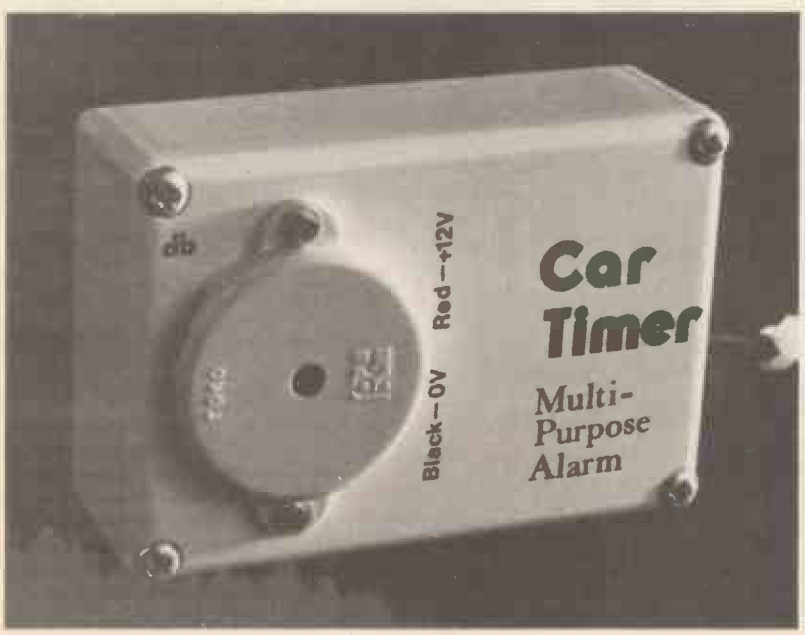


Fig. 1. Complete circuit diagram for the versatile Car Timer. Note timing link LK1.

Table 1

Connect LK1 to:	Approx. time
a	½ sec
b	1 sec
c	2 sec
d	4 sec
e	8 sec
f	18 sec
g	36 sec
h	2 min 23 sec
i	4 min 45 sec
j	9 min 30 sec



NOTE: The times given are also the "on" time of the alarm tone, e.g. LK1 to J. Alarm activates after 9 min 30 sec. Alarm turns off after 9 min 30 sec unless supply is removed first.

Figures quoted are for the following conditions:

R1 = 4k7 Supply voltage
R2 = 39k = 12
C1 = 1µ

CURRENT CONSUMPTION

Based on the component values given above and 12V supply: Timer on = 0·75mA excluding l.e.d.; with alarm = 1·7mA. (Alarm tone alters current drawn from 1·5 to 3mA as frequency increases.)

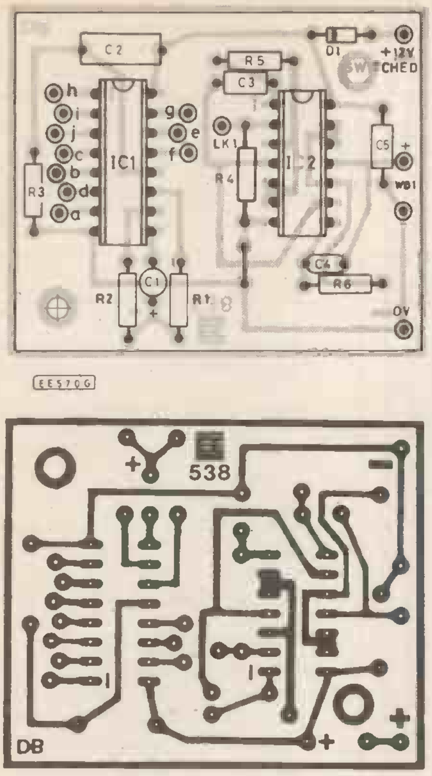


Fig. 2. Component layout and printed circuit master (full size), see EE PCB Service. Note a link wire should be attached to LK1 and one of the timing pins.

COMPONENTS

See Shop Talk page 485

Resistors

R1	4k7
R2	39k
R3	470k
R4	100k
R5	1M
R6	8k2
R7	470 (if required)

¼W ±5% carbon types

Capacitors

C1	1µ 16V tant. bead
C2	100n polyester
C3	100n min. layer polyester
C4	22n min. layer polyester
C5	100n polyester

Semiconductors

IC1	4060 ripple counter and oscillator
IC2	4011 dual input NAND gates
D1	1N4148 diode
D2	l.e.d. with mounting clip
WD1	piezo transducer PB2720

Miscellaneous

Printed circuit board (available from the *EE PCB Service* Order Code 538) or Veroboard; case (if required) (Verobox part no. 202–21024B 71·5 × 49 × 24·5mm); mounting hardware; spade connectors; switch to activate timer, e.g. microswitch, mercury tilt, push button (see text).

COMPONENTS approximate cost £5

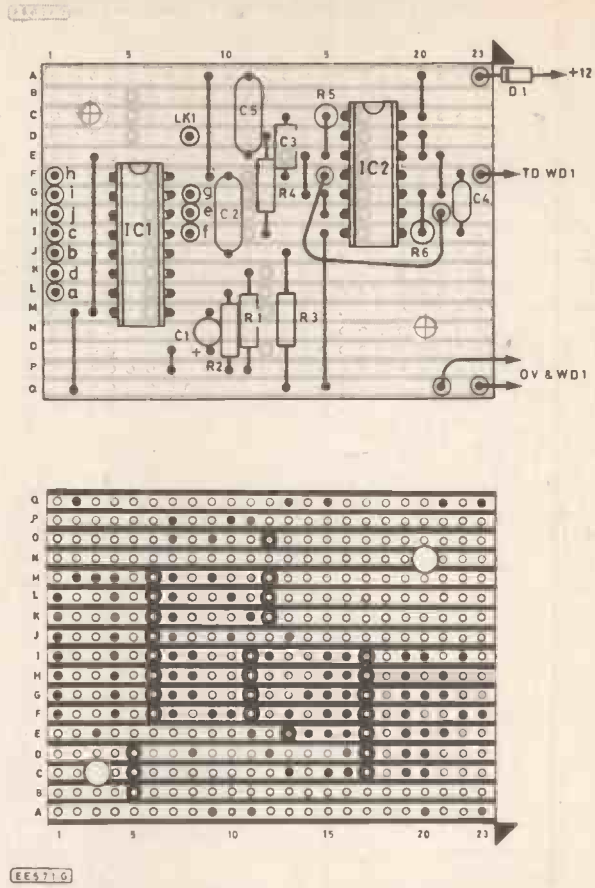
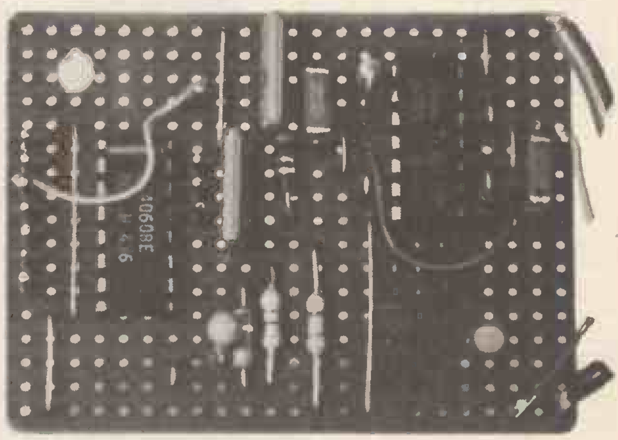


Fig. 3. Component layout and details of breaks to be made in the underside copper strips of the stripboard version.



The completed stripboard version. Note the link wire (LK1) attached to one of the timing pins.

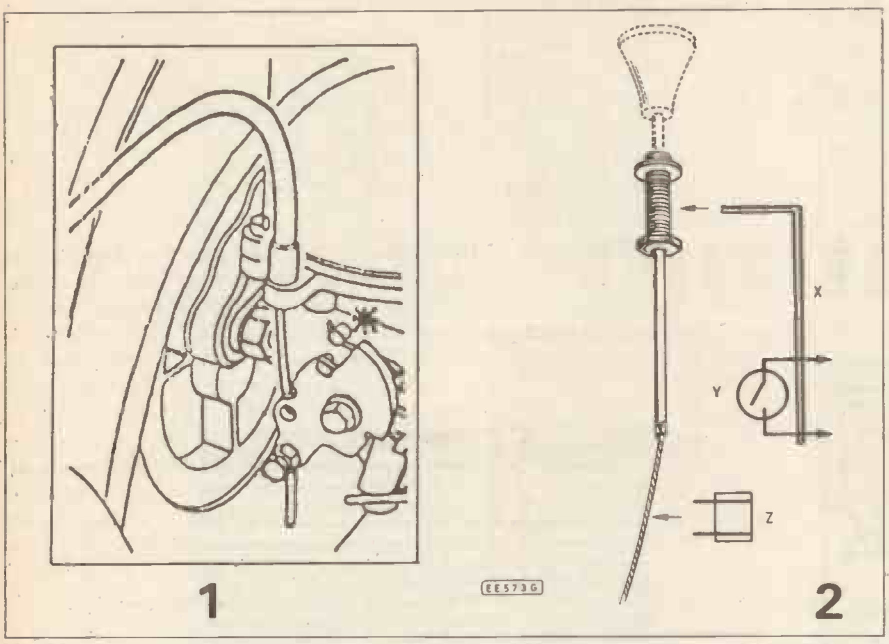
CONSTRUCTION

The circuit may be constructed using the p.c.b. layout (Fig. 2) or the Veroboard layout (Fig. 3). No special construction techniques are used, except that care should be taken when soldering in IC1 and IC2 (sockets could be used). Remember to add a wire link from LK1 to one of the oscillator outputs using Table 1 for the intended timing period. If an l.e.d. indicator is used to show the timer is on, connect it to any spare oscillator output via a 470 ohm current limiting resistor R7.

The piezo sounder should be firmly mounted to obtain maximun sound levels. Connection to the outside world, and the type of project case used depends largely on the application. The prototype was mounted in a small Verobox (part number 202-21024B) and connections made using spade terminals and "Scotch-block" break-in connectors.

SOME SUGGESTED APPLICATIONS ON NEXT PAGE

SUGGESTED APPLICATIONS



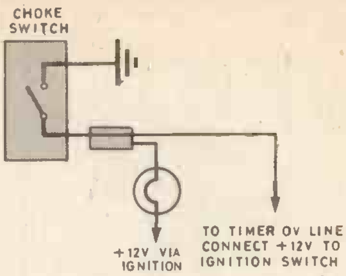


Fig. 4. Circuit of choke switch with warning light. The mechanical arrangement is shown left: 1 using microswitch and 2 using reed relay with magnet.

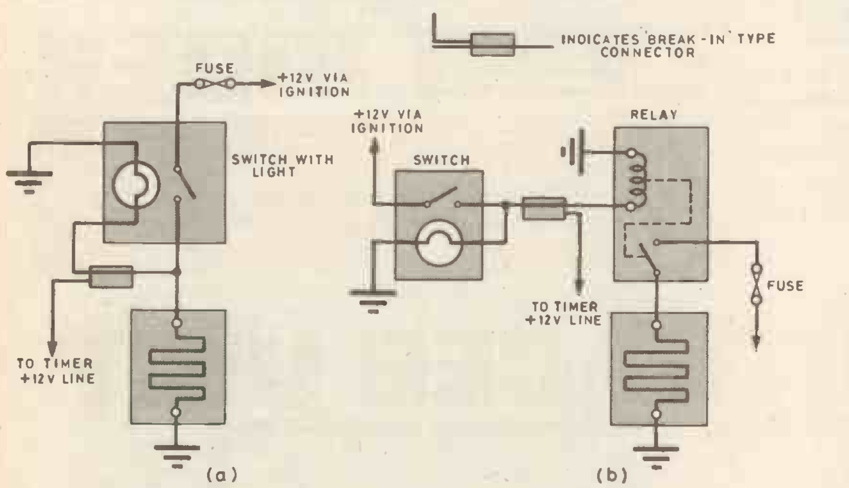


Fig. 5. Heated rear screen circuits, (a) without relay (b) with relay.

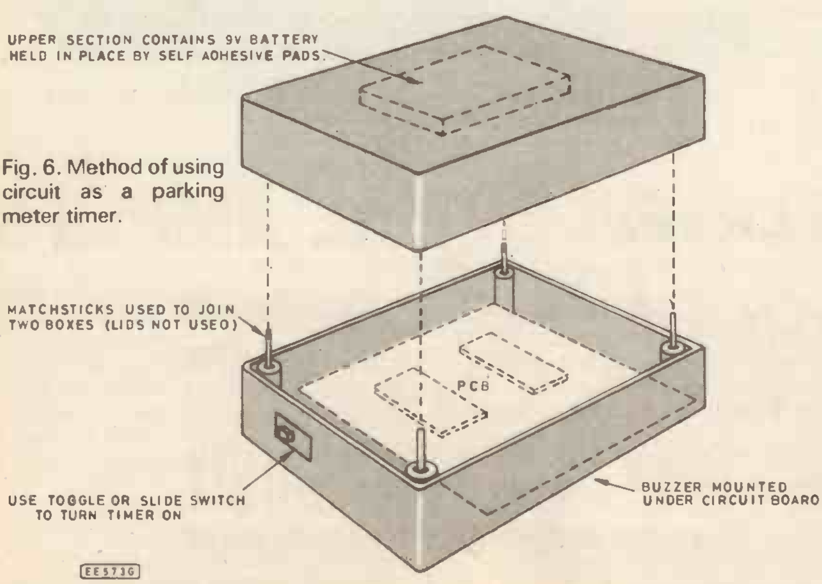


Fig. 6. Method of using circuit as a parking meter timer.

APPLICATIONS

As mentioned earlier, the project was originally designed as a "choke-in" reminder and, therefore, the unit needs to be activated when the choke control is used. Obviously it is not possible to give detailed switching methods used on every type of car, but Figs. 4 to 6 illustrate several alternatives.

The timer may be activated easily if the choke control already has a switch included, usually for a dashboard warning lamp. In many cases this switch is connected to earth which means that the timer +12V should be permanently joined to +12V via the ignition. Using the choke cable is slightly more difficult, and sections (1) and (2) show switching methods.

(1) Shows the choke cam plate on the side of the carb. A miniature micro switch is mounted where indicated by "*". The normally closed contacts are used as the microswitch lever will be released as the choke is turned on.

(2) Shows the choke cable near the control knob. A bracket (X) is attached to the control knob mounting thread, on which is a reed switch (Y). This is connected to +12V via ignition, and the +12V switched line of the timer. A small magnet is attached to the cable using twisted wire and insulation tape. The distance from the reed switch is judged by pulling the choke out and seeing whether the reed switch has engaged. Push the control back in and check that the switch has turned off. You may be surprised how far the magnet has to be fastened from the reed, as they are very sensitive. The reed and magnet method may be employed at either the control knob or carb end.

Fig. 5 also shows how the timer may be used on the heated rear screen. If the alarm goes off and the heater is still needed, just turn the switch off and then back on. The alarm will be cancelled for another time period. Finally Fig. 6 shows a parking meter and egg timer using two Veroboxes back to back.

Use two miniature Veroboxes without lids, fix lower sections using dowel, e.g. matchsticks. A 9V battery fits in top section, the circuit board in the lower section. Activate timer using an ultra-miniature toggle or slide switch. Adjust timing components to suit application, e.g. increase C2 to increase the time periods of the outputs. □

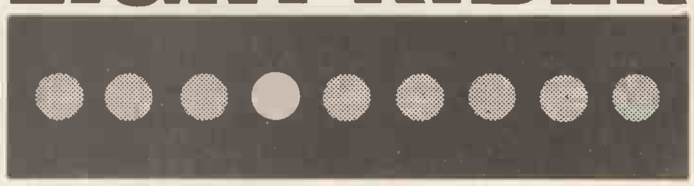
OCTOBER FEATURES...

10W AUDIO AMPLIFIER

Designed to be extremely versatile and useful, this amplifier provides 10 watts r.m.s. sine wave output power (20 watts peak) and will accept a wide variety of inputs. There are two "flat" inputs, one for dynamic and electret microphones, guitar pick-ups and other low signal sources. The other input accepts signals at standard "line" levels between 100mV and one volt. A third, completely independent input is provided with full disc RIAA equalisation for use with moving magnet pick up cartridges. The inputs can also be mixed to blend announcements with music, etc.

LIGHT RIDER

Three projects under one title—all simulations of the *Knight Rider* lights from the TV series. The three are: a lapel badge, using six l.e.d.s, a larger l.e.d. unit with 16 l.e.d.s and a mains version capable of driving six mains lamps totalling over 500 watts.



MICROTRACER UNIT

The Micro-Tracer shows an interesting way in which a computer and two integrated circuits can be used as a signal injector and tracer. The software has been written for the BBC, C64 and PET series of computers.

Feature THE DIFFERENTIAL AMPLIFIER

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

OCTOBER ISSUE ON SALE FRIDAY, SEPTEMBER 19

NEWS ...from the wo

YOUNG ELECTRONIC DESIGNER AWARDS

★ ***Umpire's decision wins top prize, and a job!, for Stephen and Howard***

★ ***Tim breaks sound barrier to win the Intermediate Class***

★ ***Gareth "gets on his bike" to win the Junior Category***

Dr Robb Wilmot CBE and the Rt. Rev. Michael Ashley Mann congratulate Stephen and Howard on becoming the winners of the Senior Section.

Now in its second year, the *Young Electronics Designer Awards Scheme* is run by Cirkit Holdings in conjunction with co-sponsors Texas Instruments and Electronics Times—a trade magazine. The competition challenges students to design and construct an electronic device with a possible application in everyday life.

After the preliminary rounds, the final aspiring designers gathered in the Great Hall at the Westminster School, London, recently to hear whether they were to be amongst the prizes. The top prize in the Senior Category carried a reserved place in the Texas graduate intake—a job!

This year, the competition was divided into three sections, senior (19–25), intermediate (15–18) and junior (under 15). Texas also donated a business computer to the establishment sponsoring the winning entries in the older age groups and 30 TI calculators to the school sponsoring the winner in the junior class.

The 1986 winners were announced by Maggie Philbin, presenter of BBC's *Tomorrow's World*, and presented by the Rt. Rev. Michael Ashley Mann, The Dean of Windsor, and Dr. Robb Wilmott CBE, Chairman of European Silicon Structures.

Final Results

After the opening ceremonies and speeches the big moment arrived and the judges' final decisions were revealed.

The winners in the senior category (19–25) went to Stephen Osborne (24) and Howard Mitchell (21) of Essex University for a Netball Umpire's Electronic Scorer. They received £500, £450 a year sponsorship to complete their studies, a vacation job and a reserved place in TI's graduate intake; upon graduation.

Second place (£250) went to Michael Scott (21), David Boyd (20) and Douglas Mackay (20) from Thurso Technical College for their Robotic Rehabilitation Arm. Third position (£100) was awarded to Adrian Travis (23) for his entry Electronic Teaching Bricks.

Intermediate Class

In the intermediate category, the winner was Tim Price who received £350 for his design of a Digital Audio Processor using a 16-bit processor and 128K of RAM.

The runner up in this section went to the only girl entrant, Rosemary Erskine (18) of Norwich High. Her Digital Anemometer won Rosemary £200. The £75 third prize went to James Lucy (16) for his BBC Micro Stage Lighting System.

Junior Class

Winner of the junior class (£250) was Gareth Arthurs (13) for his novel Bicycle Lighting Unit. The unit switched the cycle lights between dynamo and battery according to the dynamo output, preventing them from being extinguished when the cycle stops at road junction, traffic lights or is parked.

Second spot (£150) went to David Marshall (14) for his Wheelchair Controller project and a Thermometer for the Blind or Partially Sighted won £50 for Jonathan Ibbotson (14).

For details of how to enter next year's competition, write to: Carla Sharyk, Young Electronic Designer Awards, Standard House, 16–22 Epworth Street, London, EC2A 4SX.

(above) The Robotic Arm is demonstrated to Maggie Philbin (BBC) and Peter van Cuylenburgh (far right) of TI by Michael, Douglas and David.

(left) The Digital Audio Processor that won first prize for Tim Price in the Intermediate Category.

(right) Gareth (13) with his trophy and bicycle lighting unit that won top prize in the Junior Class.

INDUSTRY YEAR AWARDS

A £115,000 scheme to encourage closer links between industry and education has been announced by Minister of State for Industry, Peter Morrision.

Mr Morrison said: "I am pleased to announce that my department is launching the Industry Year Award to encourage collaboration between Industry and institutions of further and higher education. We are offering £115,000 in cash prizes, to include one for the best example of collaboration with a small firm.

"Prizes will be given in three areas of collaboration: course development, training programmes and technology transfer. The winner in each section will receive £25,000, Runners-up £10,000 and a special prize of £10,000 will be offered for collaboration with a small firm."

RADIO DATA

Radio Data System (RDS) is the new system, due to commence broadcasting in September, that will, it is claimed, make it easier for listeners to find their favourite radio programmes.

An inaudible signal will be added to v.h.f./f.m. transmitters which will enable a new generation of receivers to perform a variety of automatic functions. These range from advanced automatic tuning with a readout of the station name, a clock that is always accurate, instant switching to pick up traffic messages on other channels to the provision of a visual readout of music details of the concerto you are listening to.

The signals to control these functions are broadcast as digital codes in parallel with the main programme.

Sir George Jefferson, Chairman of British Telecom, announced that the group had achieved a profit of £1,828 million for the year ended March '86. This was 20 per cent up on the previous year.

Of this, £18 million was being allocated to the new employees' profit sharing scheme.

FREE MODEMS

Following the purchase of substantial stocks of modems, Micronet have announced that they will be issuing them free to members subscribing for one full year in advance to both Micronet and Prestel.

Following the example of the French, they hope that this precedent for the UK will encourage Prestel to do likewise.

Just Tandy

It has been reported that Tandy is to close half of its Computerworld stores because they are not making enough money. Instead certain areas will be covered by sales staff working from home, supported by their nearest centre.

Eight stores are affected and cover the areas of Bradford, Crawley, Croydon, Hull, Leicester, Liverpool, London's Victoria and Southampton. This move will leave around 40 staff to be redeployed, retrained or made redundant.

The Watford Gap

One of the UK's leading mail order suppliers for BBC Micro accessories, Watford Electronics, is to break new ground by setting up a dealer network.

The move means that in future Watford's vast range of products comprising of hardware, software and peripherals will be available from selected dealers.

Commenting on this new venture, Watford's managing director Nazir Jessa said, "There are a lot of people who don't like to purchase via mail order and who would gladly pay a little extra if only they could buy from their local dealer."

Claimed to be the largest European exhibition of musical instruments, hi-fi, in-car and TV/Video products, the 20th SIM-HI.FI-IVES show will be staged in Milan from 4 to 8 September 1986.

ROYAL SOCIETY FELLOWSHIPS

British Telecom has agreed to sponsor Royal Society Fellowships for Chinese scientific research workers to visit the UK to work in universities and research institutes. Awards will be made in fields of particular interest to BT, such as telecommunications and information technology.

Fellowships will normally be for periods of six months. Awards will cover living expenses in the UK, but not international fares which candidates will be expected to find from their home organisations.

Mr. David Pentecost is to be British Telecom's new Chief Executive, Procurement, in charge of the company's £1,900 million a year purchasing programme.

CALLING OF THE CHURCH

Five flagpoles adorn the roof of Holy Cross Church in Knutsford, Cheshire, but only one is real. The others are aerials which bring British Telecom's Cellnet cellular mobile radio network to this part of the north of England.

The church tower is one of the highest points on the local landscape, and an ideal location for the aerials. Concerned not to spoil the view, BT decided to disguise them as flagpoles, complete with ropes and pulleys.

Pictured here, the Vicar of Holy Cross Church, the Reverend Paul Moulton, stands next to the real flagpole with the four Cellnet aerials around him.

"I am pleased that the Church agreed to placing the aerials here. They are absolutely out of the way and attract no attention—it's a good example of caring for the environment", *he says.*

Comet's New Dish

Comet became the first major national retailer to enter the satellite age when two complete satellite TV receiver packages went on sale at the end of last month (July).

A basic single satellite system, offering up to eight additional TV channels, is available for the sum of £890 and a multi-satellite system, offering 14 extra channels, is being offered at £1190. The prices include full installation, 12-month guarantee, and a "lifetime" satellite dish licence.

Pilot stores to carry stocks of the satellite packages are: Hull; Norwich; Leeds and Rochester. There is no extra charge for pre-site visits.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

AURORA

Many radio amateurs have rotatable antennas enabling them to transmit their signals in the direction of the station they wish to contact. Sometimes, however, it is more effective to beam in a completely different direction.

An example of this is auroral propagation, which becomes possible when a solar flare releases energy from the sun. Energetic charged particles are carried to earth by the solar wind, impinging on the upper atmosphere and ionizing the E layer in the auroral zones around the poles.

The resulting aurora act as reflecting layers, and by directing their VHF antennas northwards amateurs make contact with distant stations who are also beaming to the north. To take full advantage of the phenomenon, advance warning is necessary. Beacon stations nearest to the auroral zones can provide the first signals to be reflected to more southerly climes, and some enthusiasts have receivers monitoring beacon frequencies continuously for any sign of an auroral event.

Others tune to Leicester University's experimental auroral monitoring radar station at Wick, on 153·2MHz, and others to Scandinavian TV video carrier transmissions around 50MHz. Immediately signals are heard above a certain strength, warning networks are activated to alert others of possible aurora.

Events are sometimes repeated after 27 days, coinciding with the rotation period of the sun. Some amateurs keep a 27 day calendar to record occurrences and forecast future events. Aurora follow a seasonal pattern, peaking around March and September, although they can occur at any time throughout the year. When radio aurora occur at night in clear weather, there may also be visible aurora.

Amateurs in northern locations have the greatest success, but in major events stations in the south of England, and in Europe as far south as Italy, can participate. Signals received have a distinctive rough sounding note, and are slightly off frequency due to Doppler shift. This effect becomes more noticeable the higher the frequency of the signals, which are receivable up to 432MHz on occasions. Morse is the favoured mode of transmission, as weaker signals are easier to copy, but s.s.b. speech can be used, especially on 50MHz where Doppler shift is minimal.

Last February, despite the current low point in the solar cycle, there was an unexpected major aurora, causing great excitement among many amateurs.

British v.h.f. stations, even in the south, made exceptionally long distance contacts into eastern Europe, Scandinavia, and USSR call-areas. In the USA, the effect of the aurora reached nearly as far south as Florida, with record-breaking contacts of up to 1348 miles on two metres, and stations spread out across normally sparsely populated bands trying to find clear frequencies.

Auroral working is a fascinating activity, combining the possibility of outstanding success with some degree of uncertainty. Next time you hear on the news that the aurora borealis can be seen from your area, think of all the local amateurs rushing to their rigs. Better still, if you know anyone with amateur v.h.f. receiving facilities, get round there fast, and listen in to the action!

NICE DAY OUT

In 1984, the Dunstable Downs Amateur Radio Club hit on the idea of holding a national amateur radio car boot sale, with few traders, just amateurs selling to amateurs at bargain prices. They held it at Old Warden Aerodrome, Biggleswade, Beds, home of the Shuttleworth collection of historic aircraft, and it was an instant success.

Last year the event was repeated, with over 100 car boots offering components, accessories, receivers, transceivers, computers, even household and motoring items. Now an annual event, this year's sale, on Sunday, 21st September, promises to be even bigger and better, and an outing for all the family.

The aircraft and motor museum is an attractive venue in its own right. Combine this with an opportunity to find out something about amateur radio at first hand, including a special-event talk-in station, GB4SC, visit the RSGB's bookstall and information stand, *and* pick up some useful components or other goodies for that next EE project, and you have a fine day out!

For 50p admission, deductible from the museum admission charge of £1.50, plus free car parking, it must also be one of the bargain outings of the year!

Apart from organising this event, the Dunstable club's activities include radio DF (direction finding) hunts; amateur TV; construction contests; and visits to places of interest. They participate in radio contests from a site on Dunstable Downs; provide the call-in station for the big RSGB rally at Woburn in August; and have a good programme of lectures throughout the year.

Newcomers to amateur radio are welcome in all these activities. Contact Phil Morris, G6EES, on Dunstable 607623, for further information, mentioning this column!

QUESTION CORNER

Q. Is there any type of simple receiver I can build to receive amateur transmission?

A. Traditionally, the regenerative receiver has been recommended for beginners to listen to amateur signals. Simple designs using just one or two transistors have appeared in EE, and this type of circuit will receive single sideband speech, Morse, and a.m. transmissions surprisingly well.

In recent years there has been a lot of interest in direct conversion receivers which are equally easy to make, although there is a need for a stable variable frequency oscillator in the circuit. A simple receiver of this type is generally claimed to give better results than a regenerative circuit.

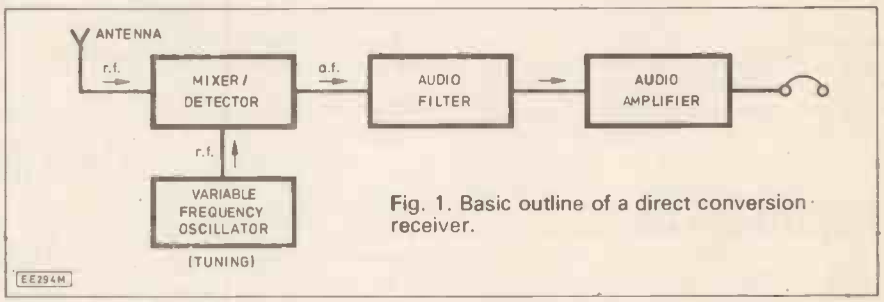


Fig. 1. Basic outline of a direct conversion receiver.

The diagram shows the basic idea. The wanted r.f. signal is mixed with the output of a local v.f.o. This oscillator is tuned slightly off the frequency of the incoming signal, and the difference between the two signals is at audio frequency, which can be filtered to provide any desired degree of receiver selectivity before audio amplification.

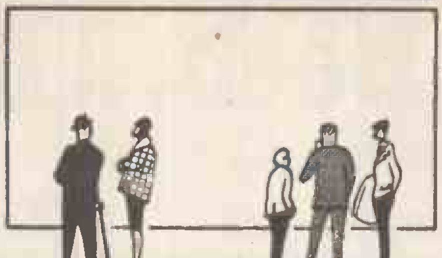
A disadvantage of d.c. receivers is that they provide double signal reception for Morse, as the sidebands of the wanted transmission can be resolved as audio signals on either side of zero-beat, the tuning point where the incoming signal and the local signal cancel each other out.

This turns to an advantage in receiving single sideband signals, when the appropriate sideband can be selected to give good reception. A.M. signals are resolved by tuning to zero-beat.

Obviously, the simpler a d.c. circuit is, the more its limitations, but even in its simplest form it can provide a useful introduction to amateur radio. Improvements can be made by using r.f. amplifiers/attenuators, improved detectors and audio filters, and by other means, and high quality performance then becomes possible.

A particular attraction of the d.c. receiver to amateurs is that the local oscillator can also serve as the v.f.o. for a low power transmitter. This arrangement is particularly popular for Morse transmission, and some of the QRP operators I have mentioned previously used transceivers of this type to extremely good effect.

SHOP TALK



BY DAVID BARRINGTON

Eureka!

Leading supplier to the BBC Micro market, **Watford Electronics** has unveiled a new RAM Expansion Card called the Eureka!

Announcing the latest addition to their range of BBC Micro expansion products, Mr. Nazir Jessa MD said "*The Eureka Card would have made Archimedes jump out of his bath twice as quickly*!"

Not only is the Eureka claimed to be cheaper than a Second Processor, but it also provides up to 14K more RAM than a 6502 Second Processor gives to the "Hi" versions of View Basic and Wordwise Plus. Shadow RAM is provided automatically.

The card fits into the processor socket of the BBC Micro and is controlled by software contained within a standard sideways ROM. It is fully buffered, not only to the on-board RAM but also to the BBC Micro as well.

A new set of OSWORD calls are provided with the card to allow blocks of extra RAM to be written to and read from directly.

We hope to review the Eureka card in a future issue (we also hoped to include a photograph, but being so new Watford were unable to supply one). In the meantime further information and price may be obtained from: **Watford Electronics, Dept. EE, 250 High Street, Watford WD1 2AN.**

Infra Red Beam Alarm

One or two items could cause purchasing problems for constructors of the *Infra Red Beam Alarm* project.

The lenses for focusing the infra red beam are stocked by Maplin. The l.e.d. type TIL38 and the detector diode TIL100 are currently listed by **Greenweld, TK Electronic, Maplin** and **Cricklewood Electronics.** The VMOS power f.e.t. transistor type VN10KM, called for in the transmitter, is stocked by Maplin and Cricklewood.

The relay used in this project is a low voltage, DIL package, "Reed" relay, with an internal diode connected across the coil. Other types of relay may be used provided they are able to operate down to about 4V and have a coil resistance of 500 ohms.

However, the layout of the printed circuit may have to be altered to accommodate other relays and a diode will have to be "hard wired" across the coil contacts. In case of difficulty in locating a suitable relay, the one used in the prototype was purchased from Maplin: code FX88V.

The printed circuit boards for this project may be purchased through our PCB Service: code EE536 and EE537.

Freezer Failure Alarm

The MOS/FET operational amplifier and the warning device used in the *Freezer Failure Alarm* should be stocked by most of our advertisers.

The printed circuit board may be purchased from our PCB Service: code EE534.

Car Timer

The "spade" connectors for the *Car Timer* project should be available from any good motorists' accessories shop.

The 4060 ripple-counter, with internal oscillator and the 4011 dual-input NAND gate devices are now fairly common and should not cause buying problems.

The printed circuit board may be purchased from our PCB Service: code EE538.

Simple Printer Buffer

Ready programmed EPROMs (£8.50) and a double-sided printed circuit board (£9.75) for the *Simple Printer Buffer* are available from **Tayside Microsystems, Dept EE, 55 Causewayend, Coupar Angus, Perthshire, Scotland, PH13 9DX.**

Most of the semiconductors and microprocessor crystal are also stocked by Maplin, CMC Components and Cricklewood Electronics. They can also supply the Centronics plug and socket.

Spectrum Joystick

Looking through our collection of components catalogues, we cannot foresee any problems with locating a 6-pin opto-isolator for the *Spectrum Joystick*—this months *On Spec* project. The D-connector and 6-way flexible cable should now be available from most of our advertisers.

The quoted price for this project is based on the RS "microswitch joystick mechanism". Of course, this sum may be reduced by obtaining this part from a local computer shop or you can make one up from separate microswitches.

Exploring Electronics

A suitable "test bed" for the *Exploring Electronics* experiments would be the circuit block used in our *Teach In '86* series.

Scratch Blanker

The delay line chip type TDA1022 called for in the *Scratch Blanker* project should be available from most component suppliers, such as: C.P.L. Electronics, Marco, TK Electronics, Greenweld and Cirkit.

The CMOS switch 4066BE is currently listed by Maplin, Magenta and Cricklewood. When specifying the **555** timer for IC9, be sure to order the low power, suffix L, or the CMOS ICM7555 device.

The printed circuit board may be ordered through the EE PCB Service: code EE539.

. . . auto-ranging resistance . . . capacitance meter . . .

ITEMS of test equipment that would once have been technically difficult and horrendously expensive to produce are now available at prices which are not beyond the means of dedicated electronics enthusiasts. This includes such things as digital multimeters, dual trace oscilloscopes, and autoranging capacitance meters. With a computer having the versatile interfacing capabilities of the BBC machines it is possible to produce sophisticated test gear with the aid of very inexpensive add-ons which make conventional budget priced equipment look positively expensive. The two simple add-ons described in this month's article demonstrate this point very well. Both use only a handful of inexpensive components, and one converts the Beeb into an auto-ranging resistance meter while the other converts it to an auto-ranging capacitance meter. In the previous article we consider ways of using the user port to enhance the capabilities of the analogue port, and these two add-ons both exploit this idea.

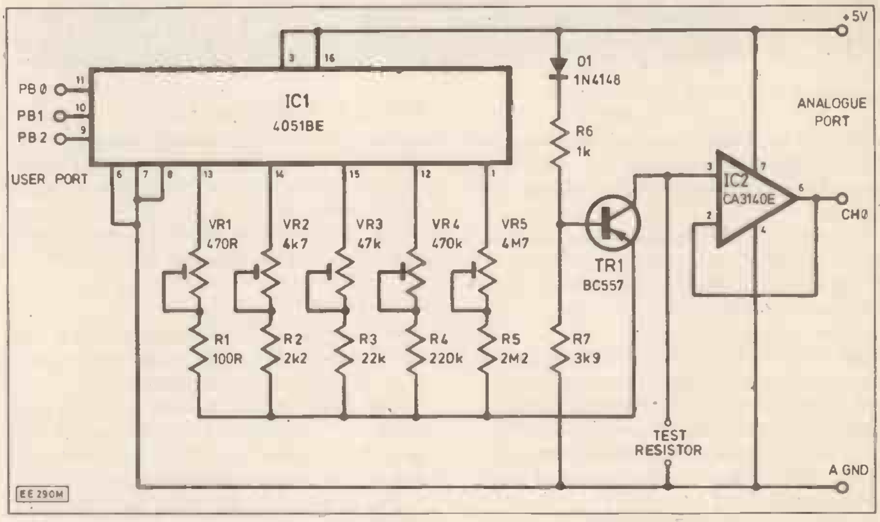


Fig. 2. Circuit diagram for the auto-ranging resistance meter.

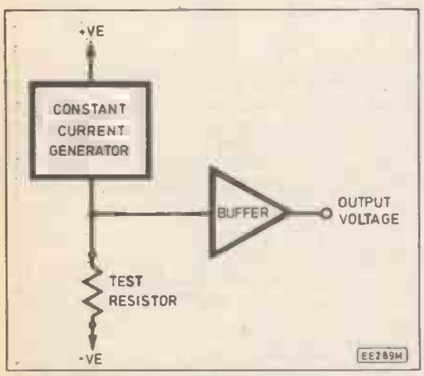


Fig. 1. Arrangement used for Resistance to Voltage conversion.

Listing 1: RESISTANCE METER

```
  10 REM AUTO-RANGING
  20  REM RESISTANCE METER
  30 REM J.W.P. 6/86
  40
  50 ?&FE62=7
  60 MODE 7
  65  PROCSCREEN
  70 REPEAT
  80   PROCRANGE
  90   PROCSHOW
  95   FOR X=1 TO 1000:NEXT
 100   UNTIL FALSE
 110 END
1000 DEF PROCRANGE
1010  V%=-1
1020 REPEAT
1030   V%=V%+1
1040   ?&FE60=V%
1045   FOR X=1 TO 500:NEXT
1050   UNTIL ADVAL1 DIV 64<1023 OR V%>4
1060 ENDPROC
1070
2000 DEF PROCSCREEN
2010 PRINTTAB(5,5);CHR$(141);"RANGE"
2020 PRINTTAB(5,6);CHR$(141);"RANGE"
2030 PRINTTAB(11,12);CHR$(141)
2040 PRINTTAB(11,13);CHR$(141)
2050 ENDPROC
2060
3000 DEF PROCSHOW
3005 V$=STR$(V%+1):IF V%>4 THEN V$="="
3010 PRINTTAB(13,5);V$
3020 PRINTTAB(13,6);V$
3030 DISP$=FNREADING
3040 PRINTTAB(13,12);DISP$
3050 PRINTTAB(13,13);DISP$
3060 IF V%=0 THEN PRINTTAB(5,20)"Reading in OHMS.     "
3070 IF V%=1 OR V%=2 OR V%=3 THEN PRINTTAB(5,20)"Reading in KILOHMS. "
3080 IF V%=4 THEN PRINTTAB(5,20)"Reading in MEGOHMS. "
3090 ENDPROC
3100
4000 DEF FNREADING
4005 IF V%>4 THEN R$="OVERLOAD":=R$
4010 R=ADVAL1 DIV 64
4020 IF V%=0 OR V%=3 THEN D=1
4030 IF V%=1 OR V%=4 THEN D=100
4040 IF V%=2 THEN D=10
4050 R$=STR$(R/D)
4060 P=INSTR(R$,".")
4065 IF P=0 THEN P=LEN(R$)
4070 R$=LEFT$(R$,P+LOG(D))
4080 IF LEN(R$)<8 THEN R$=STRING$(8-LEN(R$)," ")+R$
4090 =R$
>
```

R to V Conversion

The analogue port does, of course, measure voltage, and in order to measure any other commodity using the analogue inputs it must first be converted to a proportional voltage. Resistance is something that is quite easily converted to a proportional voltage, and there is actually more than one way of tackling the problem. The most commonly used approach, and the one which is probably best suited to our current requirements, is the simple set-up shown in Fig. 1.

A constant current is fed to the test resistor, and this produces a voltage across the resistor. Ohm's Law states that "voltage = current × resistance", and with the current at a fixed value the output voltage becomes proportional to the test resistance. For example, if you assume a current flow of one milliamp and work out the voltage produced with test resistance of 1k, 2k, 3k, etc., you will find that the answers are one volt, two volts, three volts, etc. It is important that any device measuring the output voltage has a very high input resistance, as this resistance is in parallel with the test component and will impair the accuracy of the system if it has a significant shunting effect on the test resistance. The output voltage is therefore taken via a buffer stage having an ultra high input impedance.

In theory this arrangement has an infinite operating range, but in practice several measuring ranges have to be included in order to cover a wide resistance range with good accuracy. With (say) just one range going from 0 to 10 megohms, most resistors would give an insignificant output voltage which could not be measured accurately, especially when using a digital voltage measuring circuit with a strict limitation on its resolution. Several ranges can be covered simply by having a number of different current levels available. For instance, a tenfold increase in the test current reduces the full scale resistance value by a factor of ten—reducing the test current by a factor of ten increases the full scale resistance by the same factor.

Resistance Meter Circuit

Fig. 2 shows the circuit diagram for a very simple but effective resistance meter add-on for the BBC machine, and with appropriate software this is capable of auto-ranging.

Transistor TR1 is at the heart of the system, and this is connected as a conventional constant current generator. The output current is controlled by the resistance between TR1's emitter and the positive supply rail. In this case there are five switched resistors giving the circuit five measuring ranges with full scale values of 1·023k, 10·23k, 102·3k, 1·023M, and 10·23M. This covers all the resistor values commonly used in electronics.

Each emitter resistance actually consists of a fixed resistor and a preset type wired in series. The preset resistors are adjusted to give good accuracy on each measuring range. Selection of the emitter resistance could be made by way of manual switching, but in order to achieve auto-ranging it is obviously necessary for range selection to be under the control of the computer. In this case the switching is provided by three lines of the user port and a 4051BE CMOS eight way analogue switch (ways "5" to "7" being left unused). IC1 has a significant resistance of about 200 ohms through whichever switch is activated, and this resistance forms a large part of the emitter resistance on the lowest range. This is unfortunate as it does not aid good accuracy and stability on this range, but in practice results seem to be perfectly adequate in both respects.

IC2 is the output buffer stage, and this is a MOS input device which provides an input impedance of over a million megohms. It therefore ensures good linearity even on the 10·23 megohms range. On the face of it the buffer stage is unnecessary as the analogue inputs of the BBC computer have an extremely high input resistance anyway. Despite this it is often better to include a buffer in add-ons added to the analogue port so that signals in the connecting lead to the computer are at a low impedance and not a high impedance of several megohms. This avoids problems with excessive noise pick-up in the connecting cable.

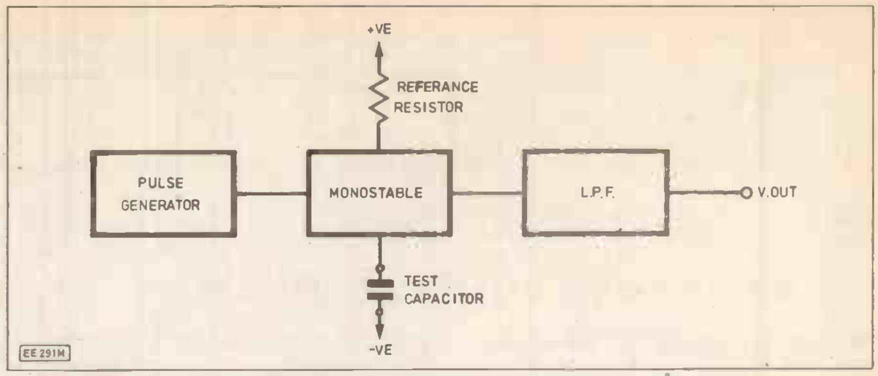


Fig. 3. A simple capacitance to voltage converter set-up.

Listing 2: CAPACITANCE METER

```
  10REM AUTO-RANGING
  20 REM CAPACITANCE METER
  30REM J.W.P. 6/86
  40
  50?&FE62=7
  60MODE 7
  65 PROCSCREEN
  70REPEAT
  80PROCRANGE
  90PROCSHOW
 100UNTIL FALSE
 110END
1000DEF PROCRANGE
1010 V%=-1
1020REPEAT
1030V%=V%+1
1040?&FE60=V%
1045 FOR X = 10 TO 2000:NEXT
1050UNTIL ADVAL1 DIV 64<1023 OR V%>4
1060ENDPROC
1070
2000DEF PROCSCREEN
2010PRINTTAB(5,5);CHR$(141);"RANGE"
2020PRINTTAB(5,6);CHR$(141);"RANGE"
2030PRINTTAB(11,12);CHR$(141)
2040PRINTTAB(11,13);CHR$(141)
2050ENDPROC
2060
3000DEF PROCSHOW
3005V$=STR$(V%+1):IF V%>4 THEN V$="="
3010PRINTTAB(13,5);V$
3020PRINTTAB(13,6);V$
3030DISP$=FNREADING
3040PRINTTAB(13,12);DISP$
3050PRINTTAB(13,13);DISP$
3060IF V%=0 THEN PRINTTAB(5,20)"Reading in PICOFARADS "
3070IF V%=1 OR V%=2 OR V%=3 THEN PRINTTAB(5,20)"Reading in NANOFARADS. "
3080IF V%=4 THEN PRINTTAB(5,20)"Reading in MICROFARADS"
3090ENDPROC
3100
4000DEF FNREADING
4005IF V%>4 THEN R$="OVERLOAD":=R$
4010R=ADVAL1 DIV 64
4020IF V%=0 OR V%=3 THEN D=1
4030IF V%=1 OR V%=4 THEN D=100
4040IF V%=2 THEN D=10
4050R$=STR$(R/D)
4060P=INSTR(R$,".")
4065IF P=0 THEN P=LEN(R$)
4070R$=LEFT$(R$,P+LOG(D))
4080IF LEN(R$)<8 THEN R$=STRING$(8-LEN(R$)," ")+R$
4090=R$
```

Software

Suitable software for the resistance meter add-on is given in Listing 1, and this supports auto-ranging. This facility operates in essentially the same manner as the auto-ranging voltmeter circuits described in the previous article, and a description of the process will not be repeated here. In order to calibrate the unit five test resistors are required, and these should be one per cent types having values which correspond to roughly half the full scale value of each range (e.g. 470, 4k7, 47k, 470k, and 4M7). Start with the preset resistors at about half resistance, then connect each resistor in turn and adjust the appropriate preset for the correct reading. The display indicates the range in use, and VR1 to VR5 operate on ranges 1 to 5 respectively.

Capacitance Measurement

There are several ways of providing capacitance to voltage conversion, but these are mostly variations on the basic method of using a C–R timing network with the test capacitor as the capacitive element in this network. Fig. 3 shows the most simple type of converter, and this is the type which is used in this capacitance meter add-on.

The pulse generator produces a constant stream of pulses which are used to continuously trigger the monostable multivibrator. Each time it is triggered the latter provides an output pulse having a duration that is determined by the C–R timing network, and which is proportional to the value of the capacitor. With a small test capacitance the output from the monostable is a series of brief pulses, giving a low average output voltage. A high test capacitance gives a long

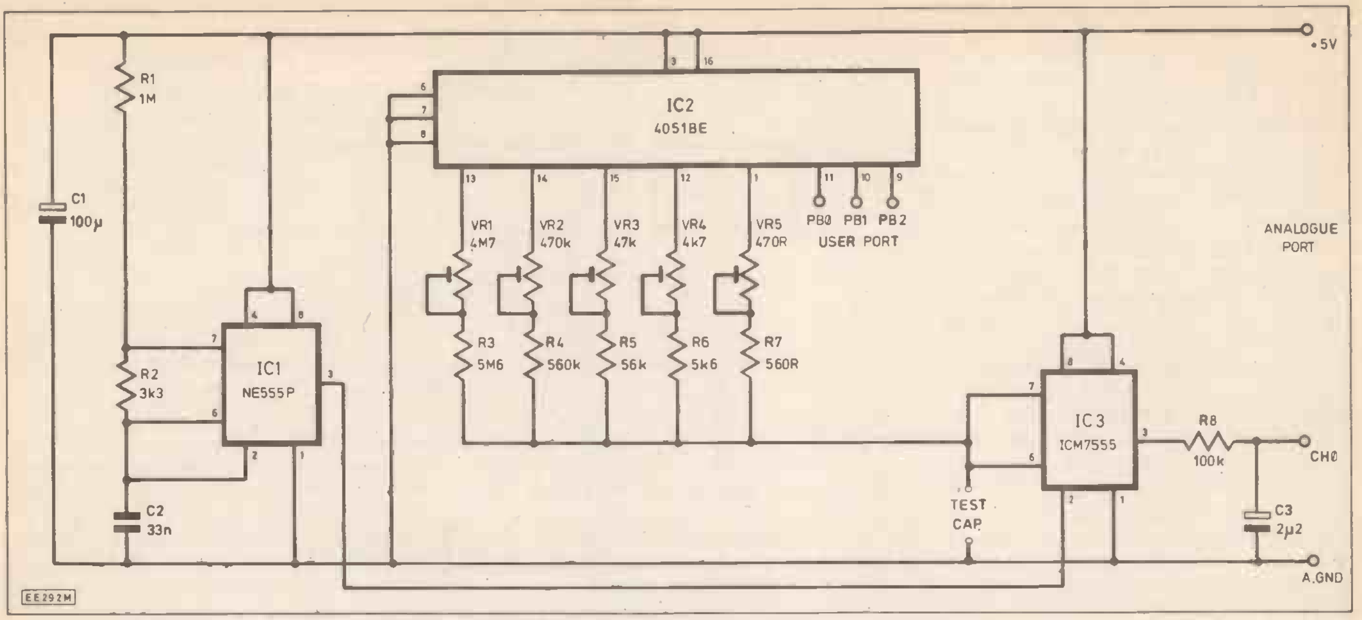


Fig. 4. Circuit diagram for the auto-ranging capacitance meter.

output pulse and a high average output voltage. In fact the average output voltage is proportional to the value of the component under test provided the value is not so high that new trigger pulses are received before each output pulse has finished (which would give a simple frequency divider action and a low output voltage).

Although the average output from the monostable is proportional to the test capacitance, the signal here is a series of pulses which the analogue converter in the BBC machine will read as zero, something beyond full scale value, or somewhere between these two extremes if a pulse starts or finishes during a conversion. This problem is easily overcome, though, and all that is required is a lowpass filter at the output of the monostable to integrate the pulses and provide a reasonably ripple free d.c. output signal.

Circuit Operation

The full circuit diagram of the capacitance meter add-on is shown in Fig. 4. IC1 operates as the pulse generator, and this is a standard 555 astable circuit. The values of R1 and R2 have been arranged so that the output signal is a series of narrow negative pulses, which is the type of signal required for the correct triggering of the monostable. The monostable is based on IC3 which is another 555 device, but this time the low power CMOS (7555) version is specified. This is not a matter of reducing the current consumption, and the advantage of the 7555 in this case is its lower self capacitance. This gives improved accuracy with low value capacitors, but the self capacitance is still sufficient to boost very low readings and give poor accuracy. Values of a few tens of picofarads or less are little used, and so this is not a major drawback, but to some extent it can be counteracted by deducting the self capacitance from readings on range one. The amount by which readings should be offset is the capacitance reading obtained on range one with no test capacitor connected.

Range switching is again accomplished by a 4051BE controlled by three user port lines. The five ranges have full scale values of 1·023nF, 10·23nF, 102·3nF, 1·023μF, and 10·23μF.

Software

The program for use with the capacitance meter add-on is given in Listing 2, and this is just a slightly revamped version of the resistance meter program. Again, for calibration purposes close tolerance components having values roughly equal to half the full scale value of each range are required (e.g. 470pF, 4n7, 47nF, 470nF, and 4μ7). A compromise may have to be accepted on the highest range as a suitable calibration component might be difficult to obtain. As before, it is just a matter of connecting each calibration component and then adjusting the appropriate preset for the correct reading.

The circuits shown here and in the previous article should give some idea of the versatility available by using the analogue and user ports together. Those who like experimenting might like to try combining the circuits to produce an auto-ranging multimeter, and the basic techniques used in these designs can be applied to other measurement applications. Where possible electronic switching should be used as it offers high speed, low cost, and low power consumption. Its disadvantages are a lack of isolation between the control signal and the signal being switched, and what is likely to be of more relevance in this context, around 200 ohms resistance through each switch. Reed relays offer a better alternative where isolation and (or) low "on" resistance is needed.

If you have any comments or ideas for inclusion in the Beeb Micro pages, please send them to: Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH.

DOWN TO EARTH
BY GEORGE HYLTON

METER SHUNT CALCULATOR

THE alignment chart, shown in Table 1, enables you to adapt a current meter to a higher current range. To do so, a resistance "shunt" must be connected across the meter terminals. By selecting the appropriate shunt resistance the current range can be multiplied by any desired factor.

To use the chart all you need to know is the internal resistance of the meter (usually marked on the dial) and the multiplication (M), see Fig. 1. A straight edge or thread stretched across the chart then gives the required shunt reistance.

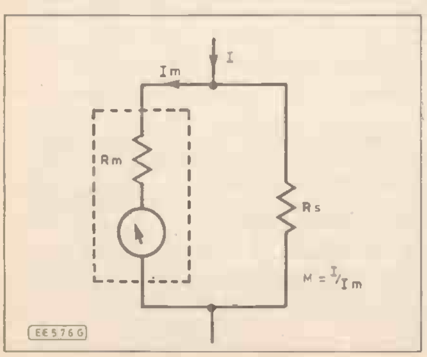
> EXAMPLE: A 0–10mA meter is required to read 0–30mA. This means that the multiplication factor is 3. If the meter resistance (Rm) is 20Ω, what shunt resistance (Rs) is needed?
>
> As shown dotted on the chart, when M = 3 is joined to Rm = 20Ω the line cuts the Rs scale at 10Ω and this is the required value of shunt.

This kind of chart cannot be read reliably when the multiplication needed is large. For multiplications of more than 11 (where this chart runs out), calculate Rs from the formula:

$$Rs = Rm/(M-1)$$

> EXAMPLE: A 100μA meter with a resistance of 1k is to be adapted to read 100mA. In this case M = 1000 and Rs = 1000/999 = 1·001Ω.
>
> In practice a 1Ω resistor could be used. Its tolerance should be as close as possible, preferably 1 per cent or better.

Fig. 1.



MEASURING METER RESISTANCE

When Rm is not marked on the meter it can be measured. Ohmmeter measurement is not accurate enough (unless you have a digital meter) and may pass a damaging amount of current through the meter.

Some current meters are designed to drop a standard voltage (such as 100mV) when passing full-scale current. If this voltage is known, the resistance can be calculated. For a 100mV full-scale drop, a 1mA meter has a resistance of 100Ω; a 100μA meter 1k; a 10mA meter 10Ω; and so on. However, meter resistances vary, so if there is no dial indication of either the resistance or the full-scale voltage drop a measurement is needed.

The method shown in Fig. 2 may not be the last word in accuracy but it calls for the minimum of standards of comparison. **WARNING: it only works on meters with linear scales!**

With S1 open, the meter current is adjusted by VR1 to produce a deflection at or near full scale. Note the reading carefully, Close switch S1 and connect close

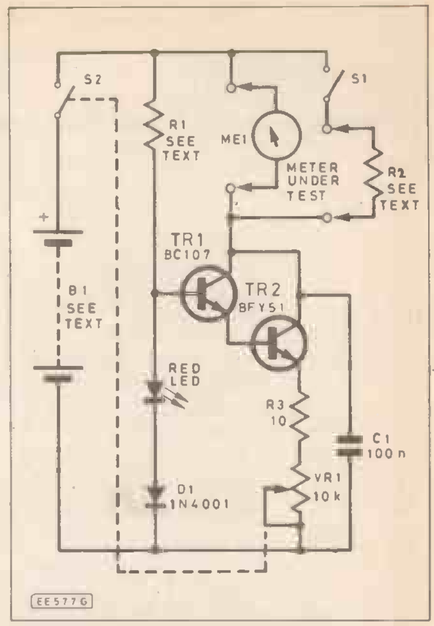
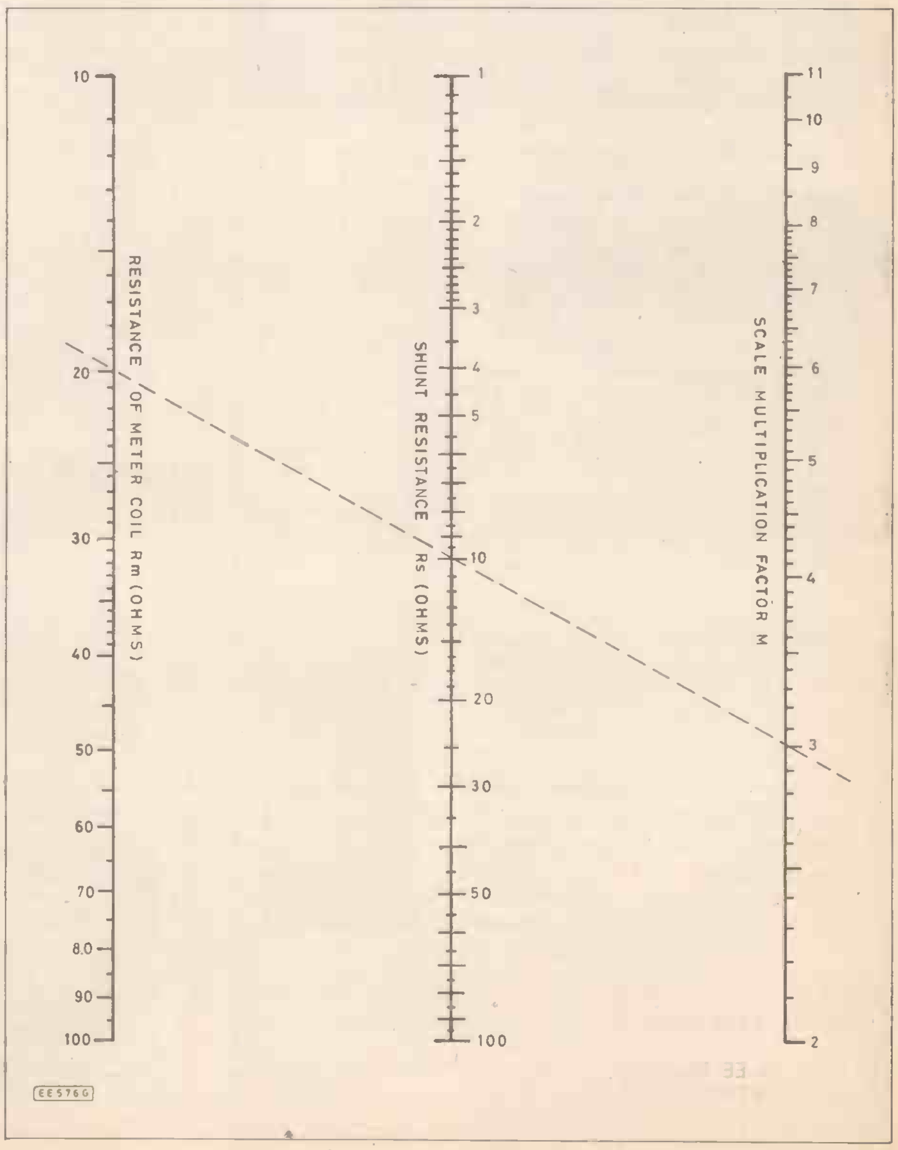


Fig. 2. Current meter resistance circuit.

Table 1: CURRENT METER RANGE EXTENSION CALCULATOR



tolerance resistors R2 until you find one which reduces the reading by very roughly half. Note the new reading.

Divide the first reading by the second to give a number, M. Join this number on the M scale of the chart to the value of your R2 resistor on the central (Rs) scale. The line now cuts the Rm scale at the meter resistance.

CIRCUIT VALUES

The meter test circuit will operate from any voltage above 3V. The only requirement is that this voltage should not change when the current changes. You can use fresh dry cells (U2 size), or a car battery, or a stabilised mains power unit.

Resistor R1 must be chosen to suit the voltage and the l.e.d. Red l.e.d.s drop about 1·6V when lit, and the silicon diode D1 drops about 0·7V. These voltages add up to about 2·3V and R1 receives the difference between 2·3V and B1.

So if B1 is 6V, the remaining 3·7V appears across R1. In this case, if the l.e.d. needs 10mA to light, R1 must be around 370Ω. (Use 330Ω or 390Ω.) For other voltages and l.e.d.s, calculate on the same lines.

The circuit will cope with meters up to about 100mA full scale. It is convenient to gang S2, the on/off switch, with potentiometer VR1. If VR1 is of the "inverse log." (reverse log.) type, meter current increases with clockwise rotation. Single inverse log. potentiometers may be hard to find, but one section of a stereo balance pot is usually reverse log, or something like it.

OSCILLATION

The purpose of capacitor C1 is to discourage h.f. oscillation, which can occur in this type of circuit, especially at high currents. If erratic results are obtained, this may indicate that the circuit is oscillating despite C1. Try a different value or put a second capacitor between base and collector of TR2.

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MARKET PLACE SEPTEMBER '86

SCRATCH BLANKER

R.A.PENFOLD

Bring your old records back to life

THE compact disc, with its click-free reproduction, is rapidly gaining in popularity and looks likely to replace conventional discs in due course. This is cold comfort to anyone who owns a large collection of microgroove recordings, since the cost of replacing them with compact discs would be enormous and many recordings are never likely to be released on compact disc anyway. In fact compact discs are not totally immune to scratches, but except in very bad cases scratches fail to have any obvious effect on the audio output signal. This is due to error detection and correction circuits that are built into every player.

Somewhat similar techniques can be applied to ordinary discs, and so-called "click eliminators" can provide reasonable results from a badly scratched and otherwise useless record. There is a limit to the degree of improvement that can be produced using a relatively simple click eliminator circuit, and the problem is not so much eliminating the click as replacing it with something. In a simple click blanker it is replaced with a period of silence, and although the gap in the signal is too short to be heard as such, it is sufficiently long to produce an audible glitch. It is a very minor glitch when compared to the effect of a bad scratch, and in some cases it can actually be inaudible. In most cases though, it sounds like and is roughly analagous to tape drop-out.

DESIGN

This design is for a reasonably simple and inexpensive scratch blanker which provides good results. It has to be pointed out that a blanker is inevitably much more complicated than a scratch filter circuit which simply provides top-cut filtering. This type of filter relies on the fact that surface scratches produce signals that are predominantly at high audio frequencies (about 7kHz or more). Severely attenuating these high frequencies gives a great reduction in the surface noise and leaves a passable standard of reproduction. Bad scratches can not be efectively combatted using filtering as they produce strong signals well down into the middle audio range, and an ordinary scratch filter would leave many of the frequency components unattenuated.

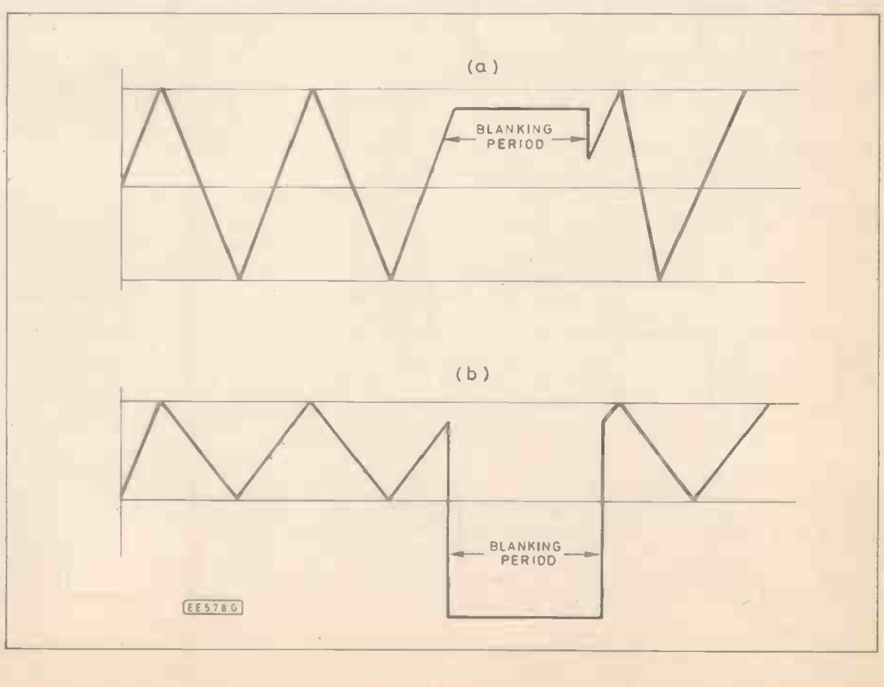
Using a lower cut-off frequency would give good attenuation of the scratch signal, but would result in a totally inadequate bandwith for music reproduction. Incidentally, a scratch blanker does not necessarily provide any reduction in audio bandwidth at all, and the unit featured here provides a full 20Hz to 20kHz bandwidth. The blanker connects between the preamplifier and the power amplifier, or it could be driven from the pick-up via a suitable preamplifier.

BLANKING

In principle noise blanking is perfectly straightforward, and merely entails cutting the signal path for a short period when a noise spike is detected. The length of the blanking pulse depends on the application, but in the present context about three or four milliseconds is adequate. The problem is complicated by the need to blank the noise pulse before it starts to appear at the output of the circuit, and in practice this requires the use of a delay line. The basic arrangement is to feed the signal to the output via the delay line first and then the electronic switch, but to drive the pulse detector circuit from the non-delayed signal. It takes the pulse detector under a millisecond to fully activate and break the signal path, and the delay line therefore only needs to provide a delay of about one millisecond in order to ensure that the noise pulse fails to reach the output.

Another slight complication is that of smoothing over the break in the signal. This is usually done using a sample and hold circuit, which is the method adopted in this design. A sample and hold circuit provides the effect shown in the waveform of Fig. 1(a). Here the signal is simply maintained at whatever voltage it happened to have at the instant the signal was cut off, and at the end of the blanking pulse it is immediately switched back to the current signal level. This does produce a slight glitch, in that at the instant the signal is switched on again the sample level and the signal level will usually be somewhat different. It is only a

Fig. 1(a). A sample and hold circuit is used to maintain the signal at a constant voltage during the blanking period. (b) Without the sample and hold circuit the blanking could make matters worse rather than better.



minor glitch though, and the switch in amplitude must always be below the peak to peak signal amplitude at the time. This ensures that under low signal conditions the glitch is always small and can never be dominant over the wanted signal.

What has to be avoided is a situation of the type shown in Fig. 1(b), where the signal is taken to a certain potential during the blanking period (or simply allowed to drift to any potential). This could produce a worse noise spike than the one which is being suppressed.

SYSTEM OPERATION

The block diagram for the signal processing stages, is shown in Fig. 2 while Fig. 3 shows the block diagram for the blanking pulse generator circuit. Starting with the signal processing stages, there are two identical circuits, one for each stereo channel. An amplifier at each input provides buffering, plus a small amount of voltage gain (about 6dB). The voltage gain is needed as the input level to the delay line would otherwise be significantly less than that required for optimum noise performance. This voltage gain also compensates for small losses through the delay line, and the overall gain of the unit is little more than unity.

The delay line is a standard "bucket brigade" or CCD (charge coupled device) type. This consists of a series of capacitors and electronic switches which sample the input voltage, and pass the samples along the chain of charge storage capacitors through to the output of the device. There is obviously a delay between each sample being taken and it finally appearing at the output, and this delay depends on the number of capacitors in the line as well as on the rate at which samples are passed from one capacitor to another. The rate of progress is controlled by a clock oscillator which is common to both channels, and it operates at a little over 200kHz. The delay line is a 512 stage type. The delay (in ms) is equal to the number of delaying stages divided by twice the clock frequency (in kHz), which works out at slightly more than one millisecond in this case.

LOWPASS FILTER

A lowpass filter is needed at the input and output of each delay line. The input filters are needed to prevent any high frequency signals present on the input signal from entering the delay line where heterodyne tones could be generated by them interacting with the clock signal. In this case the clock frequency is well outside the audio range, and it is only radio frequency signals appearing on the input due to stray pick up that might cause problems. The output filters are needed to remove the clock signal. Apart from a slight clock breakthrough, the sampling process results in a stepped output signal, and the filtering is needed in order to smooth out the steps and give a proper output signal.

Each sample and hold circuit is really just an electronic switch feeding into a charge storage capacitor. The capacitor is normally driven from a low impedance source so that it has no significant effect on the circuit. However, when the switch breaks the signal path the capacitor retains whatever charge potential it happened to have at the instant the switch opened, giving the required "hold" action. A buffer amplifier ensures that there is no significant loading on the capacitor so that it is not discharged during the blanking period.

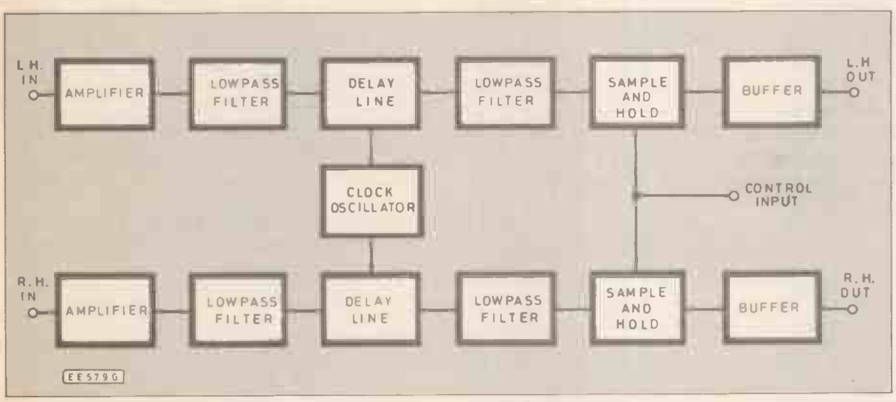
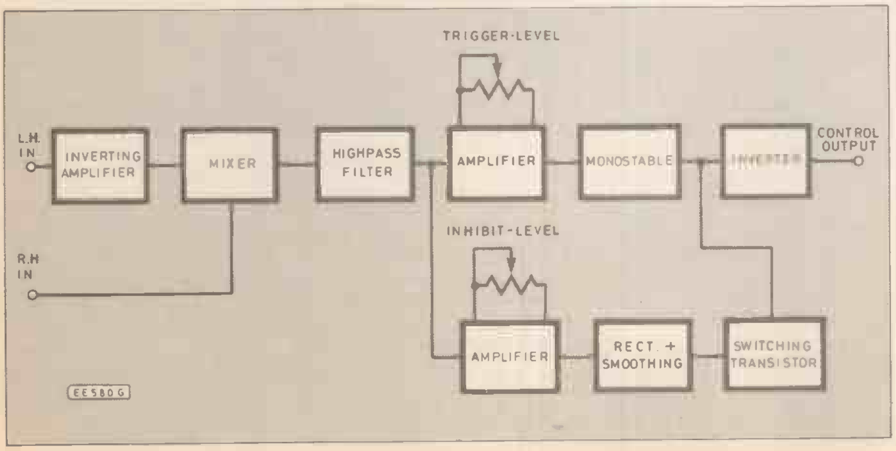


Fig. 2. Block diagram for the signal processing stages.

Fig. 3. The arrangement used to generate the blanking pulse.



BLANKING PULSES

Turning to the blanking pulse generator stages (Fig. 3), the first two stages are a unity gain inverting amplifier and a mixer. The right hand channel is fed direct to the mixer, but the left hand channel is inverted first. This gives a differential amplifier action with signals that are in-phase on the two channels tending to cancel out one another. Signals in antiphase on the two stereo channels are added together to give a strong output signal. Signals near the centre of the sound stage will be in-phase, and this results in the main signal being attenuated to some degree. On the other hand, the noise pulses will either be out of phase, or will only affect one channel, and in either case this results in a strong output from the mixer.

This does no more than slightly boost the noise spike in relation to the programme signal, and further processing is needed before strong noise pulses can be reliably distinguished from the main signal. This is achieved using a high slope highpass filter. The noise spikes have a strong high frequency content, whereas the main signal has relatively little signal content at these frequencies.

The filtered signal is amplified and then used to trigger a monostable multivibrator. The latter provides the blanking pulse to the sample and hold circuits, after its output signal has been inverted to give a pulse of the correct polarity for the sample and hold circuits.

As it stands, this arrangement seems to be capable of differentiating reliably between strong noise spikes and the main signal. However, if the sensitivity is adjusted to the point where relatively minor scratches are blanked, there is then a danger of sections of programme material which have a strong high frequency content activating the unit. This must not be allowed to occur as it would result in passages of music being virtually eliminated. There are no easy and totally effective solutions to this problem, but compromise solutions are possible. One would be to limit the blanker to just one operation in a given period of time. This would ensure that frequent spurious operations could not occur, and that sections of music could not be blanked out. Unfortunatley it would also prevent the unit from blanking out the second noise spike where two occur in rapid succession.

INHIBIT CIRCUIT

Another approach, and the one used in the final circuit, is to have an inhibit circuit which prevents the blanker from operating if a strong continuous output from the highpass filter is present. This is achieved by amplifying the filtered signal, then rectifying and smoothing it to produce a positive bias which drives a switching transistor. If the output from the filter is sufficiently strong, the transistor is biased into conduction and it effectively holds the output of the monostable in the low state, disabling the blanker action.

There may seem to be a flaw in this arrangement in that the inhibit circuit could be operated by the noise spikes, thus preventing them from being blanked. In practice this is avoided by having the attack time of the circuit just long enough to permit noise spikes to be blanked before the inhibit circuit becomes operational. This still leaves a real flaw in that the blanker is rendered inoperative during passages which have very strong high frequency content. This is not a major drawback though, since

COMPONENTS

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C3,26,103	2µ2 radial elect. 63V (3 off)
C4,8,17,18,19,20,104,108	2n2 carbonate (8 off)
C5,7,105,107	1nF carbonate (4 off)
C6	100pF ceramic plate
C9,109	150pF ceramic plate (2 off)
C10,14,16,24,110	47nF carbonate (5 off)
C11,22,111	10µF radial elect. 25V (3 off)
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C13	100µF radial elect. 16V
C27	2200µF radial elect. 35V

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IC2,102	TDA1022 (2 off)	IC9	L555CP or ICM7555
IC3	4047BE	IC10	uA7815
IC4,6,104	1458C (3 off)	TR1,2	BC549 (2 off)
IC5	4066BE	D1,2	1N4148 (2 off)
IC7	741C	D3,4	1N4002 (2 off)

Miscellaneous

SK1,2,101,102	Phono sockets (4 off)
S1	Rotary mains on/off switch
FS1	500mA 20mm quick-blow fuse
T1	Mains primary, twin 15 volt 200mA secondaries

Case about 230 × 133 × 63mm; printed circuit board (available from the *EE PCB Service*, order code *EE*539); 20mm chassis mounting fuseholder; three control knobs; eight 8 pin d.i.l. i.c. holders; two 14 pin d.i.l. i.c holders; two 16 pin d.i.l. i.c. holders; mains lead; Veropins; connecting wire; etc.

scratches are relatively unimportant and not so noticable during these passages. This system works well in practice, and enables the unit to be operated with a substantially higher level of trigger sensitivity than would otherwise be usable.

CIRCUIT OPERATION

Refer to Fig. 4 for the circuit diagram of the signal processing stages, and to Fig. 5 for the blanking pulse generator circuit. Fig. 4 only shows the circuit for one channel, and most of the components are duplicated in the second stereo channel.

The input stage is an operational amplifier (IC1a) used in the non-inverting mode and having a voltage gain of two times. VR1 provides a variable bias voltage, and as the circuit is direct coupled from the input to the output this sets the bias level for all the subsequent stages as well. In practice it is set to obtain optimum large signal handling ability from the delay line circuit.

IC1b acts as the buffer amplifier in the input lowpass filter, which is 12dB per octave type. Although delay lines often require very high slope filters at the input and output in order to obtain passable results, the high clock frequency used in this case enables excellent results to be obtained using relatively simple filters, and a 12dB per octave roll-off above 20kHz is more than adequate. The high clock frequency results in an excellent signal to noise ratio without the need for any form of noise reduction circuit.

The delay line chip is a TDA1022 (IC2) with its clock signal provided by IC3. The latter provides the clock signal for both channels incidentally. IC3 is a CMOS 4047BE astable/monostable device which operates in the free running astable mode in this circuit. The delay lines require a two-phase clock signal, but with its Q and $\overline{Q}$ outputs the 4047BE can provide these without the need for an external inverter to the second phase.

Resistors R8 and R9 provide a bias signal to IC2, while VR2 acts as a simple mixer to combine the outputs of stages 512 and 513 of IC2. The TDA1022 only has 512 delaying stages, but there is a 513th stage which is used to maintain the output level while the 512th stage is taking a sample from the previous stage, and is unable to provide a valid output level. Preset VR2 is adjusted to minimise clock breathrough, but most of the clock attenuation is provided by the third order (18dB per octave) filter based on IC4a.

The sample and hold circuit just consists of CMOS analogue switch IC5a and charge storage capacitor C10. The switches in the 4066BE device have low "on" resistances, especially when, as here, a 15 volt supply is used. Together with the low output impedance of IC4a this ensures that C10 does not introduce any significant high frequency roll-off. IC4b is the output buffer amplifier.

UNITY GAIN

Moving on to Fig. 5, IC6a is the unity gain inverting amplifier, and IC6b functions as a summing mode mixer. The mixed signal is then fed to a fourth order (24dB per octave) highpass filter based on IC7. This has its cut-off frequency at approximately 10kHz, which seems to give about optimum results in practice. The next stage is an inverting amplifier built around IC8, and this has a voltage gain which is adjustable from about 100 times with VR3 at maximum resistance, to zero when it is at minimum resistance; VR3 is the trigger sensitivity control.

The monostable is a 555 type (IC9), but in this circuit a low power version (L555 or 7555) is used to ensure that noise spikes are not modulated onto supply lines, from where they could possibly break through to the output. Pin two of IC9 is the trigger input, and under quiescent conditions this is held at about half the supply voltage. To trigger IC9 pin two must be taken below one-third of the supply voltage, and scratches will produce a suitably strong input signal to do so on negative half cycles. IC9 then provides a positive output pulse which is set at approximately four milliseconds in duration by R32 and C23. It is a negative output pulse that is required, as the analogue switches are turned on by a "high" control signal, and switched off by a "low" control level. This problem is overcome by using one of the analogue switches (IC5c) as an inverter. The fourth switch in IC5 is left unused.

The inhibit circuit functions by switching on TR1 when there is a strong, sustained, high frequency input. TR1 then holds the control input of IC5a low, thus holding the two sample and hold circuits in the "pass" state. The control signal for TR1 is obtained by amplifying the output of IC7 using a high gain common emitter amplifier based on TR2. Its output is then rectified and smoothed by D1, D2 and C22 to give the positive d.c. control signal for TR1. VR4 is the inhibit sensitivity control.

POWER SUPPLY

A well smoothed 15 volt supply is required, and this is provided by the mains power supply circuit shown in Fig. 6. This has T1 to provide isolation and voltage step-down, with push-pull rectification and a considerable amount of smoothing provided by D3, D4 and C27. A monolithic voltage regulator (IC10) then provides regulation and electronic smoothing. The total current consumption of the blanker circuit is around 60 milliamps.

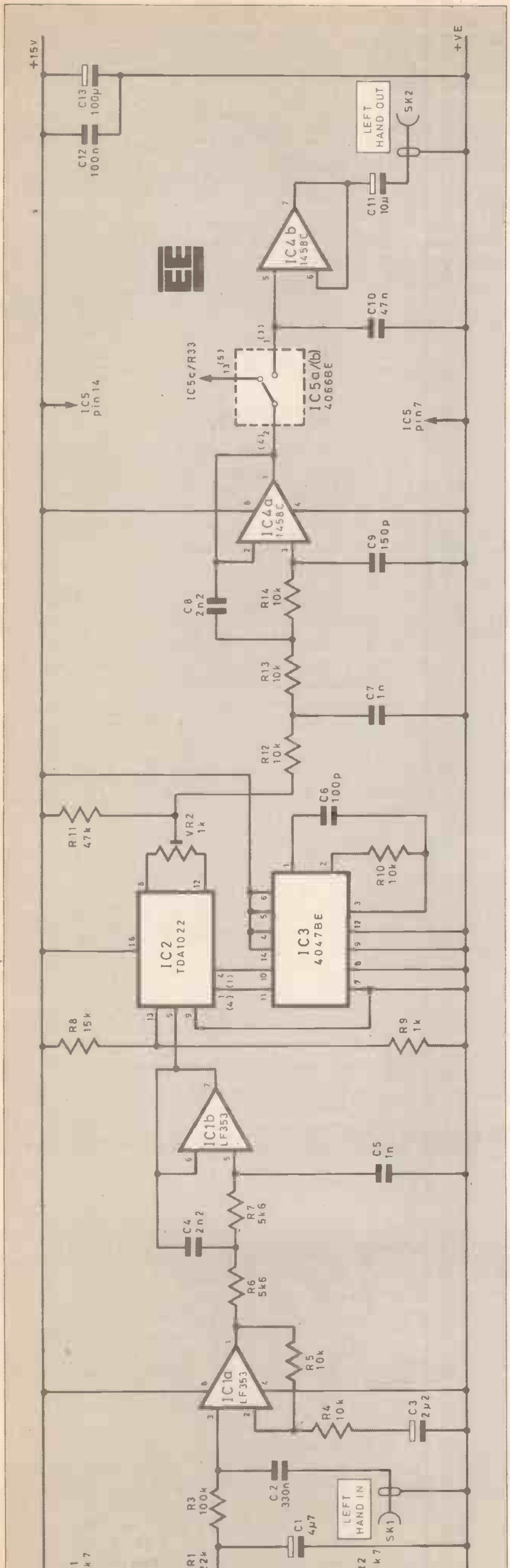


Fig. 4. The circuit diagram of the signal processing stages.

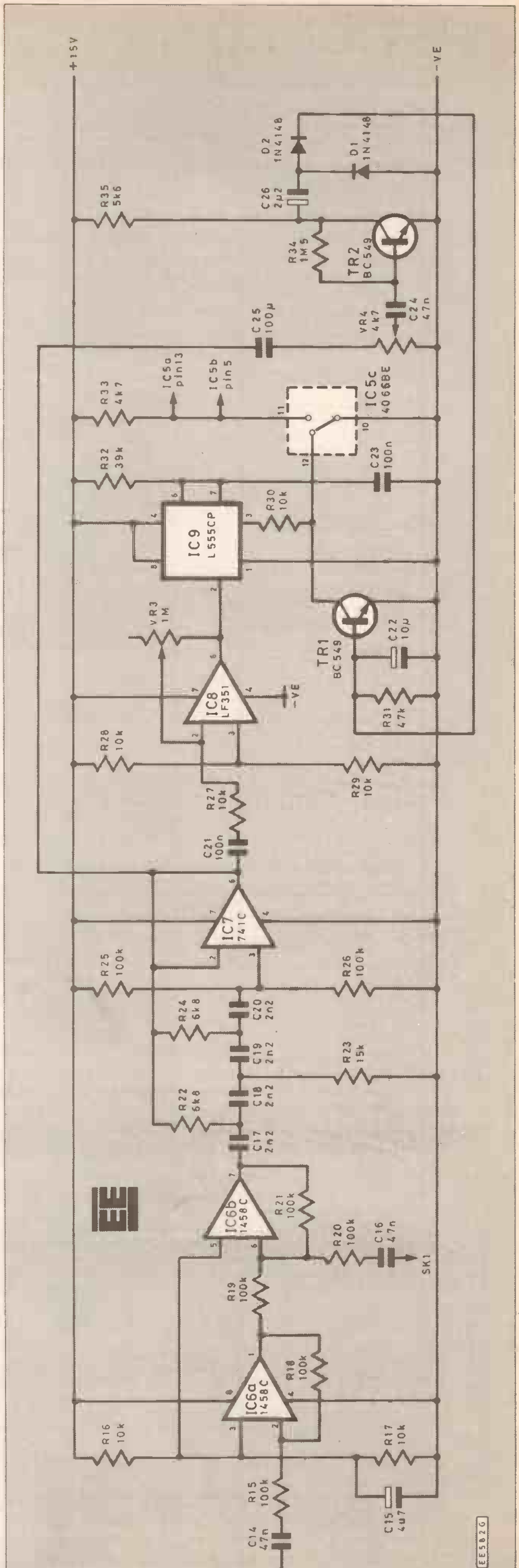


Fig. 5. The blanking pulse generator circuit.

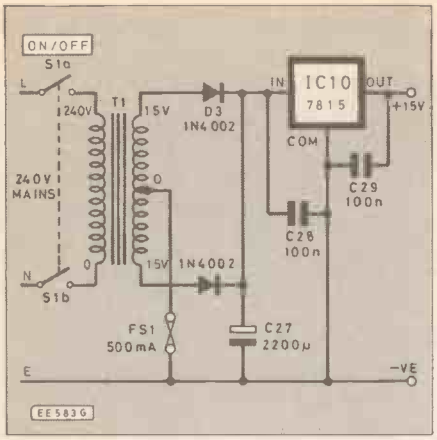


Fig. 6 (left). Circuit diagram of the mains power supply.

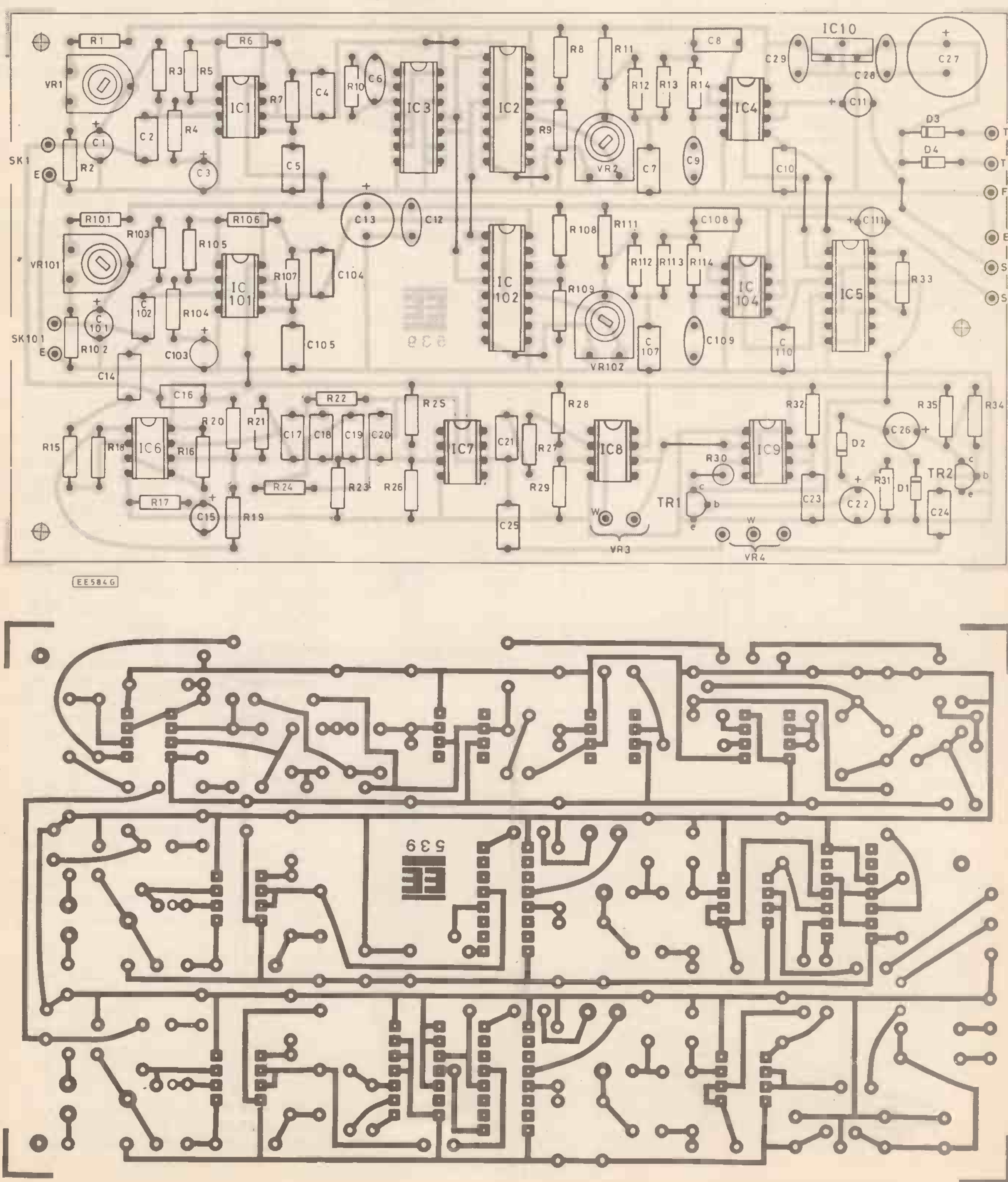
CONSTRUCTION

Construction is greatly simplified by the use of a single printed circuit board to accommodate all the components apart from the controls, sockets, fuseholder, and mains transformer. Details of the printed circuit board and wiring are shown in Fig. 7. This board is available from the *EE PCB Service:* code EE539.

The board is in most respects perfectly straightforward to construct, but there are a few points worthy of note. Firstly, in both Fig. 7 and the components list the components in the right hand channel have the same identification numbers as those in the left hand channel, except that one hundred has been added to the number (e.g. C108 is the right hand channel equivalent of C8). A few components are common to both channels, and both channels are of course served by a single blanking pulse generator. There are a number of link wires, a dozen in fact, and these are made from 20 or 22 s.w.g. tinned copper wire. The two long link wires between IC2 and IC3 should be kept quite taut, or insulated if necessary, so that there is no risk of them short circuiting together.

Components IC2, IC3 and IC102 are MOS devices, and consequently require the standard antistatic handling precautions.

Fig. 7. Component layout and printed circuit board master (full size).



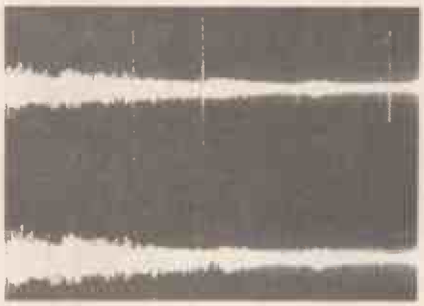
Although IC9 is also a MOS type, it has built-in protection circuits that render handling precautions totally unnecessary. IC10 will become quite hot in operation, and it is a good idea to fit it with a small aluminium fin to provide heatsinking and ensure that there is no risk of overheating. Most of the non-electrolytic capacitors are carbonate or miniature polyester types having a lead spacing of 7·5 millimetres, and it is essential that the correct type are used if they are to fit onto the board properly. Veropins are fitted to the board at all the points where connections to off-board components will be made.

HOUSING

An instrument case having approximate outside dimensions of 230 by 133 millimetres is suitable as the housing for this project. Any case of about the same size should suffice, but do not choose one significantly smaller on any dimension. The sockets are mounted on the rear panel and phono types are probably the best choice for these, although a different type could obviously be used if this would be more convenient for use in your particular set-up. A hole for the mains lead is made in the rear panel, well towards the right hand end of the panel, and this should be fitted with a cable securing grommet.

The printed circuit board is mounted on the base panel using M3 or 6BA screws and fixing nuts. Spacers about 10 or 12 millimetres long are used to keep connections on the underside of the board well clear of the metal case. The board is fitted as far to the left as possible, so as to leave space for T1 and the fuseholder at the right hand end of the base panel. A solder tag is fitted on one of T1's mounting bolts to provide a chassis connection point. For safety reasons the mains earth lead must connect to this tag, so that the case is earthed. The three controls are mounted on the front panel, and obviously on/off switch S1 should be fitted adjacent to T1, see Fig. 8 and photo.

To complete the unit the hard wiring is added, and as this is a mains powered project it is important to proceed carefully with this, and to thoroughly check the completed wiring.



Before and after oscillograph showing the effect of blanking.

ADJUSTMENT AND USE

Presets VR2 and VR102 are adjusted for minimum clock breakthrough at the output of their respective channels, but due to the high clock frequency used in this circuit there is minimal clock breakthrough at any settings of these components. It is therefore quite in order to simply set these presets at a roughly mid-setting. If an audio signal generator and an oscilloscope are available, VR1 and VR101 are adjusted for symetrical clipping on each channel. If suitable test gear is not to hand it is acceptable to simply adjust these to find any settings which give an output signal that is free from any obvious distortion. Provided the circuit is not overloaded it provides a typical total harmonic distortion level of well under one per cent.

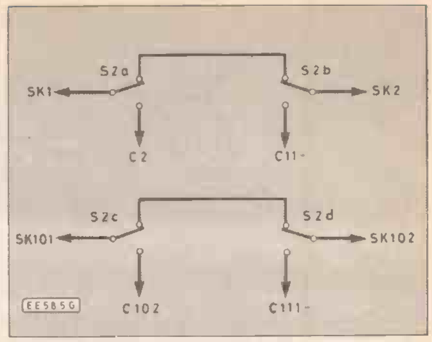


Fig. 9. Adding a bypass facility requires a 4-pole 2-way switch.

Just where in the audio system the unit is connected depends on the facilities offered by the system concerned. If a tape monitor facility is available, this can provide a convenient way of selecting the unit or switching it out, as desired. With some amplifiers and receivers preamplifier outputs and power amplifier inputs are available, and the unit can then be connected between these. A bypass switch in the blanker unit would then be needed, and all that is required is a four pole changeover switch connected as shown in Fig. 9 (a three way four pole rotary switch with the end stop set for two way operation is suitable for S2). A third alternative is to feed the unit from the cartridge via a suitable preamplifier, and ready-made preamplifiers of the appropriate type are available if a home-constructor design can not be located. The output of the unit would feed into any high level input of the amplifier or receiver, such as a "Tape" or "Aux" input. With this method it would again be advisable to include the bypass switching.

If only very bad scratches are to be processed the trigger level control will not need to be advanced very far, and results will probably be perfectly adequate without needing to advance the inhibit sensitivity control at all. With the trigger level well advanced the unit will process relatively minor scratches, but the inhibit sensitivity control must also be well advanced or it is likely that some passages of music will be blanked out. However, this is something that depends on the nature of the recording, and it is really necessary to experiment a little with the settings of the two controls to determine what works best for a given recording.

The degree of attenuation applied to the scratch pulse is massive, and there is no significant breakthrough of this signal at all. As mentioned earlier, there may be a slight audible glitch when the blanker operates, or there may be no audible effect at all. This depends on the relative signal levels at the beginning and end of the blanking period, but there is never less than a very substantial improvement in the signal. The accompanying oscillograph shows "before" and "after" traces, which clearly show the effect of the blanking. □

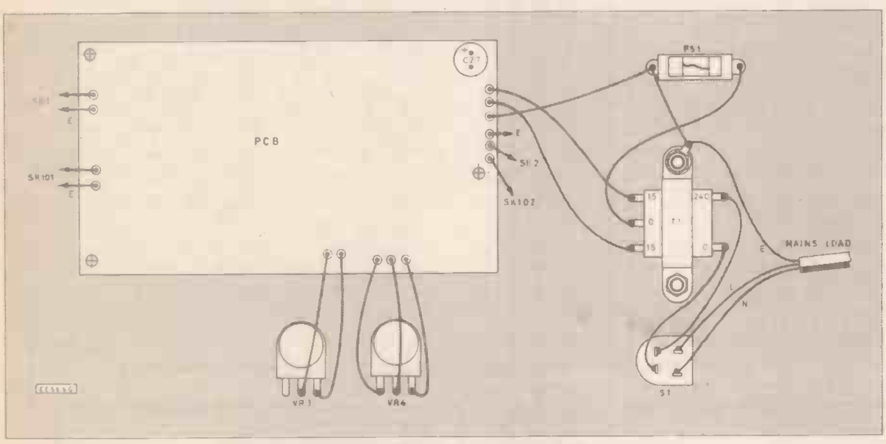
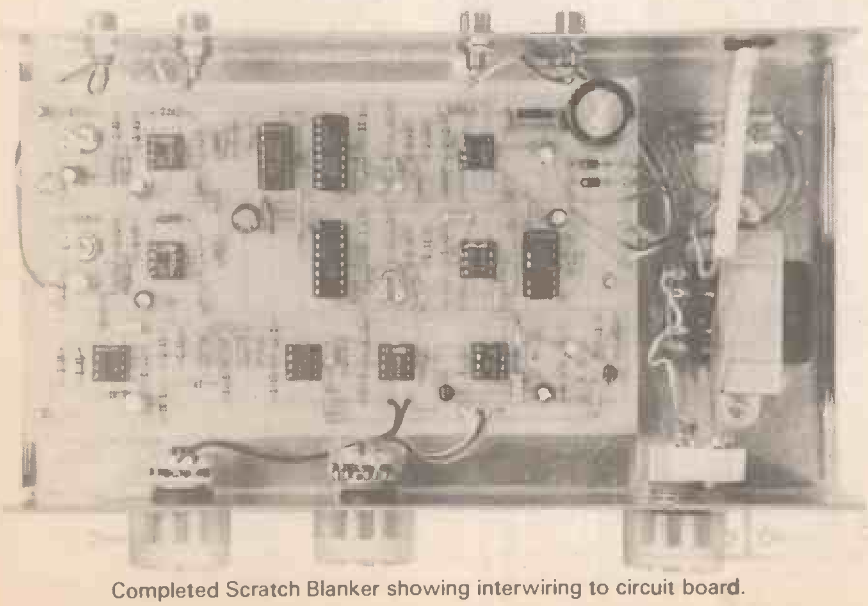


Fig. 8. Interwiring to the printed circuit board.



Completed Scratch Blanker showing interwiring to circuit board.

Actually Doing it!!

IF YOU have followed this series thus far you should now be at the stage where you can build up projects, taking them through to a neat and fully finished article. Although one could reasonably be forgiven for thinking that this is the end of things, there is often one final stage on the way to success—getting the finished project to work. Had I been writing this series a few years ago I would have emphasized that the chances of getting a project to work first time, even for an experienced constructor, were not great. These days the situation is somewhat different, with the widespread use of ready-made printed circuit boards greatly reducing the risk of errors, and making first time operation much more likely. There are still plenty of things that can go wrong, though, and if on completing your first project it fails to operate you should not be too surprised or disappointed. In more than 90 per cent of cases where a newly constructed project fails to work the problem is a simple and straightforward one which can easily be rectified by someone with little technical knowledge and little or no test gear.

THE OBVIOUS

Start by looking for obvious problems which are easily overlooked by one's eagerness to switch on and try out the new gadget. Is the battery fitted, and if it is, is it properly connected to the battery clip. The latter are a common cause of problems, and it is worthwhile gently pulling the two leads to ensure that one of them has not become detached from its press-stud. Sometimes one press-stud connects to the battery properly, but the other is a loose fit and power fails to get through to the circuit. In these cases the offending female press-stud can be crushed slightly with a pair of pliers to make it a reliable fit.

You should have thoroughly checked for errors such as integrated circuits fitted around the wrong way before switching on the unit, but probably few constructors are able to control their enthusiasm to test the new device, and most projects undergo little in the way of real checking prior to switch-on. Fortunately most modern components are very tolerant of abuse, and quite serious errors will often not result in any casualties. However, if at all possible it is obviously better to track down errors before switch-on rather than afterwards.

For one thing, if an error such as an integrated circuit fitted round the wrong way is not discovered until after the unit has been tried out, and on correcting the error the unit still fails to work, this introduces a strong element of uncertainty. It could be that there is another and unrelated error, or the integrated circuit might have been damaged. This means either spending a lot of time searching for a fault which might not exist, or replacing what might well be a perfectly good device. Some basic checking prior to switch-on can save a lot of wasted time and money.

The hard wiring is where any errors are most likely to occur, and the most common causes of problems here were discussed in previous articles. If there is something in the wiring that you were not sure about when constructing the project, it would be a good idea to take another look at this to see if you might have misinterpreted something, and if it looks as though you might have done so, try the alternative method of connection.

THE LESS OBVIOUS

More often than not a quick check over the unit will reveal some simple little error that is the cause of the problem, but some faults can be more difficult to spot. Printed circuit mounting capacitors of the carbonate or polyester layer varieties are a common cause of trouble. The standard fault is where the lead spacing is just fractionally narrower than the hole spacing in the board. On pushing the component down into place on the board one of the leads gets ripped away from the body of the component, but there may be little outward sign of this.

A close visual inspection will normally reveal this problem, though, as will gently pushing on the side of each component. If this fault is found it is often possible to solder the lead back in place, but this could affect the accuracy of the component as well as giving dubious long-term reliability. If this is done it is therefore best to regard it as only an interim measure, and to replace the component with a new type at the earliest opportunity, taking care not to give a repeat performance.

With projects constructed on stripboard the main hazard is accidental short circuits between copper tracks due to what are often quite small blobs of excess solder. With custom printed circuit boards this is less of a problem, but it can still happen, especially on areas of the board where there are a lot of connections in a small area (d.i.l. clusters etc.). Solder blobs and splashes (thin streaks of solder across the board) can be difficult to spot visually, and it is helpful to use a spirit-based cleaner to remove any excess flux from the board; a magnifying glass might also be very helpful.

CONTINUITY CHECKER

I have often come across short circuits which defy visual detection even with close and detailed inspection, and my preferred way of doing things is to use a continuity tester to check for short circuits between adjacent tracks or pads which should not be connected. This really requires the use of a tester which will not respond to very low resistances or to forward biased semiconductor junctions, as otherwise a constant stream of misleading indications are likely to be obtained. Suitable continuity checker designs appear in *Everyday Electronics* from time to time, or a multimeter set to a range having a full scale value of about 10 or 20k should suffice.

Do not be tempted into the classic mistake of building up a continuity tester from a torch battery and bulb wired in series. The problem with this arrangement is that it can force quite high currents through the circuit being tested, and this could result in the unit producing more faults than it locates. The simple continuity checker circuit of Fig. 1 is a sort of modern equivalent of the old torch bulb type, and the use of an ultra-bright l.e.d. enables the current to be kept to a suitably low level.

You may occasionally track down a short circuit with a continuity tester, but find yourself in the position of not being able to visually locate the offending piece of solder. Running the blade of a modelling knife between the two copper strips a few times over their entire length should cut through the solder and cure the fault.

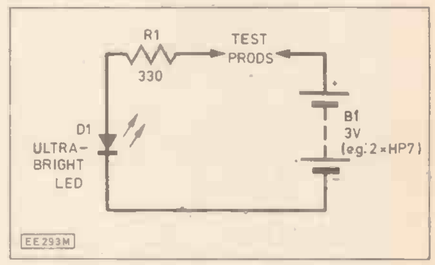


Fig. 1. Simple but safe continuity checker.

Soldering is a subject that has been covered in previous articles, and it is one which has to be mentioned again here since inadequate soldering it possibly the most common cause of projects failing to work. Good soldered joints on a circuit board should have a sort of mountain shape with a shiny surface to the solder. A rounded shape (often accompanied by a dull surface to the solder) usually indicates that the solder has not flowed over the track and lead properly. A dull and crazed finish to the surface of the solder indicates the lead has been moved as the solder solidified, causing numerous fractures in the solder.

Another problem that can occur is where a leadout wire has been trimmed slightly too short so that very little of the lead (or nothing at all) protrudes on the copper side of the board. This can result in a cap of solder over the leadout wire without it actually being soldered in place. Joints of this type can often be spotted because they are very much flatter than ordinary joints, with no sign of the leadout wire.

This is another case where a detailed visual inspection will often reveal the fault, but it can not be relied upon to do so. It is much better to use a continuity checker to test for a proper connection between each leadout wire and its copper track. Simply giving the components a firm pull will often reveal inadequate joints as the offending leadout wire may pull clear of the board, and it is worth giving this a quick try before spending a lot of time testing each connection with a continuity checker.

If a dry joint is located, do not simply try applying further solder to it. First clean off the original solder using a desoldering tool or solder wick, then make sure that both surfaces are clean and in a fit state for soldering (with any excess flux being removed), and finally resolder the connection. It would be advisable to recheck the new joint with a continuity checker. If the problem was due to inadequate leadout protrusion, it might simply be a matter of applying the iron to the joint and pushing the component fully down and into place on the board. If the lead has been trimmed too short, one way around the problem is to solder a short piece of tinned copper wire in place, and then connect the leadout to this on the component side of the board. A neater solution is to simply replace the component. I have come across d.i.l. integrated circuit holders with very short pins that are barely a board's thickness in length. It can be very difficult to produce reliable connections with these, especially when using a fairly thick piece of board, and they are best avoided.

COMPONENTS

Faulty components are quite rare these days, and unless you fail to take due care when connecting components it is extremely unlikely that a "dud" will be responsible for the problem. Therefore, if you are careful when constructing the unit and ensure that there are no faults of what could really be termed mechanical rather than electrical in nature (e.g. short circuits and integrated circuits fitted around the wrong way) the finished project is almost certain to work. It is useful to keep this in mind, and a positive approach to things gives a far better chance of success.

If a thorough check fails to reveal a fault the next step is to try checking the components, and at the very least a multimeter is needed for this. Even with the aid of a multimeter only fairly simple components can be tested. As a quick initial check, ensure that the supply is getting through to the circuit board, and to all the integrated circuits, etc., that connect to one or other of the supplies. Broken printed circuit tracks are not a common fault, but they do occur.

Any multimeter should be capable of measuring over a wide resistance range, and testing the resistors should not be a problem. Do not overlook the fact that in-circuit checks may not be very accurate due to the presence of components connected in parallel with the one you are checking. What this means in practice is that some readings may be on the low side, but a higher than expected reading is certainly indicative of a fault. If a low reading is obtained, swopping the test prods over may give a more accurate one, but the only certain way of eliminating errors due to effect of other components is to temporarily disconnect one leadout wire so that the component is effectively isolated from the rest of the circuit.

A multimeter cannot thoroughly test inductors, but a broken wire will be indicated by a very high resistance through the winding. Similarly, capacitors cannot be properly tested, but the most common fault is a short circuit through the component, and a multimeter set to a resistance range will detect this. When first connecting the meter to the capacitor the needle might give a slight kick as the component charges up. The size of the kick depends on the value of the capacitor (higher values giving larger deflections), and this can be used as a rough guide to whether or not a component is functioning properly. However, very low values will not give a significant kick of the needle even with the multimeter set to the highest resistance range, and this method is not applicable to digital multimeters.

Diodes are easily checked using a multimeter set to a resistance range. Connecting the test prods one way round should give a low reading, while a high reading should be obtained with the prods reversed. As a quick check of transistors, there should be a diode action between the base—emitter and base—collector leads, and a very high resistance across the collector—emitter leads with the test leads connected either way around. All these tests should ideally be carried out with one lead of the component under investigation disconnected from the board (or two leads in the case of transistors), and results are largely meaningless unless this is done.

Mistakes can occur in magazines (but very infrequently in *EE&EM*), and any corrections for errors in constructional articles normally appear an issue or two after the copy in which the project was published. If all else fails you can write into the magazine asking for help, but do try to include as much useful information as possible. Simply stating that a project has failed to work and asking why is very much a "how long is a piece of string?" type question. If the project does something, even something like a component getting warm, then give details of this. Even if it does nothing at all then this fact should be stated and might prove helpful. If you have a multimeter take a few voltage readings and include these. Most important of all, do not forget to include a stamped addressed envelope for the reply.

Robert Penfold

LETTERS

Spot on

Sir—In reply to David J. M. Lloyd's letter "Back to the beginning" (July '86 issue) I would like to say that as a beginner I find your magazine "spot on". My attention was first drawn to your magazine when I noticed a Waa-Waa Pedal project. I purchased my first small batch of components and completed the project in one day . . . all due, of course, to your easy to follow instructions and clear pictorial layout and diagrams. I was immediately hooked to electronics as a hobby.

I now have a regular order for your magazine. I am especially interested in your musical effects projects as I play electric guitar in a band. Car projects are of little interest to me as we do not own a car . . . we're a family of dedicated motorcyclists! "Home projects" like burglar alarms, intercoms and games are very interesting to build and useful to the whole family.

I learn something new about circuit layout and building with every project I complete. Learning from building projects and also from your *"Teach In"* series has helped me to gain a wealth of knowledge about electronic circuitry.

However, I do agree with Mr. Lloyd on the subject of computers. There *are* enough magazines covering technical information and "add-on" projects for computers. Anyway, most beginners would prefer building the more "conventional" projects rather than tackling the more difficult computer projects. That of course is just my opinion.

I disagree with Mr. Lloyd on the subject of formulae, calculations, etc. I find these of great interest and as I like to experiment with circuit design, formulae and calculations are a necessity.

Overall, I find Everyday Electronics and Electronics Monthly an excellent magazine for the beginner and not-so-beginner alike. I shall keep buying it . . . computer projects included . . . or not. Keep up the good work!

Billy McCoy,
Newcastle West,
Co. Limerick.

No more please!

Sir—I read David Lloyd's letter (July 86 issue) with some interest.

The July issue was the first electronics magazine that I have bought for several years, although I have "pottered" with circuits during that time. I agree entirely with his views upon computers. The reason that I rejected the other magazines was that they were packed with computer circuits—no more please!

I would, however, like to see more articles on circuit design and applications of popular i.c.s, how to actually make them work and tailor them to our own needs. A good example of this is the *Exploring Electronics* series—it shows us the principle of transmission, but, how would you build a modulator and r.f. amplifier??

Also, why not have more projects that can be built from readers' junk boxes? I'm sure there are thousands of us with 741s, 7400s, 4011s in our junk boxes, but unable to use them as they now seem to be "obsolete" and EE projects use only CA3240s etc., where a good ol' 741 could do the trick!

Just look at your readers' circuits. You'll see lots of 741s, BC109s etc. etc. Could it be they're trying to tell you something? Also let's have a bit of "boring" theory so we can design our own circuits—no, perhaps not—it might put you out of a job!

G. Finney,
Pontypool,
Gwent.

EE BOOK SERVICE
See Page 470

PCB SERVICE

Printed circuit boards for certain constructional projects are now available from the PCB Service, see list. These are fabricated in glass-fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas airmail. Remittances should be sent to: The PCB Service, Everyday Electronics and Electronics Monthly Editorial Offices, 6 Church Street, Wimborne, Dorset BH21 1JH. Cheques should be crossed and made payable to Everyday Electronics. *(Payment in £ sterling only.)*

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps. **Do not send any other correspondence with your order.**

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed in the latest issue.

PROJECT TITLE	Order Code	Cost
— JULY '83 —		
User Port Input/Output *M.I.T. Part 1*	8307-01	£4.82
User Port Control *M.I.T. Part 1*	8307-02	£5.17
— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
Car Intruder Alarm	8308-02	£5.15
High Power Interface *M.I.T. Part 2*	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Pt 2*	8308-04	£3.56
— SEPTEMBER '83 —		
High Speed A-to-D Converter *M.I.T. Pt 3*	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Pt 3*	8309-02	£4.48
Stylus Organ	8309-03	£6.84
— OCTOBER '83 —		
D-to-A Converter *M.I.T. Part 4*	8310-01	£5.77
High Power DAC Driver *M.I.T. Part 4*	8310-02	£5.13
— NOVEMBER '83 —		
TTL/Power Interface for Stepper Motor *M.I.T. Part 5*	8311-01	£5.46
Stepper Motor Manual Controller *M.I.T. Part 5*	8311-02	£5.70
Speech Synthesiser for BBC Micro	8311-04	£3.93
— DECEMBER '83 —		
4-Channel High Speed ADC (Analogue) *M.I.T. Part 6*	8312-01	£5.72
4-Channel High Speed ADC (Digital) *M.I.T. Part 6*	8312-02	£5.29
Environmental Data Recorder	8312-04	£7.24
Continuity Tester	8312-08	£3.41
— JANUARY '84 —		
Biological Amplifier *M.I.T. Part 7*	8401-02	£6.27
Temp. Measure & Control for ZX Comprs		
Analogue Thermometer Unit	8401-03	£2.35
Analogue-to-Digital Unit	8401-04	£2.56
Games Scoreboard	8401-06/07	£9.60
— FEBRUARY '84 —		
Oric Port Board *M.I.T. Part 8*	8402-02	£9.56
Negative Ion Generator	8402-03*	£8.95
Temp. Measure & Control for ZX Comprs Relay Driver	8402-04	£3.52
— MARCH '84 —		
Latched Output Port *M.I.T. Part 9*	8403-01	£5.30
Buffered Input Port *M.I.T. Part 9*	8403-02	£4.80
VIC-20 Extension Port Con. *M.I.T. Part 9*	8403-03	£4.42
CBM 64 Extension Port Con. *M.I.T. Part 9*	8403-04	£4.71
Digital Multimeter Add-On for BBC Micro	8403-05	£4.63
— APRIL '84 —		
Multipurpose Interface for Computers	8404-01	£5.72
Data Acquisition "Input" *M.I.T. Part 10*	8404-02	£5.20
Data Acquisition "Output" *M.I.T. Part 10*	8404-03	£5.20
Data Acquisition "PSU" *M.I.T. Part 10*	8404-04	£3.09
A.F. Sweep Generator	8404-06	£3.55
Quasi Stereo Adaptor	8404-07	£3.56
Simple Loop Burglar Alarm	8405-01	£3.07
Computer Controlled Buggy *M.I.T. Part 11*		
Interface/Motor Drive	8405-02	£5.17
Collision Sensing — MAY '84 —	8405-03	£3.20
Power Supply	8405-04	£4.93
Infra-Red Alarm System	8406-01	£2.55
Spectrum Bench PSU — JUNE '84 —	8406-02	£3.99
Speech Synthesiser *M.I.T. Part 12*	8406-03	£4.85
Train Wait	8406-04	£3.42
Ultrasonic Alarm System	8407-01	£4.72
Electronic Code Lock — JULY '84 —		
Main Board	8407-03	£2.70
Keyboard	8407-04	£3.24
— AUGUST '84 —		
Microwave Alarm System	8408-01	£4.36
Temperature Interface—BBC Micro	8408-02	£2.24
— SEPTEMBER '84 —		
Op-Amp Power Supply	8409-01	£3.45
Micro Memory Synthesiser — OCT '84 —	8410-01*	£8.20
Drill Speed Controller	8410-04	£1.60
— NOVEMBER '84 —		
BBC Audio Storage Scope Interface	8411-01	£2.90
Proximity Alarm	8411-02	£2.65
TV Aerial Pre-Amp	8412-01*	£1.60
Digital Multimeter — DEC '84 —	8412-02/03*	£5.20
Mini Workshop Power Supply	8412-04	£2.78
Power Lighting Interface	8501-01	£8.23
Games Timer — JAN '85 —	8501-02	£1.86
Spectrum Amplifier	8501-03	£1.70
Solid State Reverb	8502-01	£3.68
Computerised Train Controller — FEB '85 —	8502-02	£3.38
— MARCH '85 —		
Model Railway Points Controller	8503-01	£2.78
Insulation Tester	8504-02	£2.53
Fibrelarm — APRIL '85 —	8504-03	£3.89
Auto Phase	8505-01	£3.02
Amstrad CPC464 Amplifier		
Mains Unit — MAY '85 —	8505-02	£2.56
Micro Unit	8505-03	£2.56
Voltage Probe	8505-04	£2.67
Graphic Equaliser — JUNE '85 —	8506-01	£3.21
Computerised Shutter Timer	8506-02	£2.09
Mono-Bi-Astables (Experimenters Test Bed)	8506-03	£2.45
Across The River	8506-04	£2.63
Amstrad User Port — JULY '85 —	8507-01	£3.17
Nascom Printer Handshake	8507-02	£1.90
Electronic Building Blocks—1 to 4†	8508-01	£2.98
Tremolo/Vibrato	8508-02	£4.03
Stepper Motor Interface— AUGUST '85 —	8508-03	£2.40
Drill Control Unit	8508-04	£2.90
— SEPTEMBER '85 —		
RIAA Preamplifier Input Selector	8509-01	£2.36
Transducers Resistance Thermometer	8509-03	£2.64
Transducers Semiconductor Temp. Sensor	8509-04	£2.72
Transducers Strain Gauge — OCT '85 —	501	£2.87
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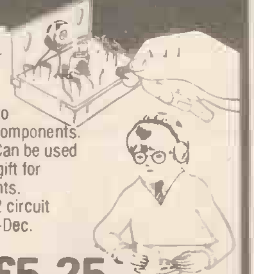

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