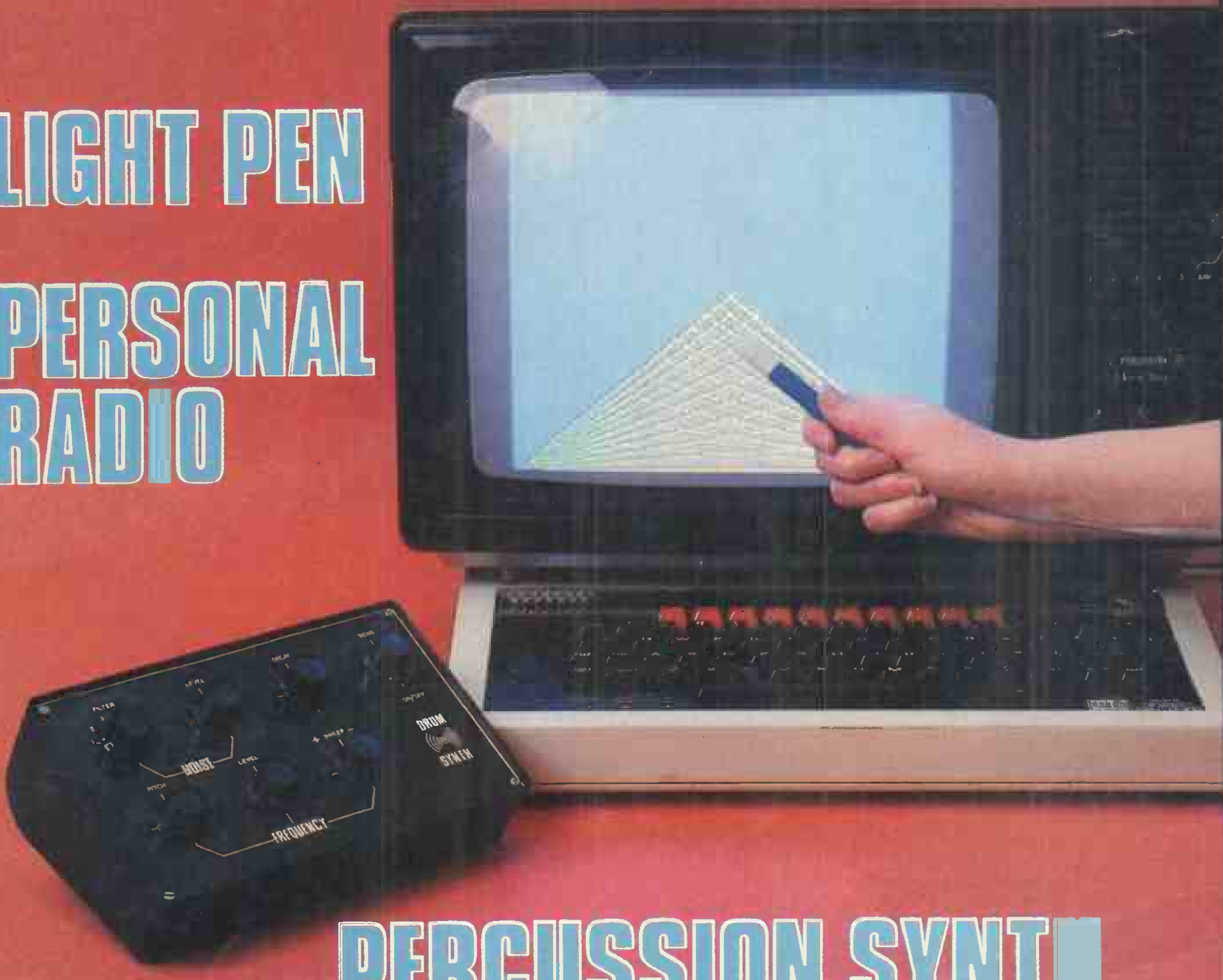
EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

JUNE 1986 $3-30 £1·10

LIGHT PEN

PERSONAL RADIO



PERCUSSION SYNTH

SPECIAL FEATURES! for SPECTRUM & BBC MICRO

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 – water 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$\frac{3}{4}$ 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
142. 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
206. 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
241. 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 B045
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**

THE AMSTRAD STEREO TUNER

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio – easy to carry about and which will give you superb reception. Other uses are a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.
Some of the features are: long wave band 115 – 170KHz, medium wave band 525 – 1650KHz, FM band 87 – 108 MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands). All made up on very compact board.
Offered at a fraction of its cost only **£4.95**

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" £6 + £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.

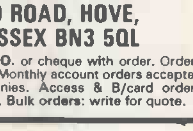
IONISER KIT

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
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 203500. **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
2P7 – Mini key, 16 button membrane keyboard, list price over £12
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
2P24 – Clockwork operated 12 hour switch 15A 250V with clutch
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
2P29 – 24 position Yaxley switch contacts rated 5A – $\frac{1}{4}$ spindle
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
2P36 – 20 Amp meter, with shunt ulnused but ex-equipment
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.
2P42 – Tubular heater, 60 watts per ft, unusued but slightly storage soiled, made by G.E.C. Perfect order (must be collected by appointment as 12ft long)
2P43 – Small type blower or extractor fan, motor inset so very compact, 230V
2P46 – Our famous drill control kit complete and with prepared case
2P47 – Joy switch kit complete as previously sold.
2P48 – Telephone ringing unit reduces mains to 50 volts and changes frequency from 50 hz to 25 hz to give right ringing tone.
2P49 – Fire Alarm break glass switch in heavy cast case
2P51 – Stereo Headphone amplifier, with pre-amp
2P54 – 2$\frac{1}{2}$kw. blow heater section of coal or log effect fire, this is a sheet metal assembly which holds the elements, the motor with fan, and the lamp holders and bits which give the flickering flame effect. Collect or add £3 to cover p&p
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
2P65 – 2 resettable trips 4.5A mains
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
2P70 – 1 E.M.I. tape motor two speed and reversible
2P71 – 1 PAPST 240 5 hz motor
2P72 – 1 115v Muffin fan 4" × 4" approx.
2P75 – 1 2 hour timer, plugs into 13A socket
2P76 – 1 audax tweeter partner to 5P26 speaker
2P77 – 1 instrument box with key size 12" × 4$\frac{1}{2}$" wide 6" deep
2P81 – ORACLE VB100 instrument panel, is a MODEM with extras, it is the heart of many viewdata systems including the Prestel unit we recently stocked It uses 25 I.C's, 2 crystals, u.h.f. modifier Aztex UM1233 etc. etc. You receive this, new, unused and complete except for 7 of the plug in I.C's.
2P82 – 9v–0–9v 2 amp mains transformer
2P83 – 25m .75 twin flat flex for mains appliances
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
2P91 – Panel meter size 2$\frac{1}{2}$" × 2" scaled power factor
2P92 – Bailey & Macky pressure switch 50 p.s.i.

£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.
4. Dial indicator, measures accurately down to .01mm, "John Bull" or equally first-class make, a must for toolmaker or lathe worker.
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.
7. Tape punch and matching tape reader, not new but believed in perfect working order if not so we would repair or replace within 12 months. Please add £2.50 postage.
8. Sensitive voltmeter relay, this consists of a 4$\frac{1}{2}$" dia moving coil meter with electronics (we will supply cct. dig.) over £120 each, they are new and still in maker's boxes.
9. Box of 25 fluorescent tubes 40 watt daylight or warm white ideal window pelmets, signs, etc. Please collect or add £2 postage.
10. Box of 25 18" fluorescent tubes assorted colours, please collect or add £2 postage.
11. 24 x 8 ft 85-120 watt warm white tubes. Ideal plant growing. Collect or send open cheque to cover carriage.
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.
14. Uniselector 360 degrees rotation, 5 poles, 50 ways, 50V coil.
15. Washing machine water pump, main motor driven so suitable for many applications.
16. Control panel case, conventional design with hinged front and finished metallic silver, easily arranged as lockable size approx. 15" x 10" x 5$\frac{1}{2}$", wall mounting.
17. Two kits: matchbox size surveillance transmitter and 2 FM receivers.

VOL 15 No.6 JUNE '86

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

ISSN 0262–3617

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

Projects

Series

Features

Our July 1986 issue will be published on Friday, 20 June.
See page 327 for details.

TEACH-IN '86

As usual, GREENWELD are supplying all TEACH-In '86 items – as we have done over the past 10 years. Our experience with these projects ensures you receive top quality components as specified at the best possible price, so you can order with confidence. This years kits are available as follows:

BASIC ITEMS: M102B2 multimeter; Verobloc, bracket & design sheets, 10 leads with croc clips + FREE – The latest GREENWELD Catalogue and a resistor colour code calculator!! PRICE, inc. VAT and post **£21.95**
or separately: M102B2 **£14.95**; Verobloc etc. **£6.21**; croc clip leads **£1.97**.

EXTRA COMPONENTS required for parts 1 and 2 .... **£1.50**
EXTRA COMPONENTS required for parts 3 and 4 .... **£3.60**
EXTRA COMPONENTS required for parts 5 and 6 .... **£4.95**
EXTRA COMPONENTS required for parts 7, 8 and 9 .... **£2.17**
PSU–EE Special Offer mains adaptor **£4.95**
REGULATOR UNIT: All parts including case, also In-line fuseholder, fuse and 2mm plugs for PSU **£16.95**
LCR BRIDGE: All parts including case **£23.95**
DIODE/TRANSISTOR CHECKER: All parts inc. case **£15.95**
AUDIO SIGNAL TRACER: All parts Inc. case **£11.95**
AUDIO SIGNAL GENERATOR **£19.50**
RF SIGNAL GENERATOR **£19.95**
DIGITAL PULSE GENERATOR **£13.20**

1986 CATALOGUE

Big 64 page catalogue packed with thousands of items from humble resistors to complex disco mixers. 8 page Bargain List + order form included, also Bulk Buyers List & £1.20 discount vouchers. All this for just **£1.00** inc. post.

BOING. . .BOING. . .BOING

Spring Supplement out now, FREE. 16 pages of bargains

COMPUTER BOOKS

all at 99p—send for list

BUZZERS

Piezo ceramic sounders by STC offered 1/2 original price. Up to 115dB output. SAE full list and spec (B/L 23).

7 SEG DISPLAYS

A remarkable purchase of red seven segment LED displays allows us to make this amazing offer – buy now whilst stocks last!

Type	Size	CC/CA	DP	1	10
MAN6740	.56"	CC	RH	120p	800p
6710	.56"	CC	RH	70p	450p
4710	.43"	CA	RH	65p	420p
4720	.43"	CA	LH	65p	420p
4740	.43"	CA	RH	65p	420p
4770	.43"	±1		65p	420p
4920	.43"	CA	none	65p	420p
3719	.3"	CA	RH	60p	400p
3729	.3"	CA	LH	60p	400p

100 Ass't'd £40 1000 Ass't'd £300
(Your choice)

AMP/PRE-AMP PANELS

Z974 Mixer Amp Panel 115x115mm. 1 watt output from TBA820M chip. 2 inputs (1 via pre-amp) from phono sockets and separate volume controls. A third pot is used to fade from one input to the other. There are also 2x4p3w rotary switches. All pots and switches have black knobs. Attached to the main panel by flying leads is a socket panel with the 2 phono i/p sockets, 2x5 pin DIN sockets and a 2 pin DIN speaker socket. Also on the panel are 2x3.5mm monitor sockets. Data sheet supplied. Very good value at just **£2.50**
Z914 Audio amp panel 95x65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol. control. Just connect batt. and speaker. Full details supplied. **£1.50**
Z915 Stereo version of above 115x65mm featuring 2xTBA820M and dual vol. control. **£3.50**

AM Tuner Panel

Z916 For use with mono amp above. Neat panel 60x45mm. **£1.50**

BUGGY KIT

Make your own computer controlled buggy – very simple circuit, an ideal introduction into the world of robotics. Uses our very popular motorized gearbox. All parts inc. gearbox and wheels, connectors, wire etc.
Spectrum/ZX81 .... **£13.95**
C64/VIC20 .... **£11.95**
BBC **£12.95**
Amstrad **£12.95**
Full instructions and circuit + program listing supplied free with kit, or 50p separately.

KEYBOARDS

TATUNG VT1400 Video Terminal Keyboard. Brand new cased unit 445×225×65/25mm 71 Alpha-numeric and function keys, + separate 14 key numeric keypad. ASCII output via curly cord and 6 way plug. Data and connection sheet supplied. **£22.50**
CAMPUTERS LYNX keyboard. 58 full travel keys. Size 334×112mm. Brand new. **£8.95**

SWITCH MODE PSU

Z993 65 Watt switch mode multi-output power supply. Astec Model AA12790. Offered at around one-third normal price, this has to be the Bargain of the Yearl! Compact unit 195×105×50mm accepting 115/230V ac input. Outputs:
+5V @ 3A
+12V @ 2.9A
+18V @ 1.0A
–5V @ 0.2A
£29.95

NOISE PANEL

PCB contains keypad + components + 57mm dia speaker. These are new units and are powered by 2xPP3 batts. Membrane keys offer: waves, steam train (slow & fast) car engine, siren. **£2.95**

SWITCH-BOX

Z996 QAS Tape Selector. Satin finish aluminium case 130×70×45mm with three push buttons on front wired to three 5 pin DIN sockets on back, enabling either of two tape recorders to be connected to an amplifier, or to each other. Comes complete with leaflet in presentation box. **£2.50**
Z997 QAS Tape Selector. Three way version, enables one amplifier and three tape recorders to be connected in many combinations. Satin finish aluminium case 180×70×45mm contains 8 push buttons and 4 5 pin DIN skts, all mounted on a PCB. Very neat. Leaflet explains all possible switching permutations. Supplied in presentation box. Special low price. **£4.95**

THIS MONTH'S PROJECTS RING FOR PRICES!

GREENWELD ELECTRONIC COMPONENTS

All prices include VAT; just add 60p P&P. Min Access order £5. Official orders from schools etc. welcome – min invoice charge £10. Our shop has enormous stock of components and is open 9-5.30 Mon-Sat. Come and see us!!
443D Millbrook Road Southampton SO1 0HX Tel (0703) 772501/783740

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EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

VOL 15 Nº6 **JUNE '86**

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GETTING IT TOGETHER

LAST month I touched on the problems of teaching electronics in schools. On a similar subject I was pleased to see an initiative by the Electronic Engineering Association (EEA) recently to encourage more students to take up electronics as a profession. There has long been a feeling in UK schools, colleges and universities that the arts are rather "better" subjects to take than to go in for some form of engineering. Thankfully this totally erroneous notion is beginning to subside in all but the most old fashioned bastions of education.

With many people unemployed it is sobering to know that the electronics industry has a 10 per cent shortage of technicians and engineers while hundreds of arts students find nowhere to go when they leave full-time education. Our schools are coming round to the thought that perhaps it is better to educate young people for their life ahead rather than just to educate them!

Getting back to the EEA initiative, which is being backed by all 60 member companies of the Association, a video has been produced which will be distributed to schools, colleges and local education authorities to be shown to students. The video is presented by BBC personality Mike Smith who talks to a group of young people working in the electronics industry. Those interviewed come from a variety of backgrounds and abilities which range from school leavers with CSEs to university graduates. Schools can also arrange visits from EEA member companies who will explain the advantages of a career in electronics and discuss the opportunities available.

Such an initiative must be welcomed by all sides and we hope the schools will be keen to show the video to students. Schools can contact the EEA should they not have any information on the video; ring Jessica Chilton of the EEA on 01-437 0678, who will be able to provide more information.

REPAIRS

This issue carries a short article on repairing commercial equipment, it is not intended to be comprehensive but will give readers some ideas and pointers to get them started. We must, however, make it quite clear that we are unable to supply any information on any commercial equipment or to help readers with queries about commercial equipment. Quite simply we would need a massive reference library and far more time than we ever get to be able to help with such queries.

Mike Kenward

BACK ISSUES & BINDERS

Certain back issues of EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY are available price £1.25 (£1.75 overseas) inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability remittances will be returned. *Please allow 28 days for delivery.*

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

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

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

OLD PROJECTS

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

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LIGHT PEN

ASHLEY LANE

Simple Light Pen for the BBC Micro, giving excellent results

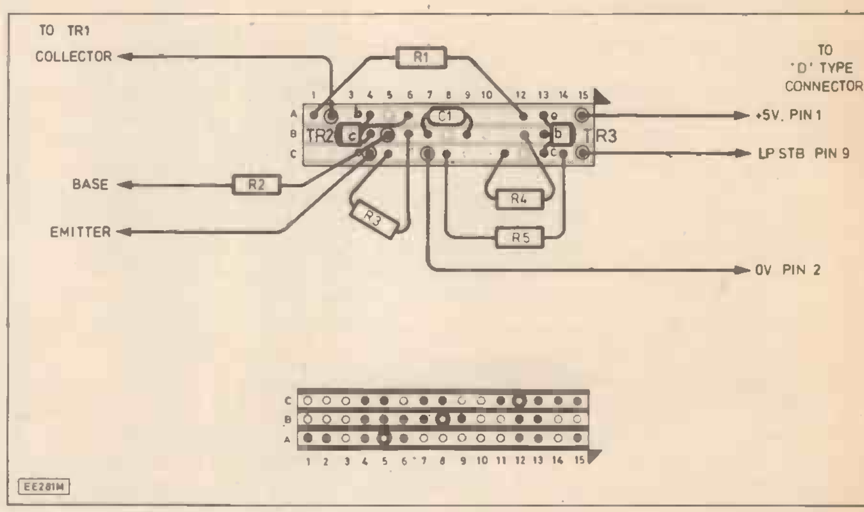


Fig. 2. Layout and wiring of the Light Pen Veroboard.

If you own a BBC Micro, you have a computer with the facility to accept a light pen. However, you may be surprised at the cost of a ready-built light pen. This is partly due to the difficulty in manufacturing a reliable piece of hardware. Some manufacturers have attempted to produce such a device, but owing to marketing considerations, i.e. cost and potential sales, the resulting units often leave a lot to be desired. In this article we present a Light Pen which, in component parts, will cost around £5.00, yet give an excellent resolution and accuracy.

HOW A LIGHT PEN WORKS

To explain how a light pen works, you must first have an idea of how a television picture is created. The phosphor, coating the inside of the screen, glows when struck by a beam of electrons emitted by a cathode gun. This beam is deflected from left to right by a set of electro-magnets called horizontal deflection coils. When the spot reaches the right hand side the beam is blanked and it is moved at high speed to the left side. During this time a vertical deflection coil is slowly moving the spot down the screen so that on the next sweep it is below the previous line. This repeats until all 625 lines have been drawn, at which time the spot returns to the top left hand corner. This is a highly simplified description as in a real TV or monitor the process is far more complex (i.e. there is interlacing).

At the most basic level the light pen is a detector of light. In the Beeb the video/TV display is controlled by the 6845 CRT controller chip. Every time the light spot passes the tip of the pen, the pen generates a digital pulse. This in turn causes the 6845 to store a number in two of its registers (R16—high byte, and R17—low byte). The number has a minimum value when the pen is at the top left hand corner of the screen and increases in unit steps to a maximum reading at the bottom right.

CIRCUIT AND CONSTRUCTION

As can be seen from the circuit diagram (Fig. 1) there are very few components needed to make the pen. The most important is the light detector. It must have good sensitivity and fast reaction characteristics. The TIL 81 phototransistor is ideal and is available at around £1.25. If unavailable the more expensive BPX 25 phototransistor can be used with identical results. Both these devices have a built-in glass lens on the tip. This is worth noting as if the glass lens is in contact with the monitor screen scoring may occur. Therefore, it is a good idea to surround the detector with some plastic to keep it off the screen.

The only thing of any interest as far as the

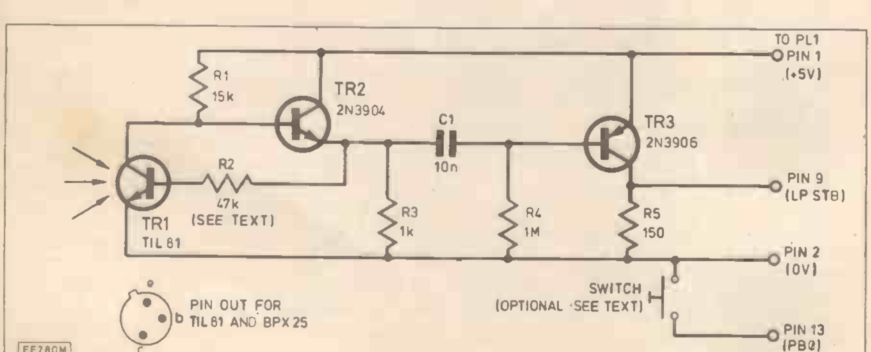


Fig. 1. Circuit diagram of the complete Light Pen.

COMPONENTS

See Shop Talk page 313

Resistors

R1	15k
R2	47k (see text)
R3	1k
R4	1M
R5	150

All $\frac{1}{8}$W ±2%

Capacitors

C1	10n as small as possible

Semiconductors

TR1	TIL81 (or BPX25)
TR2	2N3904
TR3	2N3906

Miscellaneous

15-way D connector; 15-way cover for D connector; very small piece of Veroboard; 3 (or 4)-way cable (see text); single pole push to make switch (optional—see text).

Approx. cost Guidance only £5

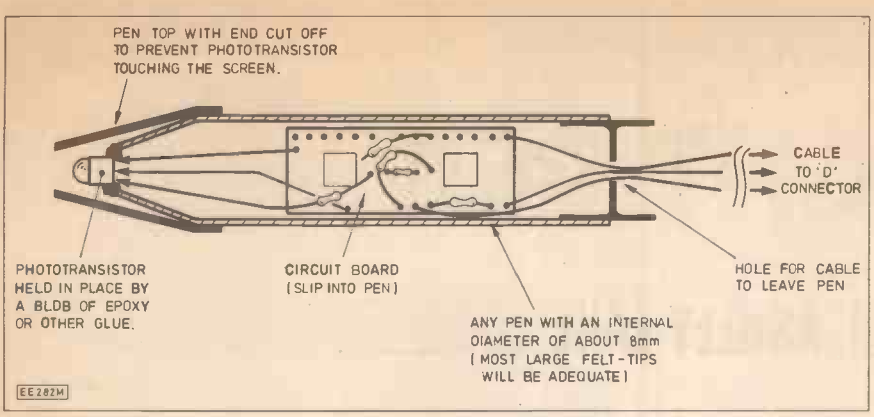
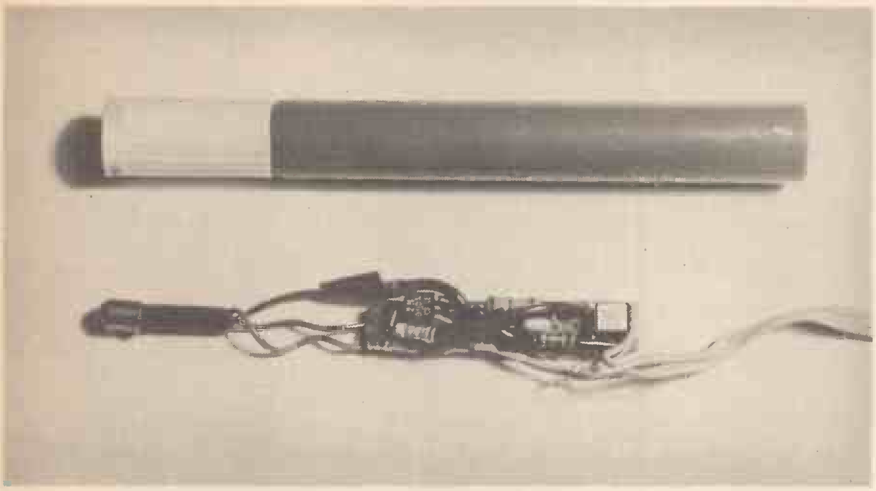
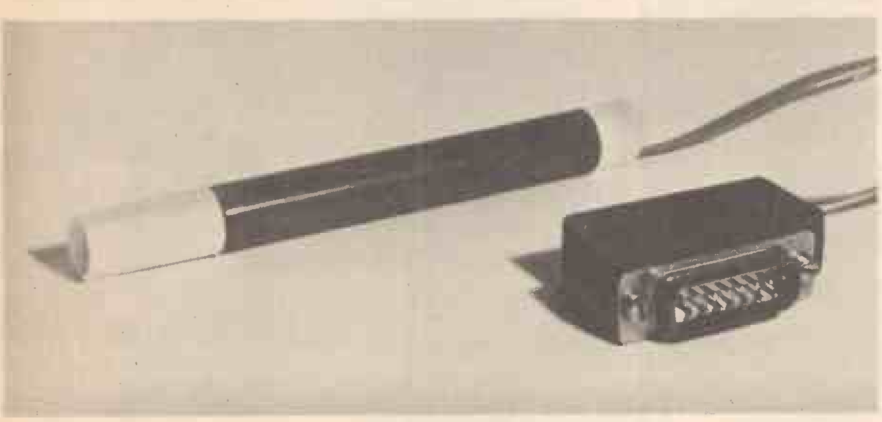


Fig. 3. Construction of the Light Pen inside the pen case.



Constructed unit ready to mount in the case.



Completed Light Pen showing connector.

circuit is concerned is that the response speed of the phototransistor is improved by biasing it into conduction, and by applying a negative feedback to the base. This is achieved by TR1, R1, R2 and R3.

The circuit is constructed on a very small piece of Veroboard (Fig. 2) so that it can be housed in a pen casing of about 7·5mm internal diameter. Construction, although a little fiddly, should present no problems —ensure all components are as close to the board as possible so that it will fit inside the pen used as a case.

After completion, try the light pen out with one of the demonstration programs. Ideally, the pen should only work within 3cm of a white screen, though this is dependent on the brightness. If it seems too insensitive try turning up the brightness control or increasing the value of R2. (This was not made variable as presets are relatively large.) If on the other hand it is too sensitive, decrease the value of R2.

If, when the pen is used with the drawing program, it gives a fluctuating pen position, it will be necessary to shorten the leads between the circuit board and the phototransistor (about 4cm max.). This is due to the signal from the phototransistor being reduced on the wire. In fact, the phototransistor can be soldered directly to the board if necessary.

ALTERNATIVE IDEAS

Some thought ought to be put towards choosing a cable for the light pen: Points to bear in mind are: flexibility, weight and size of the cable, as these affect the ease of use of the device. Ribbon cable was found to be ideal.

There are two main reasons for not putting a switch on the light pen. It is hard to obtain a switch small enough to fit neatly, and there are plenty of keys on the Beeb's keyboard anyway! If you do want to fit a switch, connect it from 0 volts to PB0 on the D connector (pin 13). For the computer to sense this make the program read ADVAL (0) AND3.

PROGRAMS

The programs listed are by no means the only ones (or even the best) for use with the light pen, but are mainly for testing. Also they reveal a simple machine code routine to read the pen position (BASIC is too slow). The first program is an example of a light pen driven menu. You can have many more options than those shown. The advantage then is that you do not have to use vast numbers of letters as options.

The second program is a simple drawing program. Select a colour by sweeping over

MENU PROGRAM

```
10 MODE4
20 xcorrect=-2:ycorrect=0  :REM (see text)
30 PROCcompile
40PROCmenu
50 END
60:
70 DEFPROCcompile
80 DIMP%100
90 [OPTO
100 .pen LDX#16:LDA#17:LDY#16
110 STX&FE00:LDX &FE01
120 STA&FE00:LDA &FE01
130 STY&FE00:CPX &FE01:BNE pen
140 RTS:]
150 ENDPROC
160:
170 DEFPROCpen
180 OS%=2820    :REM (see text)
190 T%=(USR(pen)AND&FFFF)-OS%
200 XP%=(T% MOD 40)+xcorrect
210 YP%=(T% DIV 40)+ycorrect
220 ENDPROC
230:
240DEFPROCmenu
250VDU23,254,255,255,255,255,255,255,255,255
260FOR1=0TO7:FORm=1TO3:P.TAB(0,1*4+m);CHR$254:CHR$254:CHR$254:NEXT,
270FOR1=0TO7:PRINTTAB(5,1*4+1);" Menu choice ";1:NEXT
280choice=0:REPEAT:PROCpen:IF XP%<4 AND XP%>-1 THEN choice=YP% DIV 4
290PRINTTAB(30,4);"Choice : ";choice:UNTIL0
300ENDPROC
```

DRAWING PROGRAM

```
 10 DIM P% 100
 20 [.pen LDX#16:LDA#17:LDY#16
 30 STX &FE00:LDX &FE01
 40 STA &FE00:LDA &FE01
 50 STY &FE00:CPX &FE01:BNE pen
 60 RTS:]
 70 MODE2:GCOL0,135:COLOUR135:CLS
 80 VDU5:VDU23,254;0;24;0;0;  REM see text
 90 PROCc:PROCgo:V%=0
100 REM DRAW LINE UNTIL PEN IS STATIONARY
110 REPEAT PROCPEN
120 IFX%>64 XX%=X%-CX% ELSE XX%=0
130 YY%=Y%-CY%
140 IF ABSXX%>600 THENXX%=0
150 CX%=CX%+XX%DIV4
160 CY%=CY%+YY%DIV4
170 MOVECX%-32,CY%:VDU254
180 IFABSXX%<20 AND ABSYY%<20 V%=V%+1 ELSE V%=0
190 UNTILV%>25
200 GOTO90
210 DEFPROCPEN O%=1543
220 T%=(USR(pen)AND&FFFF)-O%
230 X%=16*(T% MOD 80)
240 Y%=32*(32-T% DIV 80)
250 ENDPROC
260 DEFPROCgo:REM WAIT FOR PEN DOWN
270 REPEAT TS%=T%
280 T%=USR(pen) AND &FFFF
290 UNTILT%=TS%+80
300 PROCPEN
310 CX%=X%:CY%=Y%
320 ENDPROC
330 DEFPROCc
340 VDU4,23,255,&FCFC;&FCFC;&FCFC;&FCFC;23;8202;0;0;0;28,0,31,0,0
350 COLOUR135:CLS
360 FORT=128 TO134:COLOURT
370 VDU32,255,255,32
380 NEXT:*FX15,0
390 REPEAT PROCPEN:Z=INKEY(0):UNTIL(X%>16 AND X%<64)ORZ>0
400 IFZ=32 CLG:GOTO350
410 C=7-Y%DIV128
420 GCOL0,C
430 COLOURC+128:CLS
440 COLOUR128:CLS
450 VDU5:ENDPROC
```

it. Then start drawing. A space clears the screen in option mode. The character defined at line 80 defines the resolution of the line. (You could have this variable in option mode.) This program compensates for having no switch by waiting for the pen to stop moving (or be removed from screen).

In the menu program Xcorrect and Ycorrect are used because there are slight speed differences between display devices (i.e. a monitor may vary by a few positions to a u.h.f. TV).

OS% is very important. This is the timing delay for different modes. It should be:

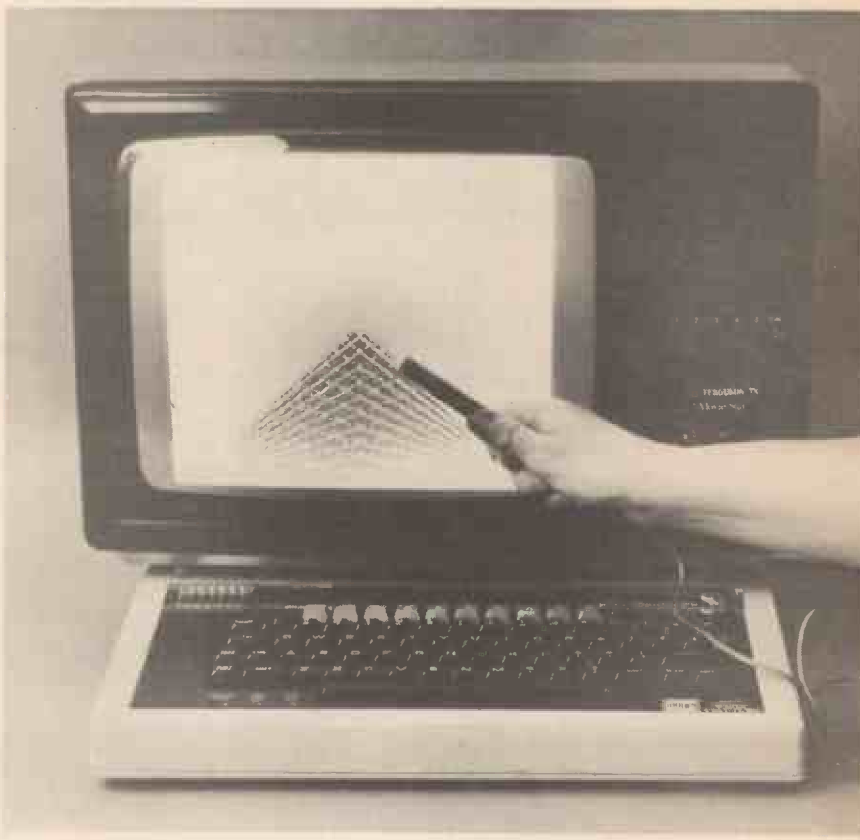
MODE	VALUE
0–2	1542
3	2054
4–5	2820
6	3076
7	10248

Also the number after MOD and DIV lines 200/210 may need to be changed to 80 if other modes are used.

FINAL NOTES

A few points to bear in mind:

1. The pen needs to detect light, so it works best on solid white. However, it does work well with bright colours, but not at all with black.
2. Text scrolling changes the mapping of the RAM to the screen, so either begin afresh with a CLS or MODE statement, or subtract the start address in R12/13 from the Light Pen registers R16/17. □



FOR YOUR ENTERTAINMENT

BY BARRY FOX

Radiation Scare

Every week now there is a new scare on the harmful radiation which is supposed to leak from computer terminals and VDUs. The fact that there is no factual evidence of leakage or damage doesn't seem to matter.

The debate is fuelled by firms which make a healthy profit out of selling expensive shields for whatever it is VDUs are currently supposed to be radiating. Like nuclear shelters, it's a good business to be in.

By the time anyone gets to test a nuclear shelter, the Sale of Goods Act will be somewhat academic. In any case those who have cause to complain that their shelter didn't work won't be around long enough to prove their complaint. With VDUs there can never be conclusive proof that something dangerous isn't leaking silent and undetected from the screen or chassis.

The latest scare is on the adverse effects of magnetic radiation. Common sense tells that the field leakages can't be very strong or it would wipe the magnetic discs being used to store data. But when VDU scare stories are involved, common sense seldom enters the picture. What might reassure scared users, however, is the reminder that exactly ten years ago Japanese company TDK was selling magnetic radiation as a *cure* for aches, pains and ailments.

Magnetic Syndrome

With Japanese government approval, TDK and the Japan Medical Journal published the results of research at the Isuzu hospital in Tokyo, and the Tokyo University medical faculty. The researchers concluded that magnetism is good for humans because the earth's magnetic field is decreasing at a rate of 0·05 per cent per year. This creates a "magnetic field deficiency syndrome".

Doctors hung powerful cobalt magnets round the necks of patients suffering from shoulder stiffness, lumbago, constipation, insomnia, dizziness and chest pains. A similar number wore dummy necklaces. More people wearing magnets felt better than those with dummies.

TDK sold magnetic necklaces in Britain which for £18 each, were claimed to help rheumatic pains and muscular stiffness. The Medical Research Council warned that magnetic necklaces should be treated with the same suspicion as copper bracelets. Nevertheless several thousand people bought TDK's magnets.

The necklaces were being sold by an agent, not TDK's own branch company in Britain. The adverts disappeared and TDK UK never sold the gismos.

I always had the sneaking feeling that TDK in Japan was simply looking for a convenient way to flog off some surplus magnets. But recently in the Far East I noticed that some pharmacists now sell magnetic sticking plasters. These are claimed to relieve pains in much the same way as the TDK necklaces. Perhaps in due course computer shops will be selling VDUs as a health aid.

Health and Safety

Meanwhile, if anyone is still worried and wants some reassurance, I suggest reading a new pamphlet published by the Health and Safety Executive *"Working with VDUs"*. It's free from area offices of the HSE (check in your phone book) or from the HSE's Head Office at Regina House, 259–269 Old Marylebone Road, London NW1 5RR.

The pamphlet also contains some useful advice on eyestrain, epilepsy and skin rash—all of which, and much more, are blamed on VDUs. Sometimes the blame is justified, but modifying the work environment and length of time spent in front of a screen will often cure the problem.

Portable Control

The latest portable stereo from Aiwa has an interesting electronic feature. An optional miniature remote control keyboard can be plugged into one of the two headphone sockets. It starts and stops the music tape, re-winds and runs the tape fast forward. The way this works gives an interesting insight into the amount of technology which is now packed into tiny portable stereo cassette players.

The headphone socket has 3V d.c. across its pins. The headphones, being responsive to a.c. audio only, ignore this d.c. bias.

The remote control contains a network of miniature resistors which are bridged by the push-button controls. When the play button is pressed the 3V supply is dropped by 470 ohms to 1·6V; in re-wind it is dropped by 390 ohms to 2V; fast forward drops it through 330 ohms to 2·3V; and "stop" drops it through 270 ohms to 2·5V.

Inside the player main body comparators sense the d.c. voltages coming in from the remote control and trigger logic chips which control the motor drive. The control panel on the main unit works in exactly the same way, being wired in parallel with the remote control.

Check List

Muddled over monitors? If you want to try using a video monitor with a computer you face all kinds of problems over matching the video signals and making the right connections. Philips has now put together an information pack on "personal computer monitors". It includes a neat check list on which monitor works with which computer and what lead is needed to make the connection.

There is a useful list of firms which supply the monitors and leads; also a hot line for technical information. Write to *Philips, PO Box 298, City House, 420–430 London Road, Croydon.*

But be patient, mine took far too long to come through. If I'd been in need of a monitor I would surely have bought one before hearing from Philips.

Numbers Game

Digits can be very confusing to non-mathematical mortals like me. The same words, kilo and mega, can mean two quite different things, depending on who uses them.

In communications technology kilo means what you expect it to mean, a thousand (1,000) and likewise mega means a million (1,000,000). But in computer technology kilo means 2^{10} or 1024 and mega means 2^{20} or 1048576. As the borderlines between communications and computer technology blur this can cause all kinds of confusion. Incidentally, when a Smart Alec firm advertises a job quoting a salary as £8K, the chances are they mean £8,000, not £8192!

For telecommunications, audio and video digitisation, kilo and mega have their pre-computer meaning. For instance, when British Telecom converts a telephone channel to digital code, it is sampled at 8kHz, which is a rate of 8,000 samples a second. Each sample is then described by an 8-bit word, to give a data stream of 64,000 bits per second.

When BT multiplexes 32 of these channels together as a single bit stream running down a single cable, the result is a data rate of 2,048,000 bits per second. Telecom's engineers refer to these as 64Kbit/second and 2Mbit/second streams. They are right, but it's easy to get muddled.

Suppose that these data streams are to be stored in digital memory. The terms mega and kilo now take on their other meanings. A 64 kilobit block of data is actually 65536 bits (64 × 1024 bits). Likewise a 2 megabit block is really 2097152 bits (2 × 1048576).

Perhaps it is fortunate that the number of bits of data which can be stored in a kilobit memory is greater than the number of bits which arrive in a kilobit stream. Imagine what a muddle it would be if there were more bits in a kilobit stream than there are bit spaces in a kilobit memory.

Speaking to MACHINES

Tom Ivall

AUTOMATIC speech recognisers provide an alternative way of communicating with machines when the hands are too busy with other tasks to allow manual operation of controls or keyboards. You simply speak your information and the recogniser translates it either into alpha-numeric text form or into command/interrogation signals.

This new kind of man-machine interface is already helping disabled people by providing voice control of domestic equipment. But it will probably find its widest use in factory automation. The drive to improve labour productivity by automation is steadily reducing the numbers of workers needed to operate industrial plants. Those who remain tend to be more fully occupied than in the past. For example, in certain jobs not suitable for mechanisation —such as handling and examining meat carcases or inspecting and sorting fragile objects—the operator's hands and eyes are fully engaged, but he is still required to enter information about the items into data collection terminals.

A similar problem is developing with military machinery. In a modern fighter aircraft, for example, the number of systems with controls and indicators requiring some degree of attention and often quick response from the pilot has multiplied enormously in recent years. Up to 2000 controls and indicators in a cockpit is not unusual.

One answer to this over-loading of human sensory and effector nerve pathways has been to turn to the medium of sound. Hand and eye can be supplemented by speech and hearing. This has been understood for some time but only recently has speech technology research and development (R&D) started to concentrate on specific projects. Voice-input/voice-output for computers and other systems is an important part of R&D programmes such as the Alvey project in the UK, the Japanese national plan to produce fifth-generation computers, and similar initiatives in the USA, France, Germany and other industrialised countries.

Not surprisingly, voice output has been the first to arrive on the scene. It is very much easier to achieve. Among speech technology researchers there is a saying that, if speech synthesis is like squeezing toothpaste out of a tube, speech recognition is like trying to get it back again through the same nozzle!

FUNDAMENTAL PROBLEMS OF RECOGNITION

The main reason for this difficulty is the tremendous variability of natural human speech. In speech synthesis the sounds available and the ways they are assembled are entirely under the control of the system designer. In speech recognition, the sounds uttered are neither standardised nor precisely controlled as time/amplitude/frequency patterns. Even within a given language, human speech can vary according to anatomy, age, sex, regional or class accent, ethnic origin, health, mental or emotional state, degree of fatigue, mannerisms such as drawling or clipped delivery and a whole host of those subtle, individual characteristics which distinguish one person's voice from another's.

And even the same person when asked to utter a standardised phrase over and over again will do this at different speeds.

There is also the big problem of ambiguity, resulting from the same sounds having different meanings. First there are the simple homophones like "to", "too" and "two". Then we have complete phrases which sound almost identical but mean different things, like "A tax on shipping" and "Attacks on shipping".

Nevertheless, automatic speech recognisers are a practical reality. They range from large research machines through ready-to-use commercial units to built-in systems in personal computers. They take the form of stand-alone recognisers in cabinets, or p.c. board products which can be incorporated in other electronic equipment, or just software which can be run on general-purpose computers or microprocessors. There are also speech recognition i.c.s available which perform most of the difficult signal processing tasks and allow electronics manufacturers and experimenters to design their own systems.

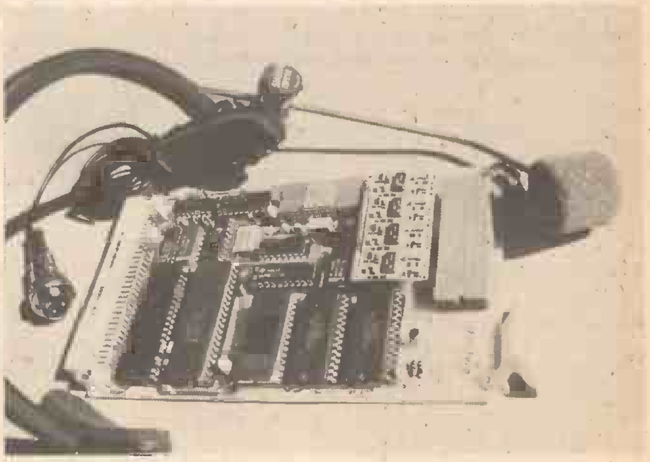
The fact that these speech recognition products are available at all is really due to the overall design strategy: don't ask the recogniser to do too much. By deliberately imposing constraints on the user it is possible to restrict the performance requirements and thus reduce the complexity of the product so that it can be manufactured economically and sold at an acceptable price.

For example, it helps considerably to limit the number of words that have to be recognised, the 'vocabulary', to something below about a hundred at one time. It also helps if the user has to make pauses between words in a phrase (an unnatural way of speaking) so that the recogniser is not required to distinguish words from each other in a continuous stream of speech—a most difficult technical problem. A recogniser assisted in this way is classed as an 'isolated-word' type, in contrast to a 'connected-word' type.

A further constraint that simplifies design and manufacture is when the recogniser is restricted to use by one particular speaker at a time—say for a working day or a shift. The recogniser is, in fact, 'trained' by the user to respond to words or phrases spoken in his or her particular voice alone (see later). Such recognisers are classed as 'speaker-dependent' in contrast to 'speaker-independent' types.

But these deliberate limitations are not necessarily to be regarded as drawbacks. In many applications the voice-input requirement is specialised and restricted. It would be a waste of technical resources and money to use a speech recogniser of greater capability than that required for the job. Thus in practice it becomes possible to match a recogniser of limited performance to a voice-input task of restricted range.

Speech recogniser board with headset microphone (top) allowing operator freedom of movement. This RM150A speaker-dependent recogniser made by Vecsys allows a vocabulary up to 112 words, uses 8-channel frequency analysis, an Intel 8088 microprocessor, a 16K byte RAM for reference patterns, and has both serial and parallel interfaces. The unit will recognise isolated words 300ms to 2s long and has a response time of 300ms.



KINDS OF RECOGNISERS

These factors have resulted in a relatively large number of limited-performance, low-price speech recognisers and a very small number of high-performance systems with correspondingly high prices. The first group are largely designed as voice data entry devices for computers or other digital systems. They are in fact computer peripherals, equivalent to other data entry devices such as keyboards and bar-code readers and give similar outputs in standard data codes.

The high performance recognisers are still largely confined to the laboratory. In contrast to voice data entry devices, they are intended for recognising relatively long sequences of words, like sentences, spoken continuously in a natural manner. Classed as 'speech-to-text' systems, they are mainly designed for office automation. An effective speech-operated typewriter, for example, would greatly reduce the number of shorthand and audio typists needed in business offices.

But the R&D here has a long way to go, and the first speech-to-text recognisers will probably only be capable of producing rough drafts of letters, memoranda, reports etc., which will have to be corrected and edited. The technical problems here are in coping with a large vocabulary of several thousand words, connected speech and ambiguities of meaning resulting from confusable utterances.

HOW SPEECH RECOGNISERS WORK

Confining ourselves to the simpler voice data entry systems, these speech recognisers work on whole words, spoken either with pauses between them or in a continuous stream. The basic principle is very simple—that of acoustic pattern matching. This does not depend on any explicit theory of speech and would work equally well for recognising other kinds of sounds. When a word is spoken the resulting acoustic pattern is compared with a whole set of word acoustic patterns, or 'reference patterns' already stored in the recogniser. When an input acoustic pattern is found to match a stored reference pattern to a pre-determined level of accuracy, the input pattern is accepted as valid and thereby 'recognised'.

This successful matching of patterns causes the recogniser to send out a sequence of characters, in a standard data code, corresponding to the spoken word. As already mentioned, this output data can be either the word spelled out as text or the code for a command/interrogation signal.

Fig. 1 shows this general principle. The user speaks into a microphone and the resulting audio signal passes into an acoustic analysis section of the recogniser. This extracts 'features' of the signal from the basic amplitude, frequency and time information it contains, to form a pattern in time. The pattern could simply be the envelope of the audio waveform, but in most speech recognisers of this type it is a frequency spectrum analysis showing the distribution of signal power at different frequencies and at successive instants of time as the word is being uttered.

Fig. 2 shows a recording in three dimensions of a spectral analysis of the audio signal resulting from the spoken sentence. "The girl was watching the fat men in the park." The horizontal axis represents time throughout the utterance, the vertical axis represents frequency, while the density or degree of blackness of the recording is proportional to signal power.

Here the successive words can be seen fairly clearly as 'clumps', across which run various black bands. These bands show concentrations of power at particular frequencies, mainly during the vowels, and are called formants. In some recognisers these formants are extracted as the acoustic 'features' mentioned above.

Many commercial recognisers perform this kind of spectral analysis by applying the input audio signal to a bank of bandpass filters. Each filter selects the power present, at successive instants, within the frequency band it covers. These filter banks provide anything from 8 to 32 output frequency channels. Sometimes they are constructed from discrete components, but integrated banks are available. Interstate Electronics, for example, offers a 28-pin i.c., the ASA-16, which provides a bank of 16 analogue bandpass filters integrated in NMOS technology. These active filters, formed from op-amps and capacitors, cover a total voice frequency range of 200Hz to 7kHz. In other systems digital bandpass filtering is used.

In Fig. 1 the information from the acoustic analysis section emerges as digital data. It then passes to a pattern classification section. Here the digital input patterns are compared with similar digital reference patterns, held in a random access memory (RAM), by a pattern matching process as outlined above.

Also stored in the RAM are strings of digitally encoded alphanumeric characters, each string being associated with a particular acoustic reference pattern. These character strings, which can be the text versions of the acoustic word patterns, are prepared in advance, off-line, by the user, working with the keyboard and screen of a computer terminal or personal computer. They are internally stored, usually in a magnetic disk memory, then down-loaded into the RAM of the recogniser, thus forming its 'vocabulary'.

Once a spoken word is recognised by pattern matching, the associated character string appears at the output and passes into a data communications interface, such as an RS-232C serial interface or an 8-bit parallel bus.

GENERATING REFERENCE PATTERNS

But how do the acoustic reference patterns get into the RAM in the first place? There are two methods in use. In speaker-independent recognisers the acoustic patterns are put there by the manufacturer of the product. This means, of course, that the operational flexibility of the recogniser is severely limited. First of all it is confined to a single natural language, so the product will only be usable in countries where this language is spoken. Then the manufacturer must provide an 'average' voice, perhaps a composite formed from several individuals. This means that any user's voice must always be an approximation to the reference voice and the recogniser will not work very accurately on users' voices which depart a long way from this average.

Furthermore the vocabulary must be strictly limited to a small number of standard words which have acoustic patterns markedly different from each other (e.g. "yes" and "no") whoever speaks them. Otherwise, the larger the vocabulary the greater the probability of error in the recogniser's pattern matching process.

For example, the Scott Instruments VET-232SD voice data entry terminal has a limited speaker-independent option of twelve standard words—"yes", "no" and the decimal digits "zero" to "nine"—or a custom-designed vocabulary of similar size. In its normal, speaker-dependent mode of operation, though, this product allows the much larger vocabulary of 200 words.

Speaker-dependent recognisers are, in fact, much more widely used. They can be 'trained' to recognise the speech of any user, regardless of language and all other individual characteristics. Training simply consists of speaking the complete set of words required for the vocabulary. Their audio signals are acoustically analysed as described above and the resulting digital acoustic patterns are fed straight into the RAM. This is indicated by the switch in Fig. 1, but in fact the training is performed with the aid of a program run on a host computer to which the recogniser is interfaced. The training program is arranged so that the user speaks each word of the already loaded text vocabulary when he is prompted by that text word appearing on the computer/terminal screen.

Typically the RAM might store up to 100 vocabulary words—acoustic reference patterns and their corresponding text character strings—but this is only the 'active' or working vocabulary. A very much larger total vocabulary can be held in reserve in, say, a disk

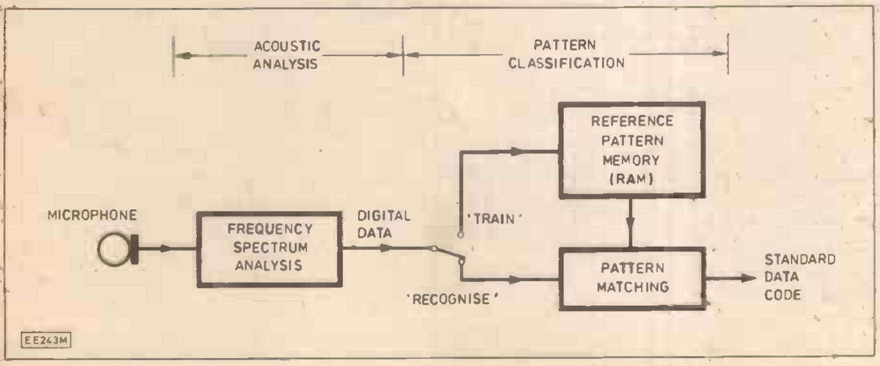


Fig. 1. Basic principle of pattern matching speech recogniser. The change-over switch represents a software program instruction for changing the mode of operation. With speaker-independent recognisers there is no 'train' mode.

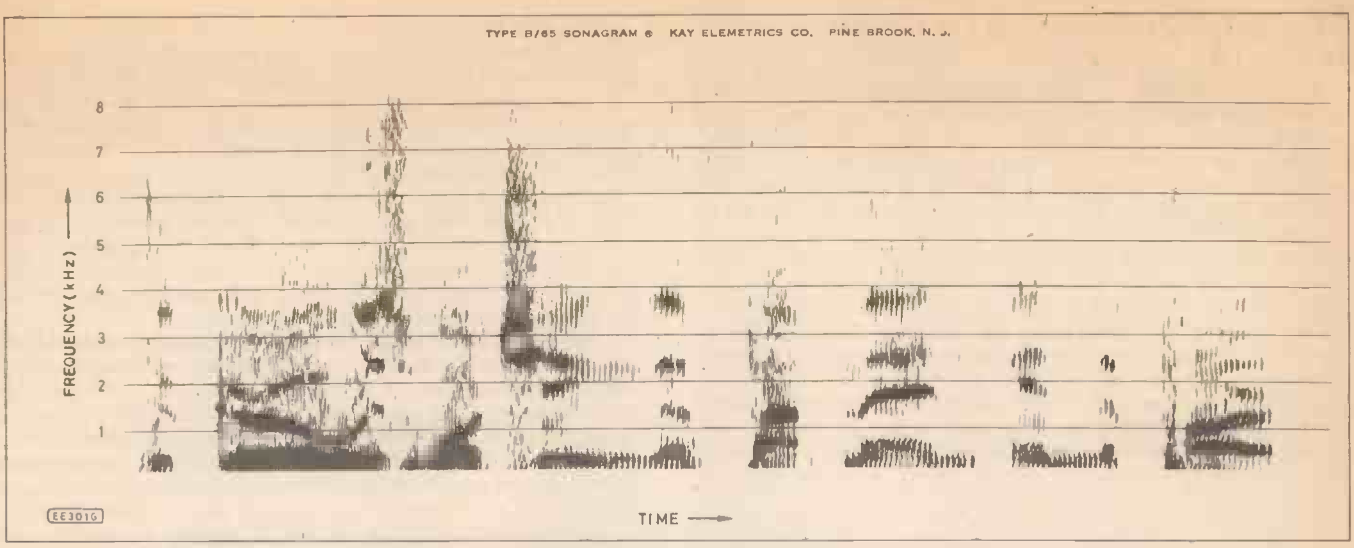


Fig. 2. Frequency spectrum analysis recording of the spoken phrase "The girl was watching the fat men in the park". Recording density is proportional to signal power. (Analysis kindly made by Wessex Electronics Ltd, using Model 7800 Digital Sona-Graph from Kay Electronics Corp. of Pine Brook, NJ, USA.)

memory, and subsets of this can be up-loaded and down-loaded between this data file and the recogniser's RAM. A typical RAM size for the activity vocabulary is 16Kbyte.

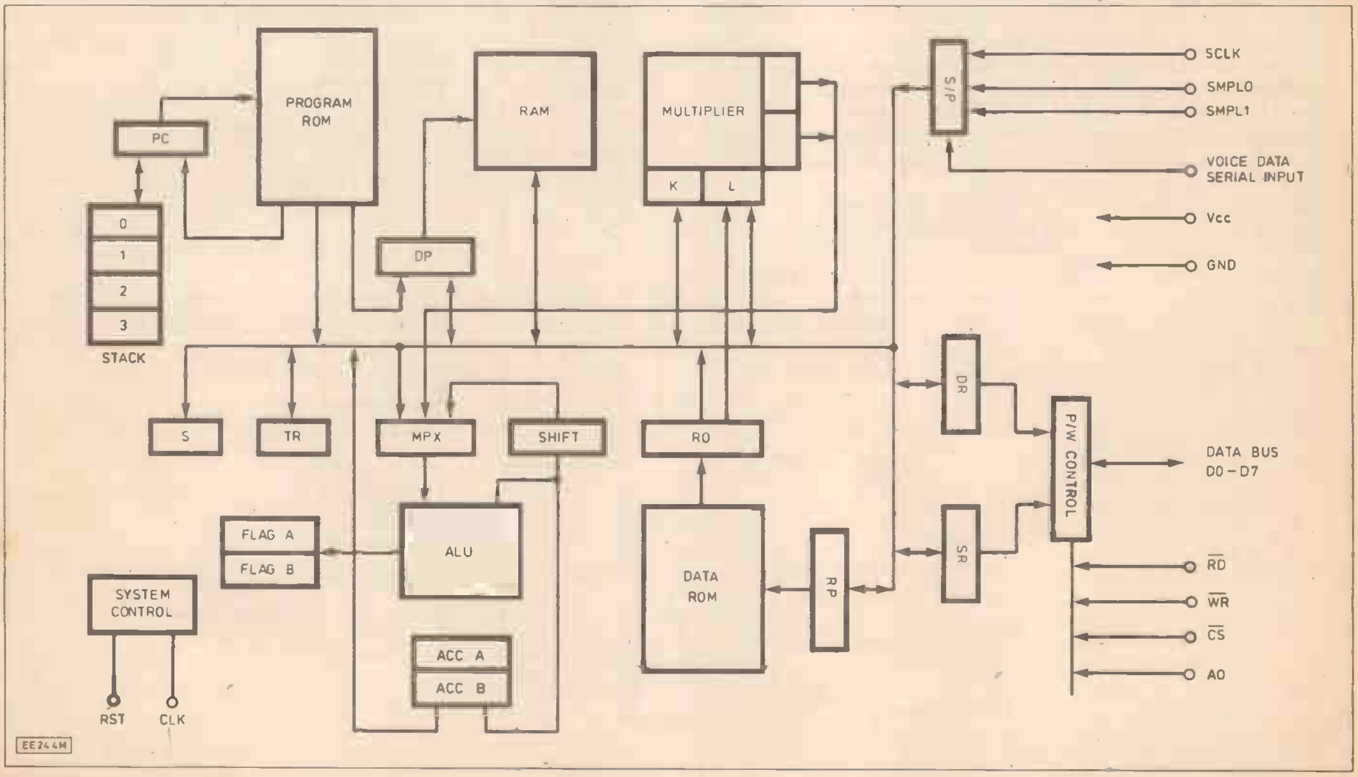
PATTERN MATCHING TECHNIQUE

In many data-entry speech recognisers the pattern matching process shown as one block in Fig. 1 is performed by a digital signal processing i.c. or chip set. This can be a standard microprocessor like the 16-bit Intel 80186, a signal processing chip like the 32-bit Texas Instruments TMS320, or an entirely specialised speech recognition set of ICs like the NEC three-chip set (MC4760, µPD7761, µPD7762) or the Interstate VRC100-2A two chip set.

The digital processor is operated in accordance with a pattern matching algorithm provided as a firmware program in a read-only memory (ROM or EPROM). It carries out its processing in response to instructions received from a host computer—including, for example, one instruction to 'train', another instruction to 'recognise.' The instruction set also controls and co-ordinates the actions of other parts of the system such as the frequency spectrum analyser and the loading of the reference pattern RAM in Fig. 1.

A common pattern matching algorithm is based on the principle of breaking down both the reference and the input acoustic patterns into elements called 'frames' and comparing these, frame by frame, to measure the degree of matching. Each frame is, in fact, a short-term spectral analysis at a particular instant of time during the utterance of a word or phrase. Looking at Fig. 2, these can be regarded as taking place at a succession of discrete points along the time axis. If the individual input frames match, to a pre-determined acceptance value, the individual reference frames, then the two whole acoustic patterns for a word are acceptably matched as well.

Fig. 3. Time normalisation by dynamic programming is performed by the internal functions shown here of the NEC speech recognition processor chip µPD7761D, part of a three-chip set. (ALU = arithmetic logic unit; DR = data register; SR = status register; A_0 selects between DR and SR; PC = program counter; DORQ = data output request; SCLK = serial clock; SMPL (0 and 1) = sampling clock inputs for A/D strobe; RST = reset signal.)



TIME NORMALISATION IN PATTERN MATCHING

There is, however, a problem about timing. The user will probably not speak the input word at exactly the same speed as he spoke the reference word during the training routine. So there is no guarantee that the input frames will in fact be compared with their correct reference frames and effective matching may not be achieved. This problem is overcome in the algorithm by computationally distorting the time scale of the input pattern so that it corresponds to the time scale of the reference pattern (or vice-versa, giving the same result).

Simple time compression or expansion over the whole word pattern does help. But this is not sufficient because timing variations between the input frames and the reference frames actually occur within the word. In short, there is a non-linear relationship between the two time scales. This can only be corrected by dynamically distorting the time scale of the input pattern of frames, during the utterance of the input word, so that the two sets of frames line up with each other. The process is called 'dynamic time warping'.

To achieve it the speech technologists have brought into play an established mathematical technique called dynamic programming. It is used generally to obtain optimum performance in time-varying processes which are subject to unpredictable, non-linear disturbances (e.g. ship steering on an optimum course; inventory control in a factory).

Fig. 3 shows an NEC chip that matches patterns by dynamic programming. It works in conjunction with a control chip and an analogue interface chip, and also performs, separately, the initial process of frequency spectrum analysis by digital filtering. First the chip is programmed into a 'spectral analysis' mode and receives at its digital voice input the serial output of an 8-bit A/D converter integrated in the analogue interface chip.

Once the spectral analysis is calculated the result is output in parallel bytes of data through the data bus D_0–D_7 to the control chip. Next the control chip programs the Fig. 3 processor into a 'pattern matching' mode. The chip then receives the input and reference voice patterns from the control chip and performs the dynamic programming algorithm.

Fig. 4 shows diagrammatically how this dynamic programming algorithm is carried out. The two patterns to be compared, input (I) and reference (R), are shown in relation to each other as sequences of frames (i_1, i_2 . . . etc. and r_1, r_2 . . . etc.). If the I and R patterns were identical the curve relating them would be a straight line (i = r). In reality the timing non-linearities make the curve a crooked one, as shown, with its sequence of points (p_1, p_2 . . . etc.) indicating the timing differences between the two patterns.

This curve is a function which maps the I-pattern time scale onto the R-pattern time scale—a 'time warping' function. The dynamic programming algorithm finds the optimum path for the curve from the many paths possible in this step-by-step process—that is, the best correspondence between the time scales of the I and R patterns.

It does this by computing a 'score' which is the sum of the frame dissimilarities, or 'distances', for the best way of aligning a given number of input (i) frames with a given number of reference (r) frames. This is computed for all the reference patterns, and the score giving the smallest sum is defined as the optimum path and the best match. This smallest sum is the residual 'distance' value—what remains after the timing differences between the two patterns have been eliminated.

This same dynamic programming principle can be extended from single word pattern matching to the matching of whole sequences of connected words as in continuous speech. It is used in this way, for example, in Logica's Logos 2 recogniser and NEC's DP-200 model.

The result of matching is either acceptance or rejection of a spoken word, depending on whether the dynamic programming 'score' exceeds or falls below a chosen threshold value (a decimal number on a scale) programmed in by the user. In Fig. 3 this result is output through the data bus to the control chip. If accepted, and therefore 'recognised', it then passes via a data communications interface to the host computer.

Fig. 5 expands the general principle in Fig. 1 by showing how a two-chip set, the Interstate VRC100-2A, is used in a complete speech recognition system. The EPROM firmware in this chip set provides 17 instructions for the user and the system will recognise up to 100 words, or 200 words with additional RAM capacity.

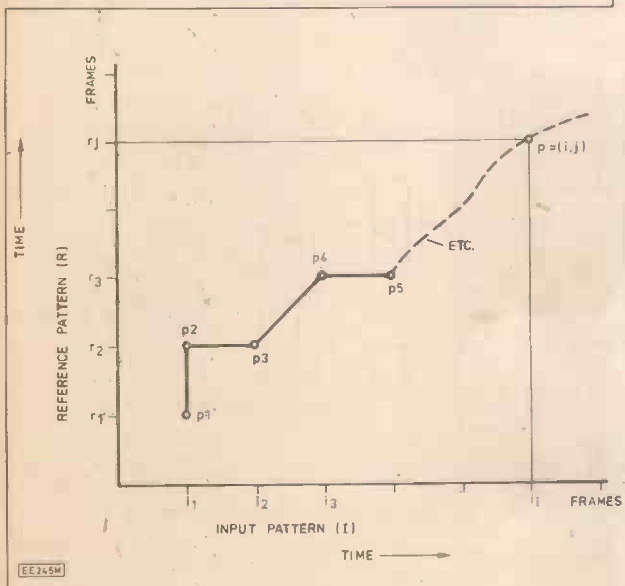
SYNTAX CONTROL

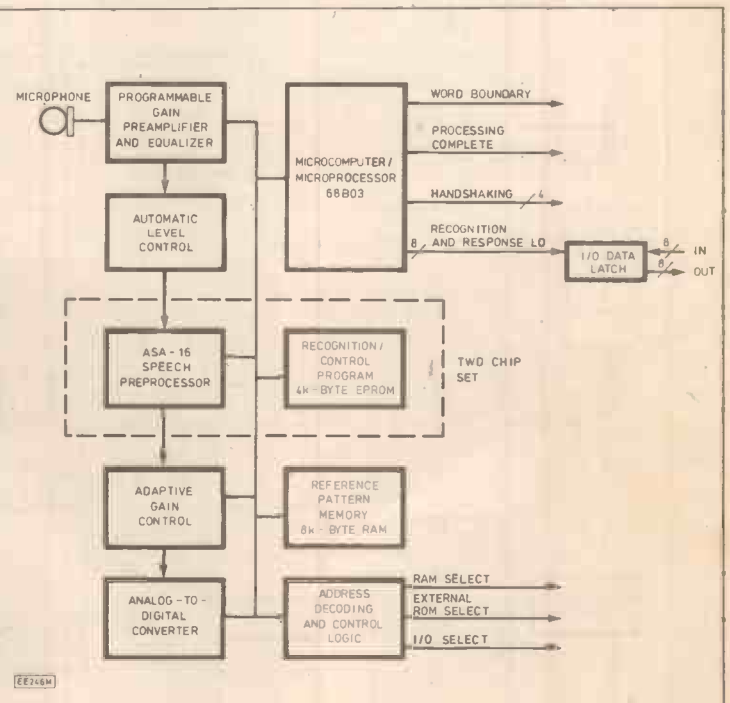
Most of these whole-word pattern matching recognisers also offer a programming facility called 'syntax control' which allows the user to specify a permitted order for any sequence of spoken words to be recognised. This can improve recognition accuracy by eliminating spurious word orders—resulting from poor matching—which do not make sense in the application. A commercial advantage of this control method is that it reduces the number of word choices that have to be made in classifying a sequence of words. This in turn reduces the amount of computation required, by restricting the calculation of pattern matching 'scores' to only those word sequences allowed by the syntax.

This syntax control works on a 'tree' or branching principle. At each branching point you can choose one path or another one—each path representing a particular word which can be selected to follow the already chosen word preceding that branching point. Thus the number of branching points available to the user determines the extent and flexibility of this word order control. It varies with products from about 10 to 250 branching points. □

Fig. 4 (below). Graph showing principle of time normalisation between input pattern (I) and reference pattern (R) by dynamic programming. Graph line shows 'distances' between input frames (i) and reference frames (r).

Fig. 5 (right). Use of Interstate Electronics two-chip set (ASA-16 and 100-2A, in broken-line box) in a complete speech recognition system. The reference pattern RAM is expandable to 16K bytes to allow a vocabulary of 200 words.





TEACH-IN 86

PART 9 · Michael Tooley BA David Whitfield MA MSc C Eng MIEE

THIS final part of our *"Teach In"* series is devoted to some applications of digital circuits. In particular, we shall be introducing an extremely useful device; the 555 timer.

COMBINATIONAL LOGIC

Last month we introduced four basic TTL gates, now let's consider a practical application of these gates. Suppose, for example, that we have been given the task of designing an automatic lighting system for an office car park. We would first examine the criteria for switching the lights "on", which would be something like this:

Monday to Friday

8.00am to 8.00pm—Lights "on" whenever the amount of daylight falls below a certain value. Otherwise lights "off".

8.00pm to 8.00am—Lights "off" regardless of the light level.

Saturday and Sunday

Any time—Lights "off".

We would do well to express these conditions in the form of a truth table, as shown in Table 9.1. This will be invaluable when we come to design the logic and will also help us to avoid any states which we may otherwise forget to allow for.

Table 9.1

Day of the week	Time of day	Light level	Car park light
weekend	night	light	off
weekend	night	dark	off
weekend	day	light	off
weekend	day	dark	off
weekday	night	light	off
weekday	night	dark	off
weekday	day	light	off
weekday	day	dark	on

In order to correctly control the car park lights we need to be aware of just three things:

(a) Day of the week; is it a weekday or is it a weekend?
(b) Time of day; is it day or night?
(c) Light level; is it dark or is it light?

Each of these parameters can be considered to be an input to our logic system (shown in outline form in Fig. 9.1). The light level input can be derived from an appropriate transducer fitted with signal conditioning to provide us with a digital output from what is essentially an analogue input.

In addition, we would almost certainly wish to incorporate some means of adjusting the light threshold. A suitable circuit could be based on a light dependent resistor and an operational amplifier comparator. The weekday/weekend and time of day inputs can be derived from a conventional digital clock. In this case the outputs would already exist in digital form.

The next step involves assigning a logic level to each of the three input signals so that we can determine the logical function of our gate arrangement. In practice the logic levels would depend upon those provided by our digital clock and transducer signal conditioning and this might take the following form:

(a) Day of the week: 1=weekday, 0=weekend.
(b) Time of day: 1=day, 0=night.
(c) Light level: 1=dark, 0=light.

We are now in a position to draw a truth table showing all of the possible input conditions together with the resulting output (the logic for which is

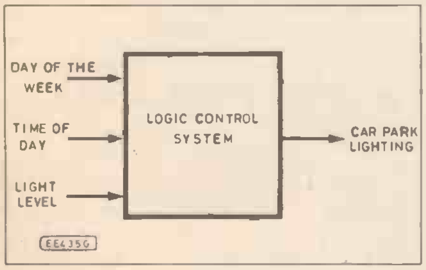


Fig. 9.1. Outline logic for the car park lighting control system.

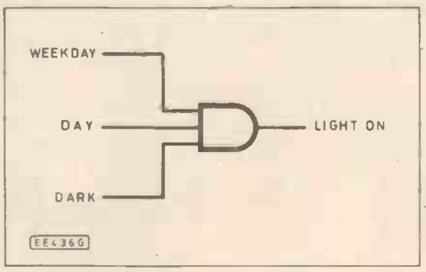


Fig. 9.2. Logic circuit for the car park lighting control system.

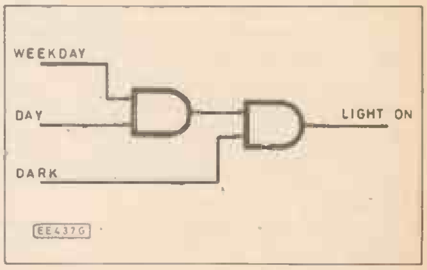


Fig. 9.3. Practical realisation of Fig. 9.2 using two two-input AND gates.

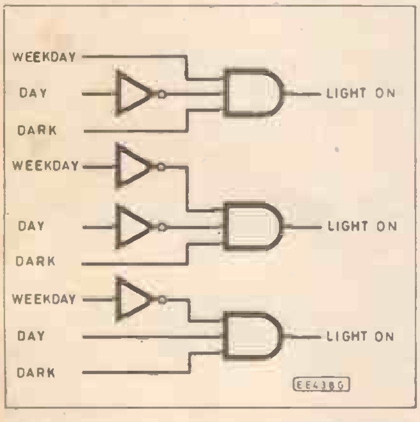


Fig. 9.4. Partial solution of the modified car park lighting control system.

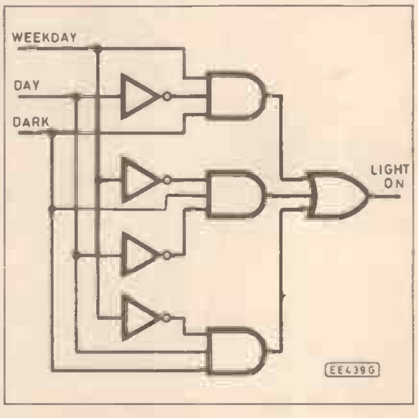


Fig. 9.5. Final solution for the modified car park lighting control system.

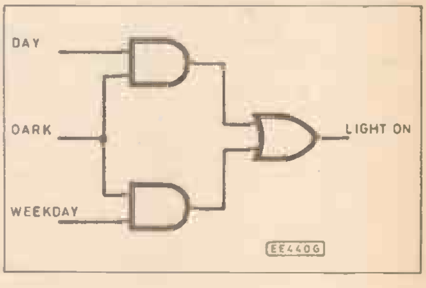


Fig. 9.6. More elegant alternative to Fig. 9.5.

Table 9.2

Day of the week	Time of day	Light level	Car park light
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

assumed to be: 1=light "on", 0=light "off"). This truth table is shown in Table 9.2 and shows that the required logical function is nothing more than AND. Hence, to control the car park lights we only need to combine our input signals using a three-input AND gate to provide a signal for switching the car park lights "on" and "off".

The logic circuit shown in Fig. 9.2 should solve the problem nicely provided, of course, that we have a three-input AND gate handy! Such things do exist but suppose that we only have access to the simple two-input gates described last month. How then could we solve the problem?

The arrangement shown in Fig. 9.3 could come to our aid. Here we are using two two-input AND gates (this could be realised using just ONE i.c. package and still leave two gates unused) to simulate the action of a three-input AND gate—simple really!

Now, let's suppose that business is booming and we need to allow for a night shift during weekdays and work during the days at weekends. We would need to amend Tables 9.1 and 9.2 so that they look like Tables 9.3 and 9.4. These are obviously a little more complex than before since there are now three input conditions in which we require a logic 1 output. The car park lights should come "on" whenever any one of these conditions is satisfied but go "off" for all other conditions. We could simply OR the three conditions together.

Let's attempt to put this into words before we develop the logic:

Car park lights "on" whenever:
weekend **AND** daytime **AND** dark.
OR weekday **AND** daytime **AND** dark.
OR weekday **AND** night-time **AND** dark.

The words AND and OR are very important since they provide us with some good clues as to the logic that we will require. Let's solve each condition separately (see Fig. 9.4) and then OR the results together (see Fig. 9.5).

This arrangement works but it is certainly not the most elegant solution. Fig. 9.6 shows another, arguably more elegant possibility. Whilst there is a strong case for designing logic arrangements so that they use the minimum number of gates, the solution one finally adopts in practice is usually conditioned by the logic gates which one has available or which would otherwise be redundant from the unused sections of i.c.'s within an existing logic system! In any event, the ultimate arbiter of whether a logic arrangement is any good is whether, or not, it actually works!

The subject of minimisation of logic gate arrangements is beyond the scope of this series. However, readers seeking further information should be aware that there are two methods which can be used for tackling this task; one is based on Boolean algebra whilst the other is based on Karnaugh maps. Many books on digital logic adequately describe both of these techniques.

BISTABLES

In any other than the most elementary of logic circuits, one sooner or later realises the need for a device which can remember a logic state in the form of a logic 1 or logic 0. Such a device should possess the ability to remember a transitory logical condition and thus it constitutes a simple form of electronic memory, the most fundamental form of which is the bistable. (The name simply indicates that the device has two stable states corresponding to outputs of either 1 or 0.)

Another word synonymous with bistable is "latch". To explain the significance of this term let us consider the difference between two commonly available types of switch; "momentary" and "latching".

A momentary switch is one in which the switch contacts make (or break if it is a normally closed rather than a normally open type) only when the switch is actually being operated. This is, for example, the case with a bell-push. We only want the bell to sound when the button is actually being pushed. It should not be possible for callers to walk away leaving the bell ringing!

A latching switch is one in which the contacts make (or changeover) whenever the switch is operated; the mechanical design of the switch ensures that it remains biased in that state until it is operated again. A word sometimes used to describe this action is "toggle". An example of a switch having a mechanical latching action is that normally associated with a room light. Once the switch is operated, the room light must stay "on" allowing one to move away from the switch without being plunged into darkness!

A SIMPLE BISTABLE LATCH

The simplest form of bistable arrangement uses nothing more than two inverters, as shown in Fig. 9.7. Readers should, by now, be very familiar with the way in which an inverter operates; a 1 input produces a 0 output, and vice versa.

The logical state of the outputs of the two gates in Fig. 9.7 must, therefore, always be complementary. If the first gate is producing a 1, the second gate must produce a 0. If the first gate produces a 0, this must result in a 1 from the second gate.

Table 9.3

Day of the week	Time of day	Light level	Car park light
weekend	night	light	off
weekend	night	dark	off
weekend	day	light	off
weekend	day	dark	on
weekday	night	light	off
weekday	night	dark	on
weekday	day	light	off
weekday	day	dark	on

Table 9.4

Day of the week	Time of day	Light level	Car park light
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

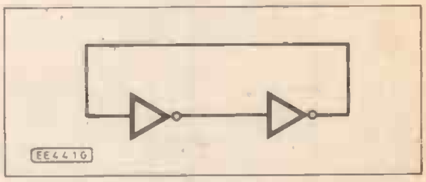


Fig. 9.7. Simple form of bistable using two inverters.

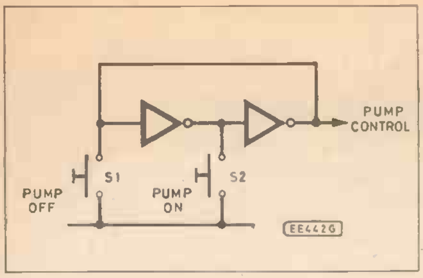


Fig. 9.8. Pump control system.

If we were to assemble such a circuit the state of its outputs would, initially at least, be indeterminate. It would be impossible to say which of the outputs would assume a logic 1 state and which would assume a logic 0 state.

Worse than that, there is no obvious method of changing the state other than by shorting one, or other, of the outputs to logic 0 in order to force the logical state at that particular point to become a 0. Such an arrangement is not considered good design practice but, don't worry, we shall show how this disadvantage can be overcome later.

The time has now come to introduce a practical example of the use of a bistable. Let's imagine that we require a logic system to control the operation of a pump. We wish to use two push-buttons to control the pump; one to switch it on (PUMP ON) and one to switch it off (PUMP OFF).

The arrangement shown in Fig. 9.8 shows how these switches can be added to the simple bistable latch of Fig. 9.7. We simply pull-down the input voltage of one, or other gate, to 0V momentarily whenever the appropriate switch is operated.

Note that, when the power is first applied, the output of Fig. 9.8 may be in either state. Disconnecting the power supply and then reconnecting it again may sometimes effect a change of state but this cannot be relied upon. It will, therefore, be necessary to re-set the bistable latch into the inactive condition by first pressing S1 (PUMP OFF) as soon as the supply has been connected. (On real logic systems there are, of course, quite simple methods of achieving this automatically!) When S2 (PUMP ON) is operated the output should go to logic 1 regardless of its earlier state. Furthermore, depressing S2 for a second time will have no further effect on the logical state of the circuit.

By now, the perceptive reader may have counted three quite different logical input conditions. These may be summarised briefly as:

(a) S1 "off" and S2 "off".
(b) S1 "on" momentarily whilst S2 remains "off".
(c) S2 "on" momentarily whilst S1 remains "off".

There is, however, one further possible input condition which we should consider. This occurs when S1 and S2 are both "on" and would arise if we were foolhardy enough to operate both push-buttons at the same time (i.e. operating PUMP ON and PUMP OFF simultaneously). Such a condition is clearly one which should, if at all possible, be forbidden!

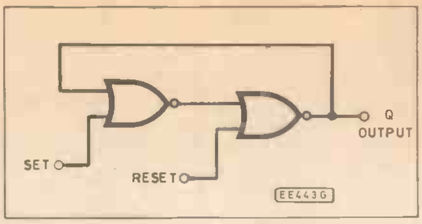


Fig. 9.9. RS bistable latch using two NOR gates.

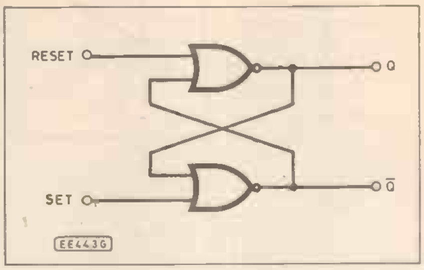


Fig. 9.10. Alternative form of Fig. 9.9.

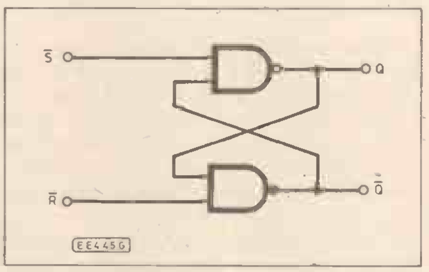


Fig. 9.11. RS bistable using two NAND gates.

AN IMPROVED BISTABLE LATCH

A much better solution to the problem of constructing a bistable is with the use of two two-input gates rather than inverters. Such an arrangement eliminates the need to short the gate outputs in order to effect a change of state. It should also be obvious that the gates we choose must be inverting types since a non-inverting gate will not produce the complementary state that we require in order to latch the bistable.

It thus remains to choose between two-input NOR or two-input NAND gates but, happily, we can use either and thus we shall describe bistable arrangements using both types. The bistable constructed from NOR gates is slightly easier to describe and so we shall start with this type.

Fig. 9.9 shows how a bistable can be constructed from two two-input NOR gates. We have labelled the inputs "SET" and "RESET". The reason for the choice of these terms is that a 1 on the SET input produces a 1 at the output. We would say that it "sets the output" (to logic 1). Conversely, a 1 on the RESET input produces a 0 at the output. It can thus be said to "reset the output" (to logic 0). The output is labelled "Q". There is no particular significance in the choice of this letter other than that it satisfies the convention adopted for bistable elements generally. Since the inputs are named SET and RESET, this simple form of bistable is called an "RS bistable".

Table 9.5

RESET	SET	Q
0	0	0
0	1	1
1	0	0

Table 9.6

RESET	SET	Q	$\overline{Q}$
0	0	0	1
0	1	1	0
1	0	0	1
1	1	0	0

We have already learned how useful truth tables can be for describing the logical function of a gate. Let's now take a look at a partial truth table for the RS bistable and which is shown in Table 9.5.

Another way of drawing the bistable arrangement using NOR gates is shown in Fig. 9.10. This symmetrical circuit shows clearly how the gate outputs are cross-coupled to the inputs. It also shows that we are only using one, of two, possible outputs. It would be a very simple matter to obtain a complementary, $\overline{Q}$, output from the gate which may be useful in a more complex logic system.

Unfortunately, our improved NOR gate bistable still has one shortcoming. We would normally expect the Q and $\overline{Q}$ outputs to be always complementary. What happens when both the SET and RESET inputs are simultaneously taken to logic 1? The answer, as you might have suspected, is that the arrangement behaves in an unpredictable manner (see Table 9.6) as the Q and $\overline{Q}$ outputs both go to logic 0!

We should clearly identify this as a "disallowed" input condition and, whilst not wishing to pretend that such a condition NEVER arises, we should take positive steps to ensure that it is unlikely to happen. At the very least, if it does occur, we should be aware and not place any reliance on the output!

RS BISTABLE USING NAND GATES

Simple RS-bistables can also be constructed using two-input NAND gates as shown in Fig. 9.11. The important difference between this arrangement and that of the NOR gate equivalent is that the SET and RESET inputs are logically inverted, i.e. they are active when they are at logic 0 rather than when they are at logic 1.

This is an important point and one which often confuses the newcomer. Such inputs are referred to as "active low" (on some logic diagrams a circle is used at the input of more complex logic gates to indicate this). However, we shall simply refer to them as (NOT SET), $\overline{S}$, and (NOT RESET), $\overline{R}$. If it is essential to have conventional SET and RESET inputs to the bistable it is, of course, a relatively simple matter to invert these signals prior to the bistable stage.

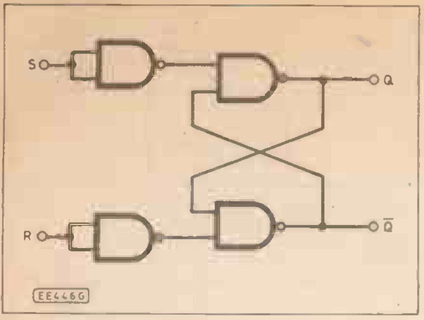


Fig. 9.12. NAND gate equivalent to Fig. 9.9.

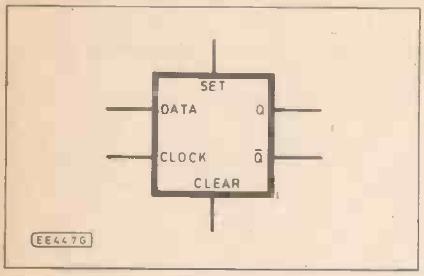


Fig. 9.13. Symbol for a D-type bistable.

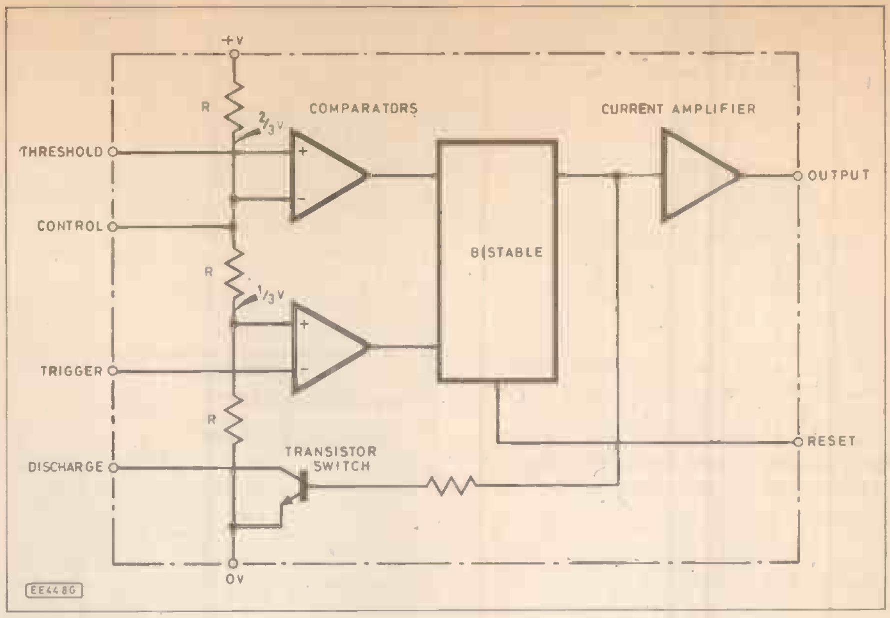


Fig. 9.14. Simplified internal arrangement of a 555 timer.

With a quad two-input NAND we could, for example, achieve this by bringing into service the remaining two unused gates in an arrangement like that shown in Fig. 9.12. The operation of the bistable is then identical to that of the NOR gated bistable which we met earlier.

CLOCKED BISTABLES

Whilst the simple RS bistable element is useful in a number of applications, it does have very severe disadvantages when several such stages are to be incorporated in a complex logic system. These problems arise from the way in which changes of state occur in the system. Earlier, we assumed that the RS bistable changed state immediately the correct SET and RESET inputs are received. At first this may sound quite acceptable, after all one of our chief aims with the design of electronic circuits is to produce the fastest possible speed of operation.

The difficulty with RS bistables is that such rapid changes are not very predictable. In many cases we have what is known as a "race condition" in which the logical output from a system may well be determined by the speed at which individual gates operate rather than the logical rules which they should obey.

What we really need is a system in which the changes occur in a controlled fashion. In such a system we can accurately predict the output states, all we need is a means of synchronising the changes within the system. This leads us to the very important concept of "clocked logic"; a logic system which employs a clock signal to control the transfer of logical information from one stage to the next.

D-TYPE BISTABLES

A further improvement on the RS bistable can be obtained by adding an additional input which determines the state of the outputs at the instant the clock changes. This, edge triggered, bistable is referred to as a "D-type". The "D" stands for "data" which is effectively loaded into the bistable stage when the clock transition occurs.

The symbol for a D-type is shown in Fig. 9.13. This has four inputs and, as usual, two outputs. The inputs are; SET, CLEAR, CLOCK and D. The outputs are our old friends, Q and $\overline{Q}$.

The D-type is rather difficult to construct using individual logic gates (one can be constructed from no less than six three-input NAND gates!) and thus a purpose-made integrated circuit version is always preferable. We shall, therefore, not concern ourselves with the internal arrangement of the device which, for most applications, would be considered a purely academic exercise.

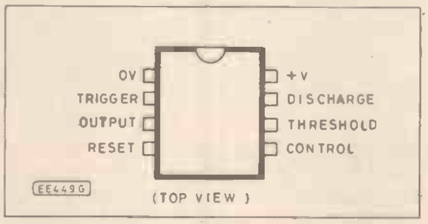


Fig. 9.15. Pin connections for a 555 timer.

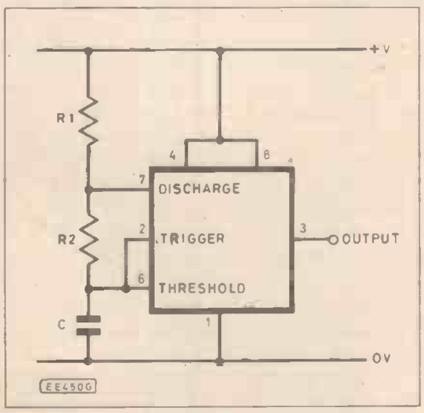


Fig. 9.16. Astable pulse generator using a 555 timer.

THE 555 TIMER

We shall close this final part of "Teach In" by introducing another extremely versatile device; the 555 timer. This device neatly combines modern analogue and digital techniques within a single integrated circuit and has found an enormous range of applications in today's electronic circuits.

The simplified internal arrangement of the 555 timer is shown in Fig. 9.14. Essentially, the device comprises two operational amplifiers (used as comparators) together with an RS bistable. In addition an output buffer is incorporated so that a considerable current can be supplied to a load (such as a relay). A single transistor switch, TR1, is also provided in order to discharge an external timing capacitor.

The 555 timer is housed in an 8-pin DIL package, the pin connections for which are depicted in Fig. 9.15. Fig. 9.16 shows how the device can be used as an "astable" pulse generator. (The word "astable" simply refers to the fact that the output does not remain in a stable state, i.e. it continuously alternates between logic 0 and logic 1 and thus can be considered to be yet another form of free-running oscillator.)

In order to understand how the astable pulse generator works, assume that the output (at pin-3) is initially at logic 1 (high) and that TR1 is not conducting. The capacitor, C, will begin to charge with current supplied by means of the series resistors, R1 and R2.

When the voltage at the threshold input (pin-6) exceeds two-thirds of the supply, the output of the comparator will change state and the bistable

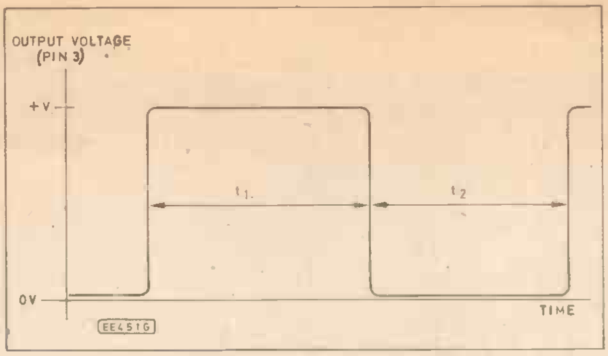


Fig. 9.17. Output waveform for the astable pulse generator shown in Fig. 9.16.

will toggle, making the output go low and turning TR1 "on" in the process. The capacitor will now discharge with current flowing through R2 and into the collector of TR1.

At a certain point, the voltage appearing at the trigger input (pin-6) will fall to one-third of the supply voltage at which point the other comparator will change state and return the bistable to its original condition. TR1 then switches "off", the final output (pin-3) goes high and the entire cycle is repeated.

The output waveform produced by the circuit of Fig. 9.16 is shown in Fig. 9.17. The essential characteristics of this waveform are:

Period for which output is at logic 1: $t1 = 0{\cdot}693\,(R1+R2)\,C$

Period for which output is at logic 0: $t2 = 0{\cdot}693\,R2\,C$

Period of output signal: $t1 + t2 = 0{\cdot}693\,(R1+2R2)\,C$

Frequency of output signal:

$$f = \frac{1{\cdot}44}{(R1+2R2)\,C}$$

Duty cycle of output signal:

$$\frac{t1}{t2} = \frac{R1 + R2}{R2}$$

Typical limits to the range of component values employed in conjunction with the circuit shown in Fig. 9.16 are as follows:

Minimum value of R1 or R2: 1k
Maximum value of (R1+R2): 3·3M
Minimum value of capacitance, C: 500p
Maximum value of capacitance, C: limited only by leakage current
Typical value for the bypass capacitor, C1: 100n

By making R2 very much larger than R1 we can use the timer to produce an almost symmetrical square wave output. If, for example, R1 is 1k and R2 is 1M the difference in the charging and discharging resistance will only be 0·1 per cent. Alternatively, there may be some applications in which an asymmetrical output waveform is desirable. In such cases we can easily calculate the required values of R1, R2 and C.

Readers should, however, note that the logic 1 time will ALWAYS be longer than the logic 0 time. The reason, of course, is that the charging resistance (R1+R2) must always be greater than the discharging resistance, R2.

Practical Assignments

ASSIGNMENT 9.1

This assignment is designed to demonstrate the operation of a 555 timer used as an astable pulse generator. The output of the pulse generator is displayed using an l.e.d. and may also be observed using the multimeter.

PROCEDURE

Connect the circuit shown in Fig. 9.18 on your breadboard using the wiring diagram shown in Fig. 9.19. Carefully check the orientation of the i.c. BEFORE connecting the 4·5V supply. The multimeter should be switched to the 10V d.c. range and initially connected in the 'V1' position.

Connect the supply and check that the l.e.d. flashes "on" and "off" with a period of about two seconds. Observe the indication on the multimeter and note that it reads approximately 4V when D1 is illuminated and 0V when D1 is extinguished.

Now reconnect the multimeter in the 'V2' position. Observe the indication on the meter and note that, when D1 is illuminated the voltage is increasing from 1·5V to 3V (approximately) whereas when D1 is extinguished the voltage is falling from 3V to 1·5V (approximately).

Readers should justify these voltage levels in relation to the supply voltage (one-third and two-thirds respectively). This should also provide a clue to the solution of Problem 9.5!

ASSIGNMENT 9.2

This assignment demonstrates the use of a 555 as a simple variable frequency square wave oscillator.

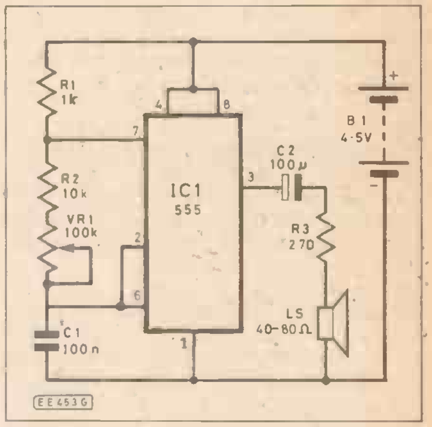


Fig. 9.20. Circuit used in Assignment 9.2.

PROCEDURE

Connect the circuit shown in Fig. 9.20 using the wiring diagram shown in Fig. 9.21. Where readers are lucky

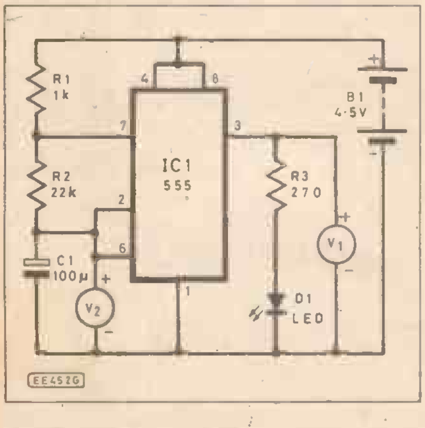
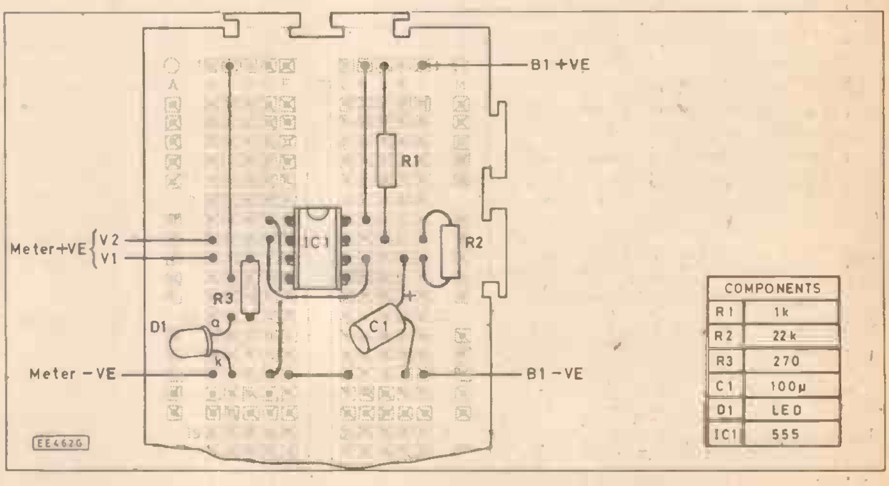


Fig. 9.18. Circuit used in Assignment 9.1.

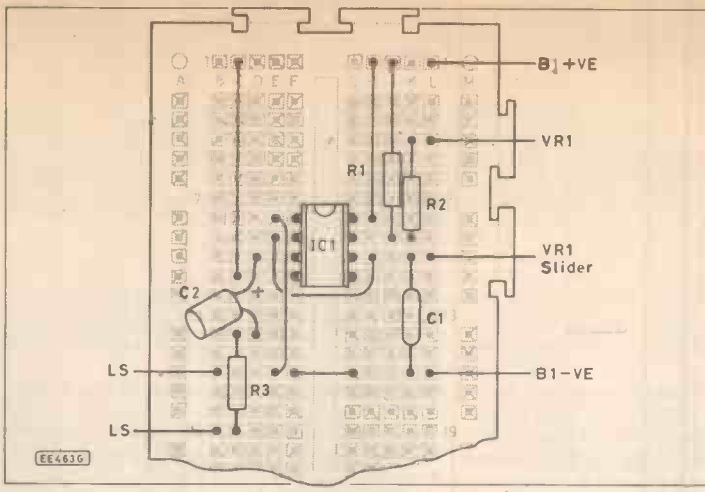


COMPONENTS	
R1	1k
R2	22k
R3	270
C1	100µ
D1	LED
IC1	555

Fig. 9.19. Wiring diagram for Assignment 9.1.

enough to have access to an oscilloscope this may be connected in place of the loudspeaker in order that the output waveform may be investigated.

Readers should note the effect of varying potentiometer VR1 (the lowest output frequency coincides with the largest value of resistance). If time permits, readers may wish to substitute different value capacitors for C1 in which case the following values are suggested; 10μ, 1μ, 10n, and 1n. These values will provide two decade frequency ranges below and two decade frequency ranges above the original range.



COMPONENTS	
R1	1k
R2	10k
R3	270
VR1	100k
C1	100n
C2	100μ
LS	40 − 80Ω
IC1	555

Fig. 9.21 (right). Wiring diagram for Assignment 9.2.

PROBLEMS

Difficulty rating: (e) easy; (d) difficult; (m) moderate

9.1 What single logic gate could be used to replace those shown in Fig. 9.22? (e)

9.2 Devise an arrangement of logic gates which can be used to replace the switch circuitry shown in Fig. 9.23. (e)

9.3 Devise an arrangement of logic gates which will produce a logic 1 output whenever two, or more, of its three inputs are at logic 1. (m)

9.4 A 555 timer is to be used as an astable oscillator which provides a logic 1 time of 1ms and a logic 0 time of 500μs. If a capacitor of 10n is to be used, determine the resistance values required. (m)

9.5 If the 555 timer in question 9.4 is used in conjunction with a +5V supply rail, sketch the waveform that would appear at the THRESHOLD and TRIGGER inputs. (d)

Answers to these problems will be given next month

EPILOGUE

For all of you that have stayed with us during the past nine months we would like to offer our sincere good wishes. Furthermore, it would not be right to mark the conclusion of *"Teach In 86"* without thanking those readers who have taken the time and trouble to write to us with comments and suggestions.

Producing a nine-part series which aims at providing an "in-depth" introduction to modern electronics yet assumes no previous knowledge has been something of a challenge; we hope that readers have found something of interest and value within these pages.

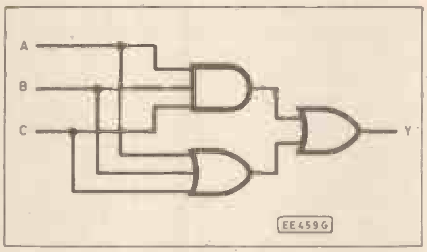


Fig. 9.22. Logic arrangement for Problem 9.1.

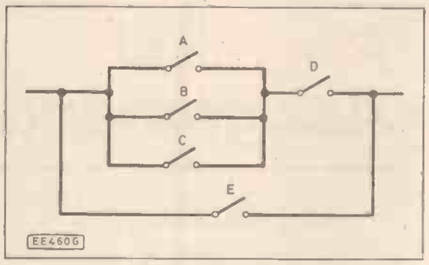


Fig. 9.23. Switch logic arrangement for Problem 9.2.

ANSWERS TO LAST MONTH'S PROBLEMS

8.1 Logic 1
8.2 See Fig. 9.24
8.3 (a) Single inverter
(b) Two-input NOR
(c) Two-input AND
(d) Single buffer
8.4 Four-input OR
8.5 See Table 9.7 (this gate is known as an "exclusive-OR")

Table 9.7

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

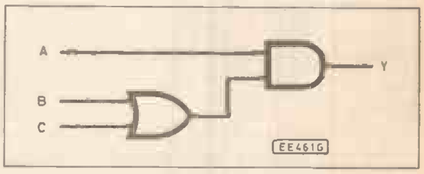


Fig. 9.24. Solution to Problem 8.2.

PERSONAL RADIO

JEFF MACAULAY

Inexpensive, easy to build and yet capable of excellent performance

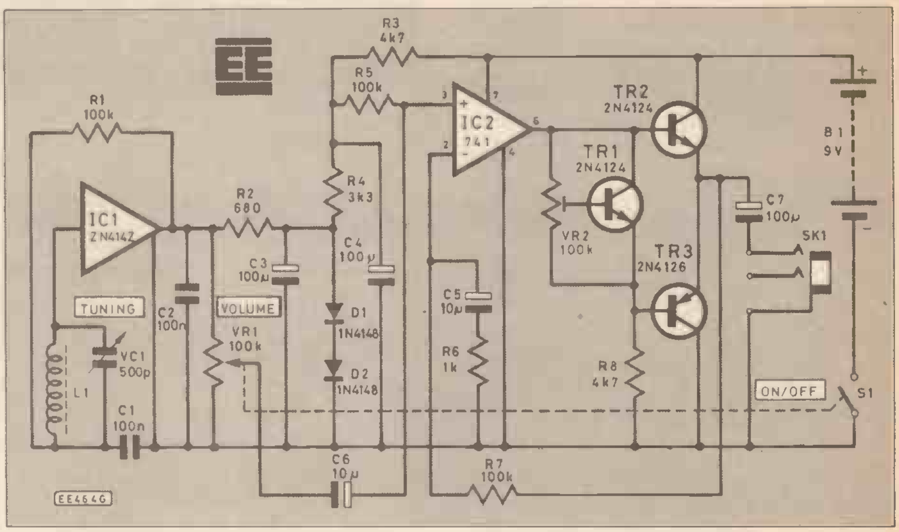


Fig. 1. Complete circuit diagram for the Personal Radio. This radio is suitable for high and low impedance headphones.

DESPITE their huge popularity personal cassette players do have a disadvantage; if you get tired of your cassettes you have no alternative to listen to. Once again Everyday Electronics comes to the rescue with a viable alternative, the Personal Radio. The requirements for such a project are fairly simple. The radio must be capable of good quality sound, be cheap, portable and economic to run.

Another just as important requirement is the ability to work into both high and low impedance headphones, eight ohm cans are standard for use with hi fi systems although the walkman types have a rather higher impedance typically in the region of 30 to 64 ohms.

As far as the circuitry is concerned this means that different output voltages are required for different pairs of phones. In practise this presents no real difficulties since if the gain is set for the worst case impedance it will be suitable for all types.

RADIO CHIP

F.M. radio would seem at first sight to be the ideal solution. Unfortunately, in practise, this idea is difficult to achieve because of body capacitance effects that make reliable reception very difficult. A.M. radio, on the other hand offers reliable reception with a good choice of programme material. The only fly in the ointment is the lack of fidelity of most A.M. circuits, the problem can be mainly solved by using the Ferranti ZN414Z radio chip. This i.c. enables a simple high performance radio to be built which should operate first time without problems. This chip is the basis of the Personal Radio described here.

The ZN414Z is a complete t.r.f. (tuned radio frequency) radio circuit on a chip. Unlike the normal radio circuits in your average "tranny" there are no i.f. stages in this design. In a normal radio the incoming r.f. signal is mixed with another r.f. signal of slightly different frequency, generated by an internal oscillator. A difference frequency is generated, termed the i.f. (intermediate frequency), this is amplified further by stages tuned to the i.f. frequency by means of tuned interstage transformers.

In this way a greatly amplified i.f. signal, modulated by the audio signal, is obtained. This signal is demodulated by a diode detector to produce just the audio signal. This form of radio receiver is universally used; it is called the superhet.

The main problem with the superhet from the performance point of view is that the tuned transformers limit the effective frequency response of the audio signal and can contribute distortion. The ZN414 approaches the selectivity and sensitivity of the superhet but uses entirely different techniques. Essentially high sensitivity is achieved by feeding the r.f. signal picked up from the tuned circuit into a high impedance. A high level of r.f. amplification is then applied before active rectification within the i.c. The result is an audio signal of reasonably high quality.

Power sources for portable equipment always pose a problem. However, with a little careful design the current consumption of this circuit has been reduced to about 5mA quiescent. This allows a PP3 to be used, giving more than 30 hours of continuous use at high volume. As current consumption is totally dependent upon volume level it depends on the user how long his or her batteries will last.

CIRCUIT DESCRIPTION

Fig. 1 shows the full circuit diagram of the Personal Radio. Radio signals are picked up by the tuned circuit formed by L1 and VC1.

At all frequencies away from the main resonance the parallel combination of L1 and VC1 looks like a near short circuit and any r.f. signals are effectively grounded through C1. At resonance the tuned circuit presents a very high impedance to the incoming signal. So if the resonant frequency of the tuned circuit happens to coincide with the incoming r.f. signal a relatively large signal appears across it.

The greater the impedance at resonance the stronger the required signal will be in comparison with the amplitude of unwanted stations. In order to retain the inherent selectivity that this provides the signal needs to be fed into a high impedance. IC1 provides an input impedance of four megohms, IC1 also acts as a high gain r.f. amplifier and detector. Because the signal level obtained from various radio signals are so different automatic gain control (a.g.c.) is also incorporated in the chip.

The chip operates from a maximum of 1·5V but takes a low current, typically 200µA, from the supply. In order to get a loud signal from the amplifier it is necessary to use a higher voltage to drive the radio. The required supply voltage for the chip is provided from the forward voltage drop across the two diodes, D1 and D2. Current is fed into these via the potential divider consisting of R3, R4, and the decoupling capacitors, C3 and C4, this also provides the bias for IC2.

The output signal from IC1 is produced across VR1, the Volume Control. C2 removes any remaining r.f. leaving just the audio signal. Having achieved an audio signal it now needs amplifying to a sufficient level to blast the eardrums of the listener! This is the function of the remainder of the circuit.

AMPLIFIER

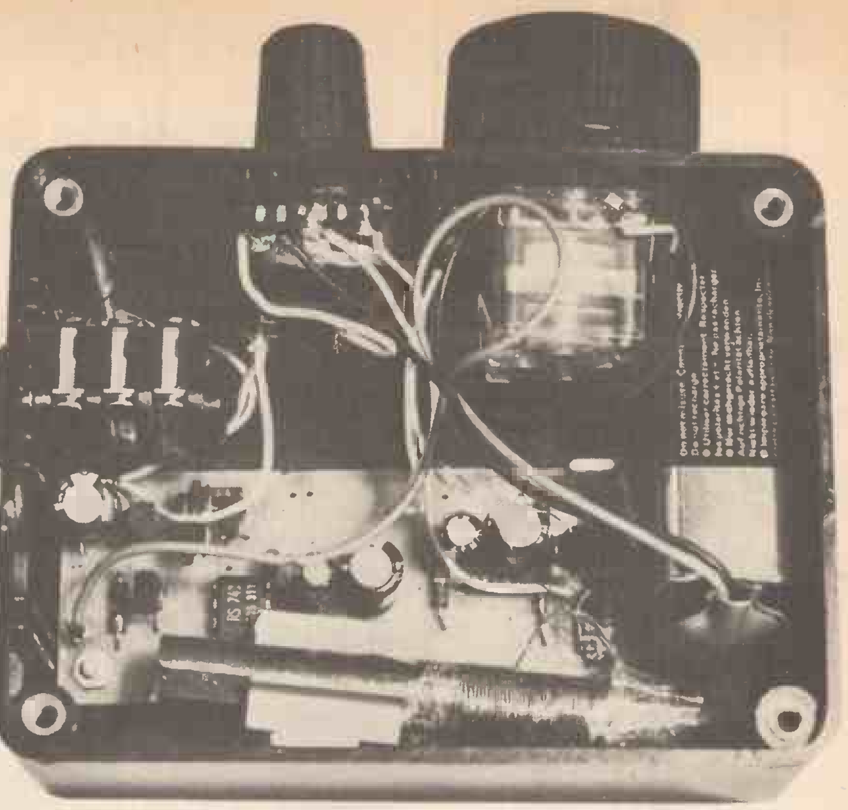
During the development of this project many kinds of radio amplifier were tried. The obvious choice, the LM386 quarter watt power amp in a nifty eight pin d.i.p. proved unstable. Instead the hybrid circuit used here offers the same level of performance with unconditional stability.

As previously mentioned the potential divider formed by R3 and R4, D1 and D2 is used to bias the op-amp IC2. The voltage at the junction of R3 and R4 is at roughly 4·5V, C4 decouples the junction of R3 and R4 to ground at audio frequencies.

Resistor R5 defines the input impedance of the amplifier. Signals from the slider of VR1 are coupled to the non-inverting input of IC2 by C6. This also ensures isolation from any d.c. levels that may be present on the input. Substantial voltage gain is required to bring the level up to a suitable value for driving the headphones and this is set by the overall feedback loop consisting of R7, C5 and R6. In particular the gain is set by the ratio of the values of R7 to R6, in this case to 100 times with the Volume control fully advanced.

Although the 741 is capable, in principle, of driving the headphones direct the sound level obtainable is definitely on the low side, thus necessitating the use of TR2 and TR3. These transistors form a simple, conventional push-pull output stage. When the output from the IC2 is positive going TR2 conducts allowing current to flow via the output capacitor C7 to the load. On negative going signals TR3 conducts and provides the required drive.

Unfortunately, as yet, no one has come up with transistors that do not require some



bias current to avoid crossover distortion. This form of distortion sounds particularly nasty and is due to the fact that transistors are basically non-linear devices when operated at or near their cut-off points. The distortion problem is overcome in this design, as in all other practical amplifiers, by biasing the output transistors so that a small current is always flowing. This needs to be done with care and the best way is to make use of another transistor circuit, in this case TR1 and associated components.

TR1 in conjunction with VR2 forms what is known as a V_{be} multiplier. To explain, an *npn* transistor will not start to conduct until the base terminal is taken some 0·6V positive of the emitter. To just make TR2 and TR3 conduct requires a bias of about 1·2V between the bases. If VR2 is set with the slider midway then transistor TR1 will turn on so that 0·6V will appear across both the base/emitter and base/collector terminals.

Resistor R8 in series with the V_{be} multiplier completes the driver circuitry. The current required is provided by IC2's output stage. The whole output stage is enclosed within the feedback loop for IC2 reducing overall distortion to an insignificant level.

Capacitor C7 couples the output signal to the headphones while simultaneously preventing the d.c. level at the output from flowing through the load.

CONSTRUCTION

Construction starts with the drilling of the case to suit the components purchased. Once this has been completed (see photos) attention can be turned to the winding of LI. This comprises 65 closely wound turns of 28 s.w.g. enamelled copper wire, the detail is shown in Fig. 3.

Start by stripping one end of the wire. This is best done by scraping the end with a very sharp knife. After stripping the insulation winding can begin. Leave about 100mm of lead free and using a strip of insulation tape anchor it to the rod. Now

COMPONENTS

See Shop Talk page 313

Resistors

R1,R5,R7	100k (3 off)
R2	680
R3,R8	4k7 (2 off)
R4	3k3
R6	1k

All 0·25W ±5% carbon

Potentiometers

VR1	100k log. with d.p.s.t. switch (S1)
VR2	10k skeleton preset (vertical mounting)

Capacitors

C1,C2	100n polyester (2 off)
C3,C4,C7	100µf elect. 16V radial (3 off)
C5,C6	10µf elect. 16V radial (2 off)
VC1	500pf, solid dielectric trimmer

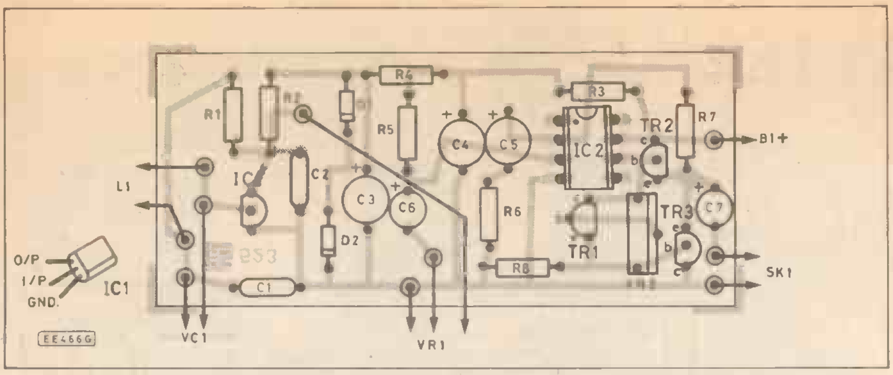
Semiconductors

IC1	ZN414Z
IC2	741 op-amp.
TR3	2N4126
TR1,TR2	2N4124 (2 off)
D1,D2	IN4148 (2 off)

Miscellaneous

B1 PP3 battery and connecting clip; SK1 stereo jack socket (¼ inch); ABS case, 100 × 76 × 40mm; two control knobs; ⅜ inch diameter Ferrite rod approx. 90mm long and 28 s.w.g. enammelled wire to form L1; p.c.b. available from the *EE PCB SERVICE*, order code 526; connecting wire, solder, fixings, etc.

Approx. cost Guidance only **£9.50**



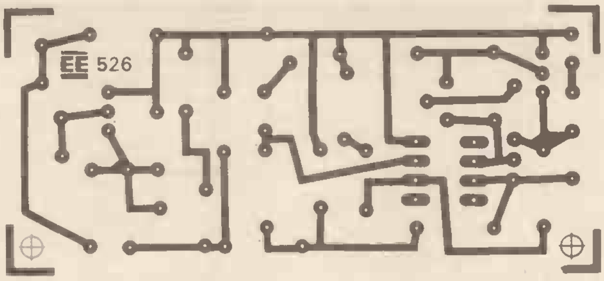


Fig. 2. Component layout and full size printed circuit board master. This board is available from the EE PCB Service: code EE526.

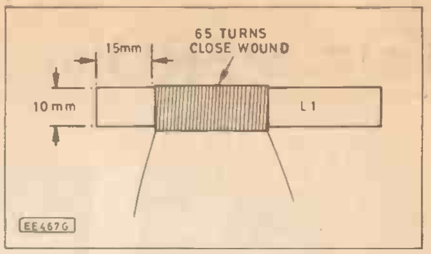


Fig. 3. Ferrite aerial coil winding details and construction.

wind on the 65 turns, small gaps between turns are irrelevent but try not to wind one turn on top of the other!

Having completed the winding anchor the free end to the rod using another strip of tape. Scrape and tin the free end and the coil is complete.

CIRCUIT BOARD

Most of the components are mounted on a p.c.b., the layout and wiring of which is shown in Fig. 2. Carefully insert the components and solder them into place. Make sure that all the polarised components are correctly orientated. Especially D1 and D2. Incorrect connection here will lead to the instant demise of IC1 when the power is applied!

Finally, attach the flying leads to the board. These should be left at least 100mm long to facilitate easy connection. Attach VC1, VR1, SK1 and the finished p.c.b. to the case.

The last part of the construction is to terminate the flying leads to their respective destinations, see Fig. 4. Check your work thoroughly, if you're happy that all is well set up VR2.

Start by setting VR2 so that the base of TR1 is shorted to the emitter as measured between these points with a multimeter. Now advance the control to just under half its travel. Attach the battery and switch on. Several stations should be heard as VC1 is adjusted. Pick the strongest and turn the volume down till you can barely hear it.

If the signal sounds distorted then slowly adjust VR2 until the distortion just disappears. Do not adjust the preset any further than you have to otherwise TR2 and TR3 may overheat. Once this is done the project is complete. □

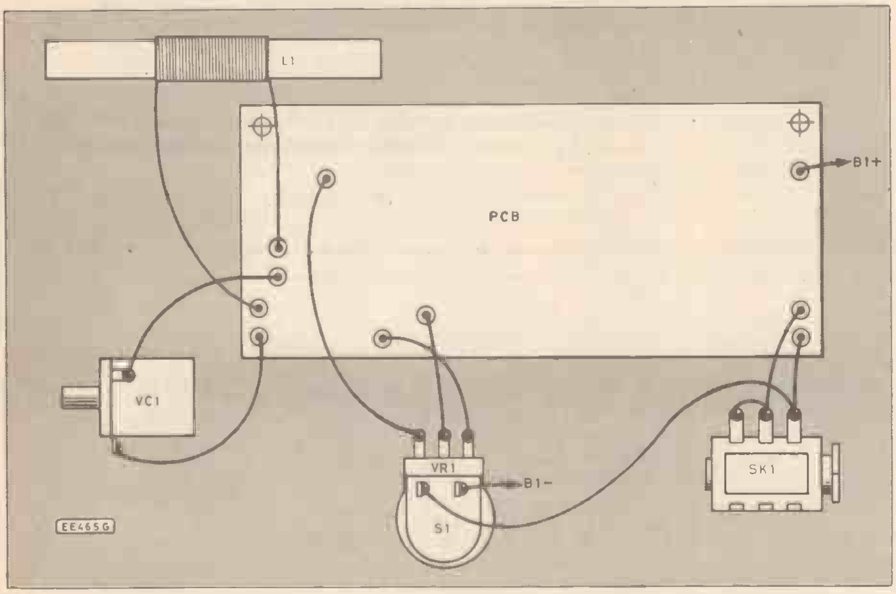


Fig. 4. Interwiring details to the circuit board. Note the use of solder pins on the p.c.b.

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

OLDEST CLUB

BACK in 1911, Professor G. P. Bailey gave a lecture in Derby's Guildhall on *"Scientific Progress in our Time"*, demonstrating the ringing of bells and the lighting of lamps by means of wireless waves. Inspired by this, local enthusiasts formed the Derby Wireless Club, and set up an experimental wireless station, call-sign QIX.

This was the very first wireless club in Britain, possibly in the world. It held an exhibition in 1913 which received national newspaper coverage, and that year saw the foundation of clubs in other places, some with the assistance of members of the Derby club.

There is a well documented history of the club's activities up to the outbreak of WW2 (World War 2), when all transmitting licences were withdrawn. Many items constructed by early members have been preserved, together with original documents and photographs.

In 1947, the Derby and District Amateur Radio Society was formed, catering for all aspects of amateur radio and electronics and, after discussion with surviving founder members, incorporated in its title, *"Derby Wireless Club 1911"*.

Now, in 1986, the Society is celebrating the 75th anniversary of its inception with a programme of events, many of which are open to the publc. A demonstration amateur radio station is operational, at various locations in Derby, throughout the year using the callsigns GB2, GB3, or GB4ERD, reflecting the Society's original call, G3ERD (Experimental Radio Derby). The first demonstration was at a commemorative Mayoral reception on 8 January, when contact was established with a number of stations in Derby's twin city, Osnabrück, in Germany, and with other cities having twinning links with Osnabrück.

Amateurs contacting the demonstration station, together with a number of other Derby stations, during 1986, will qualify for a special certificate issued in conjunction with the City Council, and commemorative QSL cards will be sent for all contacts with the club station.

If you are in the Derby area, look out for the station at, amongst other places, the Elvaston Castle Steam Rally, July 5–6; Markeaton Park, Derby Carnival Week, August 9–17; and the City Museum and Art Gallery, December 13–January 24, when a collection of vintage radio will also be on show.

Finally, an invitation is extended to readers of this magazine having an interest in amateur radio to visit the Society at its clubroom, 119 Green Lane, Derby, any Wednesday at 7.30p.m. Like many other local radio clubs, they have a good programme of activities, including lectures, film shows, discussions on matters of topical interest, and the ever popular "surplus sales". Newcomers are particularly welcome. Just say you read about the Society in *EE!* Ken Griffin, G4HDP, Anniversary Organiser, can provide more information about the celebrations, or the club, on Derby 556005.

QRP TESTS

The G-QRP Club, the British organisation catering for low power enthusiasts, arranged an interesting weekend activity in February. This was to allow Czechoslovakian amateurs to test their QRP transmitters over the path to the UK on a number of different frequencies at pre-arranged times throughout the two days.

A new Czech club has about 30 members compared to the British club's 3000 plus members, so an additional purpose in holding the tests was to encourage the new club in its activities. The UK end was co-ordinated by Gus Taylor, G8PG, communications manager of G-QRP-C, who arranged for two teams, one in England and one in Scotland, to take part. The Czech end was organised by Petr Doudera, OK1DKW, who is also a member of the British club.

Radio conditions were found to be reasonable considering the low level of sunspot activity and participants, who used between one and four watts r.f. output, were surprised to find that the 10MHz band (30 metres), which is not normally used a great deal, provided more contacts than any other.

A further interesting point was the difference between the path from Czechoslovakian stations to southern and northern parts of the UK. Stations in the north of England and in Scotland made few contacts, and most were made by those located south of a line drawn between the River Mersey and the east coast. This experience confirms previous observations that on such east/west paths the further north one of the stations is, the more difficult it is to make contact between them.

Apart from providing an interesting and enjoyable weekend for the participants, a number of useful lessons were learned, and a suggestion has already been made that the tests should be repeated next year.

FREE BOOKLET

An informative booklet, *"How to become a Radio Amateur"*, is published by the Department of Trade and Industry. It contains the conditions for holding an amateur licence, details of the types of licence, licence fees, tuition available, the examination, the Morse test, and so on.

This is available, free of charge, by writing to: Radio Amateur Licensing Unit, Post Office Headquarters, Chetwynd House, Chesterfield, Derbyshire S49 1PF.

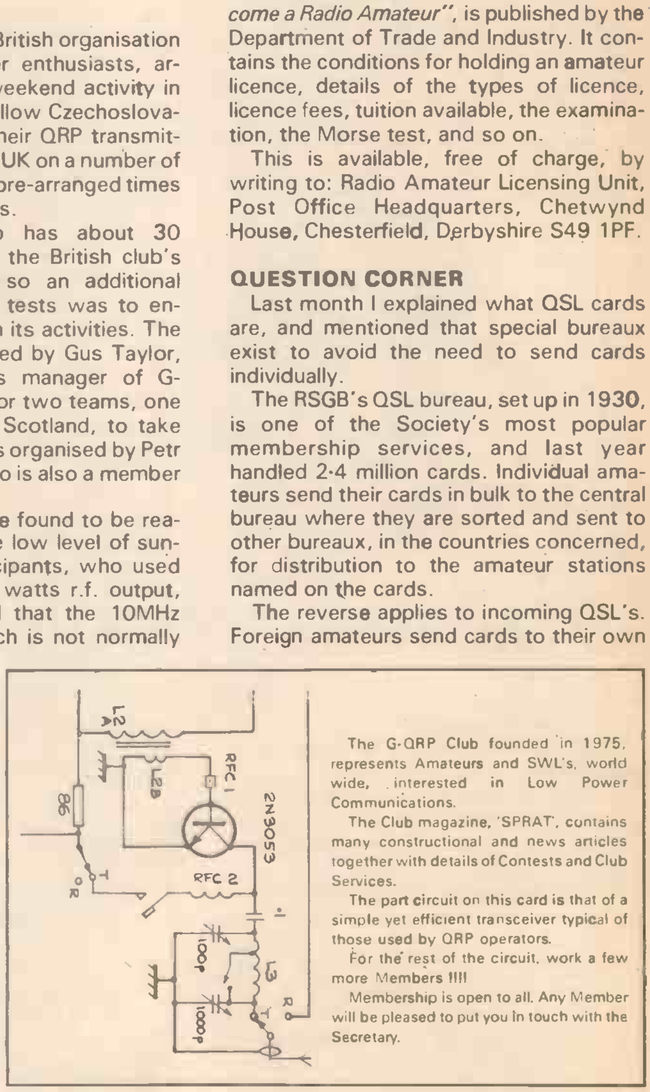
QUESTION CORNER

Last month I explained what QSL cards are, and mentioned that special bureaux exist to avoid the need to send cards individually.

The RSGB's QSL bureau, set up in 1930, is one of the Society's most popular membership services, and last year handled 2·4 million cards. Individual amateurs send their cards in bulk to the central bureau where they are sorted and sent to other bureaux, in the countries concerned, for distribution to the amateur stations named on the cards.

The reverse applies to incoming QSL's. Foreign amateurs send cards to their own

Petr Doudera OK1DKW, at his station in Prague. Apart from a vintage WW2 AR88-receiver, all equipment is home-made.



Reverse of QSL card used by members of the G-QRP Club.

bureaux which, in turn, send all those addressed to British stations to the RSGB bureau. The cards are then distributed to sub-managers who hold stamped addressed envelopes lodged with them by individual amateurs, and the envelopes are posted off when sufficient cards have been received to fill them. QSL's to and from British stations are routed from the central bureau to the appropriate sub-managers, who are responsible for particular series of call-signs, e.g. G4FAA to G4FZZ.

Arrangements vary in different countries and, unlike Britain, it is sometimes necessary to pay a fee. One of the most famous bureaux is Box 88 in Moscow, which handles all QSL's for Soviet amateurs. In the USA, the American Radio Relay League (ARRL) operates separate incoming and outgoing bureaux, and charges for all outgoing cards.

The despatch and receipt of QSL cards worldwide is an extensive, and expanding, amateur radio activity. In total, it costs a great deal of money and occupies the time of a large number of people. The RSGB bureau, for example, has two full-time staff, plus over fifty unpaid sub-managers. Multiply this by the number of countries having amateur radio, taking account of their relative amateur populations, and you have some idea of what is involved!

This is yet another facet of amateur radio which attracts a great deal of voluntary effort, and undoubtedly this highly popular activity could not continue in its present form without such help.

More news from the airwaves next month.

DOWN TO EARTH

BY GEORGE HYLTON

A READER has come across an old issue of *Practical Wireless* containing a design for a crystal set. Tuning is performed by a variable-inductance device, a variometer, without the aid of an associated capacitor. In other words, there is a variable *L*, but no *C*. How, he asks, can tuning, which calls for both *L* and *C*, be obtained in this circuit?

First, what is a variometer? It has two coils, connected in series. One coil (Fig. 1) is inside the other, and can be rotated by turning a shaft.

In one extreme position, the movable coil is in-line with the fixed coil, and the fields of the two windings assist one another; inductance is maximum. In the reverse position, the fields oppose each other and the inductance is minimum. As the shaft is rotated to move the coil from one extreme to the other the inductance changes smoothly.

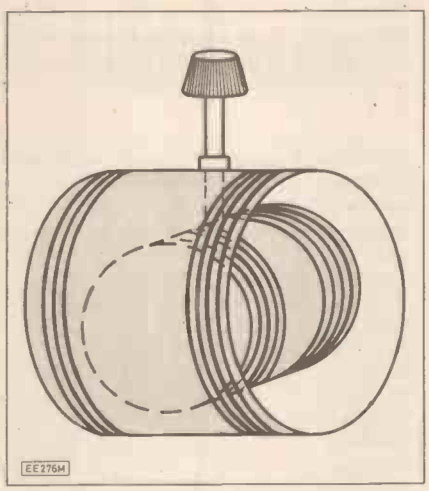
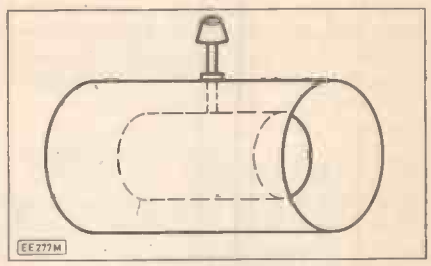
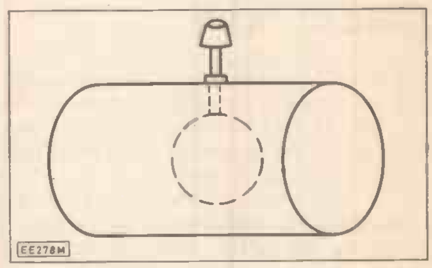


Fig. 1. Construction of a variometer. The inner coil can be rotated to vary the inductance.





EARLY RADIO CIRCUITS

Variometers weren't just used in crystal sets. They were incorporated into early valve radio receivers, too.

Fig. 2 shows part of a receiver circuit published by John Scott Taggart, a pioneer of d.i.y. radio construction, in 1923. The crossed-coil symbols are variometers: L1 tunes the aerial and L2 the output circuit of the r.f. amplifier valve V1.

As our reader found in his crystal set circuit, there are no capacitors connected across L1 and L2. So how was tuning accomplished?

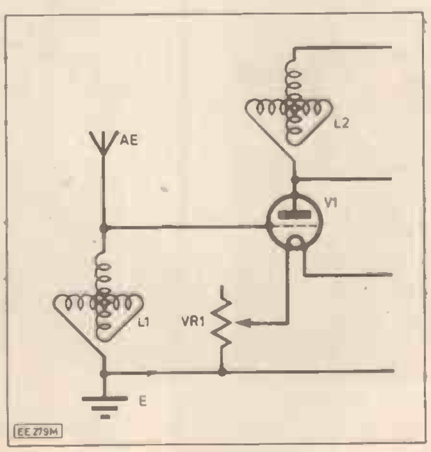
The answer is that there were capacitances, but in the form of "strays". The aerial itself behaved like a capacitance across L1. In those days of long-wire aerials it could easily amount to hundreds of picofarads, quite enough to tune L1 to medium-waveband stations.

The stray capacitance across L2 was smaller. It consisted mainly of the self capacitance of L2 (caused by the insulation between adjacent turns acting as a dielectric and the wire of the turns as plates), plus the input capacitance of the next stage, plus wiring strays. To compensate for the relatively low capacitance, L2 was of greater inductance than L1.

LOSSES

Stray capacitances often involve dielectric materials which are far from perfect. The result is that there are high-frequency "losses", that is, energy is absorbed by the dielectric, which behaves like a mixture of capacitance and resistance. A tuned LC circuit in which *C* is all strays is likely to be a poor thing with a low quality factor (*Q*) and poor selectivity.

Fig. 2. Part of Scott Taggart's ST91 radio circuit (1923) showing variometers (L1 and L2).



In 1923 such things hardly mattered. There were far fewer stations to be received, so selectivity was not such a problem. In any case, damping of tuned circuits was actually encouraged, by making valves like V1 take grid current.

The object was to discourage a circuit like Fig. 2 from bursting into oscillation because of stray feedback from L2 to L1. So variometer tuning was workable.

There is, of course, no reason why a capacitor should not be connected across a variometer, if required. It was often done.

SNAGS

Variometers are relatively easy to make. So why have they been replaced by tuning capacitors?

One shortcoming is a relatively poor performance at the h.f. end of a variometer's tuning range. Here, the inductance is at its minimum, with the movable coil in the "opposing" position. This reduces the inductance all right, but the coils are still in series and still have just as much resistance. High resistance makes for low *Q*.

Another problem is to get a wide enough tuning range. On the face of it, this should be easy. If L1 and L2 have equal inductances, then in the "opposing" position they should cancel one another out, reducing the inductance to zero and raising the tuned frequency to infinity!

In practice, this can't happen. The coils are not perfectly coupled. That is, the field of one does not link completely with the field of the other. The inductances don't cancel, but merely fall to a minimum.

This means that it is hard to cover the medium-wave band as it exists today. But a tuning capacitor can achieve it easily.

PERCUSSION SYNTHESISER

MARK STUART

It won't cost a lot of notes to stay in tune with the latest hits

THIS single channel synthesiser is capable of producing a wide range of percussion sounds. It can be set up to mimic real percussion instruments or to produce synthetic "electronic" percussion sounds.

The sound may be triggered by positive pulses from a sequencer or by tapping a piezo electric pick-up device. In the latter mode the circuit is touch sensitive the sound level varying according to how hard the pick-up is hit.

The circuit has seven controls altogether as follows:

Sensitivity Sets the gain of the trigger input circuits to suit the sequencer or pick-up output.

Pitch The frequency of the master VCO which produces the basic triangular output waveform.

Sweep This control varies the frequency of the master VCO during the beat. The effect of this control is very important and adds greatly to the quality of the synthesiser output. Sweep can be set to increase or decrease the pitch of the VCO. At its centre setting it has no effect.

Level Sets the level of the VCO signal in the output mix.

Noise Level Sets the level of the noise generator signal in the output mix.

Noise Filter A six position switch controlling a high "Q" factor tuned circuit which enables different frequencies to be emphasised from the noise generator.

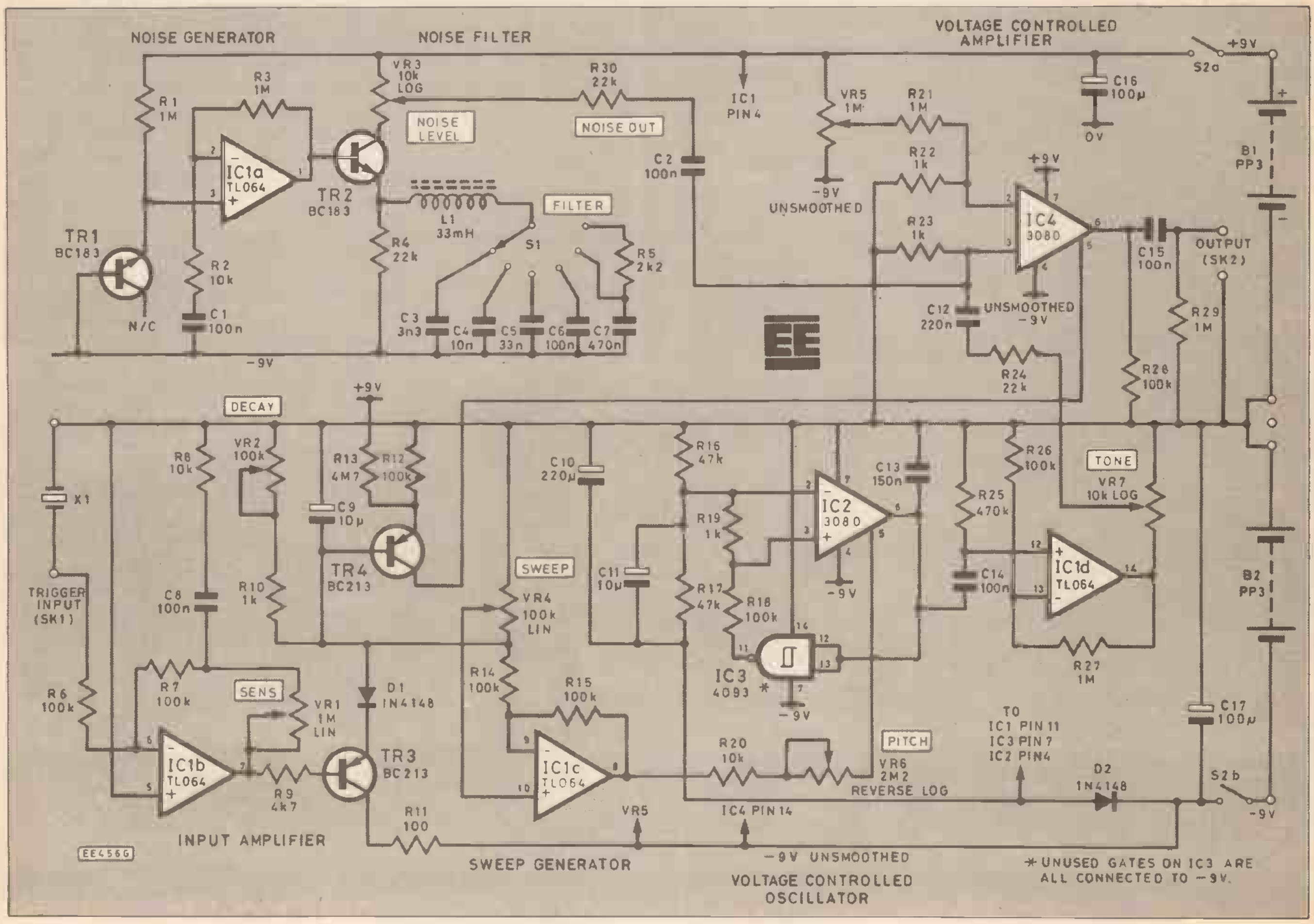
Decay Sets the time constant of the output waveform envelope. The range of the control covers from 10 milliseconds to 1 second.

Power is provided by two PP3 9V batteries which should last for a considerable time. The output signal is fed to a standard jack socket and is suitable for any amplifier with an input impedance of around 50 kilohms and standard "line level" sensitivity.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Percussion Synthesiser is shown in Fig. 1.

Fig. 1. The complete circuit diagram for the Percussion Synthesiser. The input and output sockets are standard $\frac{1}{4}$in. mono jack sockets.



As with all complex circuits it is best understood if it is explained one section at a time. The two batteries B1 and B2, connected in series, provide +9V and −9V supplies with a common centre 0V or "ground" line. A double-pole switch S2a and S2b on the sensitivity control switches these two supplies on and off.

Capacitors C16 and C17 provide supply decoupling for the majority of the circuit. A separate −9V supply is provided from the standard supply via diode D2 decoupled by C10. This extra decoupling ensures that the output signal is pure and free from low frequency voltage shifts.

WHITE NOISE

A small signal silicon transistor junction (TR1) operating in reverse breakdown at very low current is used to produce the white noise signal. A high input impedance non-inverting amplifier IC1a amplifies this signal and provides a suitably low output impedance to drive the output filter circuit. The a.c. gain of IC1a is set to 100 by R2 and R3.

Transistor TR2 is connected as a common emitter amplifier. Its gain is determined by the components connected in its emitter circuit.

Normally in such circuits a large electrolytic "bypass" capacitor connected in parallel with the emitter resistor provides a low impedance path for signal currents. This ensures a high gain over a wide frequency range.

However, in this circuit the emitter resistor R4 is bypassed instead by a series tuned circuit consisting of L1 and one of the capacitors C3 to C7, according to the setting of S1. The series tuned circuit has a high impedance except near to its resonant frequency where its impedance falls to a low value. Signal currents at or near to the resonant frequency therefore pass easily and the circuit has a high gain. Above and below resonance the circuit gain falls to much lower levels.

The effect that this filtering has on the noise signal is hard to describe, but the change is quite dramatic. Different settings of S1 enable different bands of frequencies to be emphasised as required.

The resistor R5 broadens the frequency peak on the last setting of S1 to provide a more standard type of "white noise" output. The signal from TR2 appears across VR3, the Noise Level control. From the slider of VR3 the signal passes via C2 and R30 to be mixed with the VCO signal at the input to IC4.

VOLTAGE CONTROLLED OSCILLATOR

Integrated circuits IC2 and IC3 form a voltage controlled oscillator (VCO) producing a triangular wave output. Capacitor C13 is alternately charged and discharged by the output of IC2. Switching over from charging to discharging is done by IC3 which senses the voltage level on capacitor C13.

When the voltage on C13 reaches the negative trigger threshold of IC3 the output of IC3 switches from −9 volts to 0 volts. The output of IC3 is connected to the input of IC2 via resistor R18 so that when the output voltage of IC3 changes the output current from IC2 changes also.

The voltage on C13 now begins to move towards the positive input threshold of IC3 at which point the output of IC3 switches from 0 volts to −9 volts, the current from IC2 reverses and C13 begins to charge once more towards the negative input thresholds of IC3. In this way the circuit oscillates continuously.

The frequency of oscillation is set by the value of C13 and the amount of current used to charge and discharge it. The current is provided from the output of IC2 which is a CA3080 variable transconductance amplifier. This means that the amplifier output current depends on the input signal voltage and upon the transconductance or "gain" of the amplifier.

The input voltage to IC2 is constant. It is set by potential divider resistors R18 and R19 from the constant output voltage swing of IC3. The transconductance of IC3 can be varied over a wide range by altering the current fed into the "bias" terminal, pin 5.

A "high" current on pin 5 produces a high gain and so C13 is charged and discharged rapidly giving a high frequency output. Similarly a low current produces a low frequency output.

The bias current to IC2 is derived from the output of IC1c via resistor R20 and the Pitch control VR6. When the sweep control is set to neutral (centre position) the output of IC1c remains fixed at 0V. In this condition the bias current to IC2 is set solely by VR6 which provides a frequency adjustment range of 22 to 1.

VOLTAGE CONTROLLED AMPLIFIER

The output from the VCO is amplified by IC1d and fed to the Tone level control VR7. The signal from the slider of VR7 passes via R24 and C12 to be mixed with the noise signal at the input to IC4. The mixture of input signals at IC4 is exactly as it will appear at the output of the synthesiser.

The percussive nature of the sound is dependent not on the waveform of the output signals but upon their "dynamics". That is the rise and fall (*attack* and *decay*) of the signal level. The dynamics are imparted to the signal by varying the bias and hence transconductance or "gain" of IC4 in the same way as the gain of IC2 was varied in the VCO circuit.

The envelope control current is provided by transistor TR4 which produces a current output proportional to the voltage on capacitor C9 which is connected to its base. C9 is charged rapidly via R11 and D1 whenever TR3 is turned on. Transistor TR3 is turned on either by positive trigger pulses applied to the trigger input from a sequencer or during positive half cycles of the signal from a piezo electric transducer X1. IC1b inverts and amplifies the trigger signal. VR1 sets the gain of the trigger amplifier stage to accommodate different transducers and trigger signal levels.

After the trigger pulse TR3 turns off and C9 discharges via R10 and the Decay control VR2. Setting VR2 to a low value produces a very rapid decay, a high value produces a slow decay.

The current from TR4 follows this voltage and controls the gain of IC4. Thus when the circuit is triggered the gain of IC4 rises rapidly and then falls gently at a rate set by the Decay control VR2.

In the absence of trigger pulses the gain of IC4 falls to zero so that the circuit is silent. Depending upon the setting of sensitivity control VR1, a soft tap on the input transducer may only partially charge C9 so that a quieter output signal is produced.

SWEEP GENERATOR

The voltage across C9 is also used by the sweep amplifier IC1c. The Sweep control VR4 allows the gain of this stage to be varied from +1 through 0 to −1. The output voltage of IC1c is used to provide the bias current which controls the frequency of the VCO. Varying this voltage causes the frequency of the VCO to vary.

As the Sweep control VR4 is moved from the centre (neutral) position a proportion of the envelope control voltage also modulates the frequency of the VCO. This means that the pitch and level of the output signal vary together. The amount of pitch change can be varied to introduce extreme "swooping" effects or very subtle effects which add realism when synthesising natural percussive sounds. The control can be set to introduce a pitch rise or a pitch fall by turning the control clockwise or anticlockwise.

The completed Percussion Synthesiser showing the seven front panel controls and their respective functions.

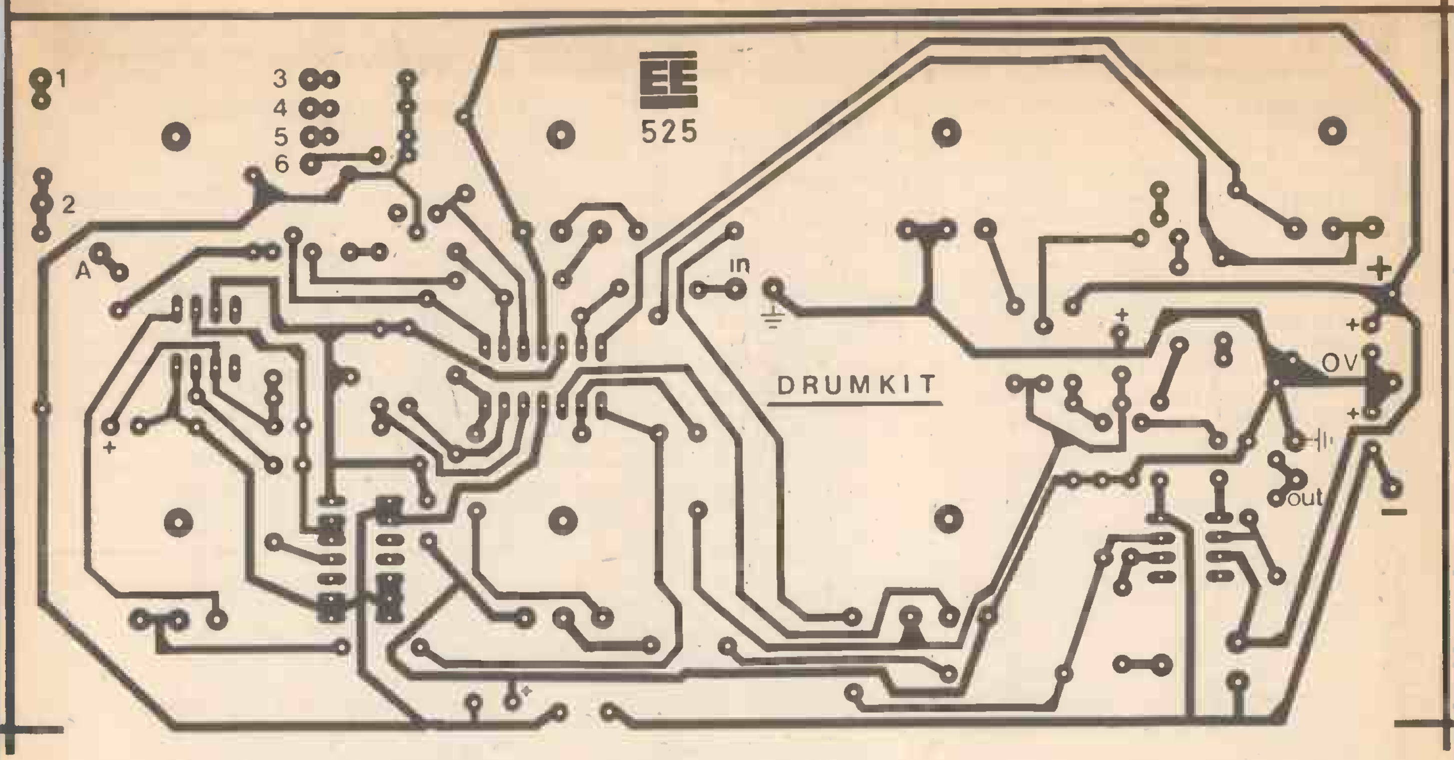


Fig. 2. Full sized printed circuit board master for the Percussion Synthesiser. This board is available from the EE PCB Service: code **EE525**.

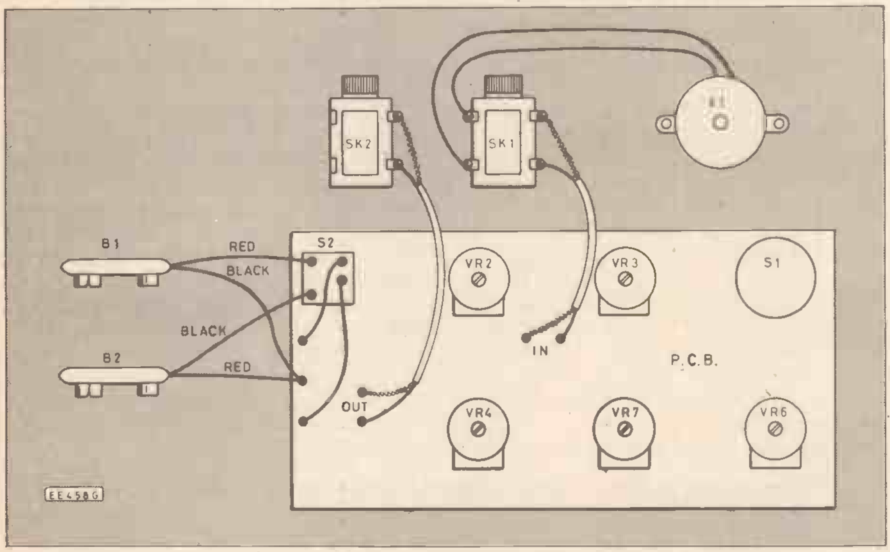
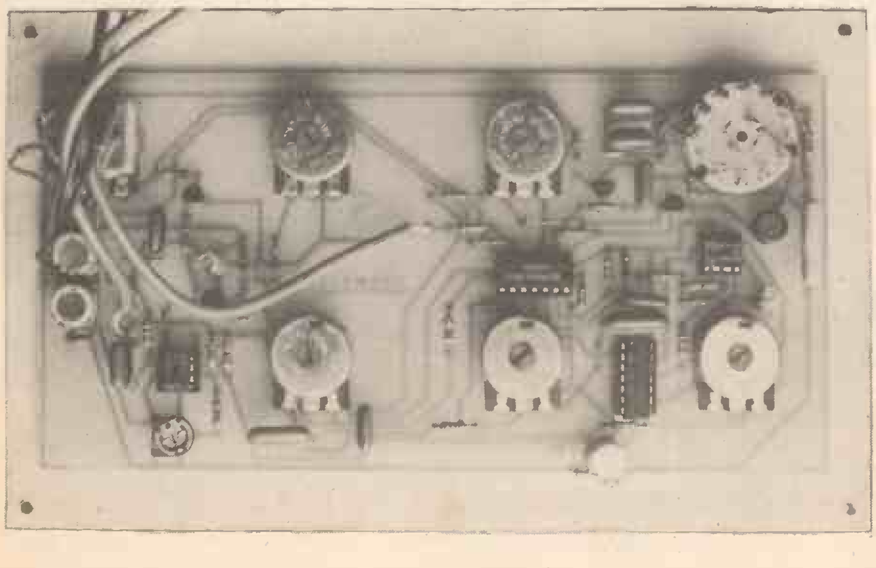


Fig. 4. Details of the interwiring of the jack sockets, battery connectors and the piezoelectric pick-up. The completed p.c.b. mounted on the rear of the front panel is shown in the photograph below.



CONSTRUCTION starts here

The entire circuit is built on a single printed circuit board and the master p.c.b. pattern is shown in Fig. 2. The board component layout is given in Fig. 3. This board is available from the *EE PCB Service*: order code EE525.

Before inserting any components use the bare board as a template to mark out the front panel of the case. Note that the track side of the board is the side that will be nearest to the panel. The front panel should be drilled with ⅜in diameter holes to take the mounting bushes of the controls as these are used to fix the assembled board to the case.

CIRCUIT BOARD

When the case front panel is complete the board can be assembled. Refer to the components list and to Fig. 3, the p.c.b. component layout diagram.

First fit seven single-sided soldering pins to the board in the positions that will be used for making connections to the battery and signal wires. The pins should be pressed right into the board from the track side so that they are almost flush and then soldered.

Next fit the wire links, preset, resistors, diodes, i.c. sockets, capacitors, and inductor L1. Solder and crop all the leads as close to the board as possible so that there is no danger of an accidental short circuit to the front panel when the circuit is finally assembled.

COMPONENTS

Resistors

R1,R3,R21, R27,R29	1M (5 off)
R2,R8,R20	10k (3 off)
R4,R24, R30	22k (3 off)
R5	2k2
R6,R7,R12, R14,R15, R18,R26, R28	100k (8 off)
R9	4k7
R10,R19, R22,R23	1k (4 off)
R11	100
R13	4M7
R16,R17	47k (2 off)
R25	470k

All 0·25W ±5% carbon film

Potentiometers

VR1	1M lin, with DPST switch
VR2	100k lin
VR3	10k log
VR4	100k lin
VR5	1M preset
VR6	2M2 reverse log
VR7	10k log

See Shop Talk page 313

Capacitors

C1,C2,C6, C8,C14, C15	100n Polyester C368 (6 off)
C3	3n3 ceramic plate
C4	10n polyester C368
C5	33n polyester C368
C7	470n polyester C368
C9,C11	10μ elec. 16V radial (2 off)
C10	220μ elec. 16V radial
C12	220n polyester C368
C13	150n polyester C368
C16,C17	100μ elec. 16V radial (2 off)

Semiconductors

IC1	TL064
IC2	CA 3080
IC3	4093
IC4	CA 3080
TR1	BC183
TR3	BC213
TR4	BC213
TR2	BC183
D1	IN4148
D2	IN4148

Miscellaneous

L1	33mH inductor
X1	PB2720 piezo
S1	2-pole 6-way rotary switch
S2	Part of VR1

B1,B2, 9V PP3 battery; i.c. sockets; ¼in mono jack sockets (2 off); PP3 clips (2 off); case; knobs (7 off); printed circuit board, available from the *EE PCB Service* —order code EE525

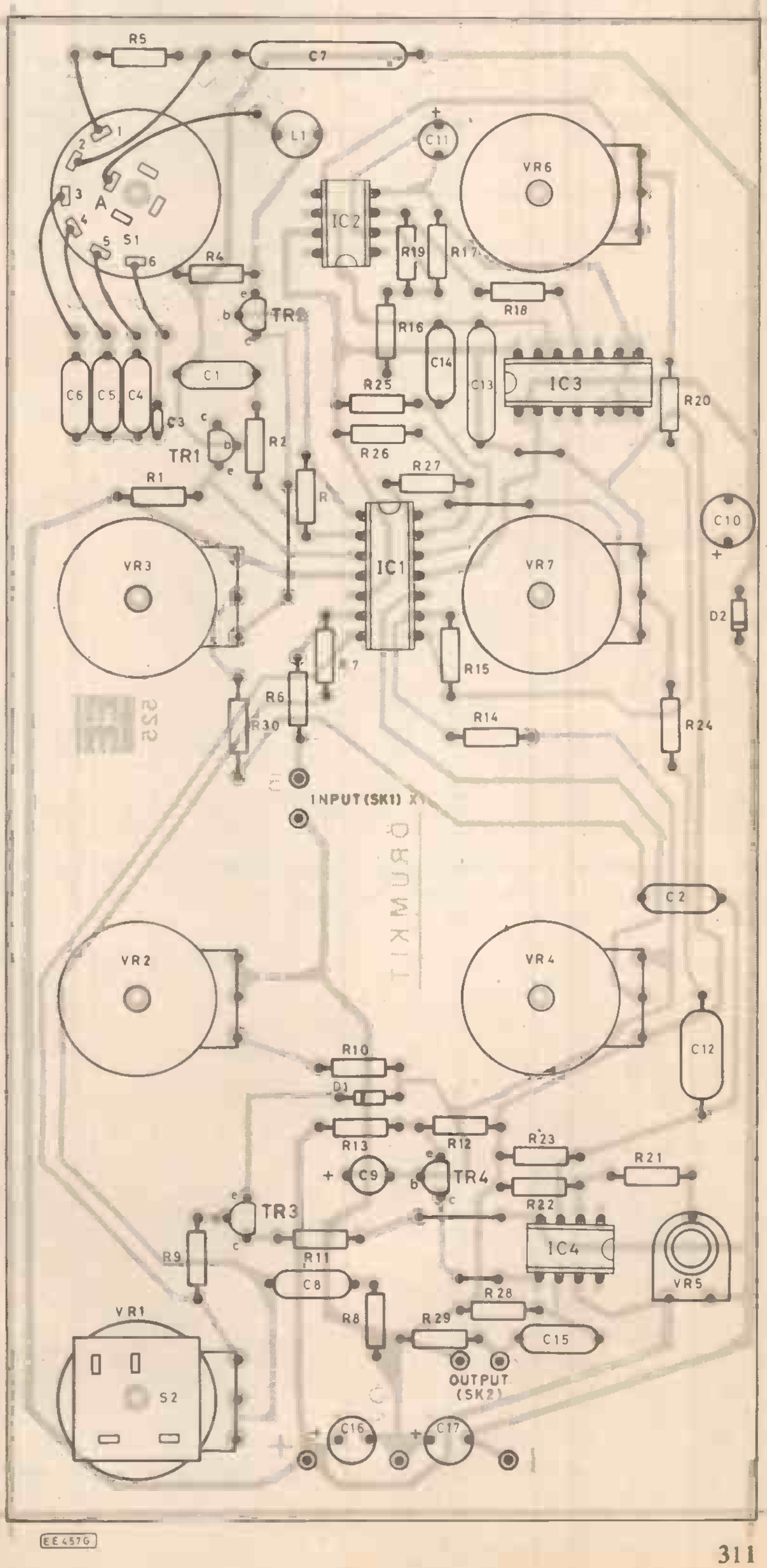
Approx. cost Guidance only **£28.95**

The potentiometers should now be mounted on the board. Carefully bend their tags forward at 90 degrees so that they fit into the appropriate holes. Washers should not be used as the most must be made of the available length of mounting bush to pass through the front panel. Fit one nut to each potentiometer to fasten them to the board, and then solder the tags.

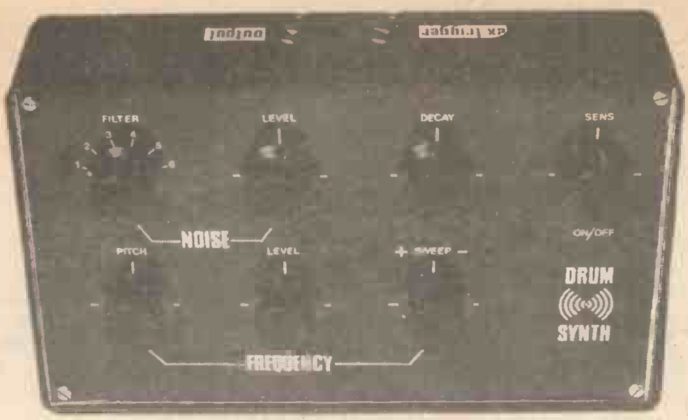
The rotary switch S1 should be fitted with the markings as shown in Fig. 3 and wired to the board using tinned wire as shown. S2 should be wired to the board using insulated wire leads. When all components are fitted refer to the interwiring diagram Fig. 4 and connect the battery clips, jack sockets and piezo electric pick-up. Note that the sockets must be connected exactly as shown as they are switched types. If the specified case is used allow about 20cm of screened wire for each socket.

At this point the circuit is ready for testing (see next section). Assuming the tests are satisfactory the board should be mounted onto the case front panel with one nut at each control. It may help to fit a thin layer of card between the board and the panel to ensure that short circuiting cannot occur if the panel is flexed.

Fig. 3. Component layout on the printed circuit board. The integrated circuits should be mounted in i.c. holders. Make sure that all wire links are in position.

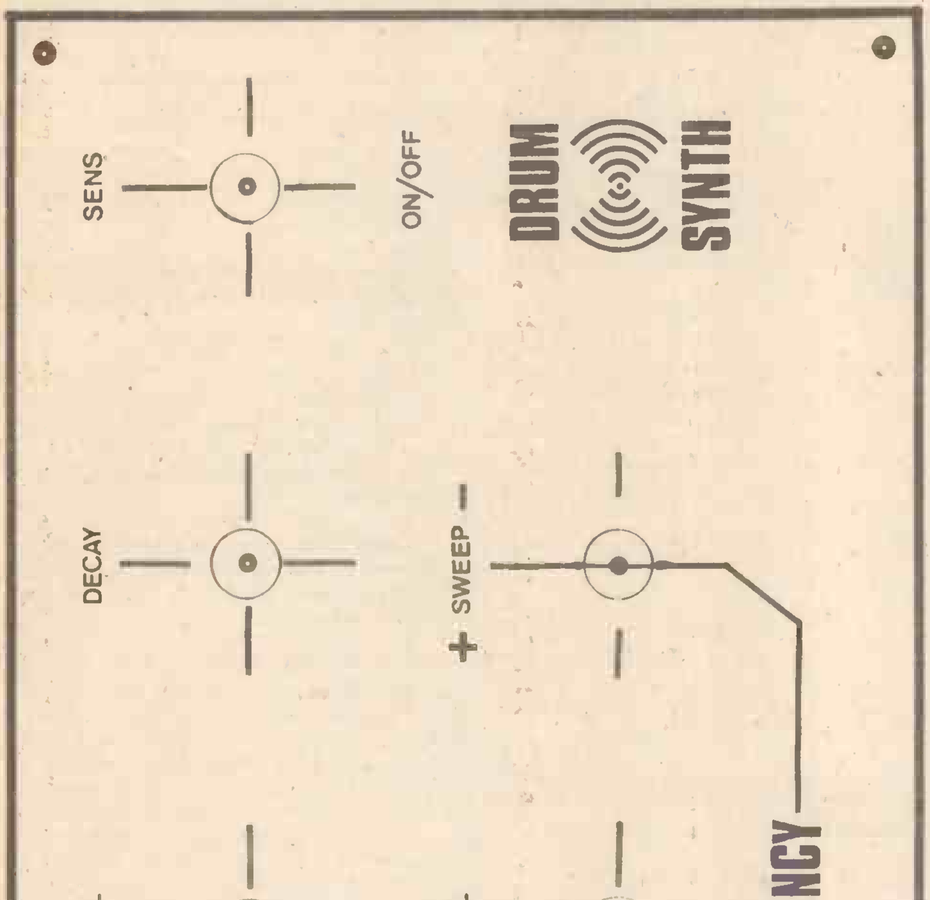


EE 457G



(left) The completed "Drum synth" showing the output and trigger sockets. This allows the sound pick-up to be mounted in a separate "practice pad".

Fig. 5 (below). Full size front panel label used in the prototype.



The pick-up can be mounted anywhere in the case using a piece of double-sided adhesive tape, alternatively it can be mounted separately in a "practice pad" and connected to the socket via a standard jack plug and lead. It is also possible to use an internal pick-up and have a second plug-in one. The socket is wired so that the internal pick-up is disconnected whenever a plug is inserted.

Mount the sockets in a suitable place on the case taking care that they do not foul the board when in position. The batteries can be fixed using double sided sticky pads.

The front panel can be labelled using letraset as shown in Fig. 5. Push fit knobs with skirts that cover the control mounting nuts are recommended. The control spindles will need cutting slightly to get the knobs to fit flush to the panel.

TESTING

Testing should be carried out after the sockets and connectors have been fitted but before the board is fitted to the front panel. Ensure that the transistors, diodes, i.c.s and electrolytic capacitors are correctly fitted by careful visual inspection.

Set VR4 and preset VR5 to mid position and all other controls fully anti-clockwise. Connect the batteries, switch on and advance VR1 to mid position.

Connect the output socket to a suitable amplifier with the volume turned to a low setting. Tap the pick-up to trigger the synthesiser and listen. There will probably be a faint click or else nothing.

Now advance VR3 and trigger again. If the noise generator is working there should be a short burst of noise like an explosion. If all is well check that VR3 varies the noise level and that S1 produces six different sounds. If the noise is present but only at a low level check IC1a, TR2 and associated components.

Next keep triggering and turn up VR7. A low frequency tone should now be present when triggered. Advance VR2 and check that much longer decay times can be obtained for both noise and tone outputs. Check that VR6 varies the pitch of the tone output.

Now check the effect of the Sweep control VR4. At each end of its range the effect should be a very pronouned shift of frequency, sweeping up or down as the note decays.

The circuit consists of a number of independent sections so fault finding should be straightforward. Work back from the output and make d.c. voltage checks around the stages with a multimeter.

The split supply configuration can be confusing so be careful to interpret the readings properly. One useful trick is to connect pin 5 of IC4 to 0V via a 100k resistor, this permanently turns on the output amplifier and enables the results of any tests to be heard.

When everything is working satisfactory VR5 can be trimmed to null any d.c. offset in IC4. Turn VR3 and VR7 to minimum and keep triggering the input. Set VR5 to null out the click produced by each trigger pulse. The setting is not critical. □

SHOP TALK

BY DAVID BARRINGTON

Catalogue Received

We have only just received the latest **Rapid Electronics** *April–September '86 Components Catalogue*, and as a general electronics components supplier, with an emphasis on semiconductor and i.c. devices, we can recommend this company as a very useful source of parts for the constructor. In fact, this catalogue is so well laid out and full of useful component lines that we would put it almost at the top of our list of "most wanted" catalogues.

This latest edition is larger than previous issues and contains 96 pages, most with photographs and illustrations. In addition to semiconductors, there are sections on connectors, p.c.b. equipment, tools and cases.

It contains over 3500 product lines sourced from over 150 manufacturers. Rapid claim that all orders are despatched on day of receipt, including telephone orders received up to 5p.m.

The catalogue costs £1, including postage, and contains a discount voucher worth £1 against future purchases. It is free to schools/colleges or companies, provided it is requested on official letterhead paper.

Copies of the Rapid April–Sept '86 catalogue may be obtained from: **Rapid Electronics Ltd., Dept EE, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD.**

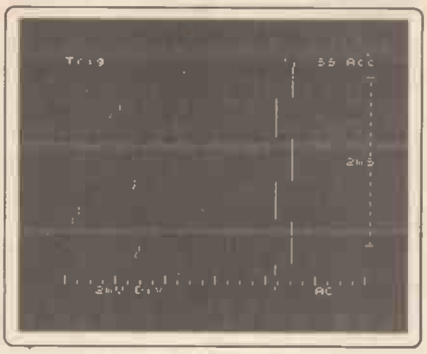
Digital Storage Scope

The more advanced constructors, schools and colleges will be pleased to hear of an oscilloscope add-on for the ZX Spectrum computer. Called the **AliDin** Scope, this new peripheral is a plug-in module with three signal input connectors. This connects to the expansion port on the ZX Spectrum computer and the software is provided on tape or microdrive.

Using the module and software, the Spectrum computer is converted into a digital storage oscilloscope using the TV screen for display. All the normal oscilloscope controls are available, but instead of adjusting knobs and dials, the Spectrum's keyboard is used and the settings are displayed on the screen along with the scales and other useful operating information.

The waveform seen on the screen is a continuously updated waveform, as displayed by any normal oscilloscope, however, the waveform may be captured and held on the screen or in memory while displaying a normal waveform for comparison. A screen copy function is provided, so that waveforms may be recorded on a printer.

These are useful for reports and handbooks, or for comparison over a period of time. The oscilloscope settings, such as timebase, amplitude and trigger mode, etc., will also be printed out since they are displayed on the screen along with the waveforms.



A display from the AliDin Scope module

The AliDin **Scope** module retails at £49.95, complete with a signal lead and handbook. Other features such as single-shot capture and trace accumulation are also included, making this a very useful all-round tool.

The software to drive the module in a "Scope" configuration retails at £24.95. Further software is to be introduced enabling the scope module to work as an intelligent chart recorder, or as a waveform spectrum analyzer.

For a complete specification and further details, readers should write to: **AliDin, Dept EE, 39 Kingsclere Road, Overton, Hants RG25 3JB.**

Code Lock

Ideal for domestic use and for high security areas, such as offices, hospitals, hotels and schools, **Paxton Automation** have just introduced an "electronic controlled keyless lock". Called Touchlock, it consists of a high security fixed bolt latch and microprocessor controlled keypad.

The 12-digit code programming keypad remembers the user's 4-digit entry code, which can be changed in seconds. The fixed bolt latch is designed to meet BS5872 requirements and a novel latch-plate portal allows a door to be put securely "on" or "off" the latch.

The Touchlock programming keypad from Paxton Automation

There is an audible warning programme for entry and exit and a bell-push which operates a door tone or separate doorbell. Extra security is provided by a palindromic code.

The logic circuitry is housed in a control "box" and is powered by four 1·5V batteries, with a claimed life expectancy of two years. There is an automatic battery low condition, audible warning facility, and a defence mechanism which protects against intruders. The control unit also contains a door release button.

Also being marketed is the Touchlock Junior, which incorporates most of the Touchlock system but uses an electronic strike release with the existing cylinder lock in place of the fixed bolt latch.

The Touchlock system sells for around £137, including VAT, and the Junior for approximately £110. For further details, readers should contact: **Paxton Automation Ltd., Dept EE, 64 High Street, Lewes, Sussex BN7 1XG.**

CONSTRUCTIONAL PROJECTS

Percussion Synthesiser

Looking through the list of components for the *Percussion Synthesiser*, the only item that could cause sourcing problems is the "reverse log" potentiometer VR6. This potentiometer is available from **Magenta**.

A complete kit of parts (£29.58, including p&p) for this project is available from **Magenta Electronics, Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST.**

Personal Radio

The only stockists we have been able to locate who lists Ferrite rods for use in the *Personal Radio*, is Cirkit. This is available in two lengths, 140mm (35-14147) and 75mm (35-14757). If readers choose the larger length, extreme care must be exercised when cutting it down to size as ferrite is very brittle and likely to "fracture".

Watchdog

We do not expect any component buying problems for the *Watchdog* project.

The printed circuit board for this project is available through the *EE PCB Service*; code EE524.

Home Telephone

The only item that could cause difficulties when purchasing components for the *Home Telephone* is the telephone handset.

We understand that **J&N Bull** stock the old type handset and these may be used in this project. We would point out that we have not tried them in this circuit, but as they cost only £2 each they are well worth trying. **J&N Bull, Electrical, Dept EE, 128 Portland Road, Hove, Brighton, Sussex BN3 5QL.**

Teach In '86

Kits for the *Teach In '86 Series* have been specially prepared by some of our advertisers. Readers should browse through the advertisements in this issue to locate a stockist nearest to their town.

Actually Doing it!!

IN LAST month's *Actually Doing It* we dealt with the home production of printed circuit boards up to the point where the board is ready for etching. In this article the final stages of production are covered, taking things through to the point where the board is ready for the components to be added. This really breaks down into two main tasks, etching and drilling.

ETCHANT

There are a number of chemicals which can be used for etching printed circuit boards, but only ferric chloride is normally used when producing boards at home. This is a relatively safe chemical to use, but it still needs to be treated with respect.

Some component suppliers sell ferric chloride in the form of a solution which is ready for immediate use, but it is more widely available as crystals or pellets. The crystals look like chunks of yellow-brown rock, while the pellets are much smaller and easier to deal with.

Both types are treated in much the same way, and are dissolved in about two to four times their own weight of water (e.g. 250gms of ferric chloride should be dissolved in about 500 to 1000ml of water). The chemical will dissolve more readily in warm water and the container agitated.

Ferric chloride is corrosive to many metals, and it should never be placed in metal containers. Plastic containers sold as storage bottles for photographic chemicals are of all plastic construction, and are consequently ideal for storing ferric chloride solution. Many glass bottles have metal screw-tops and are unsuitable.

PRECAUTIONS

Although ferric chloride is a relatively safe chemical, it still has some traits which could lead to problems for the unwary. Firstly, it is ***poisonous*** and should never be ingested. Secondly, it is an ***irritant***, and if you get any on your skin it should be washed off at once with plenty of warm water.

The solid forms are deliquescent, which basically means that they can soak up water from their surroundings (even moisture in the air) and turn themselves into a solution. Solid forms of the chemical should always be stored in air-tight containers, but wherever possible it is probably best to store ferric chloride as a solution.

If any pellets or crystals should be spilled, make sure that they are cleared up properly before they have a chance to turn into a mess on the floor. Apart from attacking many metals, ferric chloride solution will tend to stain anything it comes into contact with, and accordingly it is necessary to take great care not to accidentally spill it or let clothing droop into it.

ETCHING THE BOARD

For etching purposes the ferric chloride should be placed into a plastic or glass dish, or any other non-metalic container of adequate size to take the board. The standard approach is to use a flat dish such as the type sold as photographic developing dishes, and to place the board copper side uppermost at the bottom of the dish. This is a less than ideal way of doing things in that etching is generally rather slow unless the dish is almost constantly agitated.

During the etching process the copper replaces the iron in the ferric chloride, so that the etchant gradually changes to copper chloride. This can be seen as a change in colour from the original yellow-brown to a green-blue colour when the etchant is exhausted. The displaced iron from the ferric chloride is left as a precipitate on the surface of the board, and it is this that hinders the etching process unless agitation is used to remove it.

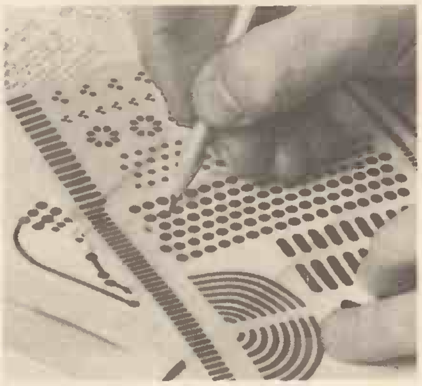
Faster etching can usually be achieved if the board is positioned vertically, or best of all, suspended copper side down in the etchant. With suitably shaped dishes or jars of the appropriate size this is not too difficult to arrange, as shown in Fig. 1.

Dishes and jars sold for use with food are ideal for our present purposes, but it

PICTURE BRIEF

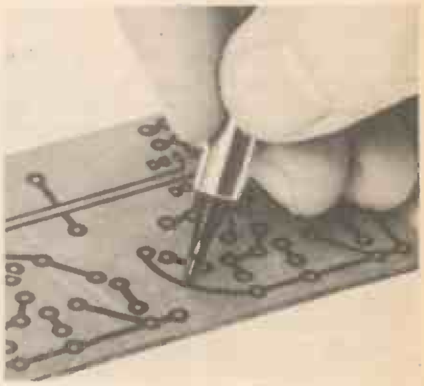
A brief, at-a-glance, guide to one of the many methods of producing your own p.c.b.s.

Some of the constituents required for etching boards: mixing jar; etching powder and plastic tongs. Always add the powder to the water, never the water to the powder.



Applying rub-down transfers ensures a neat, clean finish on the etched board.

Cleaning off the etch resist from the remaining copper tracks. This can be carried out with a scouring cloth or pad.



Using an etch resist pen to "clean-up" tracks prior to etching. These pens can be used for complete boards.

Using one of the many low voltage "mini" drills to drill out the component mounting holes.

has to be emphasised that containers used for etching should not also be utilised with food, and they should be stored and kept well away from food containers and utensils so that there is absolutely no confusion as to which is which.

ETCHING TIME

If you adopt the system which has the board copper side down in the solution, initially have the board copper side uppermost and make sure that it is properly covered with the solution with no air bubbles trapped on the surface. Then turn the board over and agitate the dish slightly. This should avoid having spots of unetched copper on the finished board.

The time taken for etching varies enormously, and can be anything from a few minutes with fresh etchant under ideal conditions, to a couple of hours or more under poor conditions with virtually exhausted etchant. Inspect the board carefully before deciding that etching is complete, as there may be a few small but important areas of copper left unetched.

inevitably very fragile and easily broken, and must be treated with due care.

Long-life drill bits are available, and are probably a worthwhile proposition when drilling fibreglass boards as the glass content in these tends to blunt ordinary drill bits quite rapidly. These drills are mostly very fragile though, and are only intended for use with a miniature electric drill and stand.

Such a set-up is ideal for drilling the component mounting holes, but when you first start making printed circuit boards it is unlikely that you will have access to a suitable tool, or will wish to buy one. The best alternative is a small and inexpensive hand drill used with expanded shank twist drills.

BOARD CLAMP

The board should be firmly held in place while it is being drilled, and one of the many miniature bench or "anglepoise" vices are ideal for this purpose. It is a good idea, when clamping the board in the vice, to "back" the board with a piece of scrap

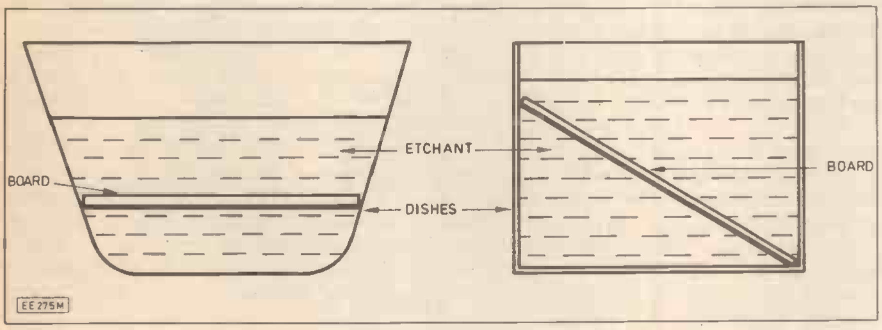


Fig. 1. Method of etching the circuit board copper side down.

Do not leave the board in the etchant longer than is really necessary as this will cause under-cutting of the tracks and pads.

Plastic tongs are used to remove the board from the etching solution, or when manoeuvring the board in any way once etching has commenced. Suitable tongs are available from photographic stores. Hold the board vertically over the dish for several seconds to let as much etchant as possible drain off, and then thoroughly rinse the board under a tap.

DRILLING THE BOARD

The holes at the centres of the pads make accurate placement of the holes quite simple, as the point of the drill will be naturally guided into the centre of each pad. The main difficulty when drilling the component mounting holes is caused by the small drill sizes involved.

I use 1 millimetre diameter holes for components such as resistors and compacitors, 0·8 millimetre diameter mounting holes for semiconductors, and 1·5 millimetres for presets, coils, etc. Ordinary drill bits of these sizes will not fit into many hand and power drills, but some component suppliers can supply miniature drill bits with wider shanks (usually 2·35 millimetres) which will fit most drills.

These are generally somewhat easier to use than ordinary drill bits of the same diameters as they are more rigid, and they are also somewhat less prone to snapping. However, drill bits of these sizes are

softwood. This helps to stop burrs or chipping of the hole as the drill suddenly breaks through.

Resist the temptation to rush through all the holes as rapidly as possible, and proceed with due care. It would be very easy to compromise the quality of the board and break several drill bits by rushing things at this stage.

CLEANING UP

Once all the holes have been drilled there is still one task to complete before the board is finished, and this is the removal of the etch resist. Etch resist remover can be obtained, and this is a solvent which will wash away most types of resist.

However, I prefer to use a polishing block or a scouring pad as this method polishes the copper pads to a very clean and bright surface which will help to produce good soldered joints when the components are fitted in place. If the components are not fitted soon after the board has been finished it might be found that the surface of the copper becomes slightly oxidised (and dull looking) by the time you do get around to using the board. It is then a good idea to polish the board again before fitting the components.

Robert Penfold

END OF AN ERA? . . . BEGINNING OF A NEW?

Our super sleuth Barry Fox reports on the behind-the-scenes developments and possible future paths of the star characters in the "headline news" that Sinclair have sold out to Amstrad for £5 million.

AS YOU will doubtless have read, Sinclair has sold out to Amstrad. News of the Amstrad buy-out broke fast. Sugar and Sinclair talked for a couple of months, finalized the deal over a weekend and the press were phoned on Monday morning (April 7) with invitations to attend a 12 noon conference.

A pointer to the future? It was the PR agents for Sinclair, not Amstrad, who made the phone call. Amstrad has been selling budget audio, CB radio, car audio, TV sets and video recorders for the last ten years. It is only in the last two years, when Amstrad has been trying to crack the computer market, that boss man Alan Sugar has shown any interest in courting the press. And most of the courting has been of financial journalists in Fleet Street.

Like Tandy, Amstrad talks about products only when they are either in the shops or due on the shelves within a couple of weeks. Amstrad has shown no interest, more accurately studied disinterest, in the specialist press. It's unlikely that the name Sinclair will now be linked with much in the way of innovation.

During the press conference Alan Sugar let slip that his deal with Sir Clive Sinclair, £5 million cash for all current and future manufacturing and marketing rights, covers more than computers. If Amstrad wants to, it can use the Sinclair brand name on other hardware, for instance portable hi fi. So there's no reason why there should not be an Amstrad Walkman, labelled Sinclair. As Amstrad buys in from the Far East, it's a depressing possibility.

Alan Sugar (right), Chairman of Amstrad Consumer Electronics with Sir Clive Sinclair at the announcement of the take-over of Sinclair Research by Amstrad.

Manufacturing

The Amstrad factory at Shoeburyness has a staff of three hundred who make whatever the company judges it is economical for them to make. At the moment they are assembling what Alan Sugar calls hi fi, but hi fi buffs would prefer to call audio. It is made up from components sourced from the Far East, for example Taiwan. Amstrad's computers come straight in from South Korea, ready-made.

So what will happen now about the manufacture of Sinclair computers? Currently they are made by AB Electronics in Wales, Timex in Dundee and Thorn-EMI in Middlesex. Thorn looks to be out of the picture. Alan Sugar also let slip that the QL is no longer made and he has no intention of selling it. Thorn made the QL.

Timex is main contractor for the Spectrum and new Spectrum 128. AB in Wales has been

CLIVE TAKES SLICE OF THE ACTION

SIR Clive Sinclair sat at the press conference, looking surprisingly sanguine at hearing his product range written off as games toys for eleven-year-old kids. You can, I suppose, afford to look sanguine when someone else has paid £5m for a failing company, which has been struggling to clear £7m in debts.

I also reckon Sinclair knew it was coming, when on February 13 he launched his Spectrum 128. At the press conference for that launch he acknowledged that "games playing is on the increase and business use is on the decrease."

He seemed curiously resigned to the fact that his computers were being used to waste time. Now we know why. He was probably already considering selling the business lock, stock and barrel to Alan Sugar.

In the beginning Sir Clive, then just plain Clive, sold hi fi systems that didn't work too well. A digital switching amplifier, far ahead of its time, tended to blow up.

Then there were calculators, digital watches, two generations of tiny TVs, a string of home computers which broke the £100 price barrier, the memorably unsuccessful QL, the even more memorably unsuccessful C-5 electric trike and hard-to-swallow promises of satellite dishes for under £100, wafer scale integration and giant memory chips.

Sir Clive still hopes to succeed with wafer scale integration. He promises a 40 megabit memory on a single chip next year. He also plans to pursue what he vaguely describes as "telecommunications" work in Winchester. And if all goes well, he will do "blue sky" research for other companies who need to hire a think tank. The silly electric trike and car project looks as dead as it was clearly destined to be.

No-one knows what goes on for sure at the Winchester telecoms lab, not even engineers at the IBA's laboratory a few miles away. The best bet is that Sinclair's team of seven there are trying to make a budget satellite dish system, and a portable cellular radio of pocket size.

The wafer scale integration idea was patented by private inventor Ivor Catt, over ten years ago. The rest of the UK electronics industry turned the idea down. Sinclair picked it up and 14 people work on it at Metalab near Cambridge.

Work goes on, too, with the flat screen TV tube and Pandora portable computer which uses it. The big question, as yet unanswered, is whether the flat tube—which relies on a fresnel lens to widen the picture to conventional 4:3 format—can provide enough resolution for text processing on screen.

An even bigger question mark hangs over the wafer scale monster chip project. The theory is simple. Chips are conventionally made, a hundred or so at a time, on a single slice of silicon, several inches in diameter. The making a few Spectrum machines. Sugar says he will look at what deals these companies can offer and then decide whether to manufacture in Britain or the Far East. "*We are a computer company, not a benevolent society*," he warns. "*We will see what prices the UK contractors can offer.*"

Fair Trading

So how will Sugar cope with two different ranges of computer, the Amstrad which has 20 per cent of the market and the Sinclair which has 40 per cent (by volume) and will the Office of Fair Trading be worried about a 60 per cent monopoly? Sugar admits he has not talked to the OFT. He may have to.

The double product line also does not worry Sugar. He sees the Amstrad as aimed at the small business market. Sinclair's computers (except the QL which is on the way out) are aimed at the entertainment or games market. "I know there are a lot of eleven-year-olds who are now bored with their computers and have them stuffed under their bed," says Sugar. "But remember there are a lot of ten-year-olds coming up."

Alan Sugar looks pleased at what he has bought. He hopes now to pressure the Common Market Eurocrats into giving him a better deal on imported electronics. "We have to buy our chips from Japan," explains Sugar. "European companies complain and talk a lot about making chips, when actually they are making about three a week. But the people in Brussels protect them by putting an 18 per cent import duty on chips.

"We want Brussels to remove duty where there isn't a European equivalent. That would stimulate UK manufacture. The ball is in the Government's court."

Sir Clive recalls that Robert Maxwell and Pergamon Press were going to rescue his company. The deal fell through. "Alan has a better track record on making computers than Pergamon Press," he muses.

Footnote

Sugar has good reason to be thankful that much of the computer press is staffed by people who know nothing about anything outside the world of computers. They think of Sugar as someone who sells computers, not as someone who has flitted from product to product in the consumer electronics business, and for the last two years happens to have settled on computers.

The computer press have seldom explained that Amstrad uses the 3in., rather than 3½in., disc format (see *For Your Entertainment* April). He did so because the format failed and a half million 3in. drives were on sale cheap.

The computer press has let Amstrad get away with quoting the price of the word processor at £399, when in fact it was £399 *plus* VAT. Sugar says this is because it is a business machine. But so was the QL, for which the price was always quoted including VAT. The instruction manual for the Amstrad word processor may be fine for computer buffs, but it is a pig for human beings.

It will be interesting to see whether, after a few months of dealing with Amstrad on Sinclair business, the computer press changes tune. It will also be interesting to see whether, in a few years time we shall be writing about *Sir* Alan Sugar.

Late News

It has just been announced that, "Any Sinclair computer product which becomes faulty within the guarantee period *must* be returned to the dealer from whom it was purchased. This will safeguard your rights as a consumer under the sale of goods act and will result in a more satisfactory method of repair."

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slice is then diced, and only the good chips used.

Catt's idea is to leave all the chips on the slice, both good and bad. Fusible links and cross connections let the slice diagnose its own good and bad circuits. After self-diagnosis the slice uses only the good areas.

As long as around half the chips are good, the slice delivers the required amount of memory or processing power. It's an interesting idea, and it will be even more interesting to see whether it works on a production scale.

By coincidence the Amstrad sale came just a couple of days after Sir Clive Sinclair put his plush London home, complete with indoor swimming pool, on the market. Now Sir Clive has no jacuzzi and cannot even use his own name in business. *He'll be back, though. He always is.*

Word processors were once only to be found on very expensive main-frame computers. The explosion of micros in the home has led to an increasing awareness of the potential of these versatile machines.

Consequently a new bimonthly magazine, entitled *Word Processing—On the Home Computer*, has been launched by Word Processing of Wolverhampton. The magazine carries features on getting the best out of the printer, regular reviews and latest products.

For further details write to: Word Processing, Dept EE, PO Box 67, Wolverhampton, W. Midlands.

Evaluating Software

The National Computing Centre (NCC) has been awarded a contract by the Department of Employment to produce standard software evaluation procedures and model test reports for micro accounting packages. The NCC will work with the Institute of Chartered Accountants and also in close liaison with HM Customs and Excise with regard to VAT and other statutory requirements.

The Department of Employment has become involved because of its concern about the problems small firms meet when evaluating packaged programs and the job losses that can result from inappropriate decisions and subsequent financial losses, particularly if software packages do not meet VAT or other statutory needs.

AIR-LINK

Airline travellers are about to take off into a new era of trouble free—traffic controllers and airport staff willing—flight arrangements. All they need is an office or home micro and a subscription to Microlink.

The reason is that Microlink, one of the UK's fast growing electronic mail services, can now provide instant round the clock information from the bible of globetrotters, the international Official Airlines Guide (OAG). At the touch of a computer key, Microlink subscribers are linked by satellite to the OAG computer in Oak Brook, Illinois, USA, which monitors the 38,000 changes of fares which take place daily and the 30,000 weekly schedule revisions.

The fares for all airlines on any given route are made available, from the lowest to the highest. The service also boasts an "elapsed time" feature which takes into account the stopover time during flights, so enabling the passenger to select the shortest duration for his journey.

Even for those inexperienced with computers or unfamiliar with airline codes, the OAG is easy to use. It will accept full spellings or airline codes and the user can select information either by single line entries or by using prompts on the system.

"We believe this will prove a major boon to our subscribers," says Derek Meakin, head of Microlink. *"It is yet another significant addition to our growing range of services".*

Retraining Collaboration

Speaking out at a Careers Research Advisory Council conference held in Cambridge recently, the Industry Under Secretary John Butcher announced a small pilot scheme to improve retraining links between colleges and local employers.

"We are proposing that limited DTI grants will be given to colleges to help with the introduction of projects designed in collaboration with local employers," he said. "The contribution of a third from my department is intended to act as a catalyst and enable employers to seriously examine whether much of their training could be better done by their local college both in the short-term, and perhaps more importantly, on an ongoing basis."

The project is still in its formative stage but Mr. Butcher went on to say. "Matching funds are being found, and employers are coming forward with help, both in the form of money and, equally importantly, with advice and technical assistance for the planning of new initiatives."

HOME TELEPHONE SYSTEM

T.R. de Vaux Balbirnie

Efficient communiction for the home, office or workshop

WHEN considering communication between two sites, the intercom springs first to mind. The telephone has certain advantages, however, which sometimes make it a wiser choice. The most important point in its favour is that natural two-way conversation is possible without having to press buttons and wait turns. The telephone gives improved privacy compared with the intercom and is also more intelligible under difficult conditions.

This project could be useful as a means of communicating between the house and a distant garage or workshop. It could be equally useful in offices, factories and shops. Fitted with a long interconnecting line the sytem is also suitable for portable use. The prototype has been tested with the units separated by up to 100 metres. The author is certain that a much greater range could be obtained if need be.

The telephones are made for wall mounting. This is thought to be most useful for the above applications. Although commercial handsets are used, the rest of the system has been redesigned to give a neat and distinctive appearance. The handset at each end hangs by its earpiece in a large hole cut in the front of a plastic box (see photograph). When the handset is removed, internal switching initiates a calling tone at a distant unit. This is automatically silenced when the called party removes his or her handset. A speech circuit is then established.

Traditional bells have been avoided in favour of solid-state buzzers. Bells would increase the size of the boxes and would consume more power. Solid-state buzzers are more reliable and the sound "carries" more effectively under noisy conditions. The tone is also distinctive and the current requirement is so low that excellent life is obtained from a PP3 battery housed in one of the boxes.

As is the case with a commercial system, the calling tone is heard in the local earpiece so confirming that the distant unit is operating correctly. A further point is that the caller hears his or her own voice in the earpiece as well as that of the distant party; this is true with commercial telephone systems too. As well as simplifying the wiring, it also helps the caller to regulate the voice to the correct volume level—an example of biological feedback.

HANDSETS

Before starting to construct the telephone system, find a supplier for the handsets. These may be of any traditional pattern having a carbon microphone and magnetic earpiece. They may be obtained new but used British Telecom units are often available cheaply. Although, if possible, it is better to buy handsets on their own it may be that complete instruments must be bought.

CIRCUIT DESCRIPION

The circuit for the Home Telephone System is shown in Fig. 1. It will be seen that the two stations A and B are slightly different from one another; A has *two* handset-operated microswitches rather than one. Also, the battery is housed in the case of B. The reason for using two single pole double throw microswitches in A instead of just one double pole double throw component is that the former type is readily available.

When a handset is removed from the hole in the case, the appropriate microswitch(es) will move from the down to the up position.

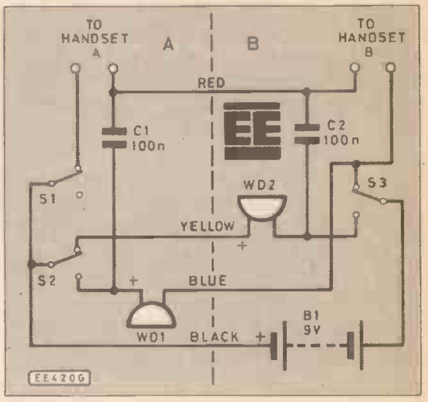


Fig.1. Circuit diagram of the Home Telephone System. Switches shown with handsets removed—speech circuit established.

Consider both handsets at rest with all three microswitches in the down position. No battery current flows since the circuit is broken at S1 and S3. If handset A is now lifted to call B, S2 allows current to flow from battery positive through the yellow wire, through WD2 (so sounding it) through S3 and back to the battery negative. When handset B is lifted to answer the call, S3 breaks the circuit so the calling tone stops, S1 allows current to flow through the local handset (microphone and earpiece in series), along the red wire to the distant handset (microphone and earpiece in series) hence through S3 to the negative of the

COMPONENTS

See Shop Talk page 313

Capacitors
C1,C2 100n (2 off)

Miscellaneous
WD1, WD2 6V solid state buzzers (2 off). S1, S2, S3 single pole, double throw microswitches (3 off). B1 9V PP3 battery and connecting clip. Telephone handsets, British Telecom type with carbon microphones and magnetic earpieces (2 off); plastic cases approx 150 × 80 × 50mm (2 off); four core line wire; connecting wire; aluminium; fixings; solder etc.

Approx. cost Guidance only **£8**

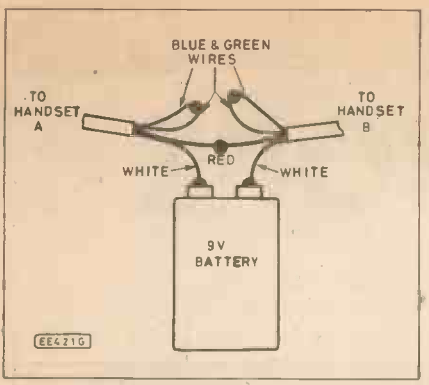


Fig. 2. Method of testing the handsets.

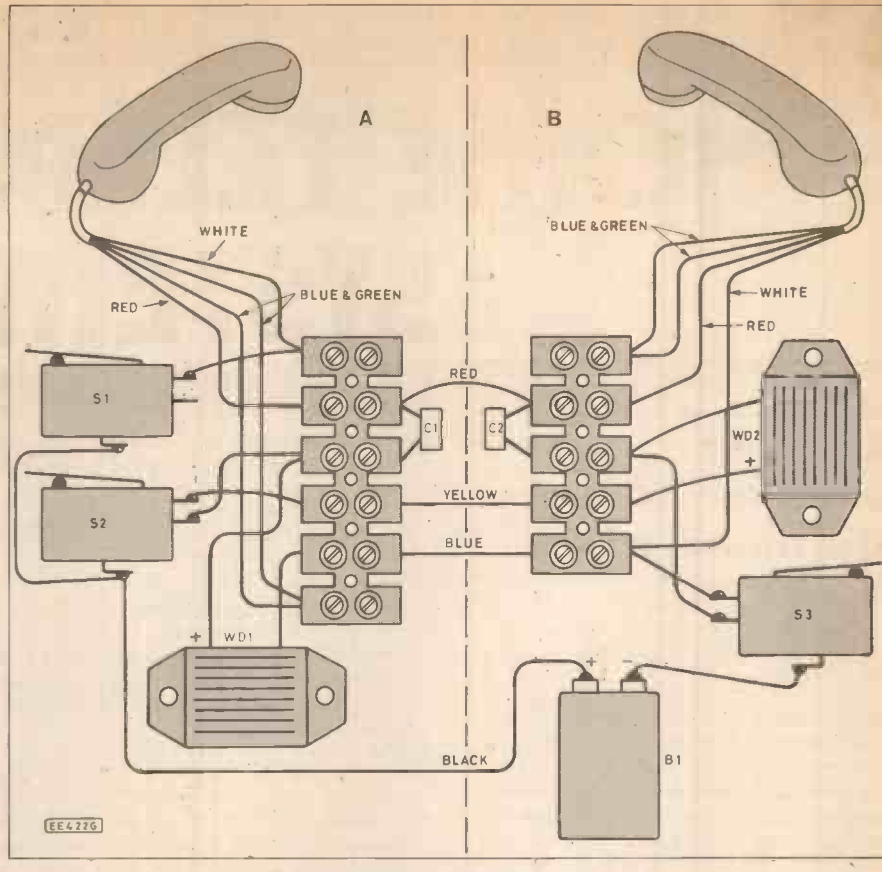


Fig. 3. Complete wiring of the system.

battery. The black wire forms a common return path for both ringing and speech circuits. If B calls A, a similar situation arises with WD1 operating through the blue wire.

Capacitors C1 and C2 allow an a.c. path between ringing and speech circuits. This has the effect of injecting some of the pulsating signal from the distant buzzer into the local earpiece so reproducing the tone. If the sound in the earpiece is too loud, C1 and C2 may be reduced in value.

CONSTRUCTION

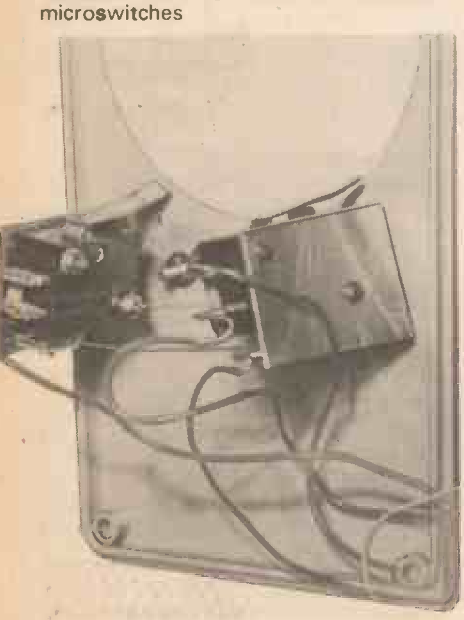
To commence construction, first remove the plastic caps from both microphone and earpiece of each handset and establish the wiring colours. Those of the prototype are shown in Fig. 2 and Fig. 3.

A check should be made to confirm that both handsets are in good working order. This is especially important where second-hand instruments are used. Connect together one earpiece and one microphone wire of each handset (blue and green in the prototype). Connect the remaining handset wires together in series with a 9V battery —see Fig. 2. Check that conversation is possible from one handset to the other. If this is so, construction may proceed.

Measure the diameter of the earpieces (66mm in the prototype). Cut a hole slightly larger than this in the front of each plastic box. Check that the earpieces may be inserted and removed *easily* see photo.

Make holes in the sides of the cases for the handset and line wires. If a British Telecom square grommet is fitted to the handset lead make use of this. Cut keyhole shaped holes in the rear of each box for mounting the units on the wall later. Make aluminium brackets to support the microswitches (see photographs). Attach the microswitches and mount the brackets in position. It may be necessary to cut a little from the ends of S1 and S2 terminals to allow the lid to be fitted to the case. If terminals need to be bent, proceed carefully or cracked microswitch bodies may result.

Photo showing mounting of the microswitches



Mount WD1 and WD2 on the base of the respective cases. Sufficient sound will emerge through the large earpiece hole. Note that the buzzers are *polarised* and will not work if connected the wrong way round.

Connections are made to a 6-way terminal block in unit A and a 5-way block in unit B (see Fig. 3). Those blocks can be glued or screwed inside the cases and must not interfere with the action of the micro-switches. Wires may be soldered direct to the micro-switch terminals if reasonable care is taken. The type of wire used for the handset leads may prove a problem to connect. A good method is to bind the bared ends with thin copper wire (for example, five amp fuse wire) before offering them up to the terminals.

TESTING

Mount the cases on the wall and check that both handsets are easily inserted and removed. Listen for the clicks of the micro-switches and make certain that these work reliably; make minor adjustments as need be.

Link the units together using four core cable. If this is not available, use four runs of single wire twisted together. Use four different colours for identification. The lightest duty wire is perfectly satisfactory.

Connect the battery and secure to the rear of case B using a mirror fixing pad or something similar. Check the operation of the entire system. When a handset is replaced after a call, the local buzzer will sound until the distant handset has been replaced too. This effect is common with other simple telephone circuits and is simply ignored.

Just one disadvantage of the system. You might find yourself too easily contacted to do the washing up! □

Although the analogue port of the BBC computer is included primarily for use with games controllers, as discussed in the two previous articles, it can also be used to good effect in accurate measuring applications. The converter is not a high speed type, and it provides only about one hundred conversions per second. The four inputs are provided by a multiplexer and a single converter. In other words, each of the inputs is connected to the converter in turn, and a reading is taken and stored for each channel. This process continues indefinitely, and when reading a channel the value returned is actually the last one to be taken and stored for the relevant channel, and it is not necessarily an accurate representation of the current input voltage.

In practice most applications do not require a vast number of readings per second, and the BBC machine's converter is probably capable of far more conversions than will normally be required. With all four channels in use the maximum number of readings that can be taken is about 25 per channel, but using the *FX16,X operating system commands it is possible to switch off some of the channels to maximise the number of readings on the channels that are used. Details of these commands are provided below:

*FX16,1	Enables ADVAL(1)
*FX16,2	Enables ADVAL(1),(2)
*FX16,3	Enables ADVAL(1),(2),(3)
*FX16,4	Enables all ADVAL channels (default setting)

If only one channel is in use it may be worthwhile using ADVAL(1) plus the *FX16,1 command to boost the maximum number of fresh readings from 25 to 100 per second. Applications such as audio digitising (which require many thousands of readings per second) are clearly beyond the capabilities of the analogue port even with only a single channel being utilized, but many useful applications such as temperature measurement, and the measurement of electrical quantities (voltage, resistance, capacitance, etc.) are not.

Accuracy

The accuracy of the port is quite good as it is a twelve bit type. Unfortunately, it is not guaranteed to have more than ten bit accuracy and resolution, and in practical applications even this level of accuracy may not be achieved. The problem is mainly caused by noise picked up at the input of the converter, and with a steady input voltage the returned readings tend to fluctuate slightly. Where operating speed is not a problem it is possible to obtain improved accuracy by taking a number of readings and then averaging them, but in most cases this is not really necessary.

Ten bit accuracy is better than 0·1 per cent, and is obviously better than that provided by many electronic measuring devices, including some expensive up-market types. In fact in most cases the overall accuracy of the system will be determined predominantly by the circuit placed ahead of the analogue port, rather than the port itself.

Voltage Measurement

The full scale value of the analogue port is nominally 1·8 volts, and readings are in the range 0 to 65520. However, as explained in last month's article, the values increment in 16s, and returned values must be divided by 16 to give a range of 0 to 4095 with increments of one. In normal use the returned values will require a certain amount of further manipulation in order to provide values directly in volts, amps, or whatever the port happens to be measuring. While it is possible to use complex software calculations to manipulate readings in order to provide the correct relationship between PRINTed values and whatever is being measured, it is generally best to arrange things so that there is a fairly straightforward relationship between the two and only some simple mathematics is required.

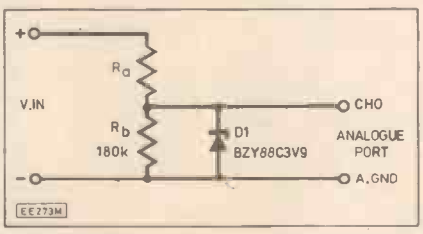


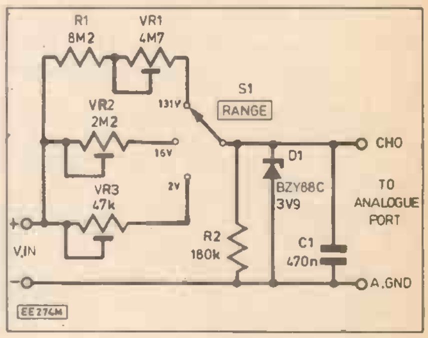
Fig. 1 (above). The basic voltage measuring circuit.

Fig. 2 (right). A simple three range voltmeter add-on.

As an example, the computer could be made to measure d.c. voltage by dividing returned values by 36400 (65520/1·8 = 36400). The problem with this method is that many returned values when divided by 36400 give a result which runs to many decimal places. Of course, the software could be made to limit the number of decimal places printed on-screen, but a more reasoned way of doing things is to scale the full scale input voltage to match up well with the 12 bit resolution of the converter. This is easily done by either adding a d.c. amplifier to boost the sensitivity of the port, or using an attenuator to reduce it. By reducing the sensitivity slightly to 2·0475 volts full scale, dividing returned values by 32000 then gives correct voltage values, with a resolution of 0·5 millivolts (0·0005 volts). This is more sensible than the original method, with its resolution of 0·4395 millivolts.

Reducing the sensitivity at the analogue inputs is very straightforward, and is simplified by the fact that the input resistance at these inputs seems to be extremely high, and can normally be ignored. Fig. 1 shows how an attenuator can be added to the analogue port, and although this is shown as connecting to the CHO input, it will of course work with any of the other channels. Resistor R_b sets the sensitivity in terms of ohms per volt, and a value of 180k with a full scale voltage of 1·8 volts gives a sensitivity of 100k per volt (180k/1·8 = 100k). The value of R_a for a given full scale voltage is easy to calculate, and is obtained by first multiplying the required full scale voltage by 100k to give the total resistance required, and then deducting the 180k contributed by R_b. For example, a full scale voltage of 8 volts would require a total input resistance of 1440k, and deducting the 180k of R_b from this gives a value of 1260k (1·26M) for R_a.

Diode D1 is a Zener diode which protects the analogue port against gross overloads. Small overloads do not cause any problems, but potentials of about five volts or so can cause the converter chip to malfunction. Switching off the computer for a few seconds and then switching on again seems to restore normal operation, but obviously a severe overload could permanently damage the converter and should be avoided.



Ranges

Usually it will be necessary to use a preset resistor (or a preset and a fixed resistor in series) for R_a. One reason for this is that the required value is unlikely to be a preferred value, or even one that could be made up from two or three preferred values connected in series or parallel. Another reason is that the use of a preset enables the full scale value to be trimmed to precisely the correct voltage, with any errors due to resistor tolerances or the true full scale voltage of the converter being other than precisely 1·8 volts being trimmed out. Fig. 2 shows the circuit for a three range d.c. voltmeter with full scale values of 2·04, 16·38, and 131 volts. C1 is used to minimise problems with noise being picked up at the output of the unit, which is at quite a high impedance.

Calibration

In order to calibrate the unit it must be fed from a known voltage that is something approaching the full scale value of the range being calibrated. The appropriate preset is then adjusted for the correct reading. For instance, on range one the unit can be calibrated against using a 1·5 volt battery, with an accurate multimeter being used to find the precise battery voltage. The three ranges are calibrated separately. The accompanying listing gives suitable software for use with the unit. This is an uncomplicated program which uses function keys 1 to 3 to select the range (which basically just means setting the right divisor). Displayed values are limited to three decimal places in order to give clearer readings on range one with no real loss of accuracy.

The analogue port can be used to measure anything that can be converted to a proportional voltage, and with the aid of the user port things such as autoranging are possible. These are topics that will be pursued in future articles.

REVIEW

Printer Commands Revealed

Printer manuals are not always the most easily understandable of documents. There are a few good ones (notably with Juki printers) but others can be obtuse, and a few are downright misleading.

The example programs demonstrating printer features are normally given in Microsoft BASIC. This can be awkward for BBC Micro users as the BBC VDU printer commands bear little resemblance to the Microsoft LPRINT equivalents.

Watford Electronics have now published a booklet, entitled *"Printer Commands Revealed"*, to solve this problem. Specifically for the Epson FX80 and RX80 and the Kaga/Taxan printers (and also the identical Canon models), it gives the printer control code sequences in BBC form, and also gives demonstration programs in BBC BASIC. It also gives the control sequences as used with the Wordwise word processor. In fact, much of the information will apply to any of the many Epson compatible printers available.

This book does not replace the printer manual, in fact, it gives page references to the printer manual for each feature. There are a couple of pages of information on using printers with the BBC Micro, however.

You should not expect too much from the book. It is not a full treatment of what can be achieved with dot matrix printers, but is really only what the title says, a translation of the control codes. Given that, the price of £5.99, for what is quite a small, ring-bound booklet does seem a bit excessive.

However, what it does it does well, and many owners of BBC micros and Epson-compatible printers should find it useful.

Watford Electronics are at Dept EE, 250 High St., Watford WD1 2AN. Tel. 0923 37774.

*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.*

LISTING 1: THREE RANGE VOLTMETER

```
>
   10@%=&2030A
   20*FX225,160
   30MODE 7
   40VDU23;8202;0;0;0;
   50PRINTTAB(0,2);"Select ranges 1 to 3 with func
tion keys."
   60PROCrange(161)
   70PRINTTAB(33,10)"Volts"
   80PRINTTAB(33,11)"Volts"
   90REPEAT
  100K=INKEY(0)
  110IF K<>-1 THEN PROCrange(K)
  120PRINTTAB(10,10);CHR$(141),ADVAL(1)/divisor
  130PRINTTAB(10,11);CHR$(141),ADVAL(1)/divisor
  140UNTIL FALSE
  150
  160
  170DEF PROCrange(range)
  180IF range=160 OR range>163 ENDPROC
  190range=range-160
  200IF range=1 divisor=32000
  210IF range=2 divisor=4000
  220IF range=3 divisor=500
  230PRINTTAB(0,20);"Range selected is ";LEFT$(STR
$(range),1)
  240ENDPROC
```

ECONOMICAL REPAIRS

L. J. STEAN

It is not generally appreciated that many of the problems that can cause electronic consumer equipment to malfunction are due to relatively minor faults. The high prices charged by the shops that specialise in these repairs are a reflection of the high cost of skilled labour, and the amount of time that must be allowed for, in order to repair some of the very complex faults that occasionally do occur.

In this brief article I will attempt to give the reader an outline of some general fault-finding techniques which may be used on a variety of different items. It is very often the case that a cheap cassette recorder or radio will be consigned to the dustbin when it fails to operate properly. These hints and tips may be useful enough to considerably extend the lifetime of these appliances. They may also come in handy when appliances are purchased cheaply from jumble sales and market stalls.

Many people who are capable of constructing highly sophisticated electronic projects may be unduly daunted by the prospect of tackling a repair to a factory made appliance. It is hoped that this article may demonstrate that many of these repairs are within the reach of the home constructor. In no way is the article intended to be comprehensive and readers should understand that it is simply not possible for *EE* to assist readers with information or advice on commercial equipment.

TRANSISTOR RADIOS

In these days of multi-function digital apparatus, the "tranny" no longer seems the marvellous technological innovation that it appeared to be during the nineteen fifties. However, they still come in useful in many locations such as the bathroom and the garden shed.

When considering the purchase of a radio from a sale, there is often some uncertainty over whether it is working or not. It is worthwhile carrying a few batteries on these occasions so that a test can be made on the spot.

After the radio has been brought home give it a complete external visual inspection and make a note of any defects such as missing knobs and loose switches. Open the battery compartment and look at the terminals. If they show any signs of corrosion they should be cleaned with a piece of very fine emery paper until no trace remains of the greenish deposit. The battery compartment can be cleaned with a cloth that has been slightly dampened with methylated spirit. It is surprising how many battery operated articles are discarded due to this fault, which is usually caused by leaving zinc-cased batteries inside the apparatus whilst it is not in use.

Try turning the tuning indicator. If the marker does not appear to move the drive cord may be broken. The tuning knob is usually connected to the tuning capacitor by a nylon cord via a series of pulleys. It may require some experimentation to find the exact arrangement that will operate the tuning drive successfully and it can be an aggravating task on some badly designed radios. Nevertheless, this is a common fault to find on discarded radios, and one that needs no specific knowledge of electronics to rectify.

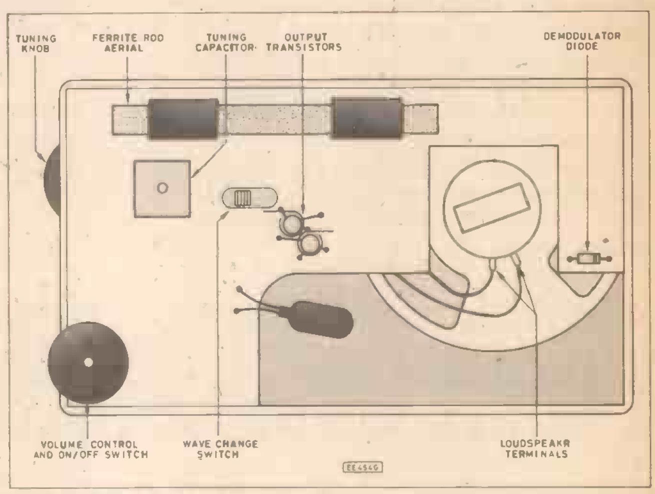


Fig. 1. Simplified layout diagram of an old MW/LW transistor radio showing the main features.

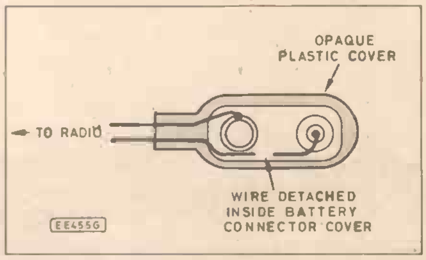


Fig. 2. Check for a break in the battery connector lead underneath the plastics cover.

You can now connect up the radio to the correct type of battery or to a variable power supply set to the correct voltage. Switch it on; if no sound at all comes from the radio do not despair. Disconnect it and remove the back (Fig. 1). Find the two leads from the loudspeaker terminals and check for continuity back to the main circuit board using an ohmmeter set to the lowest resistance range. Do the same with leads from the on-off switch and the battery leads.

A common cause of malfunction in radios using "snap on" battery connectors is a break in the wire underneath the plastic cover due to the bending stresses which come about when the batteries are changed. All appears to be intact to the naked eye but the meter soon shows up the fault (Fig. 2).

If the on-off switch does not make an audible click, it is probably faulty and will have to be replaced. Another "no-go" condition is due simply to minute traces of dirt and grease on the contacts of the wavechange switch. Alternatively, the radio may only function on one waveband. It is always a good plan to clean these mechanisms when the radio has not been in use for some time by spraying them with an aerosol switch cleaner. However, make sure that the brand that you use does not attack plastics or the radio itself will show signs of disintegration! A crackly noise and intermittent operation is probably a sign that the volume control potentiometer needs cleaning in the same way.

Another fault occurs when one of the windings on the ferrite rod aerial becomes detached from the circuit board. This will either put one waveband or both out of action. A little detective work with a magnifying glass may reveal the break. In fact it is a good idea to examine the circuit board fairly carefully to see if there are any cracks in it, and to look for components with broken leads.

DISTORTION

If there is considerable distortion to the sound, or if there is a complete absence of sound after making the other checks, it is probably worth testing the output transistors. These are usually grouped closely together. They may have heatsinks on and they will have at least one connection directly to the loudspeaker. These transistors work harder than any of the others and have more of a tendency to fail. They should be unsoldered from the board and checked on a transistor tester or multimeter for the usual fault conditions, and replaced if necessary.

The glass demodulator diode occasionally goes open-circuit; a slight hiss may be heard from the amplifier but no stations will be received. Replacement is an easy matter once the correct diode is located.

If by now results have not been forthcoming, it is probably best to consign the radio to the spare parts draw. Other faults that occur call for a detailed knowledge of a radio beyond the scope of this article. In my experience however, the above simple faults account for over 50 per cent of those found in discarded radios.

PORTABLE CASSETTE RECORDERS

Portable cassette recorders, usually originating from the Far East, and bearing a variety of unfamiliar brand names, are also proliferating on the secondhand market. They all use transistors, and can usually operate on mains or batteries.

The switches, leads, and circuit leads can all be checked in the same way recommended for radios. There are some special points on recorders which may require attention.

It is a good idea to make sure that the tape heads are clean otherwise recordings will sound faint or distorted. A special head cleaning cassette may be used, or a matchstick with a small piece of cloth wound around it and dampened with methylated spirit may be rubbed gently on the heads to remove all trace of oxide. It is usually only necessary to press the "Play" switch to expose the heads to view. It is also important not to bring any metal object too near the heads as they may become magnetised. A pronounced hiss will then be noticeable on playback and a demagnetiser will have to be procured to rectify the condition.

A small screw at the side of the playback head is used to adjust the azimuth angle. If playback sounds muffled delicate adjustments should be made to this screw whilst a tape is playing to secure the brightest tone possible. Special tapes with audio tones are available for adjusting the heads on hi-fi equipment but are not really necessary for cheap recorders.

If the speed of the recorder is slow or uneven the drive band is the usual culprit. These rubber bands become stretched with age; they are usually fairly easy to replace although the recorder will have to be partially dismantled. Keep a careful note of the locations of the various small screws as they are easily forgotten whilst band replacement is being tackled. Audio shops often stock replacement bands for recorders so be sure to save the old one so that the correct size replacement is purchased.

RADIO-CASSETTE RECORDERS

The combined radio and cassette recorder need not be treated in any way differently than the separate appliances. Do not let the compact circuitry dissuade you from looking for simple faults. The extra switches may need replacement or cleaning if only one part of the machine operates. Some of the newer equipment now use integrated circuit amplifiers and unless you are experienced at handling these, it is wise not to attempt replacement.

RECORD PLAYERS

I will only discuss those record players with transistor amplifiers here although some of the remarks will apply to older models using valves. The examination of the amplifier and speaker proceeds along the same lines as that given in connection with radios. However, first of all check the condition of the stylus by inspecting it for wear with a magnifying glass. Make sure that the delicate wires coming from the cartridge are securely fastened. If the sound seems distorted changing the cartridge often solves the problem. Some record players will accept a signal input to the amplifier from another source. If this sounds alright then you can be reasonably sure that the stylus or cartridge is at fault.

If a mechanical fault exists on the autochange or turntable, it is probably a good idea to look around for obvious causes, e.g. broken springs or loose screws, but unless you are mechanically minded it is wise not to spend too much time attempting a repair. The mechanisms are often complicated and vary according to the design of the individual manufacturer.

GENERAL NOTES

It is important to retain a methodical approach when attempting to repair a piece of equipment that is being dismantled for the first time. Keep a careful note of any wires that you have to disconnect and keep all the nuts and screws in a small container. Otherwise much time can be lost scrabbling around on the floor looking for a necessary part. Refer to other articles on soldering and testing components if you are uncertain in these areas. The use of a signal generator can be of much help if you decide to tackle circuit board repairs.

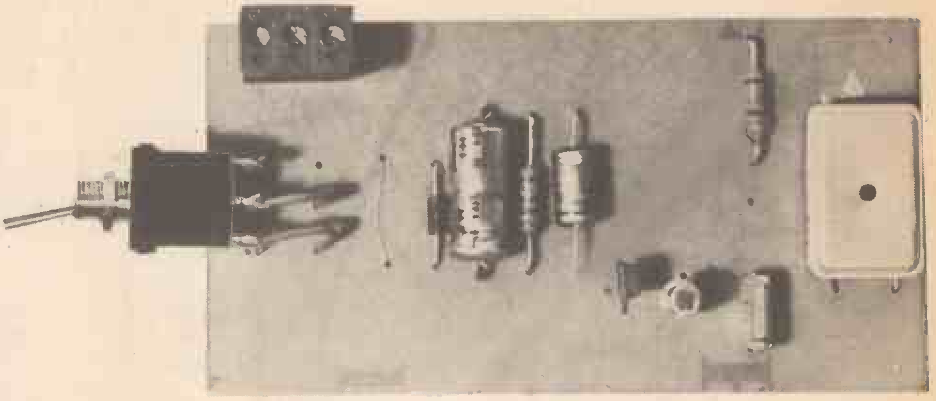
In these days of rapidly increasing service charges it makes sense for everyone who has an interest in electronics to feel confident enough to look at their own mass produced equipment if it starts to play up. You may not find the fault every time but in the end you will be bound to save on some repair bills . . . thus saving cash to spend on projects!

Very often the value of the equipment is less than a potential repair bill and therefore it is well worth having a go at repairing the unit before discarding it. □

WATCHDOG

MICHAEL PERROW

Electronics to watch your car battery, by reminding you to turn off the lights



It is probably just a matter of time before anyone who drives a car gets caught out with a flat battery as a result of leaving their lights on when the vehicle is left unattended. In winter this can happen all too frequently—having set off to work in pitch darkness and arriving at work in broad daylight. Beware, though, I have been caught in summer, too. A sudden downpour, dull skies, poor visibility etc., on go your lights. You continue driving and the weather gradually improves but of course you forget about your lights. When you park up your battery is slowly drained of energy and when you return the engine will not even turn over.

Having been caught out many times I decided to bring some electronics to the rescue. "Watchdog" was conceived as a simple but effective lights-on reminder. The p.c.b. has deliberately been designed to be large so that even if this is your first attempt at a project you will stand a very good chance of success. It is also an ideal project to try your hand at making your own printed circuit board, if you so wish (see *Actually Doing It*).

HOW IT WORKS

Transistors TR1 and TR2 (Fig. 1) form a very basic audio frequency oscillator which will generate an audio note of about 800Hz (with the component values shown) providing that there is a potential difference of about 10 volts between points A and B.

Switch S1 is shown in the "Watchdog" position. With the ignition switch on but with the sidelights off the 12 volts positive from the car battery is fed via the ignition switch and the S1a to point A; point B also assumes 12 volts positive. If the sidelights are now switched on there is still no change because the 12 volts positive via the light switch, S1b and D1 still leaves point B unchanged. In both these conditions there is no output from the oscillator. However, if the ignition is now switched off with the lights still on, point B stays at 12 volts but point A goes down towards earth via R2. There is now a potential difference between points A and B and the oscillator functions giving an audio output in the speaker. Thus indicating that your lights have been left on.

COMPONENTS

Approx. cost Guidance only **£5**

See Shop Talk page 313

Resistors
- R1 68k
- R2 820
- ½W carbon ±10%

Capacitors
- C1 100n
- C2 4·7μ elect. 15V
- C3 100μ elect. 15V

Semiconductors
- TR1 ZTX109 or BC109 (npn)
- TR2 ZTX502 or BC327 (pnp)
- D1 1N4001

Miscellaneous

LS1 50 ohm (or greater impedance) loudspeaker; S1 2-pole-changeover switch; connecting wire; three-way connecting block; printed circuit board (available from the *EE PCB Service order code 524*)

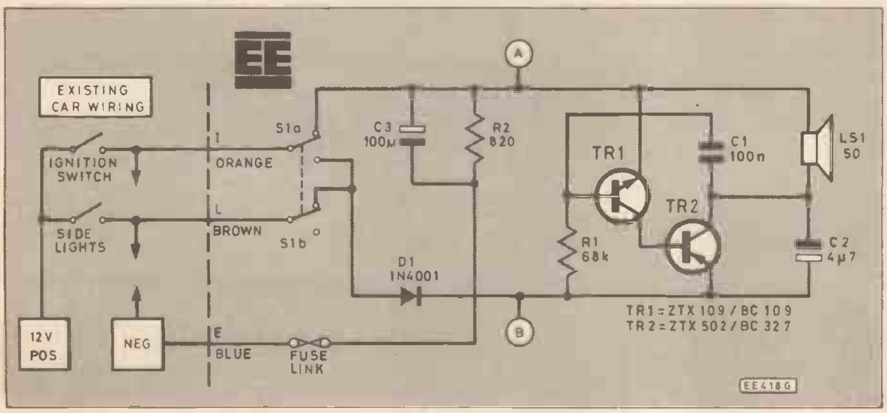


Fig. 1. Complete circuit diagram of the Watchdog. Wiring to the left of the broken line shows connections to the car. See text for reference to the fuse link.

Should you wish to park with your lights on—no problem—just change over S1. This will remove the 12 volts from point B because S1b is now open. In this condition when you return and switch on the ignition then point B will again assume 12 volts via

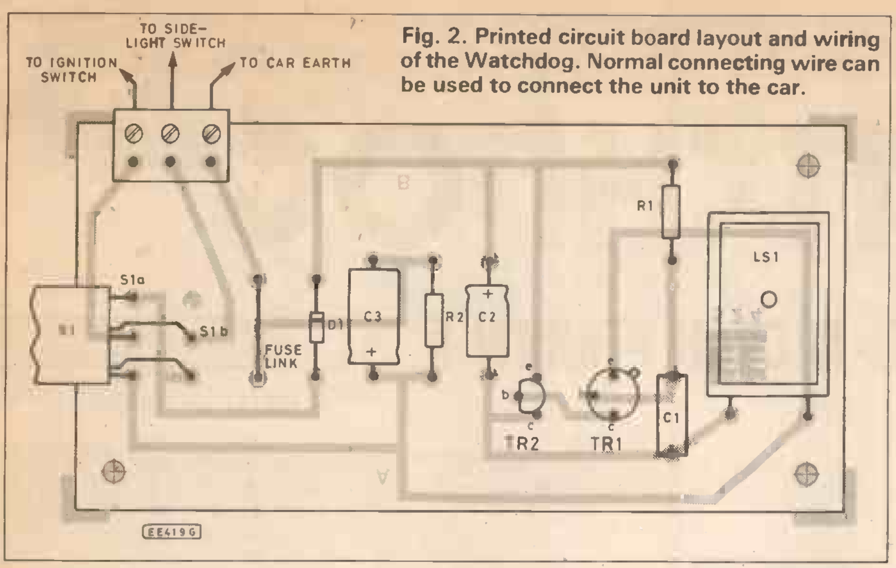
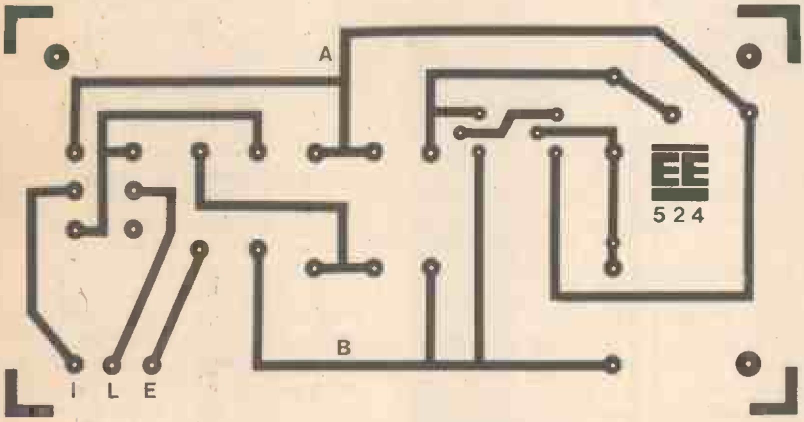


Fig. 2. Printed circuit board layout and wiring of the Watchdog. Normal connecting wire can be used to connect the unit to the car.



S1a and D1 and the oscillator will sound. This will remind you to switch the circuit back into the "Watchdog" position.

CONSTRUCTION

Referring to Fig. 2, mount the switch, capacitors and resistors in their correct positions. Note capacitors C2 and C3 are polarised and must be connected the correct way round, as must the diode. The two transistors can then be mounted. Any available loudspeaker with an impedance of 50 ohms or above can be used—the smaller the size the better. The fuse is simply a single strand of wire taken from a length of multi stranded hook up wire. This saves having to buy a fuse and fuse holder and helps keep down costs whilst still providing a measure of protection.

The casing and mounting is left to the individual and will vary depending upon the type of car and mounting position. When the unit has been built, the oscillator can be tested out by connecting 12 volts between points A and B—B is positive.

Using the coloured wire indicated, connect the orange lead to the switched side of the ignition and the brown lead to the switched side of the sidelights. The blue wire should be connected to any suitable good earth. You may need to refer to the electrical wiring diagram for your car to establish the most suitable positions to connect up the wires.

Once the unit is connected, test it by switching the lights on with ignition off—"Watchdog", should sound—switch S1 over—"Watchdog" should go quiet. Next, turn on the ignition—"Watchdog" should sound again, until S1 is reset. □

The Man Behind the Symbol

No10 Joseph Henry

by Morgan Bradshaw

LAST month we met Michael Faraday and the dynamo. At about the same time, working independently, 3000 miles away in America on the problems of induction was Joseph Henry who gave his name to the unit of inductance. (See Table 1.)

Henry was born in Albany, New York, on 17 December 1797, the only son of Scottish immigrant parents. Attending a local country school until the age of 13 he showed "little interest in study". He began his career as a watchmaker's apprentice. At the age of 16 he chanced upon a book, *"The Problems of Natural Philosophy"*.

This changed his outlook on life and interests so much that he enrolled as a student at the Albany Academy where he studied Chemistry, Anatomy and Physiology with a view to becoming a doctor. In 1825 he received an unexpected appointment to survey a route for a road across New York State from the Hudson River to Lake Erie, this broadened his interests to engineering.

In 1826 he returned to the Albany Academy to teach mathematics and natural philosophy, and it was here that he started his first experiments in electromagnetism. Henry was the first to insulate wire for the magnetic coil. He also invented the "spool" or "bobbin" winding which allowed electromagnets to be wound with extremely long lengths of wire.

The resulting electromagnets were more sensitive than their predecessors and could be used for the detection of electric currents sent over great distances. Electrical dynamos or motors use the electromagnet in practically the form in which it was left by Henry.

Photo: Courtesy IEE Library

TELEGRAPH

Using such a magnet in a mile long electric circuit of copper wire Henry, in 1830, caused a small bell to ring at the end of the line. This is believed to have been the first electrical magnetisation of iron at a remote point, the starting point of the telegraph.

Transferring to the College of New Jersey (later to become Princeton University) in 1832, Henry startled the campus by setting up a telegraph line between the laboratory and his house: He added the "relay" to his telegraph machine, and is believed to have been the first to use the earth as a return conductor.

It was also in 1832 that he published his paper on self induction. He found also that a second induced current could induce a third: the third a fourth: and so on, indefinitely, and that these currents could be induced at a distance.

Some of his experiments on induction involved the transmission of electric force without wires through the floors and walls of buildings, and in one case he magnetised a needle by the transmission from a lighting flash eight miles away. This appears to be the earliest record of the action of electromagnet waves of the type employed in radio telegraphy and telephony today.

The discovery of the oscillatory character of the electrical discharge came in 1842.

LONDON

Henry has been called the "Father of the Wireless Telegraph". Early in his career Samuel Morse of Morse Code fame came to Henry for advice and in 1837 when visiting London, Henry helped Cook and Wheatstone who were constructing their telegraph line along the Great Western Railway.

Whilst in London Henry took the opportunity of meeting his competitor Michael Faraday. He had actually duplicated Michael's fundamental discovery of electromagnetic induction early in 1832. A contemporary recorded "The two great men met at King's College, London, as friends not as competitors or enemies, talk was soon replaced by experiment".

In December 1846 Henry resigned the Professorship of Natural Philosophy at Princeton to become the organiser and first secretary of the newly formed Smithsonian Institute. Under his secretaryship government support for all scientific activity was enlisted, but not content to be known only as an administrator, Henry continued with a wide range of practical experiments in various fields, ranging from researches in meteorology, which laid the foundation for the US Weather Bureau, to the invention of a new method for determining the velocity of projectiles.

Table 1: The Henry (*H*)

The unit of self and mutual inductance was named in recognition of Joseph Henry's work by the International Electrotechnical Commission at a meeting in Chicago in 1893, who defined it as the inductance of a closed circuit in which an e.m.f. of 1 volt is produced when the electric current in the circuit varies uniformly at the rate of 1 ampere per second.

Mutual Inductance

When two coils are coupled by their magnetic fields, a changing current in one coil will produce a changing magnetic flux and induce an e.m.f. in the other coil. The mutual inductance is a measure of the closeness of the coupling between the two coils.

Self Induction

When the current flowing through a coil changes, the accompanying change of magnetic flux will produce an e.m.f. which tends to oppose the change in the current. The self inductance is a measure of the impedance offered to the flow of current.

RECOGNITION

Accounting for Henry's failure to gain international and general recognition of his achievements, friends and students alike commented that he was always dilatory about publication, but as Joseph Henry himself wrote. "I have sought no patent for inventions, and solicited no remuneration for my labours, but have freely given their results to the world, expecting only in return to enjoy the consciousness of adding to the sum of human knowledge and to receive the credit to which they may justly entitle me".

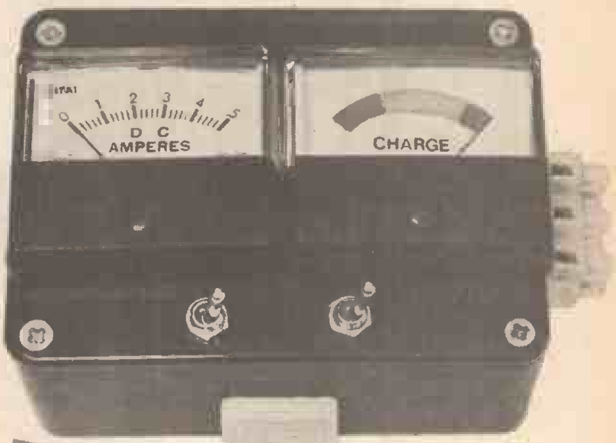
Henry died in Washington on 13 May 1878. The boy who had "shown little interest in studying" had by general consent become one of America's foremost physicists and scientific administrators.

JULY FEATURES...

TILT ALARM

Portable, easy to operate, with a two minute alarm time out. This simple alarm was designed initially to attach to the handle of the inside of a hotel room, but the list of applications is almost endless.

CARAVAN BATTERY MONITOR



This unit takes the guesswork out of battery care for caravanners. It shows current being consumed and the state of battery charge. Invaluable to prevent a flat battery.

NEW SERIES

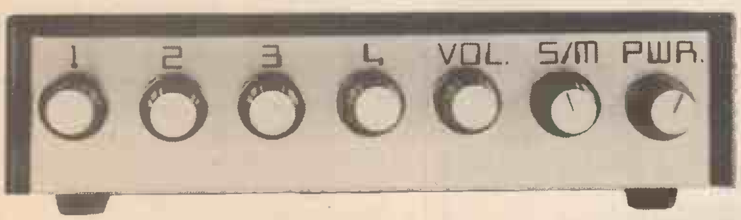
EXPLORING ELECTRONICS

A new series that introduces the various elements of electronics by employing them in simple circuits. Using the same bread-board as *Teach In '86*.

COMPUTER INTERFACES

The operation of the three most common interfaces is explained—Centronics, RS232C and IEEE488—thus allowing the reader to understand some of the problems of interfacing.

HEADPHONE MIXER



Allows up to four signal sources to be monitored using headphones. The unit can also be used as an ordinary mixer if desired. Suitable for stereo or mono operation.

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

JULY ISSUE ON SALE FRIDAY, JUNE 20

a regular feature for the Spectrum Owner...

by Mike Tooley BA

LAST month we introduced some routines in BASIC and FORTH which can be used to drive our stepper motor interface. This month we shall turn our attention to reducing the load on the Spectrum's over-worked internal power supply by describing some external supplies which can be used in conjunction with our various interface projects. Before we get started, however, one or two points concerning the layout of our various *On Spec* projects should be made.

Layouts

Several readers have written requesting p.c.b. or Veroboard layouts for *On Spec* projects. The policy, at least as far as *On Spec* is concerned, has been that of cramming as much information as possible into these pages and, since layouts and wiring diagrams tend to occupy some considerable space, detailed constructional information has usually been omitted.

Happily, most of the circuits described in the column can be laid out quite easily and, provided one carefully checks the layout before applying power or connecting to the Spectrum, few problems should be encountered.

In order to assist readers in the task of laying out circuits for construction, our *On Spec* "Update" now includes a sheet which can be used for laying out Veroboard circuits. This sheet is enlarged to A4 size and, if desired, may be photocopied by readers in order to produce further layout sheets.

Whilst on the subject of layouts, T. A. C. Gigg of Bristol has sent in a very useful BASIC program which will allow readers to print their own layouts using a ZX or Alphacom 32 printer. The program should be entered, saved to tape and then run. Thereafter, the COPY command may be used to dump the screen and produce a neat layout sheet comprising 30 strips by 42 holes.

Here is Mr Gigg's program:

```
10 FOR y=0 TO 175 STEP 6
20 PLOT 0,y
30 DRAW 255,0
40 NEXT y
50 FOR x=2·5 TO 255 STEP 6
60 FOR y=2·5 TO 175 STEP 6
70 PLOT x,y
80 NEXT y: NEXT x
```

External Power Supplies

When several interface modules are to be used simultaneously with the Spectrum, or where a single interface module requires an appreciable supply current (as is the case with our Stepper Motor Interface), it becomes necessary to provide the supplies externally and not rely on the Spectrum's own hard pressed internal power supply.

COMPONENTS

Resistors

R1	470
0·25W ±5% carbon	

Capacitors

C1	4700µ elec. 25V
C2	2200µ elec. 25V
C3 to C8	100n polyester (6 off)
C9 to C11	10µ elec. 25V (3 off)

Semiconductors

D1,D2	1N5401
D3,D4	1N4001
D5	Red l.e.d.
IC1	7812 +12V 1A reg
IC2	7805 +5V 1A reg
IC3	7905 −5V 1A reg

Miscellaneous

T1	Mains transformer (see text)
FS1	1A fuse and panel mounting fuseholder
Output terminals	4mm (various colours)
Heatsink(s)	(see text)
S1	SPST mains on/off switch

ALTERNATIVE VERSION

Resistors

R1,R2	270 1W 5% (2 off)
R3	270 0·25W 5%

Semiconductors

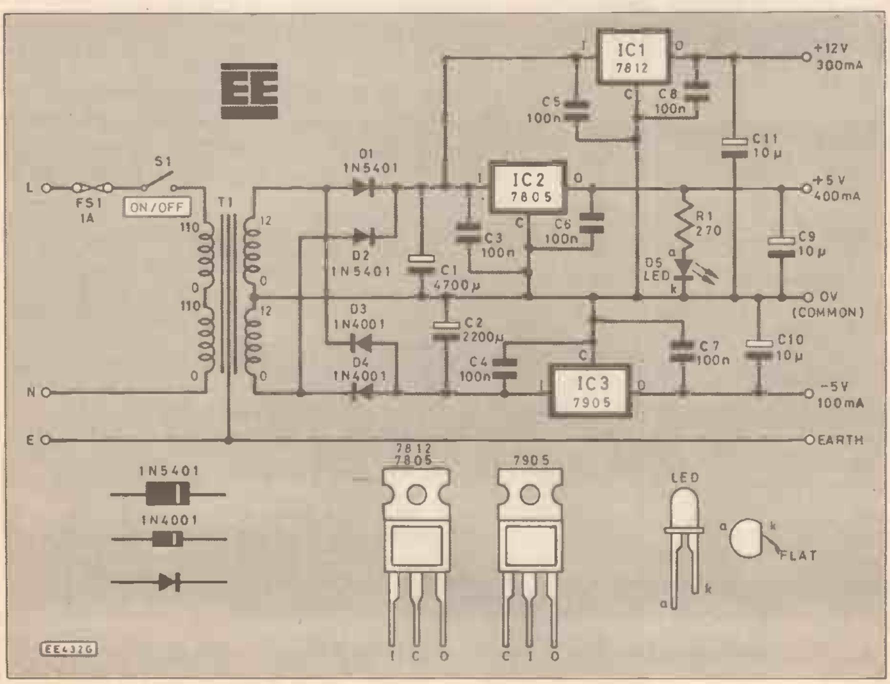
D1	Red l.e.d.

Miscellaneous

Switched mode PCB	Tandy 277-1016
T1	Tandy 273-1515 or 273-7023 (see text)
FS1	1A fuse and panel mounting fuseholder
Output terminals	4mm (various colours)
S1	SPST mains on/off switch

Approx. cost Guidance only **£6.50**

Fig. 1. Complete circuit diagram for the Spectrum external d.c. power supply.



For most purposes three separate supply rails should suffice. These should have the following ratings:

+5V at 400mA (or more)
+12V at 300mA (or more)
−5V at 100mA (or more)

The above rails will more than adequately replace those which are respectively available at pins 3B, 22A and 20A of the Spectrum's edge connector.

A conventional external power supply arrangement, based upon three monolithic three-terminal voltage regulators, is shown in Fig. 1. The mains transformer should be rated at a minimum of 20VA and should have two separate secondary windings each rated at 12V 0·8A minimum. Alternatively a similar transformer having a centre-tapped 12V-0V-12V secondary winding may be employed.

Construction

Construction is extremely straightforward, however adequate heatsinks will be required for use in conjunction with IC1, IC2 and IC3 (the latter will require an insulating kit if a common heatsink is to be employed). The thermal resistance of individual heatsinks should be 6·8°C/W, or lower, whereas the thermal resistance of any common heatsink should be no more than 3°C/W.

The decoupling capacitors, C3 to C8, are required in order to ensure high-frequency stability and should be mounted as close to their respective regulators as is possible.

Switch Mode Version

An alternative to the conventional arrangement is shown in Fig. 2. This circuit employs a ready-built switched mode power supply module which can be obtained from most Tandy shops and is very reasonably priced at around £5.

The input to the p.c.b. module is derived from a mains transformer having a single 18V secondary rated at 1·5A. Alternatively a centre-tapped 9V-0V-9V unit may be used (see components list); in such cases the centre tap is simply ignored.

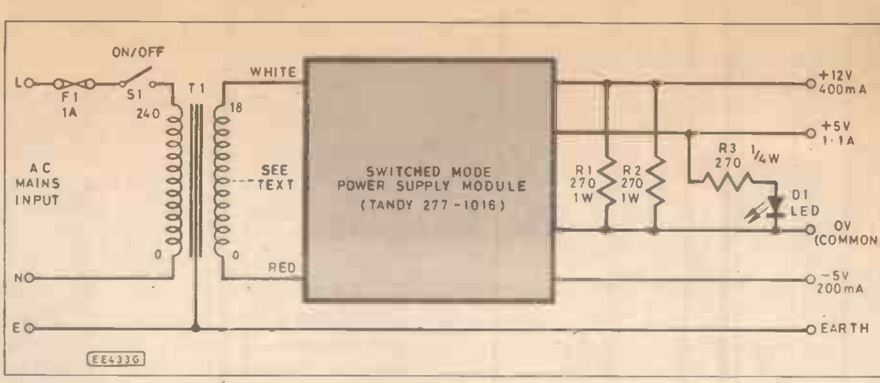


Fig. 2. Circuit diagram of the alternative switched mode external d.c. power supply.

Any comments and suggestions for inclusion in *On Spec* should be sent 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: An ultra-simple Output Port which can be used in a wide range of applications, from operating your central heating system to controlling your model railway!

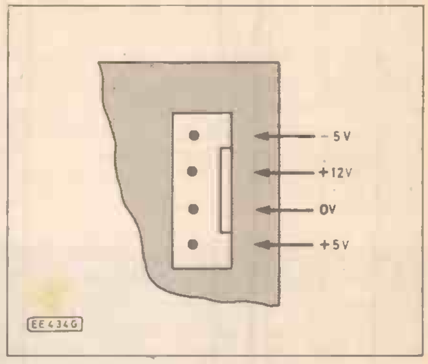
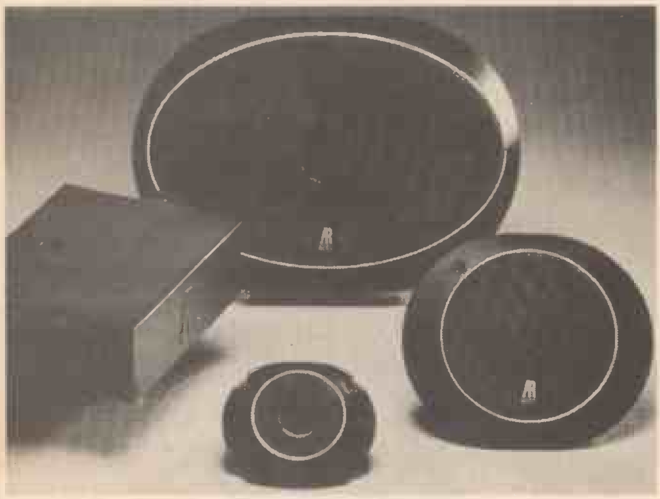


Fig. 3. Output connections for the Tandy switched mode PCB module.

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

IN-CAR ENTERTAINMENT

Top quality domestic hi-fi loudspeakers have been the hallmark of AR for the past thirty years. In fact many of their developments have become hi-fi "milestones" and in hi-fi circles **Acoustic Research** is well respected for quality and innovation.



Now their expertise has been used to create a new range of in-car hi-fi louspeakers which combine AR's latest advancements in Polypropylene cone and tweeter technologies to deliver a level of musical enjoyment normally associated with domestic systems. Polypropylene, it is claimed, is unaffected by heat or moisture and so is ideal for consistent, reliable performance in the harsh car environment.

The new loudspeakers have been engineered to fit commonly used mounting apertures. In addition, models GCS300, GCS400, GCS500 and GCS600 have black painted metal grilles and "gold"-finished trim.

The GCS300 is a three-way system using a 6 × 9in (15·3 × 23cm) woofer, with an axially-mounted $2\frac{1}{4}$in (5·7cm) liquid-cooled midrange and a one inch (2·54cm) liquid-cooled tweeter. Full crossovers on midrange and tweeter are provided. They are priced at £69.95 per pair.

The smaller GCS400, priced at £49.95 per pair, uses a $6\frac{1}{2}$in (16·5cm) woofer/midrange and a $\frac{3}{4}$in (19mm) liquid-cooled tweeter mounted coaxially, to combine compact dimensions with excellent musical reproduction.

Coming down slightly in size, the GCS500 includes a $5\frac{1}{4}$in (13·3cm) woofer/midrange and a coaxially-mounted one inch (2·54cm) liquid-cooled tweeter. GCS500s are priced at £45.95.

Where cost and space are important considerations, full-range units are the answer. For instance, GCS600 comprises a single 4in (10·2cm) dual-cone full-range drive unit, with black grilles and "gold" finish and are priced at £29.95.

The dashboard-mounting GCS1200, competitively priced at £19.95 per pair, incorporates a 4 × 6in (10·2 × 15·2cm) driver to cover the whole range.

Some of the new automotive loudspeakers will be available only to special order and these include the top-of-the-range GCS100 range model. This is a true three-way loudspeaker with a full crossover for superb sound. Also available only to special order are AR's GCS200, a high-quality two-way loudspeaker, and the GCS1400 dash-mounting full-range single-driver system.

Teledyne Acoustic Research, Dept EE, High Street, Houghton Regis, Dunstable, Beds, LU5 5QJ.

SURFBOARDS

A new concept for building prototype circuits using surface mounting chips (SMD's) has just been marketed by **Global Specialties.**

With Global's Surfboard the designer places a Plastic Leaded Chip Carrier (PLCC) into a carrier socket and has instant breadboarding access to the electronics within the chip, without the need for soldering or permanent connections.

The board provides a numbered breadboarding tie-point for each lead on the chip carrier. Connection of a particular lead is achieved by inserting standard 22-gauge hook-up wire into the corresponding tie-point.

Changes are easily made without damage to the chip carriers or components. More than one SMD can be included in a prototype circuit through the use of additional Surfboards inter-linked through the connecting "blocks".

Three models are available which accommodate 44-pin, 68-pin and 84-pin devices. For further details of local stockists and prices contact:

Global Specialties (UK) Ltd., Dept EE, Shire Hill Industrial Estate, Saffron Walden, Essex, CB11 3AQ.

PERIPHERAL OF THE YEAR

The WS3000 Professional modem from Miracle Technology has won the Peripheral of the Year category of the prestigious British Microcomputing Awards 1986.

It is the second year running that Miracle Technology has reached the Awards finals, its WS2000 Modem was runner-up in the same category last year. On both occasions Miracle's were the only modems even to be shortlisted.

Miracle Technology (UK) Ltd., Dept. EE, St. Peters Street, Ipswich, IP1 1XB.

BOOK SERVICE

The books listed below have been selected as being of special interest to our readers, they are supplied from our editorial address direct to your door.

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DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.
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Completely revised and updated, this book is an invaluable aid in helping all those who have a radio receiver to obtain the maximum entertainment value and enjoyment from their sets.
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BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.
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PLEASE ALLOW 28 DAYS FOR DELIVERY

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.

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.

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— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
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— SEPTEMBER '83 —		
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— OCTOBER '83 —		
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— DECEMBER '83 —		
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— JANUARY '84 —		
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6/86

EDUCATION AND CAREERS

INDEX TO ADVERTISERS

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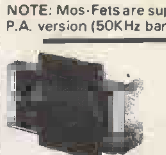

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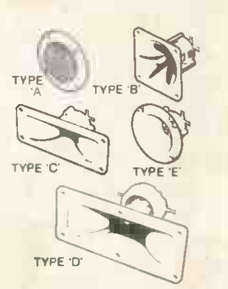

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