EVERYDAY
ELECTRONICS
and ELECTRONICS MONTHLY

JULY 1986 £1·10

New Series!

EXPLORING ELECTRONICS

LEARN BY EXPERIMENTING... PART 1

COMPUTER INTERFACES EXPLAINED

TILT ALARM · HEADPHONE MIXER

Newcomers Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

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

1. 5 – 13 amp ring main junction boxes
2. 5 – 13 amp ring main spur boxes
4. 5 – surface mounting switches suitably insulated for mains voltage
5. 3 – electrical switches intermediate type, will also replace 1 or 2 way switches, white flush mounting
7. 4 – in flex line switches with neons
9. 2 – mains transformers with 6V 1A secondaries
10. 2 – mains transformers with 12V $\frac{1}{2}$A secondaries
11. 1 – extension speaker cabinet for $6\frac{1}{2}$" speaker
13. 12 – glass reed switches
17. 2 – ultra transmitters and 2 receivers with circuit
19. 2 – light dependent resistors
25. 4 – wafer switches – 6p 2 way, 4p 3 way, 2p 6 way, 2p 5 way, 1p 12 way small one hold fixing and good length $\frac{1}{4}$ spindle your choice
28. 1 – 6 digit counter mains voltage
30. 2 – Nicad battery chargers
31. 1 – key switch with key
33. 2 – aerosol cans of ICI Dry Lubricant
34. 96 – 1 metre lengths colour-coded connecting wire
39. 1 – long and medium wave tuner kit
41. 8 – rocker switch 10 amp mains SPST
45. 1 – 24 hour time switch mains operated (s.h.)
48. 2 – 6V operated reed switch relays
49. 10 – neon valves – make good night lights
50. 2 – 12V DC or 24V AC, 3 CO relays
51. 1 – 12V 2 CO miniature relay very sensitive
52. 1 – 12V 4 CO miniature relay
53. 2 – mains operated relays 3 × 8 amp changeover (s.h.)
54. 10 – rows of 32 gold plated IC sockets (total 320 sockets)
55. 1 – locking mechanism with 2 keys
56. 1 – miniature uniselector with circuit for electric jigsaw puzzle
60. 5 – ferrite rods 4" × 5/16" diameter aerials
61. 4 – ferrite slab aerials with L & M wave coils
63. 1 – Mullard thyristor trigger module
64. 10 – assorted knobs $\frac{1}{4}$ spindles
65. 5 – different thermostats, mainly bi-metal types
66. 1 – magnetic brake – stops rotation instantly
67. 1 – low pressure 3 level switch can be mouth operated
69. 2 – 25 watt pots 8 ohm
70. 2 – 25 watt pots 1000 ohm
71. 4 – wire wound pots – 18, 33, 50 and 100 ohm your choice
72. 1 – 1250 watt dimmer Ultra ref SE20
77. 1 – time reminder adjustable 1-60 mins clockwork
81. 2 – 30A panel mounting slyslok fuses
85. 1 – mains shaded pole motor $\frac{3}{4}$" stack – $\frac{1}{4}$ shaft
89. 1 – mains motor with gear box 1 rev per 24 hours
91. 2 – mains motors with gear box 16 rpm
96. 1 – thermostat for fridge
98. 1 – motorised stud switch (s.h.)
101. 1 – $2\frac{1}{2}$ hours delay switch
103. 1 – mains power supply unit – 6V DC
104. 1 – mains power supply unit – $4\frac{1}{2}$V DC
105. 1 – 5 pin flex plug and panel socket
107. 1 – 5" speaker size radio cabinet with handle
110. 10 – slider type volume controls
111. 2 – musical boxes (less keys)
112. 1 – heating pad 200 watts mains
113. 1 – FM front end with tuning condenser and data
114. 1 – 1W amplifier Mullard 1172
115. 1 – wall mounting thermostat 24V
118. 1 – teak effect extension 5" speaker cabinet
120. 2 – p.c. boards with 2 amp full wave and 17 other recs
121. 4 – push push switches for table lamps etc.
122. 10 – mtrs twin screened flex white p.v.c. outer
123. 100 – staples for thin flex
124. 25 – clear plastic lenses $1\frac{1}{2}$ diameter
127. 4 – pilot bulb lamp metal clip on type
128. 10 – very fine drills for pcbs etc.
129. 4 – extra thin screw drivers for instruments
132. 2 – plastic boxes with windows, ideal for interrupted beam switch
134. 10 – model aircraft motor – require no on/off switch, just spin to start
136. 2 – car radio speakers 5" round 4 ohm made for Radiomobile
137. 1 – $6\frac{1}{2}$" 4 ohm 10 watt speaker and 3" tweeter
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 coi 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 BD45
298. 2 15 amp round pin plugs brown bakelite
300. 1 mains solenoid with plunger compact type
301. 10 ceramic magnets Mullard 1" × 3/8 × 5/16
303. 1 12 pole 3 way ceramic wave charge switch
304. 1 stereo amp 1 watt per channel
305. 1 tubular dynamic microphone with desk rest
306. 1 module, speaker & battery to make musical card
307. 5 thermal fuses 15 amp woods metal
308. 1 T.V. turret tuner (black & white T.V.)
309. 12 adaptable legended knobs $\frac{1}{4}$" spindle
310. 2 oven thermostats
311. 1 Clare Elliot sealed relay 12V
312. 1 pressure pad switch 24 × 18 (Trigger Mat)
313. 5 sub miniature micro switches
314. 1 12" 8 watt min fluorescent tube white
315. 1 6" 4 watt min fluorescent tube white
316. 1 round pin kettle plug with moulded on lead

MULLARD UNILEX AMPLIFIERS

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

CAR STARTER/CHARGER KIT

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

Ex-Electricity Board. Guaranteed 12 months.

VENNER TIME SWITCH

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

SOUND TO LIGHT UNIT

Complete kit of parts of a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by $\frac{1}{4}$" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is **£14.95** in kit form.

12 volt MOTOR BY SMITHS

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

25A ELECTRICAL PROGRAMMER

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

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

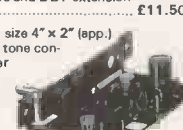
IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included. **£11.95** plus £2.00 post.

TELEPHONE BITS

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

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



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

J & N BULL ELECTRICAL
128 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QL

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

OVER 400 GIFTS YOU CAN CHOOSE FROM

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

TWO POUNDERS*

2P2 – Wall mounting thermostat, high precision with mercury switch and thermometer
2P3 – Variable and reversible 8-12v psu for model control
2P4 – 24 volt psu with separate channels for stereo made for Mullard UNILEX
2P6 – 100W mains to 115V auto-transformer with voltage tappings
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" × 10" × $5\frac{1}{2}$", wall mounting.
17. Two kits: matchbox size surveillance transmitter and 2 FM receivers.

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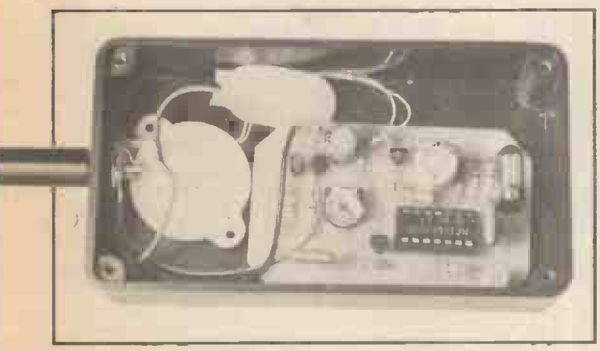
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .



exploring electronics

OWEN BISHOP

SEE PAGE 364

Projects

Series

Features

Our August 1986 issue will be published on Friday, 18 July. See page 349 for details.

Our August 1986 issue will be published on Friday, 18 July. See page 349 for details.

SUMMER SALE!!

MANY ½ PRICE BARGAINS! CABLE, BOXES, DIL SKTS, LEADS, KNOBS, HARDWARE ETC, ETC! BUT FIRST YOU'LL NEED OUR CATALOGUE—WE'LL SEND YOU ONE

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PACKS

K524 Opto Pack £3.95 **£2.95**
K525 Preset Pack £6.75 **£3.95**
K528 Electrolytic Pack £3.95 **£3.20**
K531 Precision resistors £3.00 **£2.50**
K532 Relays £6.00 **£3.00**
K517 Transistors £2.75 **£1.95**
K523 Resistors £2.50 **£2.00**
K520 Switches £2.00 **£1.70**
K522 Copper clad board £1.00 **£0.70**
K530 Polyesters £3.95 **£2.95**
K518 Disc Ceramics £1.00 **£0.70**
K503 Wirewound Resistors £2.00 **£1.50**
K505 Pots £1.70 **£1.40**
W4700 Push button banks £2.95 **£2.00**
K526 Heatsinks £5.50 **£4.00**
K527 Hardware £4.00 **£3.00**
K534 Sleeve Pack £1.00 **75p**
K536 74 Series Pack £4.00 **£3.00**
K537 I.C. Pack £6.75 **£4.00**
K538 Diode Pack £2.50 **£1.50**
K539 L.e.d. Pack £5.95 **£4.95**
K540 Resistor Pack £2.50 **£2.00**
K535 Spring Pack £1.70 **80p**

½ PRICE PANELS

Z914 1W Mono Amp **75p**
Z915 1W Stereo Amp **£1.75**
Z916 Am Tuner **75p**
Z925 Relays **95p**
Z926 Relay/Triac **92p**
Z927 Reeds **30p**
Z966 Modem **£3.25**
Z967 Modem **£4.25**
Z936 Stereo Amp **£1.00**
Z918 Inverter **£1.25**
Z919 Inverter **£1.10**
Z912 RF Panel **75p**
Z910 RF Panel **75p**
Z911 RF Panel **35p**
Z913 RF Panel **35p**
Z942 Joystick Interface **£1.00**
Z974 Mixer Amp **£1.25**

FIBRE OPTICS—66% OFF!!
20m coils 1mm core—single £6.30 **£2.15**
twin £11.00 **£3.75**

COMPUTER BOOKS—up to 90% off!! £9.95, £6.95, £5.95
Now all **99p** each!!

UHF Modulator 50% off!
Aztec UM1286 £6.00 **£3.00**

NEW PACKS

(more sent with catalogue)

K554 Thermistors. Mostly disc, rod and some valuable bead types. Identification/data sheet included. Big variety up to 40mm dia. Catalogue value over £50. 100 **£8.00**

K547 Zener Diodes. Glass & plastic, 250mW to 5W ranging from 3V to 180V. All readily identifiable. 100 **£4.50**

K548 Tantalum Capacitors. Wide range of values from 0·1 to 68μ, 3V to 50V. Includes both beads and valuable solid types. 100 **£6.50**

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 year's 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**

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
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ABS BOXES
STANDARD MINIATURE
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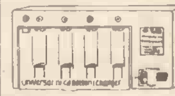

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RADIATION

WORLD events influence the content of EE—sounds good, doesn't it, but in reality it is not. I do not wish to get into a discussion on the pros and cons of atomic power, let us just say that we have all recently been made fully aware of the consequences if something goes wrong. The Russian disaster and the resulting massive release of radiation has brought home the dangers. Following the disaster we have been asked by many readers for a Geiger counter design—we will be publishing a straightforward design in our August issue.

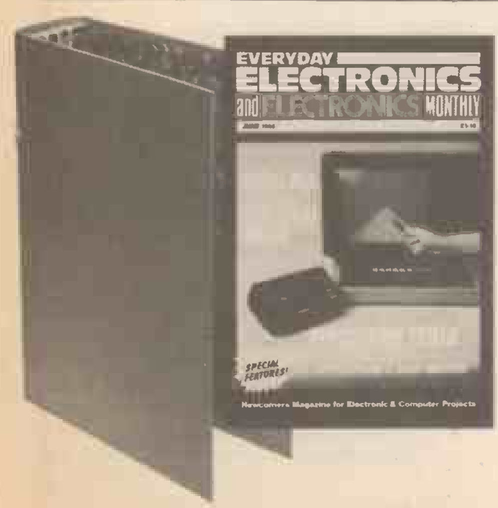
In the meantime, regular readers might find the series we published previously of interest. The three articles comprised: *What is Radiation* (Aug. 84), *Fission and Fusion* (Sept. 84) and *Radiation Detectors* (Oct. 84). These short articles at least provide some background knowledge about various rays and their detection. At the end of the first article the author, A. J. Bentley, made the following interesting statement:

"FRIEND OR FOE

The radiation which surrounds us comes from the rocks in the earth and the water in the sea, from dust and gases in the air, even the atoms from which our bodies are made emit radiation. This has always been so since the earth was formed and always will be so. Radioactivity is not some evil man-made thing but a natural consequence of the way the universe is constructed. It is new only in the sense that we have only just become aware of it. As always there are those who wish to use this discovery to kill others, and there are those who wish the knowledge to be lost and forgotten. It must have been the same when the first shivering cave-dweller discovered fire.

If we compare that first open fire to a modern central heating system, is it too much to hope that we can safely benefit from this find?"

Let us hope that the world learns by its mistakes. Meanwhile, our article will provide a means for testing food and drink as well as checking the general environment etc; we hope it will help put people's minds at rest, if nothing else.



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HEADPHONE MIXER

R.A. PENFOLD

A no-frills mixer which can be used to monitor up to four inputs, in either mono or stereo

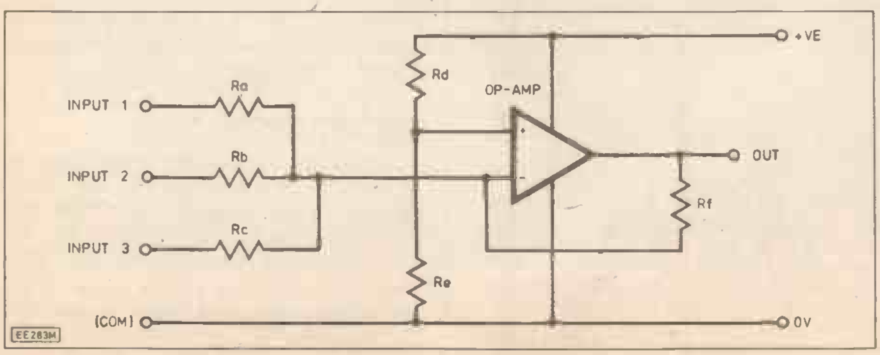
A HEADPHONE mixer is an item of equipment which will probably be unfamiliar to many readers, but it is basically just a simple mixer circuit feeding into a headphone amplifier. Although this might not seem to be a very useful piece of equipment, it is one of those devices that after a few weeks in use leaves you wondering how you managed without one previously. A headphone mixer is probably of most benefit to someone involved in the field of electronic music. If you have (say) a polyphonic synthesiser controlling a monophonic synthesiser and a drum machine, these would probably all have headphone outputs, but you can not plug the headphones into all three at once. However, by feeding the three audio outputs into the headphone mixer they can all be monitored simultaneously, and the mixer permits channel balancing as well as providing overall control of the volume.

This project is not restricted to use in electronic music set-ups though, and it can be used in any situation where up to four signal sources must be monitored using headphones. It can also be used as an ordinary mixer if desired as it does not have to feed into a pair of headphones, and will work equally well with most amplifiers, tape recorders, etc. By only utilizing one of the inputs it can also function as a straightforward headphone amplifier when necessary. The unit is thus much more versatile than might at first appear to be the case.

The four inputs of the circuit all have an input impedance in the region of 100k. Two inputs have an input sensitivity of about 500 millivolts r.m.s. for maximum output and are suitable for use with high level outputs such as those provided by cassette decks and keyboard instruments. The other two inputs have an input sensitivity of only about 50 millivolts r.m.s. and these are suitable for use with low level sources such as an insensitive guitar pick-up, as well as high level signal sources. The unit will not work properly with very low level signals (such as those provided by any normal types of microphone) unless a suitable preamplifier is added ahead of the inputs, but it is highly unlikely that the unit would ever need to be used in such a set-up anyway.

Full stereo operation is provided with the left and right hand channels handled by separate mixer and output amplifier circuits, but the stereo channels must be correctly balanced at source as the mixer uses dual gang level controls with no balance controls. In many cases only monophonic operation will be required, and a mono/stereo switch is provided. When this is set to the "mono" mode any signal fed to a left hand channel input will appear on both the right and left hand outputs, so that the unit effectively functions as a four channel monophonic mixer with the right hand inputs being ignored.

Fig. 1. Basic summing mode circuit.



SUMMING CIRCUIT

Most mixers are based on an operational amplifier connected in a configuration which is generally known as the "summing" mode mixer circuit. This is really just a slight variation on an ordinary inverting amplifier circuit, as can be seen from the basic summing mode circuit of Fig. 1.

Resistors R_d and R_e simply form a potential divider circuit which biases the non-inverting input of the operational amplifier to about half the supply voltage. If dual balanced supply rails are used then the non-inverting input is biased to the 0 volt supply rail, but most audio circuits based on operational amplifiers have a single supply rail plus potential dividers to provide bias voltages.

If we ignore R_b and R_c for the time being, the circuit is just a basic inverting amplifier with R_a and R_f acting as the negative feedback network which set the voltage gain and input impedance of the circuit. The operational amplifier itself has an extremely high voltage gain of typically around 100,000 times at low frequencies, and the voltage that is amplified is the voltage difference across the inputs. With the non-inverting input more positive than the inverting input the output swings positive. Reversing the comparative input levels sends the output negative. Due to the high gain of the device only a minute voltage

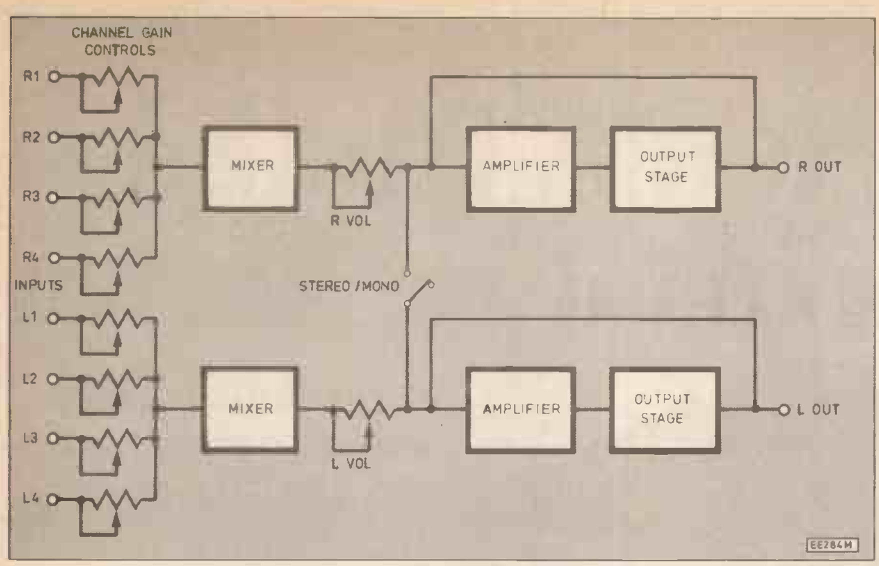


Fig. 2. Block diagram of the Headphone Mixer.

difference is needed at the inputs in order to send the output fully positive or negative.

The very high "open loop" voltage gain of an operational amplifier is not needed in audio amplifier applications, and negative feedback is used to reduce the gain of the circuit as a whole (known as the "closed loop" voltage gain) to the required level. The feedback action is quite simple, and it effectively maintains the two inputs at the same voltage. If we consider the circuit under quiescent conditions, the output will go to the bias potential at the non-inverting input, and due to the coupling through R_f to the inverting input this balances the two input voltages. If for any reason the output should go more negative, this would take the inverting input more negative, unbalancing the inputs and sending the output more positive to restore the balance. If the output should go more positive, then the inverting input would go more positive, again unbalancing the input voltages, but this time sending the output more negative to restore the balance. This balancing action is central to the operation of both the basic inverting amplifier and the summing mixer circuit.

If an input signal is applied to R_a, and it takes the input more positive, a potential divider action across R_a and R_f results in the inverting input going more positive. This sends the output negative, but it only goes sufficiently negative to pull the inverting input back to its original level. If we take an easy example and assume that R_a and R_f have the same value, the output will go negative by an amount that is equal to the positive input voltage. If R_f is made larger than R_a it then becomes necessary for the output to go more negative than the input voltage in order to restore the inverting input to its previous level. The closed loop voltage gain of the circuit is therefore controlled by the ratio of R_a to R_f, and is in fact equal to R_fR_a.

Note that although the signal is inverted through the circuit, this is of no consequence in an audio amplifier application where the polarity of the signal does not have any noticeable effect on the final sound from the headphones or loudspeaker. Another point worth noting is that as the voltage at the inverting input does not alter significantly, it forms what is termed a "virtual earth". This is important as it results in the current flow in R_a being much the same as if the right hand end of this component was genuinely coupled to earth, and the input impedance of the circuit is therefore equal to the value of R_a. It is probably the simplicity with which required input impedance and voltage gain figures can be obtained that has led to the popularity of operational amplifiers with audio circuit designers. R_a is given a value equal to the desired input impedance, and then this figure is multiplied by the required voltage gain in order to determine the value for R_f.

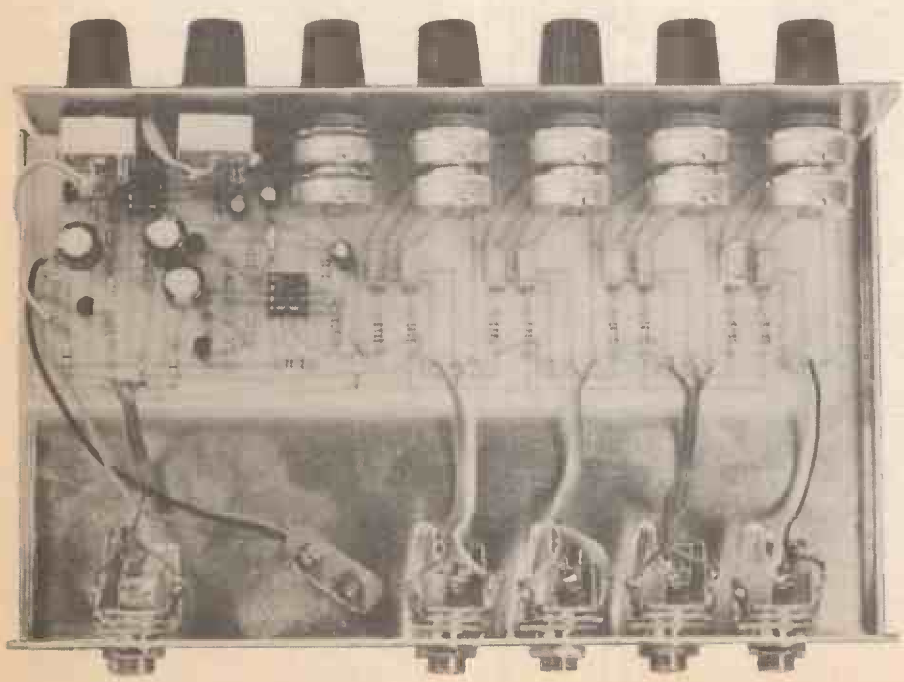
So far we have not considered the other two inputs, but the overall action of the circuit remains the same when these are in use. If all three inputs are fed with the same signal, the three resistors are effectively in parallel and the gain of the circuit is stepped up by a factor of three as the output has to feed a signal to R_f that counteracts the sum of the input signals. With different signals applied to each input the situation is similar with the output still having to balance the sum of the input voltages, and consequently giving the required mixing action. Although three inputs are shown in Fig. 1, by adding input resistors it is possible (in theory) to have as many inputs as you like.

SYSTEM OPERATION

The block diagram of Fig. 2 shows the system used in this mixer. There are two four channel summing mode mixers, with a separate mixer being required for each stereo channel. The output from each mixer is fed via an overall volume control to a low gain amplifier. Each amplifier in turn feeds into an output stage which enables quite high output currents to be provided. Negative feedback is provided over each amplifier and output stage in order to combat distortion (mainly of the cross-over variety) through the output stages.

The unit is effectively a small power amplifier capable of providing both a fairly high peak to peak voltage and quite strong output currents. This may seem to be unnecessary as, apart from a few very expensive and high quality types, most headphones require a driving power of just a few milliwatts. The main reason for using small power amplifiers at the output is to enable the unit to successfully drive medium and high impedance types which require a strong drive voltage and little current, and low impedance types which require very little drive voltage but relatively high currents. It also enables the unit to operate properly with some insensitive low impedance types that require fairly high drive powers. However, the unit will not drive the few types of headphone that are intended for direct connection to the loudspeaker outputs of powerful amplifiers.

When set to the "mono" position the mono/stereo switch simply couples the left hand channel signal to the input of the right hand channel amplifier stage so that signals applied to a left hand channel input appear on both outputs.



CIRCUIT OPERATION

The circuit diagram for one channel of the unit is shown in Fig 3. The other channel is identical apart from C1, S1, S2, R8, and B1, which are not duplicated in the other channel. Incidentally, the components in the other channel have been given the same identification numbers, but with one hundred added, in the components list and construction diagram.

IC1a acts as the summing mode mixer,

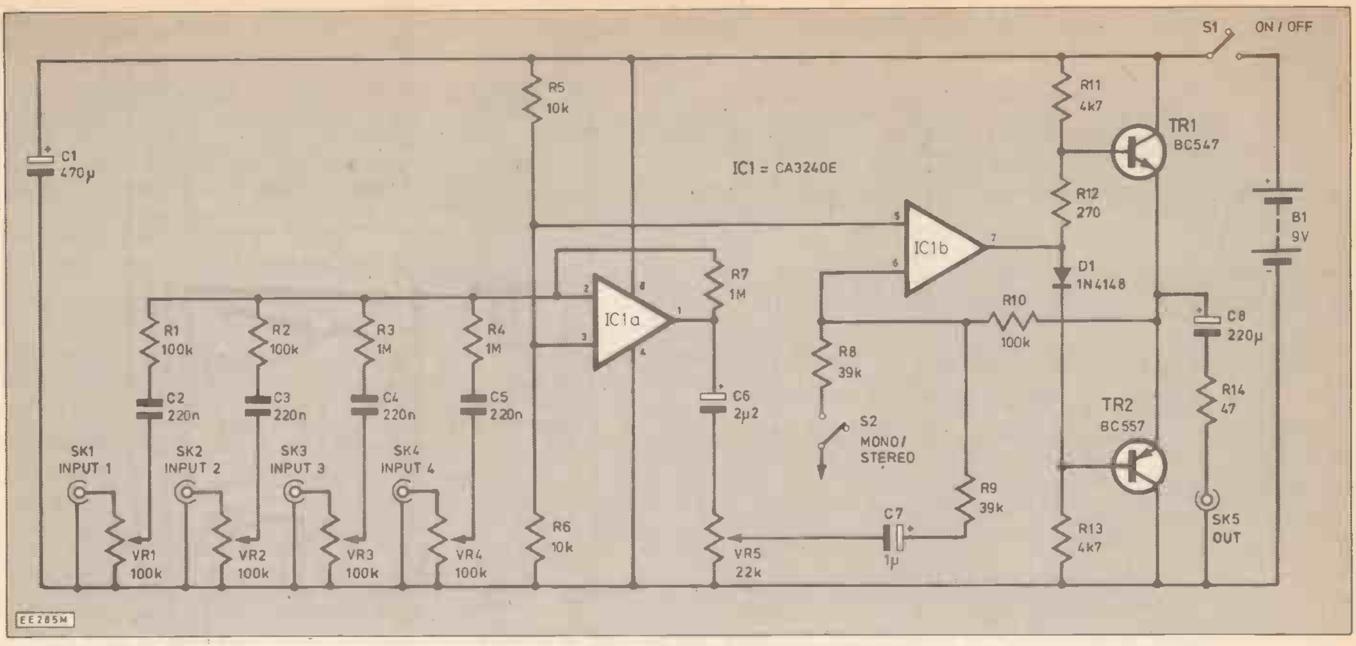


Fig. 3. Circuit diagram of one channel of the unit.

COMPONENTS

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Resistors

R1,R2,R10, R101,R102 R110	100k (6 off)
R3,R4,R7,R103, R104,R107	1M (6 off)
R5,R6,R105, R106	10k (4 off)
R8,R9,R109	39k (3 off)
R11,R13,R111, R113	4k7 (4 off)
R12,R112	270 (2 off)
R14,R114	47 (2 off)

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Potentiometers

VR1 to VR4	100k log, dual gang (4 off)
VR5	22k log. dual gang

Capacitors

C1	470µF radial elect. 10V
C2 to C5,	220nF carbonate (8 off)
C102 to C105	2µ2 radial elect. 63V (2 off)
C6,C106	1µF radial elect. 63V (2 off)
C7,C107	
C8,C108	220µF radial elect. 10V (2 off)

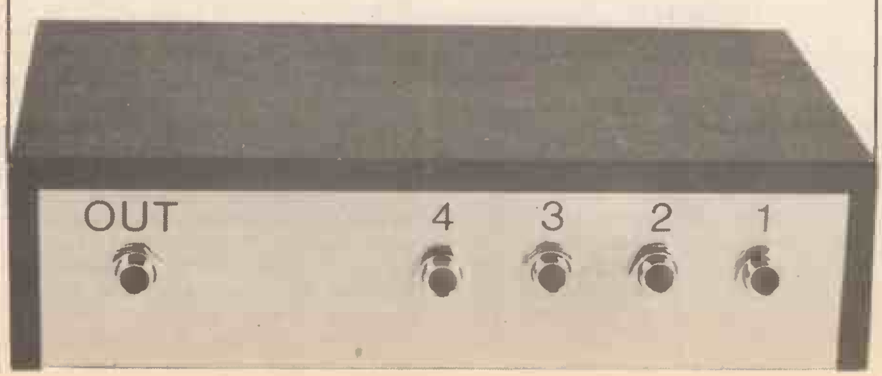
Semiconductors

IC1,IC101	CA3240E (2 off)
TR1,TR101	BC547 (2 off)
TR2,TR102	BC557 (2 off)
D1,D101	1N4148 (2 off)

Miscellaneous

SK1 to SK5	Standard stereo jack sockets (5 off)
S1,S2	Rotary or miniature toggle on/off type (2 off)
B1	9 volt PP3 size battery

Metal case about 203 × 127 × 51mm; printed circuit board (available from the *EE PCB Service*, order code EE530); seven control knobs; two 8-pin d.i.l. i.c. holders; battery connector; wire, solder, pins, etc.



and the configuration here is exactly the same as the one in Fig. 1 which was described previously, except, of course, that an additional input is provided. Also, a d.c. blocking capacitor (C2 to C5) and a level control (VR1 to VR4) is included at each input. Resistors R3 and R4 have been given the same value as feedback resistor R7 so that there is unity voltage gain at these inputs. R1 and R2 have a value equal to one tenth of the feedback resistance, giving a voltage gain of ten times (20dB) and increased sensitivity at these inputs.

Capacitor C6 couples the output of the mixer stage to the overall volume control, VR5. From here the signal is coupled to the input of the voltage amplifier which has IC1b operating as a low gain inverting amplifier. Transistors TR1 and TR2 are a fairly conventional complementary class B output stage. The quiescent bias produced by R12 and D1 is somewhat lower than would normally be used, and on its own it is not sufficient to cut down the level of crossover distortion to an insignificant level. However, by including the output stage in the negative feedback loop, coupled with the massive amount of feedback and high slew rate of IC1b, this gives no discernable cross over distortion on the output signal even at low volume levels. It is not advisable to try a cheaper dual operational amplifier such as a 1458C as a substitute device for IC1, as most alternatives have an inadequate slew rate which would give severe distortion on the output, and in most cases they would also give a greatly reduced output voltage swing.

An advantage of the very low quiescent bias used at the output stage is the low quiescent current that this gives. The quiescent current consumption of the circuit is only about 11mA and it does not rise significantly when driving most headphones at high volume. A PP3 size 9 volt battery is adequate to power the unit, although a higher capacity type such as a PP9 is preferable if the unit is likely to be used for long periods of time.

Resistor R14 attenuates the output of the unit when it drives low impedance headphones. With most types there would otherwise be a danger of excessive output and

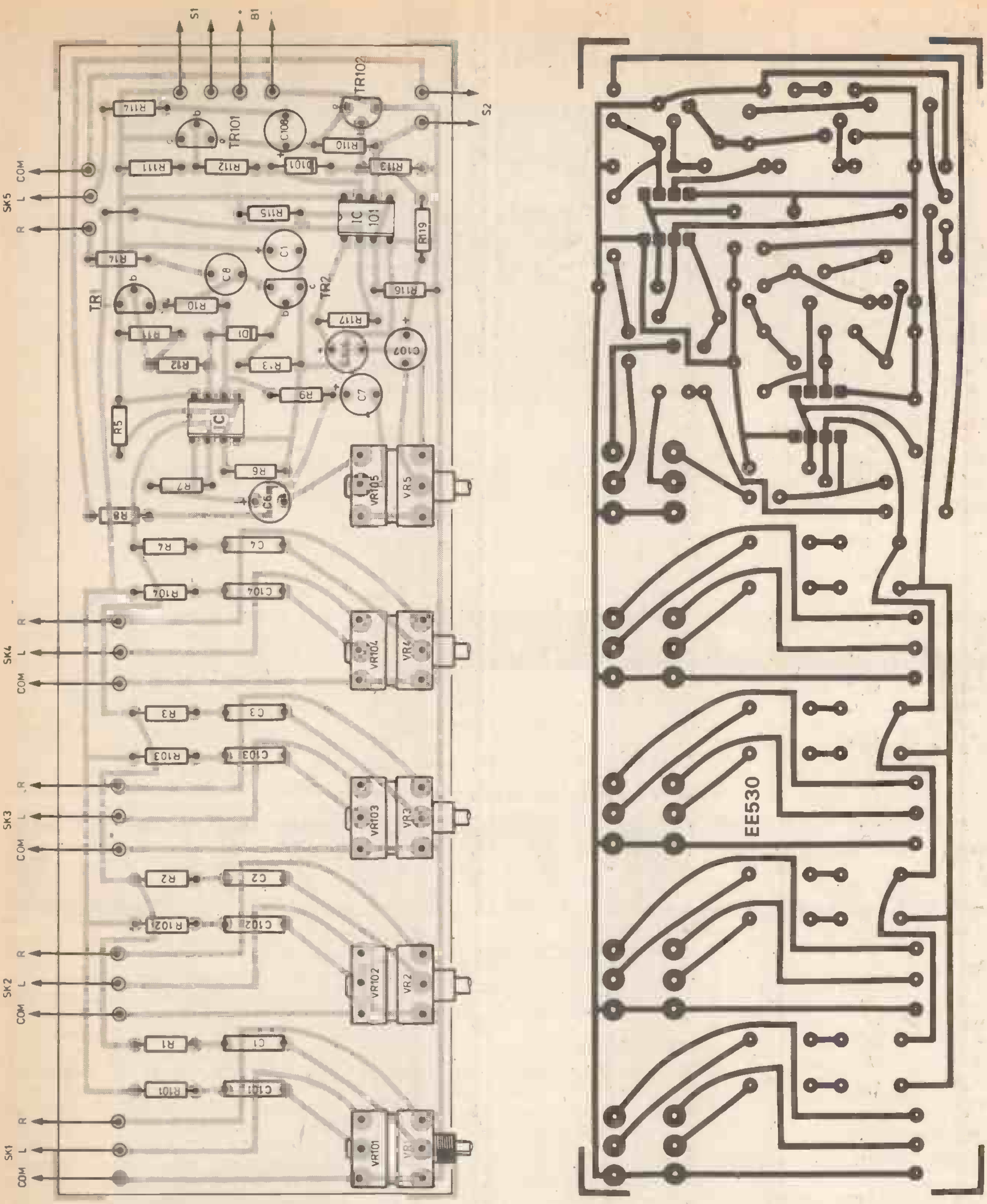


Fig. 4. PCB layout and wiring of the Headphone Mixer.

damage to the users' ears. When used with medium and high impedance headphones R14 becomes superfluous, but it then introduces relatively low losses and there is no need to bypass it. If the unit is only to be used with high or medium impedance headphones then R14 (and R114) may as well be omitted and replaced by link-wires. They can also be replaced by link-wires if you have insensitive low impedance headphones (many ultra-lightweight types are in this category) which require relatively large drive powers.

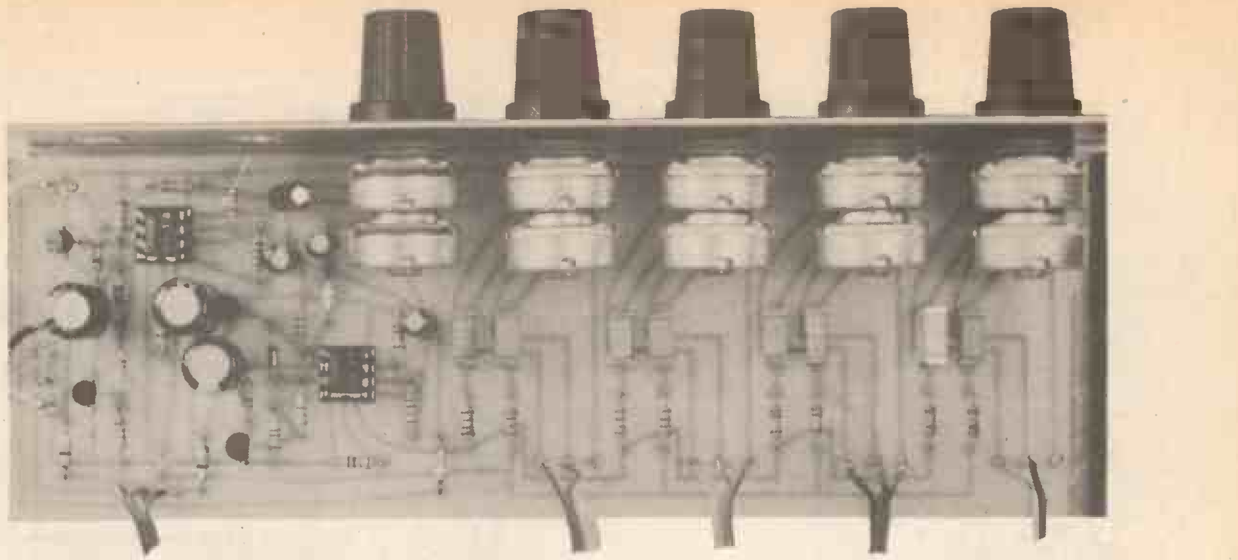
IC1b acts as a two input summing mode mixer rather than a simple inverting amplifier, with R8 providing the second input. When S2 is set to the "mono" position (closed) the output from the master volume control of the left hand channel is mixed into the right hand channel.

CONSTRUCTION

Virtually all the components, including the five dual gang potentiometers, are fitted on the printed circuit board. Only the sockets, switches, and battery are not. Fig. 4 gives details of the printed circuit board.

Start by fitting the small components and soldering them into place. Also fit the single link-wire (between R14 and R111) and pins at the points where connections to the battery, switches, and sockets will be made. Be careful to fit the electrolytic capacitors and the semiconductors the right way round. In particular, make quite sure that D1 and D101 have the correct polarity as a very high current will flow through the output stages if they do not. The CA3240E used in the IC1 and IC101 positions is a type which has a PMOS input stage, and accordingly the usual antistatic handling precautions must be taken. Basically this just means fitting these devices in eight pin d.i.l. i.c. holders, but not actually fitting them into place until all the connections have been completed. When mounting the potentiometers make certain that they are pushed right down onto the board before soldering them in place, and use a generous amount of solder. If their spindles need trimming this should be done before they are mounted on the board.

A metal instrument case which measures



203 by 127 by 51 millimetres is just about adequate to accommodate the board and the other components. The board is mounted in the case via the five potentiometers which are secured to the front panel in the normal way. There is just adequate space for two rotary switches (S1 and S2) on the right hand end of the front panel (miniature toggle switches would be a more comfortable fit). The five sockets are mounted on the rear panel, and standard stereo jacks are probably the most practical choice for all five sockets, but if any other types would be more convenient for some reason then it is, of course, perfectly all right to use these.

To complete the unit the small amount of hard wiring is added. There is no need to use screened leads at the input, and ribbon cable is probably the easiest type to use. If the input sockets are wired up with the two stereo channels round the right way, using standard mono input plugs with the unit switched to the mono mode will result in the input signals appearing at both outputs. Alternatively, stereo plugs can be used when the unit is operated in the mono mode, with only the earth and left hand channel tags of each plug being connected.

It is not essential to use rotary printed circuit mounting potentiometers, and the board can be hard wired to any type of potentiometer, including single gang slider types which many constructors might prefer. The printed circuit board would then need to be mounted on the base panel of the case, and the case would ideally be a type having a sloping front panel. This would make the controls easier to use, and sloping front panels are also generally quite large and able to accommodate a number of slider controls.

The unit is very simple to use, and the main point to observe is that you keep the master volume control well advanced unless you want to set the overall volume at a low level. Do not have the main volume control well back and then try to set a high volume level using the individual channel controls, since this would almost certainly lead to overloading and severe distortion. □

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R.A.PENFOLD

We examine the operation and connection of the three most common standard computer interfaces: Centronics, RS232C and IEEE488

COMPUTING can be a confusing hobby, especially when you try to expand a basic system into something a little more elaborate and useful. There are probably as many different types of interface as there are computers, and although there is a vast array of computer add-ons available, only a few percent of these can be used directly with most computers. In fact many machines only have the manufacturer's own variety of interface or interfaces, and will only operate directly with add-ons manufactured specifically for the particular computer (or make of computer) concerned.

However, there are some standard computer interfaces, and fortunately there is a trend towards the inclusion of at least one of these on newly introduced computers. With one of these interfaces fitted there is usually a wide range of suitable peripherals to choose from, and not just one or two manufacturer's-own units. A standard interface does not overcome all interfacing difficulties though, and there can be problems when connecting two supposedly standard and identical interfaces. This is usually just a problem with connecting leads, and is caused by the use of inexpensive connectors at the computer (often just an edge connector formed by the printed circuit board) instead of the correct type called for by the interface specification. For instance, I have come across several home computers equipped with a Centronics-type printer port, but I have yet to see one which has the correct 36-way connector.

In this article we will look at the operation of the three most common standard computer interfaces, the **Centronics, RS232C,** and **IEEE488** types. Hopefully this should help any prospective users to obtain good results when using any of these interfaces, and also to decide which is the most suitable for their requirements.

CENTRONICS

The Centronics printer interface, or "parallel" printer interface as it is often termed, is probably the best starting point as it is the most simple of the three types. It differs in one important respect from the other two in that it is only usable as an output, and it cannot be used to feed data into the computer. This is perfectly satisfactory for use with printers of course, and for some other computer peripherals, but it is unsuitable for an application where two-way communication is required, such as a modem interface.

With the Centronics system the data is sent in parallel form. In other words, each byte of data is sent on eight wires plus an earth line, with all eight bits being transmitted simultaneously. It is worth noting that some computers do not actually implement all eight bits, and that in some cases the most significant bit is simply connected to ground. The Amstrad CPC464 is a machine which falls into this category. This method is usually satisfactory in practice as the ASCII codes and ASCII based codes used in most computers only use the seven least significant bits. It can sometimes lead to problems though, as some printers use the eighth bit for control codes, and if the most significant bit is not implemented it is not possible to send these codes.

In practice a simple eight data line plus earth system cannot function properly as the printer would have no way of determining when fresh bytes of data were available and waiting to be printed. This is overcome by the inclusion of a negative **Strobe** line, which is another output from the computer. This briefly pulses low each time a fresh byte of data is available, indicating to the computer that the data for the next character to be printed is available on the data lines. The timing diagram of Fig. 1 helps to show the way in which this operates. The printer has an eight bit data latch at its input, and this uses the strobe signal as the latching pulse.

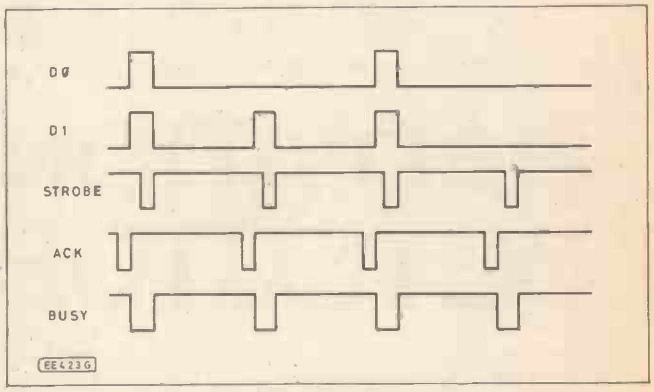


Fig. 1. Centronics timing diagram.

Most computers drive the data lines from latching outputs which remain static between bytes, but this is not strictly necessary as the states on these lines between strobe pulses is irrelevant, and these lines could be used for other purposes during these periods (as in the Oric 1 computer). On the other hand, some home constructor add-ons which are driven from parallel printer ports rely on the port providing latching outputs, and will not work at all with those that do not.

HANDSHAKE

The system as described so far will only work if the printer can accept data as fast as the computer can send it. As the computer is likely to be able to send data at a speed of many kilobytes per second it is unlikely that the printer could do so, as even fairly high speed types can only print at around a couple of hundred characters per second. Even if the printer has a buffer, it is still possible that the computer could output data at an excessive rate for the electronics in the printer, and the buffer might have an inadequate capacity to hold all the data from the computer anyway.

Some means of regulating the flow of data to a rate that can be handled by the printer is therefore essential, and the Centronics system gives two "handshake" options. These are the **Busy** and **Acknowledge** lines. Note that it is only necessary to implement one or the other of these, and while connecting both might not actually cause a malfunction, it would be pointless. Although most (probably all) printers have both Busy and Acknowledge outputs, many computers only have an input for one or other of these. The BBC model B computer is typical, with only an Acknowledge input.

If we start with the Busy line, this is normally low. When the

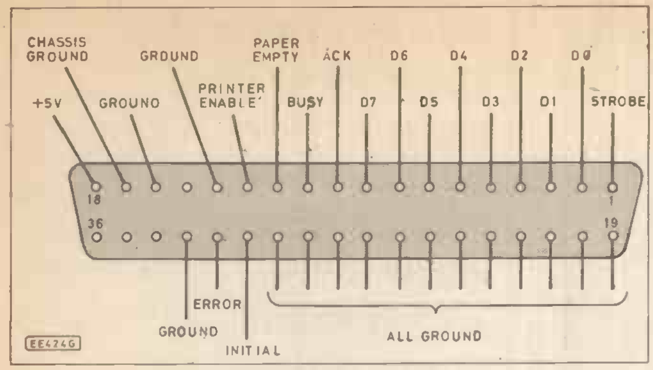


Fig. 2. Connection details for a standard Centronics interface.

computer outputs a byte of data the printer sets the Busy output high, and it holds it in that state until processing of that byte of data has been completed. The computer uses a software routine to monitor the Busy line and provide a hold-off until it returns to the low state. The next byte of data is then written to the port, the printer sets the Busy line high again, and so on, until the transfer of data has been completed.

The Acknowledge line is normally in the high state, and when a byte of data is received by the printer it stays high. It is not until the byte of data has been processed and the printer is ready for the next byte that the Acknowledge line is pulsed low. The software routine in the computer must therefore monitor the Acknowledge line and provide a hold-off until the negative pulse is detected.

In practice you might find that the handshake input of the computer, regardless of what it is called, will operate with either handshake output of the printer, or even that it will only operate with the wrong one. This occurs because, as can be seen from Fig. 1, the Busy and Acknowledge signals are quite similar. What tends to complicate things slightly is that there seems to be less than total agreement on the correct polarity for the handshake signals. In some cases it might be necessary to invert the handshake signal in order to obtain satisfactory results, but in most cases a suitable handshake connection (even if it means resorting to cross coupling of Acknowledge and Busy) can be found.

CONNECTOR

The standard connector for the Centronics printer interface is a 36-way Amphenol type, but these are often sold simply as "Centronics" plugs and sockets. Printers are fitted with sockets incidentally, and a 36-way Amphenol plug is therefore needed to make connections to a printer fitted with a Centronics interface. Some business computers have the same type of connector, but most home computers use either IDC sockets or edge connectors at their parallel printer ports.

Fig. 2 shows connection details for a standard Centronics interface (and 36-way Amphenol connector). There are several connections here which have not been discussed so far, but probably the only ones of these that you will need to use are the ground connections. There are a number of these, and this is done purposely so that they provide screening between the signal lines of the ribbon cable used to connect the computer to the printer. Otherwise there is a danger of stray capacitance in the cable causing signals to be coupled from one lead to another, generating corruption of the data. Even with these screening leads the maximum recommended cable length is only two metres. In practice there is usually no problem if a single earth lead is used, but the cable length is restricted to only about half a metre or so.

The other lines are provided on most printers, but are all absent from the printer ports of most home computers. The **Error** line is an output from the printer which simply goes low if an error condition occurs. This can be monitored by the computer and used to halt the flow of data when an error occurs. The **Initial** terminal is an input to the printer, and after an error condition has occurred the printer can be reset by a low pulse fed to this input. An alternative which can be used where Initial is not implemented on the computer is to just turn the printer off and then on again.

Paper Empty (or **Paper End** as it is sometimes termed), as its name suggests, goes low to indicate that the printer is out of paper. This feature is one which is only likely to be implemented on a printer with a cut sheet feeder, although it is a feature of some tractor feed printers. **Print Enabled** is an output which goes high when printer is selected (if it has a select/deselect switch). The 5V output is a +5V d.c. supply which can normally provide currents of up to about 100 milliamps.

The facilities available vary slightly from one printer to another, and a clock signal of some kind is sometimes available at one of the normally unused pins. An input to give an automatic double line feed is another line which is sometimes included, either at one of the normally unassigned terminals or in place of one of the other minor facilities. Every printer should be supplied with a manual which gives at least basic details of its input port and the exact facilities it provides.

Fig. 3 shows the printer port connections for some of the many popular home computers that are equipped with this facility. Although a wide range of connectors are used, they generally adhere to the basic connection arrangement of Fig. 2 so that wiring up a suitable printer lead is as simple as possible.

SERIAL INTERFACES

The RS232C is the best known type of serial interface, but there are several other types that are really just variations on the same basic system. Probably the best known of these is the RS423 as used for the serial interface of both the BBC model B and Enterprise 64 computers. The RS232C and RS423 systems are compatible with one another and it makes little practical difference which one your computer has.

With a serial interface the signal is carried on just one data line plus an earth lead. Obviously no more than one bit at a time can be carried by the single wire, and each byte therefore has to be transmitted literally bit-by-bit. The convention is for the least significant bit to be transmitted first, running in sequence through to the most significant bit which is transmitted last. Simply transmitting bursts of data in serial form is of no practical value, since there is no way for the receiving equipment to correctly interpret what would appear to be just a random series of pulses. One way around the problem is the synchronous approach where a third line is used to carry some form of synchronisation signal. For instance, this could be a sort of clock or strobe signal to indicate the times when the data line should be sampled to determine the state of each bit.

ASYNCHRONOUS

Synchronous interfaces are used in practical systems, but they seem to be in the minority, and most serial systems, including the RS232C and RS423 ones, use the asynchronous approach. Rather than relying on an additional signal line an asynchronous system uses extra signals on the data line. The most important one of these, and the only really essential one, is the start bit. Under stand-by conditions the data line is in the low logic state, but at the start of a byte it goes high for a certain period of time. This change in state indicates to the receiving equipment that a byte of data is about to commence, and that it must sample the data line at regular intervals thereafter until the state of each bit has been determined.

All practical asynchronous systems seem to use an additional bit or bits at the end of each byte, and these serve as a form of error checking. There is always at least one stop bit, and sometimes two stop bits are used. The data line is simply set high for a period of one or two bits, as appropriate.

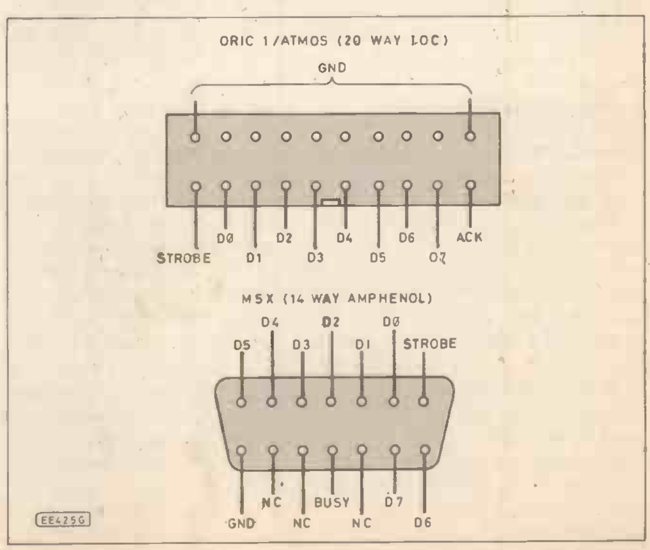


Fig. 3. Printer port details for a variety of computers (continued overleaf).

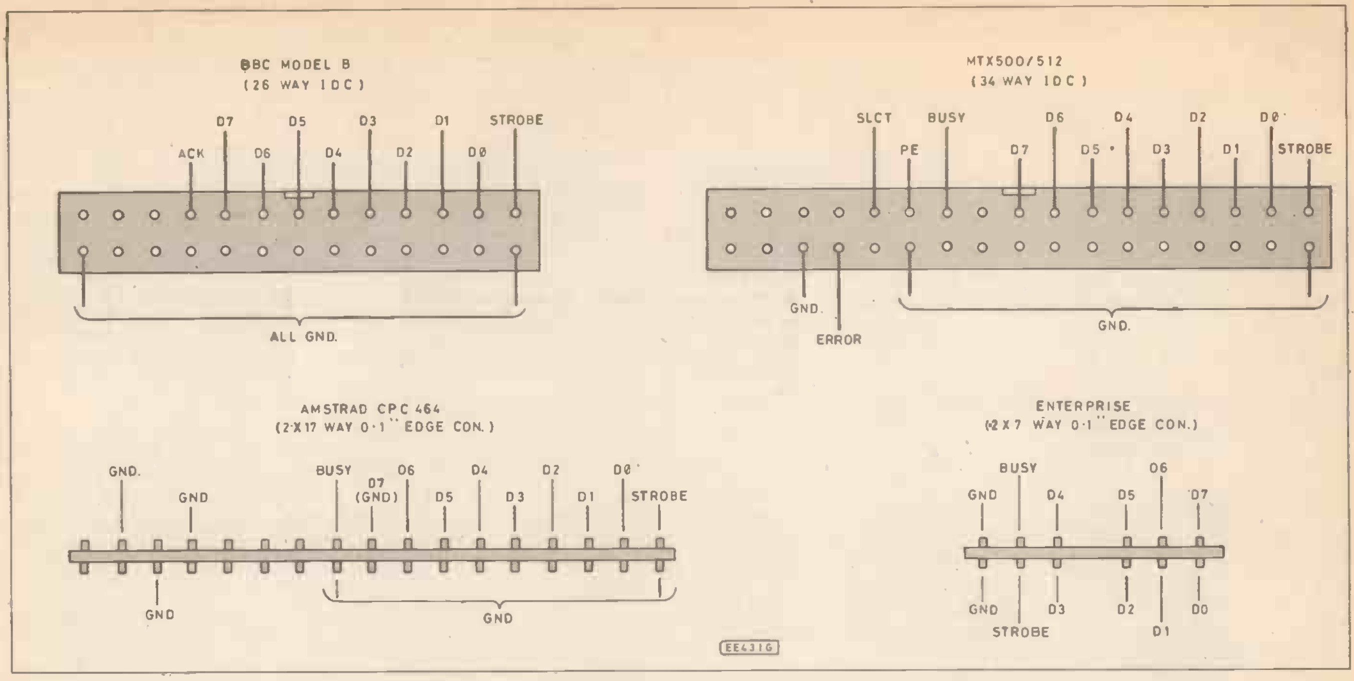


Fig. 3 (continued). Printer port details for a variety of computers.

Some systems use parity error checking, or at least have the facility to do so. It is a system which seems to be little used in practice. With parity error checking each byte always contains either an odd number of 1s or an even number of 1s, depending on whether odd or even parity has been selected. Obviously either an odd number of 1s in every byte or an even number of 1s in every byte is something that will not happen without some assistance from the hardware, and this assistance takes the form of an additional high bit (the parity bit) added between the last data bit and the first stop bit, as and when necessary. A simple flip/flop circuit at the receiving equipment is practically all that is required to provide parity checking and to indicate any errors that occur. Parity checking is not infallible, and a double glitch can preserve correct parity but corrupt the data.

Fig. 4 helps to clarify the way in which an asynchronous system operates. An important point to note here is that the voltage levels are not ordinary 5V logic types, but are nominally −12V and +12V. In fact the maximum acceptable voltages are +25V and −25V, but the standard calls for a minimum of just +3V and −3V. The RS423 system has nominal signal levels of plus and minus 5V (plus and minus 4V to 7V is the acceptable range), together with higher drive current (150mA maximum instead of 10mA) and less stringent demands with regard to rise and fall time. This gives somewhat greater operating range for a given baud rate, but the RS423 system is compatible with RS232C equipment. In practice standard 5V logic levels will often drive RS232C and RS423 inputs satisfactorily, but this cannot be guaranteed to work in every case. An RS232C or RS423 output should not be used to directly drive an ordinary logic input as this could lead to the destruction of the input device.

SIGNAL POLARITIES

Incidentally, serial interface explanations sometimes show the signal polarities as the opposite of those shown in Fig. 4 with the signal at +12V under quiescent conditions, and going to −12V during the start bit. Measurements on RS232C and RS423 interfaces seem to confirm the polarity indicated in Fig. 4. The confusion probably arises because serial interface devices do require and generate signals of the opposite polarity to that shown in Fig. 4. However, they are intended for use with line drivers and receivers that provide the necessary level shifting, and also provide an inversion of the signal. Not all serial interfaces use special interface devices to generate and decode signals, but instead rely on ordinary digital input and output lines plus suitable software routines to generate and decode the signals.

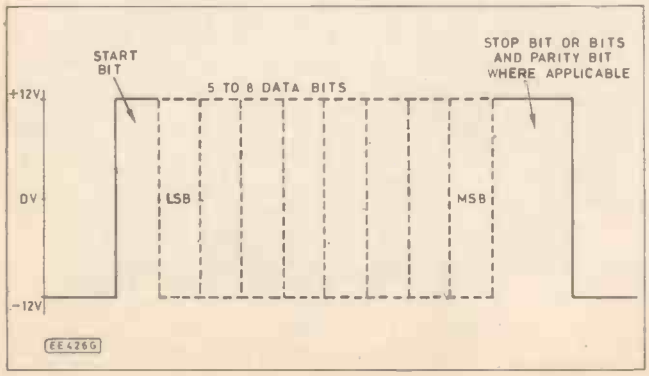


Fig. 4. The make up of an RS232C byte.

As will probably be apparent, wiring two serial interfaces together correctly will not necessarily give a proper transfer of data from one unit to another. To ensure correct data transfer both pieces of equipment must be set to use the same word format. The most common of these is one start bit, eight data bits, one stop bit, and no parity (which is the standard format for RS423 equipment). There are several others in common use though, and apart from the options of one or two stop bits, and odd, even, or no parity, five, six, seven or eight data bits can be used. In computing applications only seven or eight data bits are normally encountered, since ASCII and ASCII-based character codes require at least seven data bits; five data bits might also be encountered though, as five-bit word formats are used in radio communications (RTTY) systems.

There is another factor to take into account, and this is the rate at which data is sent. Obviously the receiving equipment must sample the data line at the appropriate intervals after the start bit has been detected if each bit is to be decoded properly. In order to ensure correct synchronisation of the transmitting and receiving circuits there are a number of standard transmission/reception rates. These are 45.45, 50, 75, 150, 300, 600, 1200, 1800, 2400, 4800, 9600 and 19200 baud. The baud rate is the number of bits sent per second if a continuous data stream is transmitted. It is no coincidence that the higher baud rates are multiples of the lower ones (with the exception of 45.45 which is only used in amateur RTTY systems), and this enables a single clock oscillator plus binary divider chain to provide virtually a full range of baud rates.

The RS232C system is guaranteed to operate at up to 20k baud over a distance of 15 metres. Capacitance in the connecting cable could distort the signal and cause corruption of the data if higher baud rates and (or) longer cables were to be used. On the other hand, at low baud rates of around 75 to 1200 baud it is feasible to use connecting cables much longer than 15 metres. For communications over very long distances the serial signals are normally tone encoded at the transmitter and then decoded again at the receiver, as in a modem system. There is actually a form of serial interface (the RS422 system) which can handle baud rates of up to 10M baud over short distances, or up to 100k baud over a range of up to 1200 metres. This is achieved using a balanced (two signal wire) system, but it has made no impact in the home computing field as yet, and for most purposes the RS232C and RS423 systems are perfectly satisfactory.

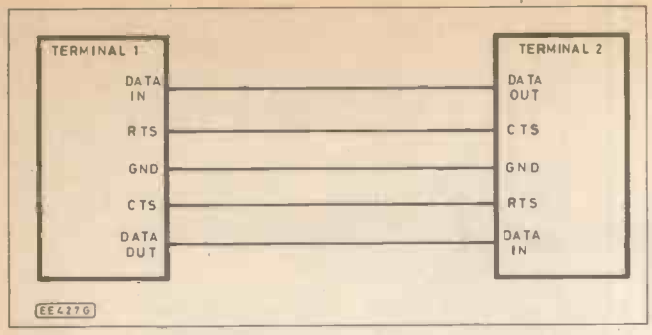


Fig. 5. A typical five wire serial interconnection system.

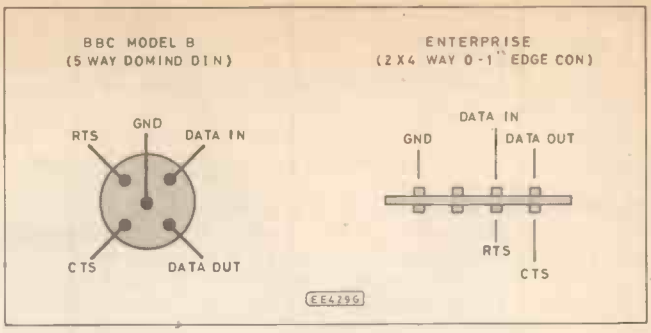


Fig. 7. Connection details for the BBC and Enterprise serial ports.

INTERCONNECTIONS

At the most basic level RS232C interconnections just consist of two wires, one to connect the two signal grounds, and the other to connect the data output of the transmitting device to the data input of the receiving device. For two-way communications three wires are required, a ground connection and two leads to cross-couple the data inputs and data outputs of the two devices. In other words, a separate signal wire is needed to carry signals in each direction.

Serial data systems are relatively slow, and handshaking to control the flow of data is sometimes unnecessary. Typically ten bits per byte are transmitted, which at 300 baud corresponds to a maximum transfer rate of just 30 characters per second. However, at high baud rates the transfer rate can be around one kilobyte per second or more, and some applications do require handshaking to be implemented. The system of handshaking is very simple, and just requires one extra connecting lead (or two in a two-way system).

At the receiving equipment the handshake line normally implemented is **DTR** (data terminal ready) which connects to **CTS** (clear to send) of the transmitting equipment. DTR goes positive to indicate that the receiving equipment is ready to receive data, or negative to provide a hold-off. **RTS** (request to send) may be implemented in place of DTR, and **DSR** (data set ready) may be present instead of CTS, or you may have all four available. At a practical level it is often a matter of trying out a few options to determine which handshake arrangement gives correct operation, but a typical set-up providing two-way communication with full handshaking would use a five-wire arrangement something like that shown in Fig. 5.

A point which is well worth noting is that it is sometimes necessary to implement handshaking even where it will not provide any regulation of the data flow. This occurs where a piece of equipment will not provide any output unless its handshake input is taken to the appropriate signal level. The RS423 output of the BBC computer, for instance, will not output data unless the CTS handshake line is taken positive.

RS232C CONNECTORS

The standard RS232C connector is a 25-way D type, and this uses the method of connection shown in Fig. 6. Some of the pins are unused, and in practice, even if the port uses the proper type of connector, only the ground, main signal, and main handshake lines, are likely to be implemented, with the other terminals just being left open circuit. The Sinclair QL, for example, only implements ground, data in and data out, CTS, DTR, and a +12 volt line to act as a dummy DSR line (for use with equipment that requires the handshake input to be taken positive in order to enable output). While this falls well short of the full RS232C standard, it is perfectly adequate in normal use. Some home computers do not use a 25-way D-type connector for their serial ports, and Fig. 7 gives connection details for the RS423 ports of two such computers, the BBC model B and Enterprise.

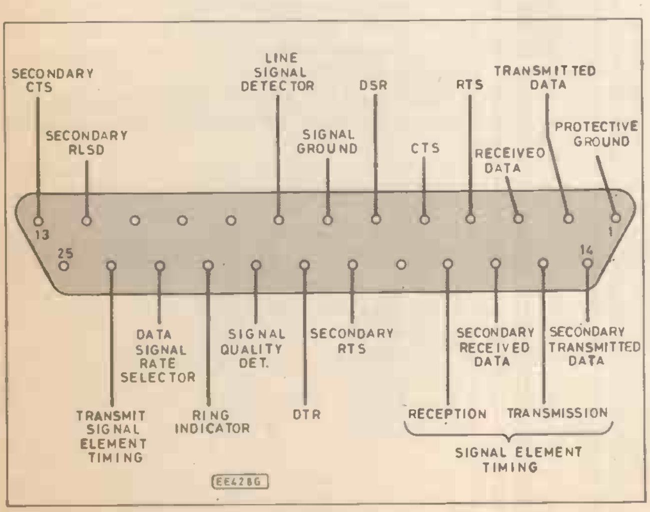


Fig. 6. A full RS232C interface uses a 25-way "D" connector as shown here.

The original idea of the RS232C standard was to have two types of equipment, data communications equipment (DCE) and data terminal equipment (DTE). Data terminal equipment is the normal type, and it transmits on the data output and receives on the data input. With data communications equipment things are reversed, with transmission on the data input line and reception on the data output. The handshake lines are similarly reversed. This may seem a rather strange way of doing things, but the idea is to enable a piece of DTE equipment to be connected to a piece of DCE equipment using a standard 25-way D to 25-way D cable without the need for any crossed connections. This works fine if you have two suitable pieces of equipment, and some computers helpfully provide two serial ports, one DTE configured and the other DCE connected, so that they can be connected to any item of RS232C equipment (provided it has the correct type of connector) using a standard lead and the appropriate one of the two ports. Obviously some care needs to be exercised when interconnecting serial ports, but outputs have current limiting and if two outputs should be accidentally connected together it is unlikely to cause any damage.

IEEE488

The IEEE488 (or IEE488 as it is often but incorrectly called) is a much more complex form of interface than those described previously. Paradoxically it is the one which, on the face of it, readers of this magazine would find most useful, but is also the one which few are ever likely to use. Its main application is in the field of automatic test gear and other scientific equipment, but the cost of the sophisticated equipment which uses this interface is quite high and beyond the means of most amateur users. Hopefully, the cost of such equipment will fall to a more affordable level in the future, or low cost surplus equipment will become available.

This type of interface is also used to some extent with such things as plotters and disc drives. Although I know of no home computer that is equipped with an IEEE488 interface, add-on types are available for some computers including the BBC model B and the Commodore machines.

The IEEE488 interface is a parallel type with data carried on eight lines. It permits up to fifteen devices, including the controlling computer, to be interconnected in either the linear or the spider arrangement. There are three categories of device which are termed "talkers", "listeners", and "controllers". The controller is the one at the heart of the system which would normally be a microcomputer or minicomputer, and there can only be one controller per system. A talker is one which is set to output data onto the eight-bit bus, and a listener is one which is set to receive data.

Many devices are actually talkers and listeners (including the controlling computer), but they can only provide one action at a time, and there can only be one talker in the system at any one time. This is analagous to the internal structure of a microcomputer where various input/output devices are connected to the data bus, and the control and address buses ensure that only one device at a time outputs data onto the data bus.

Being a parallel system only short connecting leads are permitted, with a maximum individual cable length of four metres. In a system the maximum cable length is two metres per device or a total of 20 metres, whichever is shorter. The advantage of using a parallel system is the high maximum data transfer rate of up to 1M byte per second.

In addition to the data lines there are three handshake lines and five control lines. This may seem to be rather a lot, but it is a sophisticated set-up in which each device has an individual address so that data can be directed to just one device. Furthermore, devices can have secondary addresses. One way in which this can be used is to enable the operating mode of a device to be varied, depending on the secondary address to which data is written. For instance, a multichannel digital analogue converter could have a different secondary address for each channel, giving easy access to each channel. Remember that this is a two-way system, and it could equally well be used to read a multichannel analogue to digital converter.

CONNECTORS

The standard IEEE488 connector is a 24-way Amphenol type and connection details for this are given in Fig. 8. Perhaps of more relevance to microcomputer users is the greatly cut down version used in the Commodore serial bus, as fitted to the VIC-20, Commodore 64, C16, and Plus 4 machines (the PETs have the full IEEE488 interface incidentally). The Commodore serial version is a synchronous type with the clock signal providing a synchronisation signal. This is not a clock signal in the sense of a straightforward clock oscillator, and it provides information such as positive transitions to indicate when valid bits of data are present on the bidirectional data line. The clock line is a bidirectional type, as the talking device and not the controller always provides the synchronisation signal.

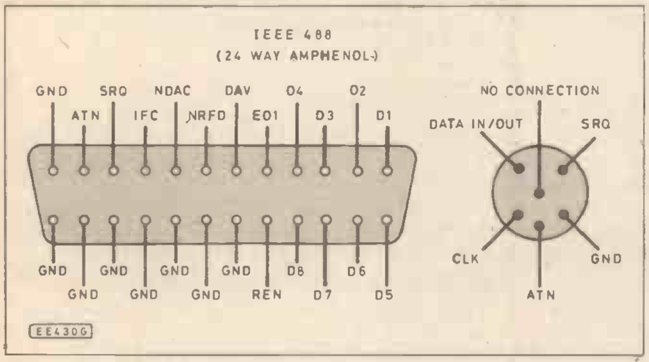


Fig. 8. The IEEE488 parallel port connections, and the "cut down" Commodore serial version.

The SRQ (Serial Service Request) is an input to the computer which any device on the bus can pull low in order to indicate to the computer that it requires servicing. ATN (Attention) is used to start a command sequence. The computer takes this line low in order to set all devices on the bus as listeners, and it then sends the appropriate address. If the selected device fails to respond within a certain period of time, it is assumed to be absent and the computer provides a **"Device Not Present"** error message.

Further details of this interface, including some timing diagrams, can be found in "Commodore 64 Programmer's Reference Guide", published by Commodore. Although the Commodore's serial version can probably do everything that the full IEEE488 interface can achieve, and an IEEE488 adaptor can be obtained, the serial nature of the interface and simplified control and handshaking arrangement inevitably result in greatly reduced maximum operating speed. □

HINTS AND TIPS

LAMPS IN SERIES

If a 40-watt filament lamp is connected in series with a 100-watt lamp and the mains applied which one glows brighter? Answer: the 40-watt lamp.

You can baffle your non-technical friends with this apparently unusual behaviour. But a closer look shows that it is not really mysterious. The same current flows through each lamp. The voltage drop across a lamp, and therefore its brightness, depends on the lamp's resistance. The lower the wattage the higher the resistance. So the lower wattage lamp drops more volts and shines brighter.

When lamps are to be used for lighting there's little point in connecting them in series. The light output from a filament varies with the fourth power of the voltage. This means, for example, that if one lamp of a series pair robs the other of a mere ten per cent of the voltage then the light output falls by about a third. On the other hand the life of a filament is greatly increased at reduced voltage and in special circumstances this can make series connection worth while. If lamps are used as sources of heat rather than light then the loss of light doesn't matter. And if only a dim light is acceptable, series working is all right. One case is Christmas tree lights. If two strings are connected in series they glow much less brightly but the chances of having to identify a failed bulb are greatly reduced.

MAINS ISOLATION

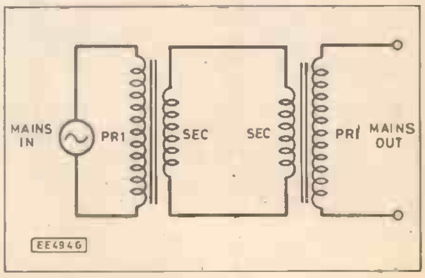
Service engineers often instal isolation transformers to reduce the risk of accidental shock when working on electronic equipment. The risk of shock can be quite high when the mains supply has an earthy or neutral side as in Britain and where the equipment being serviced has one side of its circuitry (usually the "chassis" or "earth" side) connected to one side of the mains. Even if the equipment does not use this "live chassis" arrangement there is still a risk of contact with the mains connection inside.

An isolation transformer is a 1:1 mains transformer. The equipment under test is driven from its secondary which is unearthed and therefore floating. Contact with one side of the floating secondary carries little risk of shock so long as the transformer's inter-winding insulation is good.

Isolation transformers of adequate power rating (say 300W for supplying a colour TV) are expensive. Occasionally, high-power transformers designed for other purposes can be bought very cheaply. They are unlikely to be of 1:1 ratio, but if a pair of identical transformers can be obtained these can be interconnected back to back as illustrated. The output is at mains voltage irrespective of the turns ratio.

Since there are now two lots of insulation between output and mains, isolation should be good. Less helpful is the fact that there are now two lots of transformer losses. The power rating should be reduced somewhat to allow for this.

WARNING. The transformers MUST be double-wound. Auto-transformers must not be used as they cannot provide isolation.



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LS01	20	LS124	115
LS02	19	LS125	35
LS03	21	LS126	35
LS04	17	LS132	44
LS05	20	LS133	44
LS08	19	LS138	36
LS09	20	LS139	36
LS10	18	LS151	34
LS11	20	LS153	62
LS13	24	LS154	115
LS14	34	LS155	44
LS15	20	LS156	54
LS20	18	LS157	34
LS21	20	LS161	55
LS22	20	LS163	54
LS27	20	LS164	54
LS28	22	LS165	90
LS30	20	LS166	85
LS32	18	LS173	45
LS33	22	LS181	185
LS37	20	LS192	54
LS38	20	LS197	72
LS42	34	LS221	62
LS73	26	LS240	64
LS74	24	LS241	58
LS75	30	LS242	60
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LS83	42	LS247	60
LS85	50	LS251	44
LS90	24	LS257	44
LS93	30	LS266	32
LS95	50	LS273	54
LS107	40	LS367	40
LS109	38	LS373	59
LS112	40	LS374	60
LS113	38	LS393	46

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TILT ALARM

I.P. KEMP

Protects cases, doors, car boots, roof racks, tool or jewel boxes etc.

THIS simple Tilt Alarm was designed to be portable and easy to operate. It can be used in any situation where an attempted theft involves tilting something.

The initial idea was that it could be attached to the handle on the inside of a hotel room door but there are many other applications. The lids of suitcases or camera cases are suitable places as are garage doors, tail gates and car boots. It is also suitable for protecting items fitted to a roof rack. The list of possible applications seems to be unlimited. The unit is small enough to be built into a jewel box (or tool box).

The alarm is particularly suitable for use in situations where it is left unattended for long periods. A two-minute alarm time-out prevents the battery being exhausted, and the possible annoyance of neighbours, in the event of a false alarm (or an abandoned theft attempt).

After the time-out the alarm resets and will respond again when tilted. The alarm is set by removing a "key" made from a miniature jack plug. This method is cheap and easy and offers good security. An opportunist thief will be totally unprepared for an alarm of any kind and certainly won't hang around trying to turn it off.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Tilt Alarm is shown in Fig. 1. The "tilt" is detected by S1 which is a mercury tilt switch. This is a simple glass bulb containing a blob of mercury which is free to move around if the bulb is tilted. Two wires which pass into the bulb at one end are short circuited when the mercury blob bridges them and open circuited when it does not.

In this application the tilt switch is positioned so that the mercury blob is normally away from the two wires but falls to bridge them when disturbed. The alarm circuit must, therefore, detect when the tilt switch changes from open circuit to short circuit.

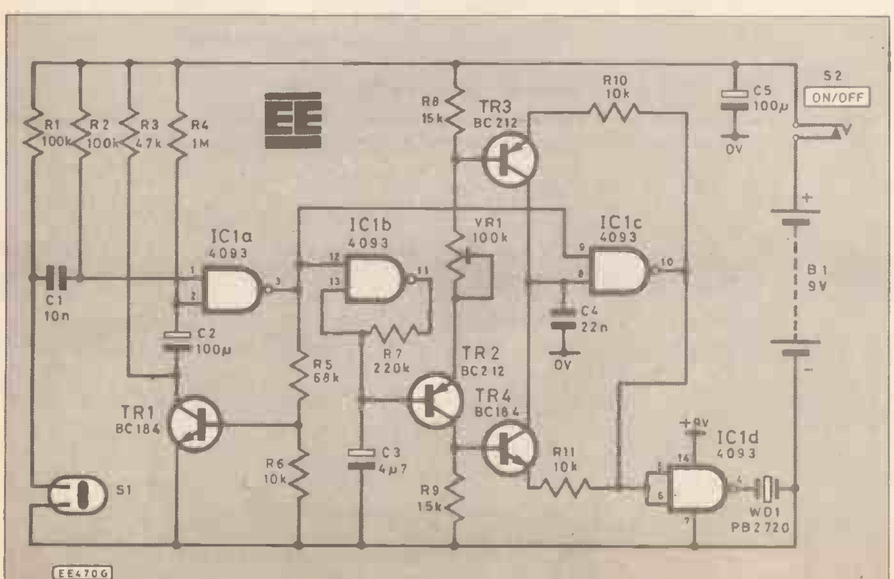
The closing of the tilt switch is detected by IC1a. Normally both inputs to IC1a are held high. A truth table for all four NAND gates of IC1 is given in Table 1.

Table 1. Truth Table for Two Input NAND Gate

INPUT 1	INPUT 2	OUTPUT
H	H	L
H	L	H
L	H	H
L	L	H

H — High or Logic 1
L — Low or Logic 0

Fig. 1. Complete circuit diagram of the Tilt Alarm.



With its two inputs held high the output of IC1a will be low. Transistor TR1 will not receive any base bias current via resistor R5 and so will be turned off. The collector of TR1 will be held at the positive supply voltage via R3. IC1a also feeds one input each of IC1b and IC1c.

From Table 1 it can be seen that holding either of the inputs of these gates low forces the outputs to remain in the high state regardless of the other inputs. The alarm stays quietly in this state until the tilt switch is disturbed and switches from open to short circuit. When this happens the input of IC1a is briefly pulled low via capacitor C1.

With one of its inputs low the output of IC1a switches from low to high, turning on TR1 via R5. As TR1 turns on its collector voltage falls from the positive supply voltage to almost zero. This fall in voltage is passed via capacitor C2 and pulls the other input of IC1a from high to low. The low on this input of IC1a now takes over and holds the output in the high state regardless of the state of the other input.

IC1a would remain latched in this state except for the effect of resistor R4, via which C2 gradually charges. After approximately 100 seconds the voltage on the positive end of capacitor C2 has risen sufficiently to take the input of IC1a from the low state to the high state. The other input of IC1a is already held in the high state via R2 and so with both inputs high the output of IC1a switches from high to low and turns off TR1.

The collector of TR1 rises to supply voltage and the circuit settles down once again with both inputs of IC1a in the high state and its output in the low state. Even if S1 remains closed the circuit action will be unaltered because capacitor C1 and resistor R1 only allows the input of IC1a to be pulled down for a few milliseconds.

The circuit will be re-triggered next time S1 changes from open circuit to short circuit and the whole 100-second cycle will repeat. The 100-second time period is set by the values of C2 and R4. These values can be reduced for shorter periods but should not be increased much because the small charge current and the high leakage current of big electrolytic capacitors will give unpredictable results.

ALARM TONE GENERATOR

IC1b and IC1c form a frequency modulated audio generator which produces a particularly penetrating sound when used with miniature piezo-acoustic transducers because it excites their natural resonances.

In the quiescent state the output of IC1a is low and holds one input each of IC1b and IC1c low. In this state the outputs of IC1b and IC1c are high and they cannot oscillate.

COMPONENTS

See **Shop Talk** page 367

Resistors

R1,R2	100k (2 off)
R3	47k
R4	1M
R5	68k
R6,R10, R11	10k (3 off)
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C4	22n polyester C368

Semiconductors

IC1	4093 *CMOS*
TR1,TR4	BC184 *npn* silicon (2 off)
TR2,TR3	BC212 *pnp* silicon (2 off)

Miscellaneous

S1	Mercury tilt switch, type MGT2
S2	2·5mm switched jack socket
WD1	PB2720 piezo-electric resonator
B1	PP3 9V battery and clip

2·5mm plastic jack plug; case; sticky pads; 14-pin i.c. socket; printed circuit board, available from *EE PCB Service:* code EE 527.

Approx. cost Guidance only £8

When the alarm is triggered the output of IC1a and the inputs of IC1b and IC1c connected to it become high. From the truth table of Table 1 it can be seen that when one of the inputs of a gate is high, the output is always the opposite of the other input. I.e. the gate can be treated as a simple inverter.

The gates in IC1 are not just "straight" CMOS NAND gates. They also have a Schmitt trigger action. Schmitt trigger gates have a built in hysteresis effect so that the output switches sharply between states even if the input changes slowly.

This feature enables the gates to function and oscillators with the addition of just one resistor and one capacitor. IC1b is connected as such an oscillator and operates as follows:

Initially assume that the input of IC1b is low and its output is therefore high. Capacitor C3 will be charged via R7 until the voltage across it rises to a voltage known as the upper input threshold voltage of IC1. At this point the output switches from high to low and C3 now begins to discharge via R7.

The hysteresis of the Schmitt trigger gate means that the output will not switch from low to high until the input voltage has fallen to a lower voltage known as the "lower input threshold". At this point the output switches from low to high, C3 begins to charge via R7 again, and the cycle repeats.

The output from the i.c. is a square wave as it switches backwards and forwards between states. The voltage across C3 is a gently rising and falling triangular waveform. This waveform is used to modulate the frequency of a second similar oscillator formed around IC1c.

VOLTAGE CONTROLLED OSCILLATOR

In the second oscillator C4 is the capacitor which is charged and discharged via two transistors TR3 and TR4 instead of a single resistor. By varying the base bias voltage on the two transistors it is possible to alter the amount of current that they pass and hence the rate at which C4 is charged and discharged.

To understand how this circuit works assume the base of TR2 is held at half of the supply voltage. The emitter of TR2 will be above half of the supply voltage by 0·6V (the base—emitter voltage of TR2).

Preset potentiometer VR1 sets up the current that flows via resistors R8, R9 and transistor TR2 and would normally be adjusted so that there was 1·6V across R8 and R9, (the base current of TR2, TR3 and TR4 is insignificant, so the current in R8 is practically identical to that in R9, about 105 microamps in this case).

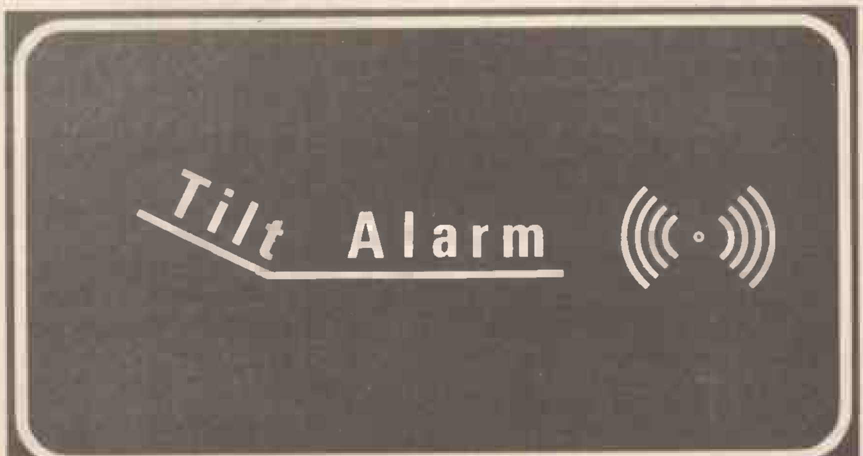
When the output of IC1c is high it almost reaches the supply voltage and so the voltage across TR3 and resistor R10 is 1·6V. Allowing 0·6V for the base-emitter junction of TR3 this leaves 1V across R10 giving a current of 100 microamps passing through TR3 to charge C4. When the output of IC1c is low TR3 is turned off and TR4 turned on. As there is 1·6V across R9 there will be 1V across R11 and so the discharge current of capacitor C4 will also be 100 microamps.

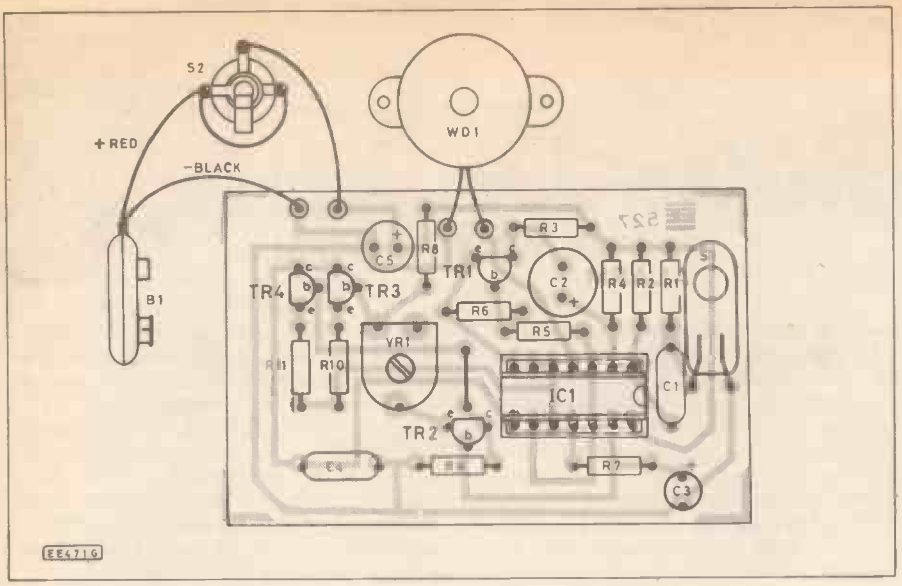
The base voltage of TR2 is varied by the low frequency triangular waveform across capacitor C3. This causes the voltages across R8 and R9 to vary and so alters the charge and discharge currents of C4 and the frequency of oscillation.

The values are chosen so that the output of IC1c is a square wave which sweeps up and down between 2kHz and 3kHz at a rate of 2Hz. IC1d is a simple buffer stage which isolates IC1c from the loading effect of the output transducer WD1.

The alarm is turned on by removing the plug from the miniature switched jack socket S2. The socket is wired so that the alarm will keep sounding even if a nail or other (conducting) object is used to attempt to foil it. The choice of a 2·5mm jack socket ensures that matchsticks cannot be inserted.

Front panel design for the Tilt Alarm.





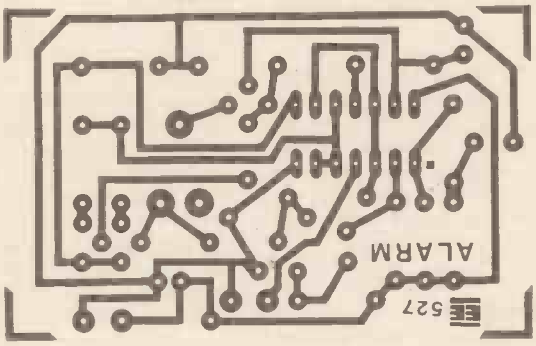
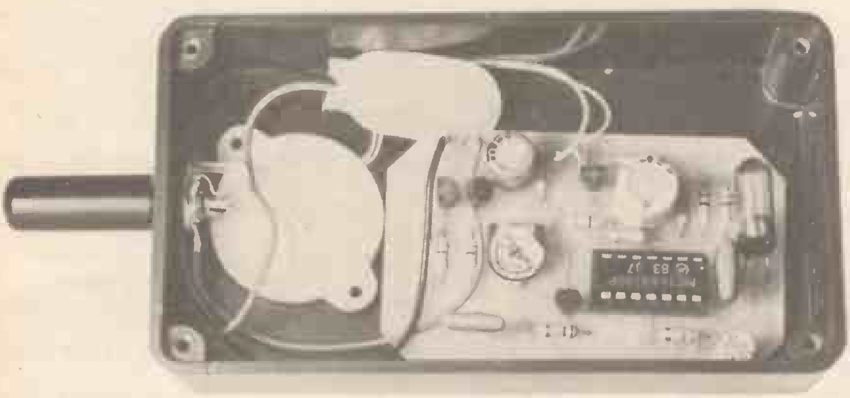


Fig. 2. Component layout and wiring.



CONSTRUCTION

The alarm is built on a single small printed circuit board. This board is available from the *EE PCB Service*, order code EE527. The component layout and wiring is shown full size in Fig. 2. A socket is recommended for IC1 as it aids troubleshooting enormously if the i.c. can be removed when making checks. The electrolytic capacitors C2, C3 and C5 must be fitted the right way round as must the transistors and the i.c. Take care not to confuse the two types of transistor.

The tilt switch can be mounted on the board as shown but may also be fitted remotely on wire leads. The main thing is to get the switch set at the correct angle so that it is normally open but closes on an attempted theft. The operation of the switch can be checked easily by watching the mercury blob fall from end to end.

The prototype was built in a plastic case measuring 60 × 110 × 30mm. Sticky pads are used to mount the board, transducer and battery.

TESTING

When the alarm is complete check that S2 is working correctly so that power is only supplied to the circuit when the plug is removed. Insert the jack plug, connect a battery and set the position of S1 so that it is open circuit. Remove the plug and check that the alarm is silent. As soon as S1 is tilted to the short circuit position the alarm should sound. Tilting S1 to the open position should have no effect and the alarm should continue to sound for between 60 and 120 seconds. The frequency range of the alarm sound should be set by VR1 for the most penetrating effect. Resonances in WD1 are influenced by its mounting method so the setting of VR1 should be done with the alarm in as near to its final form as possible.

IN USE

The alarm can be fixed to the object to be protected by using double-sided tape, Blu-tak, Velchro strips or any other appropriate method. Battery drain is negligible when the alarm is not sounding and small even when it is. A PP3 battery will probably last for a year's "normal" use.

Although a tilt switch is used in the design it is also quite possible to use any other sensor that changes from open circuit to closed circuit when disturbed. Pressure mats and micro switches wired in parallel with S1 could be used to give additional protection. □

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

NATIONAL CONVENTION

The major amateur gathering of the year is undoubtedly the RSGB's National Amateur Radio Convention at the National Exhibition Centre, Birmingham. Held over the weekend April 5–6, this year's event featured lectures on VHF Equipment Through the Ages; Solar Cycle 21; Low-power Operating; Microwave TV; How to get on 50MHz; and An Introduction for Beginners.

All the latest equipment could be seen, or bought, whilst the component market-place was as popular as ever, suggesting that home-construction still finds its place in the hobby. There were a number of stands by the RSGB and various specialist organisations, some of which held meetings of members during the convention.

A "talk-in" station guided mobiles through the complexities of Birmingham's traffic, and a demonstration amateur radio station was operated by the Solihull Amateur Radio Society.

Some 10,000 visitors attended the convention during the weekend, and many friendships were made, or renewed, by amateurs from all parts of the UK, and overseas, who at other times meet only on the air.

MORSE EXPERIMENT

Class B radio amateurs, learning Morse code with the intention of obtaining a Class A licence, had a special concession during the 12 months ended March 31, 1986. They were not normally allowed to use Morse "on-the-air" until they had passed the official Morse test, but during the one year experiment Morse operation was permitted on the VHF bands.

The concession, negotiated by the RSGB with the DTI, was to enable learners to practice Morse sending and receiving in preparation for the amateur radio Morse test, and give them experience under real operating conditions.

There were a number of limitations to ensure that inexperienced operators did not interfere with regular Morse operation. This was mainly by restricting practice operating to non-Morse sections of the bands, and requiring operators to announce their call-signs by telephony at the beginning and end of each transmission.

Throughout the year a large number of learners took advantage of the concession, often having pre-arranged contacts with experienced operators to help them gain proficiency. All in all, the experiment has been deemed a success, and at the time of writing it is expected the DTI will shortly formalise the facility as a permanent feature of the amateur (B) licence, by means of a notice in the London Gazette.

NEW CALL BOOK

The RSGB's new "Amateur Radio Call Book" lists approximately 56,000 call-signs currently licensed in the UK and Eire, including names and addresses of licensees, updated from the previous edition.

A major change is the inclusion of a members' handbook, providing information about the RSGB and its activities. Amongst other things, there is a useful year planner and RSGB calendar, to ensure that favourite events are not overlooked; details of band plans; lists of amateur codes and abbreviations; details of awards and contests; a worldwide countries checklist; a schedule of slow Morse practice transmissions; and details of various amateur societies, clubs, and specialist organisations.

The call book is probably referred to by amateurs more than any other publication, and the addition of this further information will make it even more useful. Despite the addition of 40 pages compared to last year, the price has been reduced thanks to the use of computer technology in its production, and in future there will be two fully up-dated editions each year.

QUESTION CORNER

Q. Can you give some information about the Radio Amateurs' Examination?

A. Certainly! The City and Guilds of London Institute is the body responsible for setting the RAE, which is held twice yearly at many centres throughout the UK and overseas, on an internal or external basis. In the period December 1984–December 1985, 9,200 candidates completed the examination and 6,103 were successful, a pass rate of 66·3 per cent.

The content of the examination is supervised by an Advisory Group, with members nominated by the CGLI, RSGB, DTI, BT, IEE, IERE, plus a number of eminent educational bodies. A revised syllabus has been introduced this year, and the emphasis changed in several areas. For example, questions on electrical theory are reduced from 18 to 10 per cent in the examination paper, whilst "transmitter interference" increases from 34 to 43 per cent.

The most significant change relates to "operating procedures, practices and theory", up from 8 to 18 per cent, reflecting a long felt need that newly qualified amateurs should have better preparation for going on the air, in practical terms.

The examination is in two parts, the first, lasting an hour, covering licensing conditions, and transmitter interference. The second, lasting $1\frac{1}{2}$ hours, covers what is, in effect, basic radio theory, including solid state devices, receivers, transmitters, propagation and aerials, and measurements.

It is not a difficult examination for someone keen enough to study for it, and it provides a very useful background in its own right for those interested in radio communication, even if they have no technical background to begin with. There are a number of ways to study for the examination, including correspondence courses and evening classes. There are a number of good books available, and you can even "do-it-yourself" if you wish.

A copy of the examination regulations and syllabus can be obtained from The City and Guilds of London Institute, Sales Section, 76 Portland Place, London W1N 4AA, price £1.50 post free, quoting "Subject 765". A set of sample questions costs a further £1.30.

HAVE A GO!

Try a few typical questions! The answers are given at the end.

1. If a component in a d.c. circuit has a p.d. across its terminals of one volt and the current flowing through it is one ampere, then the component has
a) a resistance of one ohm
b) a capacitance of one farad
c) an induction of one henry
d) a charge of one coulomb

2. A resistor is colour-coded such that its resistance value is nominally 100k ohms. If the tolerance of the resistor is 2 per cent, then the resistance value may be between
a) 99k ohms and 101k ohms
b) 98k ohms and 102k ohms
c) 97k ohms and 103k ohms
d) 96k ohms and 104k ohms.

3. The output from the b.f.o. in a superheterodyne receiver is usually applied at the output of
a) mixer stage
b) r.f. amplifier
c) last i.f. amplifier
d) audio amplifier

4. The intelligence is contained in the carrier of a frequency modulated signal by
a) rate and amount of amplitude deviation
b) rate and amount of frequency deviation
c) amount of frequency deviation only
d) rate of frequency deviation only

5. The purpose of a standing wave ratio meter is to ensure that the
a) radiated power is within the permitted maximum
b) aerial system is correctly balanced
c) transmitter is matched to the aerial system
d) reflected power is equal to forward power

6. The spelling of the word TCHAD using the recommended phonetic alphabet is
a) Tare Charlie How Able Dog
b) Tango Cork How Alpha Delta
c) Tempo Cork Hotel Able Delta
d) Tango Charlie Hotel Alpha Delta

Of course, they get a bit harder as you work through the exam! My thanks to the CGLI for providing much of the information, including the sample questions, reproduced here. Answers = 1 a), 2 b), 3 c), 4 b), 5,c), 6 d).

MORE QUESTIONS?

Questions about amateur radio are always welcome. Send them to me c/o the Editor, and I will feature them in Question Corner.

VOX BOX AMPLIFIER

GEORGE CHURCHER

Add power to your computer's voice

THERE are several speech synthesisers available to enable you to make your home computer "talk", though most leave it to the user to find a suitable method of producing sound. Hooking up to your hi-fi is not always practical and something portable near the computer is desirable—hence "Vox-Box". It can also double as a telephone monitor or a Bench Test Amplifier.

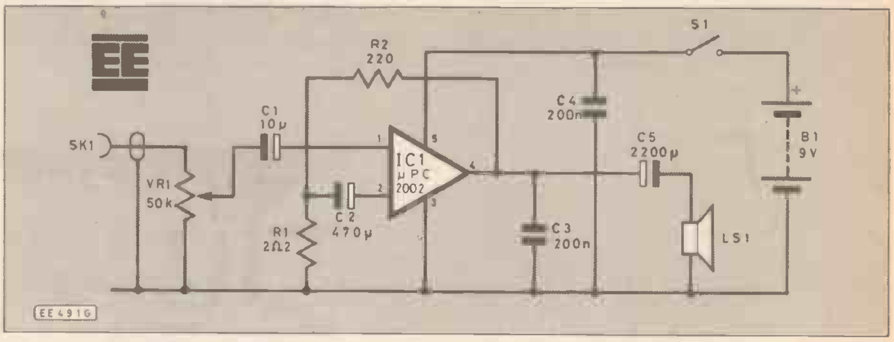


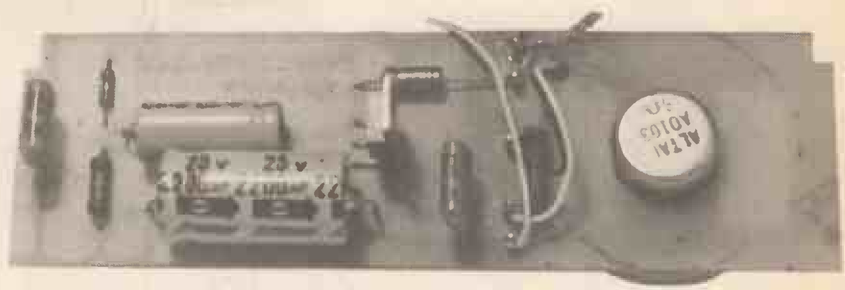
Fig. 1. Complete circuit diagram for the Vox Box Amplifier.

CIRCUIT OPERATION

There are a number of audio amplifier i.c.s now available and the one chosen for this design is particularly suitable for hobbyist use since it only requires a few biasing components. The µPC 2002 is housed in a special package with a heatsink fin to attach a heatsink. Pin numbering is shown in Fig. 1 which also gives the complete circuit diagram.

The audio input is fed to the non-inverting input of the amplifier via the volume control VR1 and C1. Components R1, R2 and C2 provide feedback to the inverting input of the amplifier, setting the gain and reducing distortion of the circuit. The output is linked to LS1 via C5, a 4Ω speaker gives greater output but volume is adequate with 8Ω.

Power is provided by a PP6 9V battery or by a six AA size cells. Rechargeable AA type cells may be used if required; these will give around 5V which is adequate to supply IC1.



Completed circuit board removed from the case.

CONSTRUCTION

Most of the components are mounted on a p.c.b. as shown in Fig. 2. The board is also used to mount the 1½ inch diameter speaker. Since there are remarkably few parts and a fairly large board the order in which they are fitted is not critical. The small cutaways on the p.c.b. allow clearance for the rim inside the lid. The width of the p.c.b. stops it moving in the case.

A standard plastic case was used for the prototype which measured 150 × 80 × 50mm externally. This houses all the components, battery, and p.c.b. When using a PP6 battery care should be taken when drilling the holes for the volume control to ensure that the battery plus the clip will enter without fouling. Two "sticky-fixers" will hold the battery in place.

Drill a pattern of holes in the side of the case to produce a speaker aperture. Take care to remove all plastic swarf and any sharp edges before offering the p.c.b. and speaker into the box or damage to the speaker cone could result. "Sticky-fixers" make suitable adjustment for positioning the speaker in relation to the board and case. The spongy quality of these pads provide all the face pressure required to achieve good sound quality.

Finish construction by connecting all the wiring as shown in Fig. 3 and testing the unit. □

COMPONENTS

See Shop Talk page 367

Resistors

R1	2Ω2
R2	220

¼ W ± 5% carbon

Potentiometer

VR1	50k linear

Capacitors

C1	10µ axial elect. 25V
C2	470µ axial elect. 25V
C3,C4	200n polyester (2 off)
C5	2,200µ axial elect. 25V

Semiconductor

IC1	µPC 2002, TDA 2002, or LM 383 audio amplifier

Miscellaneous

SK1 3·5mm mono jack socket; S1 S.P.S.T. toggle switch; B1 9V PP6; 1½ inch diameter 8 ohm speaker; p.c.b. available from the *EE PCB Service*, order code EE529; knob to suit potentiometer; plastic case approx, 150 × 80 × 50mm; Veropins (5 off); nuts, bolts, wire, solder, etc.

Approx. cost Guidance only **£10.00**

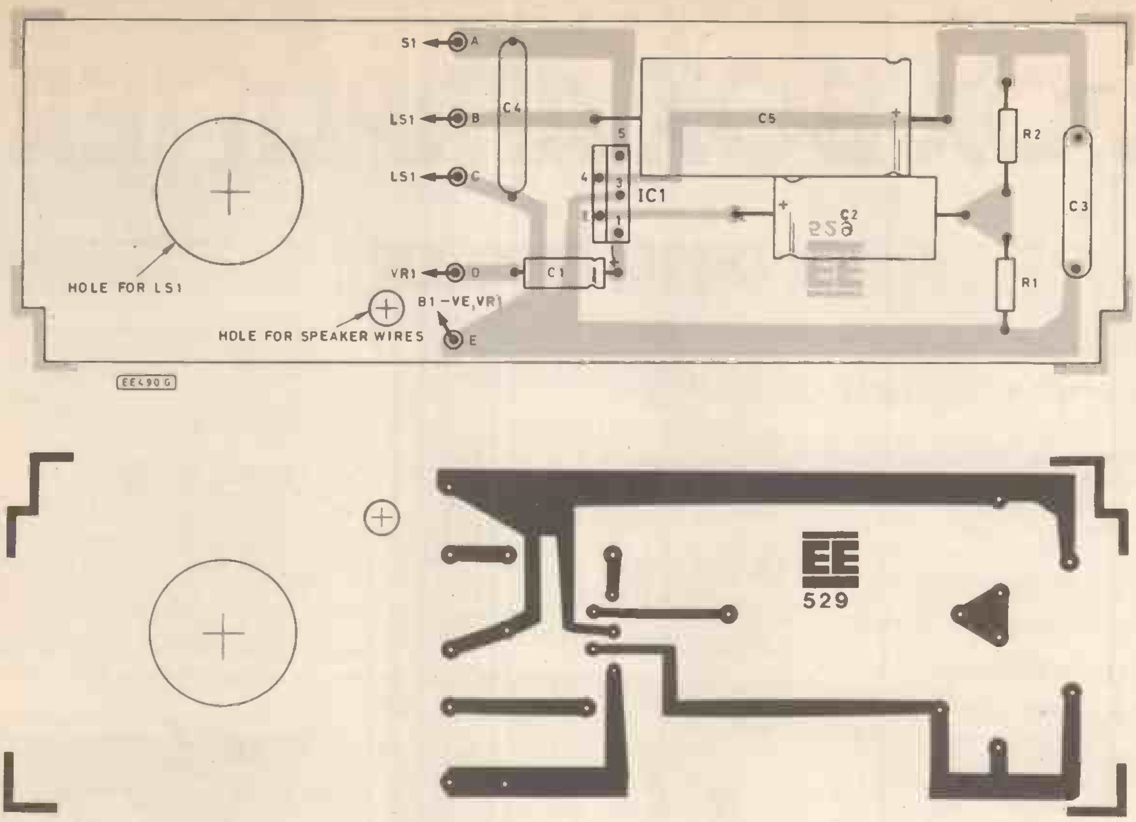


Fig. 2 (above). Component lay-out and full size printed circuit board master pattern. This board is available from the *EE PCB Service:* code EE529.

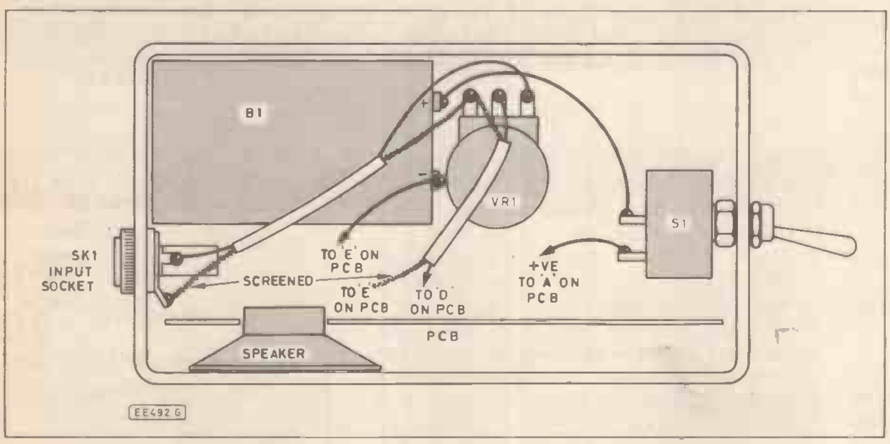


Fig. 3 (left). Positioning of components in the case and details of the interwiring to the circuit board.

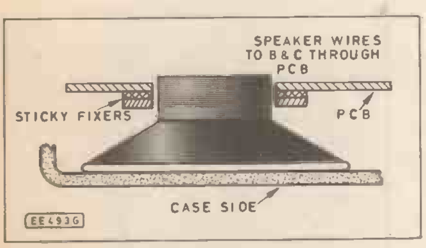
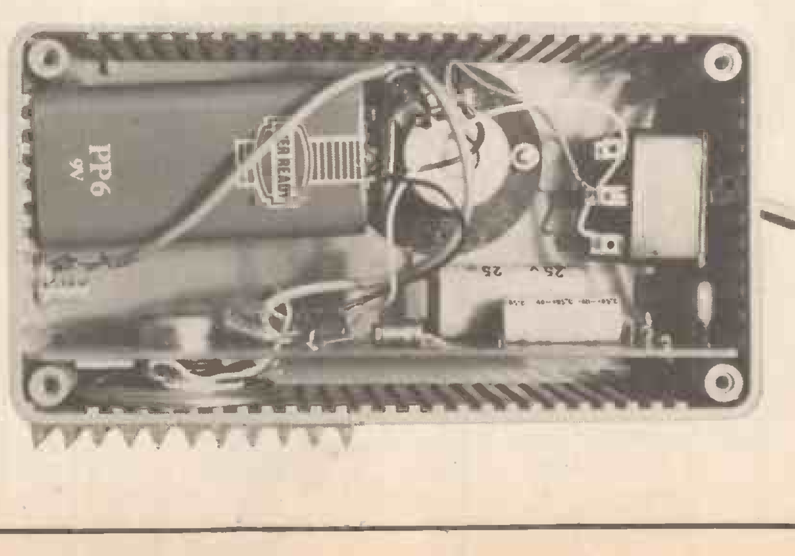


Fig. 4. Details of the arrangement for mounting the speaker between the p.c.b. and case side using "sticky-fixers".

The completed circuit board slotted into the retaining grooves in the side of the case can be seen in the photograph on the right. Before mounting components in the case, a series of holes must be drilled in the side where the speaker is sited.



exploring electronics

OWEN BISHOP

PART 1 Semiconductor diodes

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

THE expansion of modern electronics began with the development of devices made from semiconducting materials. We begin our explanation of electronics by using one of the simplest of the semiconductor devices, the semiconductor diode.

Conduction in diodes

A diode consists of two types of semiconductor material (called *n-type* and *p-type*) in contact with each other. This forms a *p-n junction*. When a *p-n* junction is made, a potential difference of about 0·6V appears across it (a virtual cell).

Forward bias: No conduction if the voltage is not enough to overcome the field at the *p-n* junction. Above this the diode conducts easily.

Reverse bias: No conduction, except for a very small leakage current, even if the reverse voltage is 100V or more. Above this, the diode suddenly begins to conduct very readily. Unless the leakage current is limited by the external circuit, a large current may pass through the diode and destroy it. Silicon diodes can be made to stand 1000V reverse bias, or more.

Zener diodes: The voltage-current curve has a sharp "knee". Under reverse bias, it begins to conduct readily at a clearly marked Zener voltage. Zener diodes are used to stabilize voltage—more later in the series.

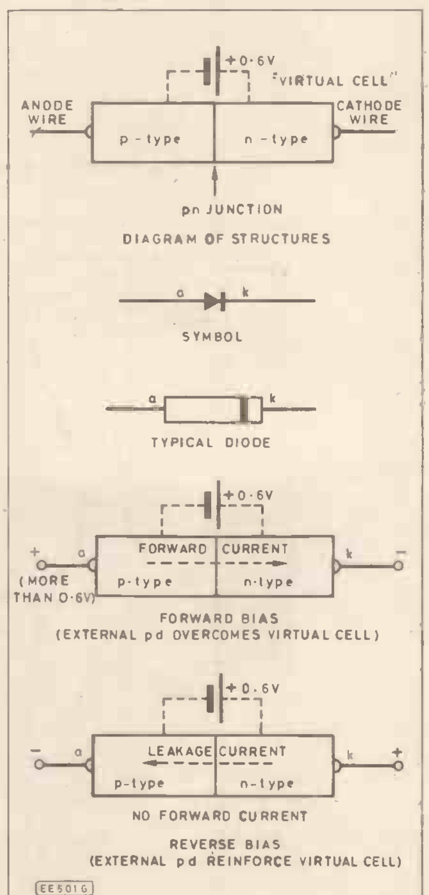


Fig. 1.1. The construction, circuit symbol and operation of the diode.

Testing diodes

Set up the circuit of Fig. 1.2. Make sure that the diode is inserted the correct way round. It is marked with a band at one end to indicate the cathode wire, k (see Fig. 1.1). When you connect the battery, the lamp lights. Does it shine with its full brightness? To

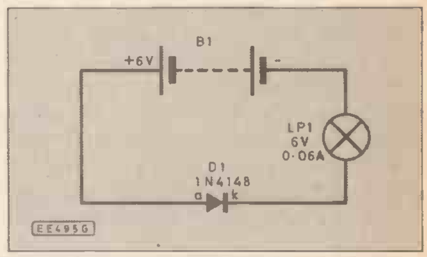
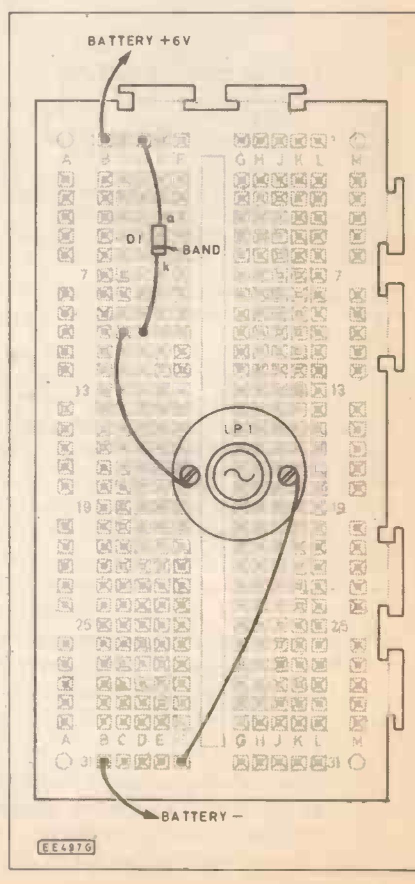


Fig. 1.2. Circuit for testing a diode. The "breadboard" layout is shown below.



COMPONENTS

Capacitors

VC1	miniature trimmer capacitor 5·5–65p
C2	68p silvered mica (optional)

Semiconductors

1N4148	silicon signal diode
0A91	germanium point-contact signal diode

Miscellaneous

LP1, filament lamp 6V, 0·06A; X1 Crystal earphone (as used on transistor radio or tape player); L1 Ferrite rod approx 150mm long, 12mm diameter and length (approx 2m) of 28 s.w.g. enamelled copper wire; Breadboard (e.g. Verobloc); battery box with four 1·5V cells; lamp socket; connecting wire for aerial and earth.

Approx. cost Guidance only **£10**

check this, repeat the test, using a short length of wire in place of the diode.

Repeat the test again with the diode connected the other way round (with anode wire, a, next to the lamp). Does the lamp light when you connect the battery? Reverse the diode and connect again, just to check that it really does conduct, after all.

This is a useful circuit for testing diodes. The diode should conduct easily when put in the circuit in one position (forward biassed, see Fig. 1.1), but not conduct when put in the opposite position (reverse biassed). If it conducts well in both positions or does not conduct in either position, it is faulty and should be thrown away.

A SIMPLE RADIO RECEIVER

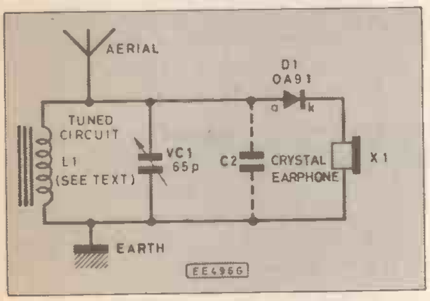


Fig. 1.3. Circuit diagram for a Simple Diode Radio. The working layout is shown opposite.

This receiver is similar in many ways to the old-fashioned crystal set, used in the early days of radio. In the crystal set the *detector* was a crystal of galena with a thin wire, called a "cats-whisker", touching against it. The detector had the same kind of action as a diode. In this circuit (Fig. 1.3) we use a diode as a detector. Like the early crystal sets, this receiver does not work well unless you live close to a fairly powerful medium-wave radio transmitter.

How it works

The way a radio signal is produced and transmitted is described in Fig. 1.5. When this signal is received in the aerial, it causes very small electric currents to flow to and fro, at high frequency. These radio frequency oscillations cause the receiver tuning circuit (L1 and VC1) to oscillate strongly. The reason for this is that the circuit is tuned to resonate at the same frequency as the broadcast signals. We will explain *why* it resonates later in the series.

We can alter the setting of VC1 to tune the receiver to stations that are operating at different frequencies. The radio-frequency oscillations of the current in the tuning circuit are shown at A in Fig. 1.4. If we connect an earphone directly to the tuning circuit, we hear nothing, for the frequency is so high that it is above the limits that our ears can detect. The solution is to put a diode detector in the receiver circuit. The diode conducts current in one direction only, so the current appearing at the cathode of the diode is as shown at B (Fig. 1.4). The earphone now responds to the *average* current (C). The waveform of the average current corresponds to that of the

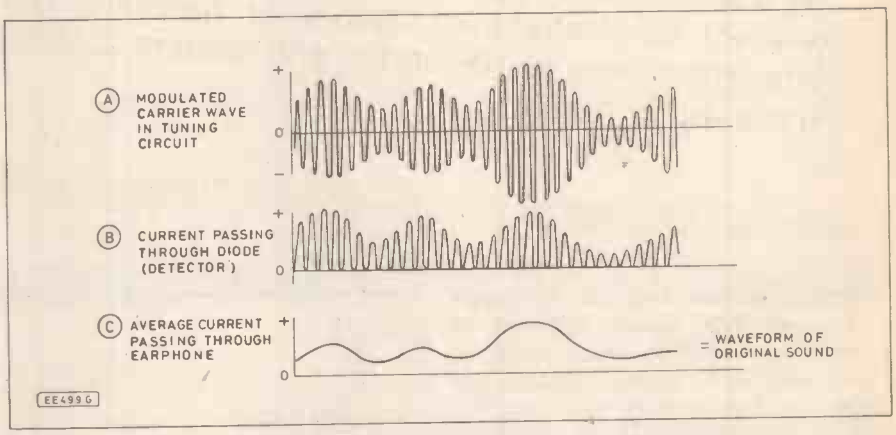
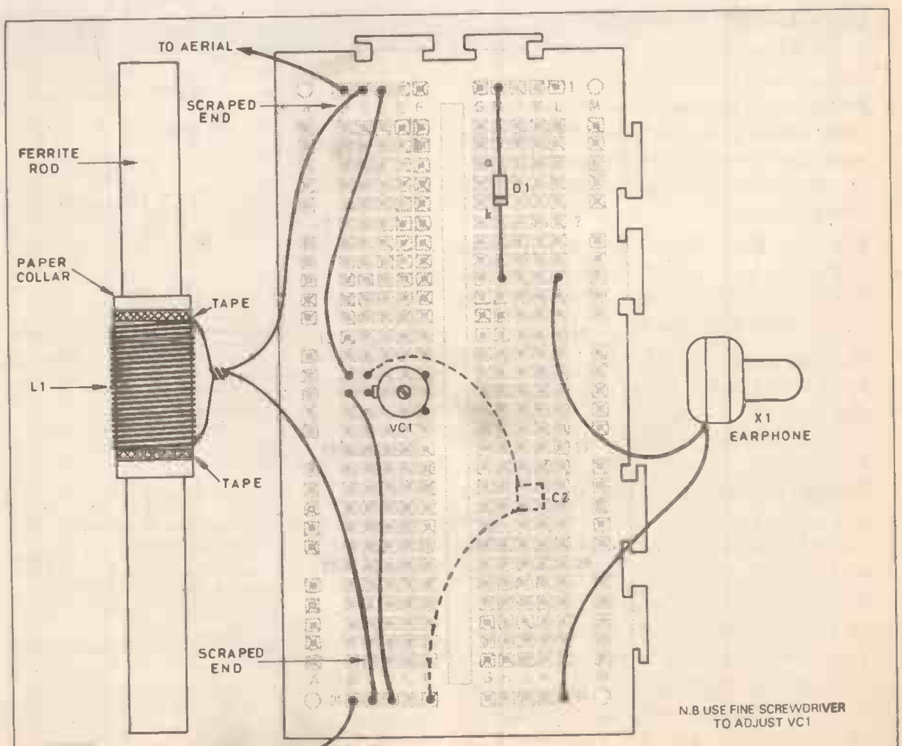


Fig. 1.4. The action of the radio receiver on the received signal.



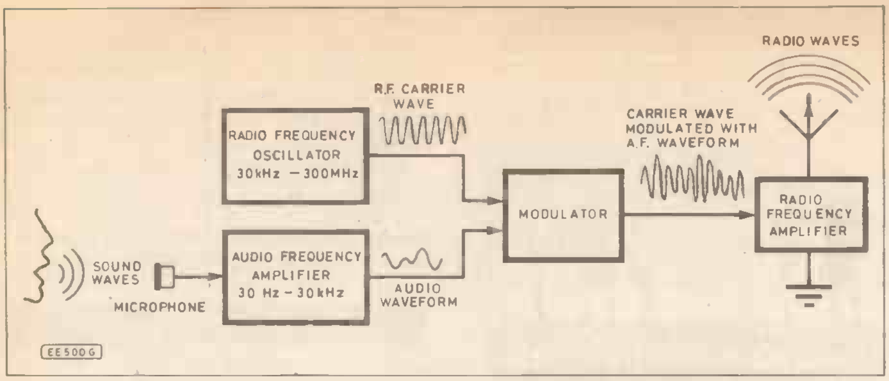


Fig. 1.5. Block diagram of a radio transmitter (amplitude modulation).

original sound signal. The current flowing through the earphone produces a sound that we can hear. It is a reproduction of the original sound signals.

Building the radio receiver

The main task is the winding of the aerial coil. Wrap a piece of paper around the ferrite rod and fix it with sticky tape. Then wind the coil of enamelled copper wire on the paper sleeve, until you have 70 turns. Each turn should touch but not overlap its neighbours. When you have finished winding, fix the ends of the coil in position by wrapping a piece of tape around each end and twist the wires together. Allow about 10cm of free wire at each end of the coil. Scrape the enamel from the ends of these wires.

An aerial is essential for good reception. It should consist of insulated wire and be at least 10 metres long. If possible, place it outdoors, as high above the ground as you can, and as far from buildings as you can. If you find it difficult to do this, see how well you can get the receiver to work with the aerial indoors.

The earth connection is made to a cold-water pipe (to bare clean metal, not to painted pipe) or to a metal rod or sheet, buried outdoors in damp soil.

When you have built the circuit, use a screwdriver to vary the setting of VC1 slowly, and listen to the earphone while you do so. You should be able to tune to at least one station. If you receive nothing, try again during the evening, when the reception of most stations is generally better than by day.

If you still hear nothing it may be that the frequency of your local station is outside the tuning range of the circuit. Try increasing capacitance, by putting a fixed-value capacitor in parallel with VC1 (C2, shown with dotted lines). The value of this capacitor should be about 68pF.

You could also try increasing or decreasing the number of turns in the coil. If the worst comes to the worst and you cannot hear anything, do not be too disappointed. The set is probably working but the currents are so small that the sounds are too faint to hear. Later in the series we will see how these currents can be amplified so that you can hear them. Keep the coil that you have wound, ready for use in the next radio project of the series.

Next Month: Using a Transistor.

You Will Need . . .

Resistors
33, 47, 82, 100, 220, 330, 470 ohms (1 of each). Plus several values up to 47 kilohms.

Transistors
ZTX300 *npn* junction (2off)

Miscellaneous
LP1, LP2 6V 0·6W lamp, in holder (2 off); Battery holder, with four 1·5V cells; Breadboard (e.g. Verobloc).

CIRCUIT EXCHANGE

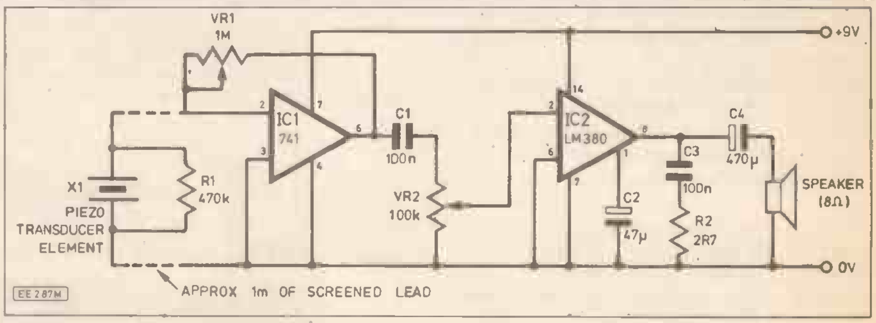
This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part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

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

We are looking for original ideas which may be simple or complex, but most importantly are useful and practical.

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

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



STETHOSCOPE

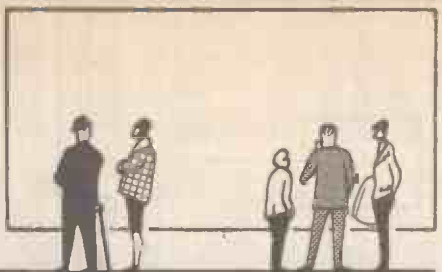
THIS circuit is intended to be used as an electronic stethoscope. I designed it for my uncle so he could listen to a clock's mechanism. I found it to be very sensitive. It uses a 741 as a pre amp and a LM380 as the main amp. On LM380 pins 3, 4, 5 and pins 10, 11, 12 are heat sink pins and should be connected to 0V.

Best results are obtained when the voltage is a steady 9V VR1 and VR2 should be set at the centre of their tracks at first and then finely adjusted.

Resistor R1 should be soldered on the piezo element and one meter of screened wire was used to connect it to the circuit. The piezo element was obtained from Maplin No. QY13P.

R. Gordon,
Totteridge,
London.

SHOP TALK



BY DAVID BARRINGTON

Getting Started

This month we have received details of two new tools which should appeal to the constructor. These are the **Plasplugs** wire stripper and a general purpose cutter.

One of the attractions of electronics construction is that you do not require a vast collection of tools or "special" equipment to get started in this hobby. You don't even require acres of space.

However, as the constructor becomes more experienced and able to tackle more complex projects, the need for a special workbench or workshop area will arise. For instance, you will require a few test instruments and a good bench power supply unit, and, of course, provision will have to be made for the ever increasing stock of components.

But until this stage is reached, the newcomer can enjoy the pleasures of electronics whilst taking up the minimum of space and needs only a few essential tools.

Basic Tools

A suggested minimum selection of tools and equipment for electronic construction would be as follows: Three screwdrivers; miniature side-cutters; fine long-nosed pliers; wire strippers, with adjustable thickness stop; small soldering iron (15–25 watt), with a variety of bit shapes and sizes; and, finally, a small multimeter.

Of the three screwdrivers, two should be ones with blade widths of about 2mm ($\frac{1}{8}$in.) and 4mm ($\frac{3}{16}$in.). The smaller one being suitable for "grub" screws in control knobs. The third should be a "Philips or Pozidriv" type, many screws now have this type of "head".

The pliers should be the fine needle-nosed type, these enable fine wires to be manipulated in place and also make good "emergency" heat shunts when soldering.

We strongly recommend the purchase of a pair of wire strippers as it is so easy to nick or damage the wire when removing the protective sleeving for soldering. This invariably leads to a very weak join.

With so many good soldering irons on the market the only point we would make is this. Choose one that is rated at about 15 to 25 watts and is easy to handle. The ones with "flexi-leads" are fairly good and do not tug or feel heavy after numerous soldering operations.

The range of tools is very large and come at all sorts of prices. You may be tempted to buy the cheapest. Don't! These tools should last a lifetime, so most of the cheaper ones can be discounted. Always try to buy the best quality tool you can afford and you should not be disappointed.

For the constructor, the multimeter is probably the most versatile, important and easy to use piece of test gear available. It is not possible to describe all the requirements of a good multimeter as features and functions are changing all the time but for simple checks and fault finding a basic analogue meter should be capable of the following functions:

Voltage ranges from 10V to 500V d.c. and a.c. Current ranges from about 1mA to 1A and resistance ranges from 0 to 1 megohm. Most of our advertisers carry stocks of very good multimeters and they will be only too pleased to advise.

Wire Strippers

There are several special wire strippers on the market, varying from the elaborate and expensive to the very simple and reasonably cheap, all are very efficient.

A simple to operate wire stripper "gun" has recently been introduced by Plasplugs, the d.i.y. tool people.

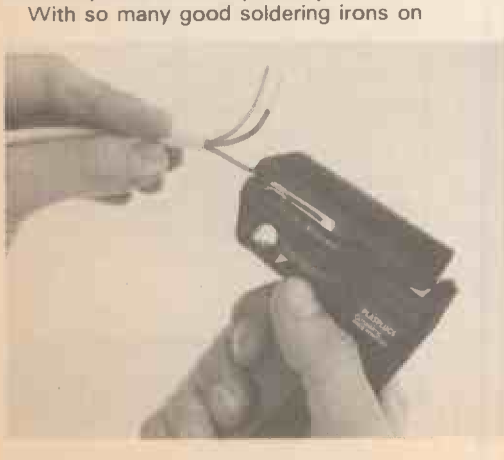
The Automatic Wire Stripper has a large "trigger" and an adjustable trim length blade in the jaws of the gun. Once set up it will cut and strip the insulation from single, twin or multicore cables, in one operation, simply by squeezing the trigger. The Plasplugs Automatic Wire Stripper costs £3.95 and is available from DIY stores.

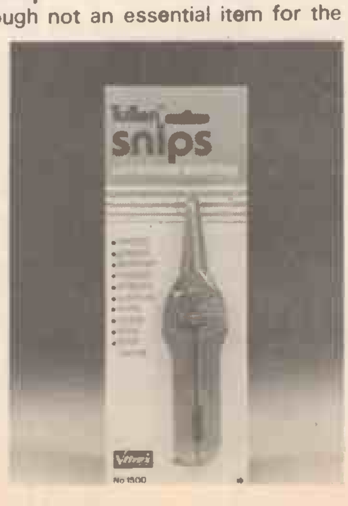
It's a Snip

Although not an essential item for the toolbox, the latest general purpose cutters from **Vitrex** would certainly prove handy.

The hardened blades are claimed to be self-sharpening and will cut materials such as 22 gauge (0·7mm) mild steel, paper and fabrics.

The Vitrex Snips have rounded tips for safety and cost £4.10, inclusive of VAT. For details of local stockists write to: **Florin Ltd., Dept EE, 457–463 Caledonian Road, London, N7 9BB.**





CONSTRUCTIONAL PROJECTS

Caravan Battery Monitor

Suitable meters for the *Caravan Battery Monitor* should be available from most of our advertisers. It is not necessary to obtain meters of identical physical size to those used in the prototype model as the size of case can be chosen to suit.

Due to the possible high currents associated with this project, it is essential that heavy-duty auto-type wire is used where specified.

Vox Box Amplifier

Readers may experience some difficulty in purchasing the µPC2002 power amplifier i.c. used in the *Vox Box Amplifier.* This is carried by **Marco Trading** or may be stocked by some Tandy stores. However, in case of difficulty we suggest that constructors opt for the more readily available LM383 device.

We do not expect any component buying problems for the rest of the parts for this project. The printed circuit board may be purchased through our *PCB Service:* code **EE529.**

Tilt Alarm

The mercury "tilt" switch used in the *Tilt Alarm* could cause sourcing problems. The one used in the prototype was purchased from **Magenta.** The printed circuit board for this project is available from our *PCB Service:* code EE527.

A full kit of parts (£8.25, including p & p) for the Tilt Alarm is available from **Magenta Electronics Ltd., Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs, DE14 2ST.**

Two-Chip Output Interface

This month's *On Spec* project entitled *Two-Chip Output Interface* calls for a BI-MOS Octal Latch/Driver device, type UCN5801A. This i.c. is currently listed by **Maplin**, order code QY77J, for £7.95.

Exploring Electronics

The "test-bed" called for in the first instalment of *Exploring Electronics* is the same circuit block used in our *Teach In '86 Series.*

Special kits have been made up by some of our advertisers for the Teach-In series and they also sell the solderless breadboard separately. Readers should browse through the advertisements in this issue to locate a stockist nearest to their town.

Headphone Mixer

The components for the *Headphone Mixer* project seem to be standard "off-the-shelf" items and should not cause any buying difficulties.

We do not envisage any component buying difficulties for the *Electronic Scarecrow* or *Squeekie* projects.

CARAVAN BATTERY MONITOR

T.R. de Vaux Balbirnie

Keep a watchful eye on your battery's state of health!

A 12-VOLT electrical system in the caravan is regarded as essential nowadays to operate equipment ranging from the familiar lights and water pumps to televisions, keyboard instruments and games. Even a computer is a possibility. A hook-up lead from the towing vehicle is useful but complete independence is only achieved with a separate in-board supply. Some caravaners carry a spare 12V battery which is fully charged before leaving home. Exchanging this with the car battery from time to time keeps the charge topped up. This method works well on touring holidays providing current consumption is kept moderate. Unfortunately, this is easier said than done. The *Caravan Battery Monitor* takes the guesswork out of battery care and ensures that you will not be let down unexpectedly. It is suitable for all systems where the current requirement does not exceed 5A, this being sufficient for most users.

The first function of the circuit is to display the current being used on an ammeter. This promotes economy by keeping users aware of which items, or combinations of items, require most current. The second function is to indicate the *state of charge* of the battery. This uses a voltmeter covering the range 11 to 13V approximately. A freshly-charged battery develops an off-load voltage in excess of 13V which gradually falls to under 11V, when it needs charging. Measuring this voltage gives a good indication of how much charge is left. A further feature is an audible warning (which may be switched off) when the current drawn exceeds a certain preset value.

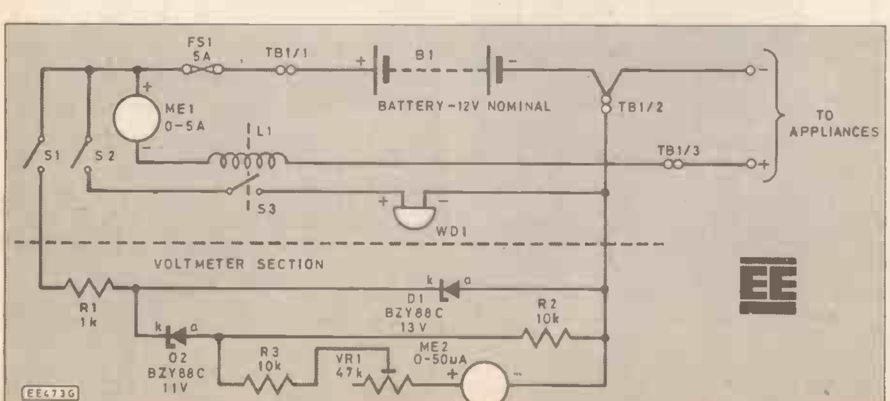
CIRCUIT DESCRIPTION

The circuit for the Caravan Battery Monitor is shown in Fig. 1. In use, main-line battery current flows through fuse, FS1, 0–5A ammeter, ME1, and coil, L1. L1 forms the basis of the high current warning and this part will be described later.

With S1 closed, current flows into the voltmeter section. This current is very small so S1 could be left switched on. However, there is no point in leaving it on without reason. The 0–50μA meter, ME2, is converted by R3 and VR1 into a voltmeter of 2V nominal full-scale deflection. The rest of the circuit, consisting of 13V Zener diode, D1, and 11V Zener diode, D2, together with resistors R1 and R2, provide a "zero" at 11V and full-scale reading of 13V. With the battery fully charged and more than 13V between its terminals, 13V will exist across D1. About 11V will exist across D2 so the difference of 2V will appear across R2 and give full-scale deflection of ME2.

As the battery discharges, the difference between its terminal voltage and 11V will be recorded by ME2. When the battery voltage falls below 11V, D2 will fail to conduct and no voltage will appear across R2—the meter then reads zero. If a standard voltmeter were used, most of the scale length (0–11V) would not be used, making accurate readings impossible to obtain. The purpose of VR1 is to adjust for accurate full-scale deflection. This allows for slightly differing voltage levels and for differences between individual meters.

Fig. 1. Circuit diagram of the Caravan Battery Monitor.



BUZZER WARNING

Meter ME1 shows the total current being consumed, but an additional warning is provided by an "overload" buzzer. The coil, L1, is wound on the body of reed switch, S3. A magnetic field in proportion to the strength of the current in L1 is obtained and when sufficient, S3 closes and operates the buzzer, WD1. By adjusting the number of

COMPONENTS

See Shop Talk page 367

Resistors

R1	1k
R2,3	10k (2 off)

½W ± 1% metal film

Potentiometer

VR1	47k miniature preset (horizontal mounting)

Semiconductors

D1	BZY88C 13V Zener diode
D2	BZY88C 11V Zener diode

Miscellaneous

ME1	0–5A panel meter
ME2	0–50μA panel meter (45 × 50mm, matching pair)
WD1	12V solid-state buzzer
S1,2	SPST toggle switches (2 off)
S3	Miniature reed switch body size 20·3 × 3·2mm diameter approx.
FS1	20mm fuse holder with 5A fuse to fit
TB1	5A terminal block—three sections required
L1	20 s.w.g. enamelled copper wire—approximately 25cm required

0·1in. matrix stripboard, size 9 strips × 14 holes; stranded wire; 5A auto-type wire; fixings; plastic box approx. size 100 × 75 × 40mm external.

Approx. cost Guidance only **£14**

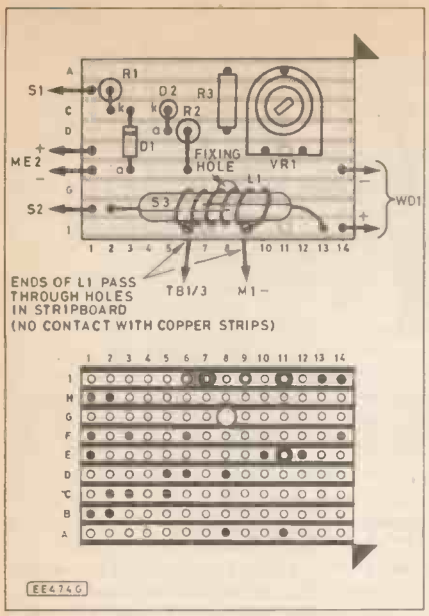
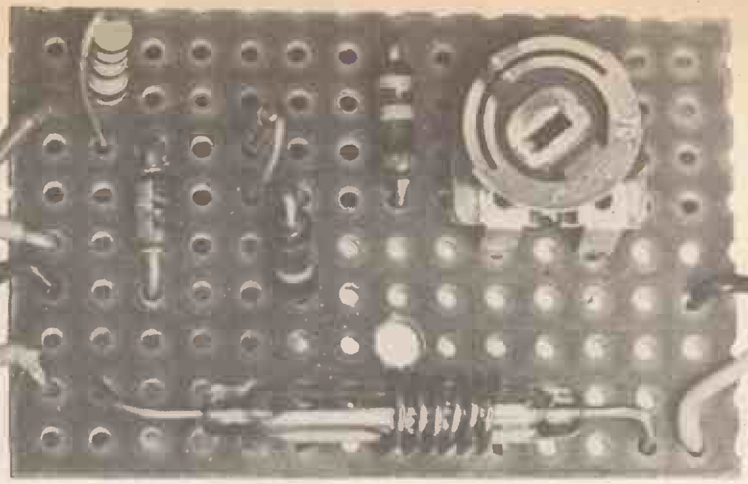


Fig. 2. Layout and wiring of the stripboard.



Photograph of the completed Veroboard for the Caravan Battery Monitor.

turns of wire used for L1, the buzzer can be made to sound at any current up to 5A. S2 switches off the buzzer warning if desired.

CONSTRUCTION

Refer to Fig. 2 and construct the circuit panel using a piece of 0·1 inch matrix stripboard, size 9 strips × 14 holes. Make the breaks at VR1 position and in strip I as indicated. Drill the fixing hole and solder the on-board components into position, noting the polarities of the Zener diodes. When preparing the reed switch, do not bend the wire ends too close to the body since the glass is easily broken. Solder the reed switch with clearance to the circuit panel to allow room for winding L1. Use 6 turns of 20 s.w.g. enamelled copper wire to begin with, passing the ends through holes in the circuit panel for support. Note that there is no contact with copper strips here.

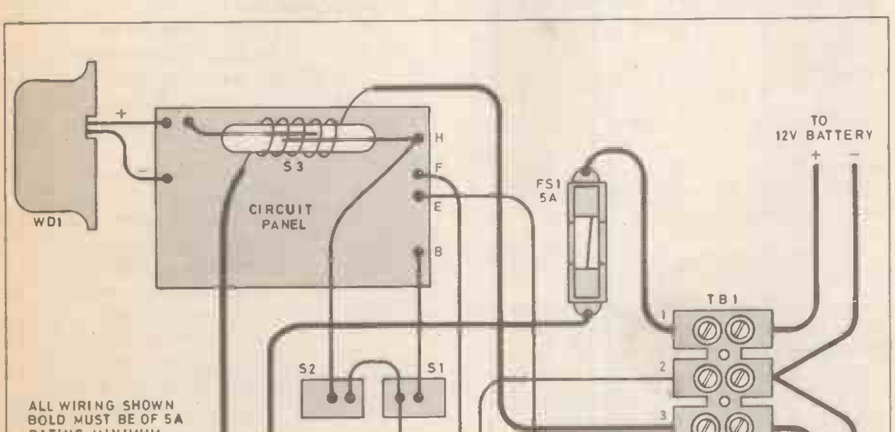
Make holes in the box for switches, buzzers, meters and for the fuseholder, terminal block and circuit panel mounting. Attach these components but do not mount the circuit panel yet. For neatness WD1 can be mounted through a hole in the case with its flange glued to the inside of the case. Refer to Fig. 3 and complete the wiring. Note the polarities of the meters and WD1. All wires shown in bold or thick lines should be rated at 5A minimum—the others may be of any light-duty stranded type. Attach the circuit panel to the rear of the box with a single fixing through the hole drilled for the purpose. Insert a 5A fuse into the holder and adjust VR1 (sliding contact fully *clockwise*).

TESTING

Begin with a fully-charged battery. Switch off all appliances and connect the positive and negative terminals to TB1/1 and TB1/2 respectively using 5A auto-type wire. Connect TB1/3 and TB1/2 respectively to the positive and negative appliance feed wires. The ammeter should read zero and the voltmeter a low reading. Adjust VR1 so that ME2 gives full-scale deflection. Switch on appliances and note that M1 shows the current being used. At some stage the buzzer may sound and the number of turns on L1 may be adjusted so that this happens at some chosen current (4A in the prototype). If it fails to sound at 5A, then more turns are required. Once WD1 is sounding, the current must be reduced *below* the triggering value for it to switch *off* again.

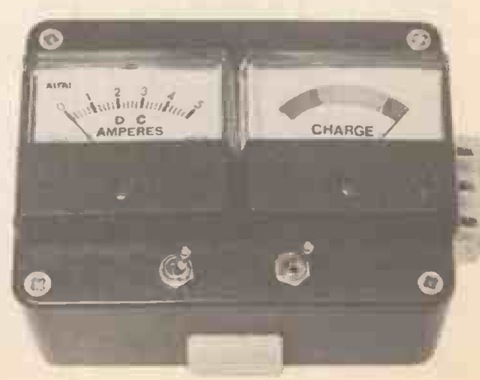
As the battery discharges, the voltmeter reading will fall. Learning to interpret these readings can only be done over a trial period. The best time to read ME2 is when the battery has rested, since then the voltage tends to recover a little. Note that it is normal for the reading to fall when the battery is on load.

Fig. 3. Wiring of the complete Caravan Battery Monitor.



COLOURED SCALE

Although the readings given by ME2 may be used as they stand, some users might prefer to make a new scale marked with coloured zones for High, Medium and Low charge. In many cases, the front cover of the meter simply "snaps" off to reveal the scale fixings. These may be taken out and *with great care* the scale removed. This may be painted white and the zones added when dry. In the prototype, green was used for high, yellow for medium and red for low charge. □



Actually Doing it!!

ALTHOUGH buying the components might seem to be the easiest part of project construction, queries from readers show that problems can, and frequently do arise. Very often the problem is simply that a particular component does not appear in any of the catalogues the reader happens to have, and the solution to this problem is to obtain as many component catalogues as possible. Some component retailers offer a vast range of components, often with many thousands of different products. However, the full range of components currently available is so vast that no one supplier is likely to be able to supply all your requirements, and the more catalogues you have the better your chance of being able to track down an awkward component. Also bear in mind that magazines normally provide the name and address for sources of difficult to obtain components used in their constructional projects (*Shoptalk* in *Everyday Electronics And Electronics Monthly* for example).

THE RIGHT TYPE NO.?

The other major problem when buying components is making sure that you obtain the right parts, and do not confuse one component for another. With most components there is no real difficulty here, and it is just a matter of making sure that proper details of the component are included on your order (linear or logarithmic potentiometers, resistor wattage rating, etc.).

Most of the problems are associated with semiconductors and, in particular, types which are available under a range of slightly different type numbers. This mostly affects integrated circuits, and what usually happens is that a manufacturer produces a moderately successful device, and then one or more other manufacturers "second source" the device. This makes the device more attractive to potential industrial users since it means that they will not be tied down to a single source of supply. The problem for the home constructor is that the various manufacturers of a device may not all use exactly the same type number.

A good example of this is the popular 555 timer device. This was originated by Signetics, and had the part number NE555P. "NE" is a prefix which is often used for Signetics devices, 555 is the true part number, and "P" is a suffix which is often found on part numbers. It usually indicates that the device is in a d.i.l. plastic package, and the alternative of "N" is also commonly encountered.

Another common suffix is "C", which indicates a "consumer" device. These are lower quality devices than the "M" (military) versions which have a wider operating temperature range, and in some cases are superior in other respects. Consumer versions are normally quite adequate for home-constructor designs, and the only type that most component retailers will supply.

Returning to our 555 example, if you buy a few of these from various sources some will probably have the original NE555P type number marked on them, but others will have slightly different type numbers. On checking through my stock of 555s I found the alternative type number of µA555TC. The "µA" prefix indicates that the device is manufactured by Fairchild, and the TC suffix shows that it is a plastic packaged consumer quality device (Fairchild uniquely use "T" rather than "P" or "N" to indicate an 8-pin d.i.l. plastic package).

If you order a popular device such as the NE555P and the device you are supplied with does not have exactly the right type number there is probably no need to panic, and the device you have is probably exactly the same device from a second source manufacturer. The list below gives the prefixes used by some of the larger semiconductor manufacturers.

PREFIX	MANUFACTURER
CA, CD	RCA
LM, LF, LH	National Semiconductors
ICL, ICM	Intersil
MC	Motorola
NE, SE	Signetics
SN, TL	Texas
µA	Fairchild
Z	Ferranti

The CMOS logic family are another good example of type numbers which are dependent on the manufacturer. Apart from the manufacturer's prefix there is also a choice of three suffixes. The original devices had "AE" as their suffix, but these have now been superceded by "BE" types which have improved static protection at the inputs and buffers at the outputs. The two types are largely interchangeable, and there should be no problems if a "BE" device is used where an "AE" type is specified, but substitution the other way around is somewhat less safe and best avoided. The third suffix is "UBE" which is used for unbuffered devices. These will usually work in place of "AE" and "BE" types without any difficulty, but where a design calls for a "UBE" type it is probably essential to use one.

The 74XX series of logic devices seems to sprout new ranges of device (74LS, 74C, 74HC, etc.) almost daily. Although these ranges are to some extent mixable, it is definitely advisable to use precisely the type specified in a components list, and not to try substituting equivalents from other families unless you are quite sure you know what you are doing.

Suffixes on linear part numbers are not usually of great importance, but in the case of some RCA devices (the CA3130, and CA3140 for instance) there are various versions available from component retailers, and problems could result if you obtain a device having the wrong suffix. The most common suffix these days is "E" which indicates a d.i.l. plastic package. There are also "T" (TO-99 metal case) and "S" (TO-99 metal case with leadouts preformed into the 8-pin d.i.l. configuration) versions. A further complication is that some devices are available with 8- or 14-pin d.i.l. packages, and this includes devices such as the popular 741C and 748C operational amplifiers as well as certain RCA devices. Somewhat unhelpfully, 8- and 14-pin versions often seem to sport exactly the same type number.

Where devices are available in TO-99 8-pin versions it is normally possible to fit a metal can type where the layout is designed to suit a d.i.l. device. With an "S" suffix device its preformed leadouts should fit straight into the layout, and with a "T" version the leads can easily be formed into the 8-pin d.i.l. configuration. Fitting a d.i.l. device into a layout intended for a TO-99 type would almost certainly take some redesigning of the board, but most project designers produce layouts to suit the more common (and usually less expensive) d.i.l. versions, and this is unlikely to be a problem.

Fig. 1 gives the pin numbering for 8-pin d.i.l. and TO-99 devices. Usually when a device is available in 8- or 14-pin d.i.l. versions the 14-pin version is effectively the 8-pin version with six dummy pins added. Fig. 2 shows pinout details for 8- and 14-pin versions of the 741C operational amplifier, and this demonstrates what I mean. An 8-pin device will easily fit into a layout designed for a 14-pin type, taking due care to fit it into the right block

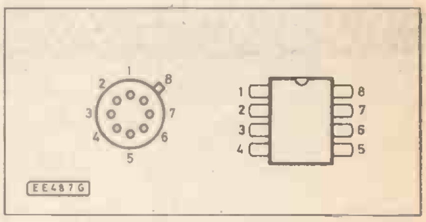


Fig. 1. Pin numbering for 8 pin d.i.l. and TO99 devices.

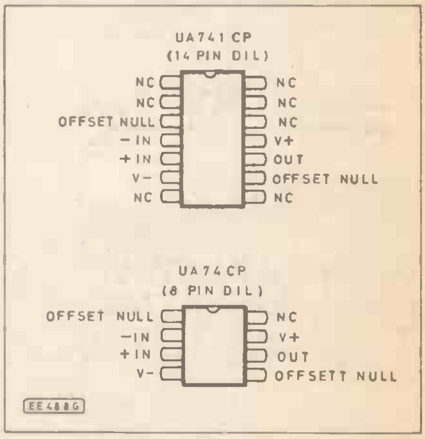


Fig. 2. Pin details for 8 pin and 14 pin versions of the 741C.

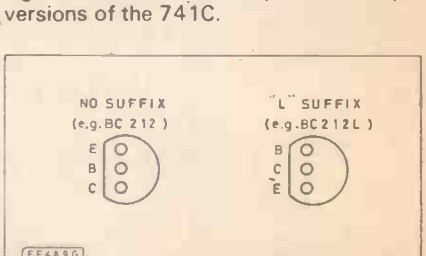


Fig. 3. BC212 and BC212L leadout details

of 8 holes, but a 14-pin device will obviously not fit into an 8-pin layout without some redesigning of the board.

The safest approach for the beginner is to order components from one of the large mail order catalogues where the type of encapsulation will normally be specified, or options will be available. Alternatively, use a local supplier where you can make sure you have the right version before parting with any money.

TRANSISTORS

Fortunately, when it comes to most other semiconductors, such as diodes and transistors, the type number is the same regardless of the manufacturer, and where the same chip is available in more than one encapsulation it is normal for each version to have its own type number. There are a few exceptions, and some devices such as BC184 and BC212 have a suffix letter which indicates the leadout configuration. Fig. 3 shows the two leadout arrangements. Note that with transistor leadout diagrams it is the convention that they are base views (i.e. the view looking onto the leadout wires), whereas integrated circuit pinout diagrams are top views (i.e. as seen with the pins pointing away from you).

There is no convention in the case of integrated circuits which have transistor type encapsulations, such as small voltage regulators and temperature sensors. Top views seem to be more common than base views, but the diagrams for these should specify what type of view it is, and this is something that you should check rather than making assumptions that could well be wrong.

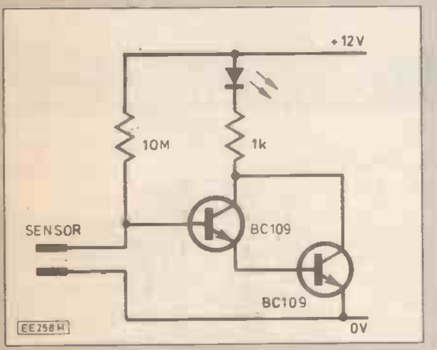
A number of transistors are available in three gain groups, and these are indicated by an "A", "B", or "C" suffix. "A" indicates the lowest gain group while "C" is for the highest. For most home constructor designs any version ("A", "B", "C" or an ungraded device with no suffix) will be suitable. However, where a device such as a BC109C is specified it is important that the device is a high gain type, and a BC109A, BC109B, or a plain BC109 may not function properly in the circuit.

With 2NXXXX transistors such as the 2N2926 there is a colourful alternative method of gain grading. A coloured spot on the device indicates its gain group, with colours ranging from brown for the lowest gain group, through red, orange, and yellow to green for the highest gain group. This system is clearly based on the resistor colour codes, and is a system that is unlikely to be encountered much with modern designs. Many older projects call for a particular 2N2926 colour, and some of the larger stockists can still provide a particular gain group for this component.

Robert Penfold

CIRCUIT EXCHANGE

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



WASHER BOTTLE LEVEL INDICATOR

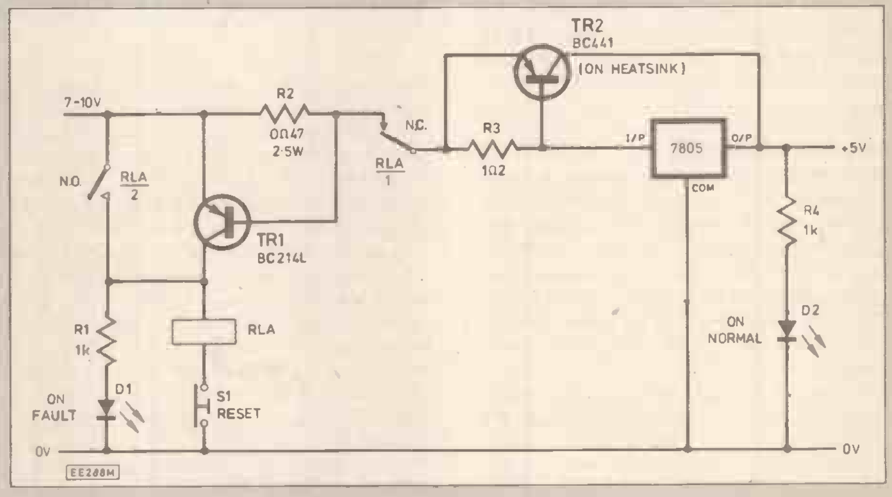
The washer bottle circuit above, tells you when the level of the windscreen washer bottle is getting low.

It is designed for both positive and negative earth cars. The indicator used is a l.e.d. because they are quite cheap. The rest of the components are also common.

The circuit is designed around a Darlington pair (BC109) being held low by the sensor. The 10 Megohm resistor pulls the Darlington high when the water level falls below the sensor.

The sensor consists of two wires bared and pushed into the bottle at the required height for the l.e.d. to light (usually just above the drain pipe).

Perry Andrews,
Basildon.



FOLDBACK CURRENT LIMITING

The circuit above is a simple and cost effective solution to design a short circuit protection for many power supplies. It will switch both voltage and current to zero as the current exceeds a pre-designed value, dependent on R2.

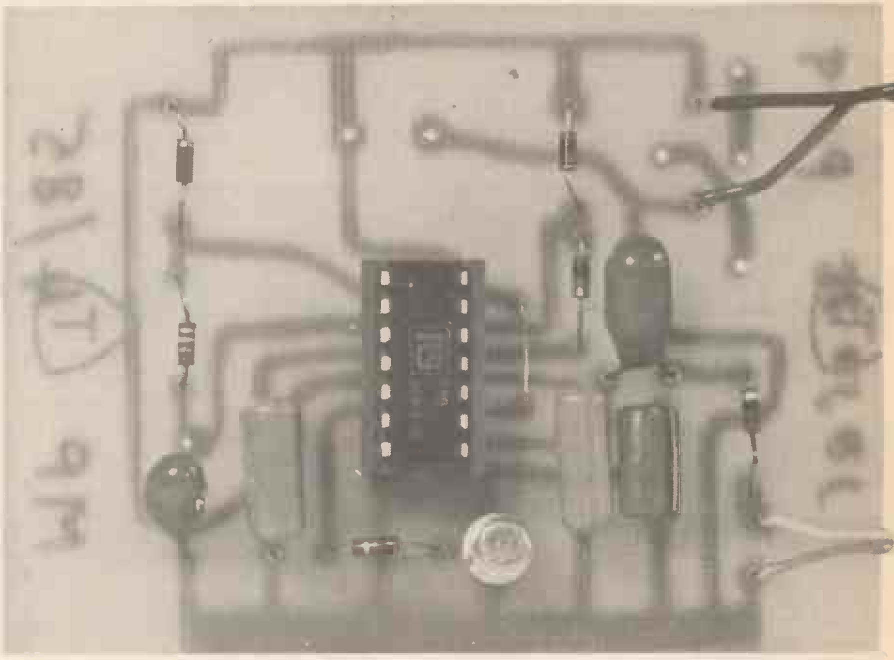
At low output currents, TR1 is off, and as the output current increases the voltage drop across R2 increases until it's great enough to bias TR1 on. Which in turn energises the relay and switches RLA/1 and RLA/2 contacts off and on respectively, stopping current going to the regulator and TR2. Even if the output load is now removed RLA remains energised through contact RLA/2. The reset push button switch is used to de-energise the relay and reset the circuit back to normal. TR2 is used as a current booster and takes over at a level determined by R3.

For the values shown above the circuit provides approximately 1.3A current limiting and TR2 takes over at about 0.5A current limit to the regulator. The output load regulation of this circuit is much better than the normal foldback limiting circuits, since the series resistor is omitted from the output.

F. K. Mohammed,
Swansea.

ELECTRONIC SCARECROW

MICHAEL PERROW



Send the birds flying with some simple circuitry

THERE is nothing more annoying than to spend time carefully cultivating a nice vegetable garden only to find that its favourite inhabitants are the best fed birds. When you come to harvest your crops all you find are their left overs!

This electronic scarecrow may be one solution—it produces a lovely rounded rasping note at timed intervals. It has even been known to cause next doors cat to make a hasty retreat.

Another use for this bird scarer is to attach it to your television aerial to help keep the path below clean. Although I must admit that in the first instance it might have the opposite effect as the birds flee in fright!

HOW IT WORKS

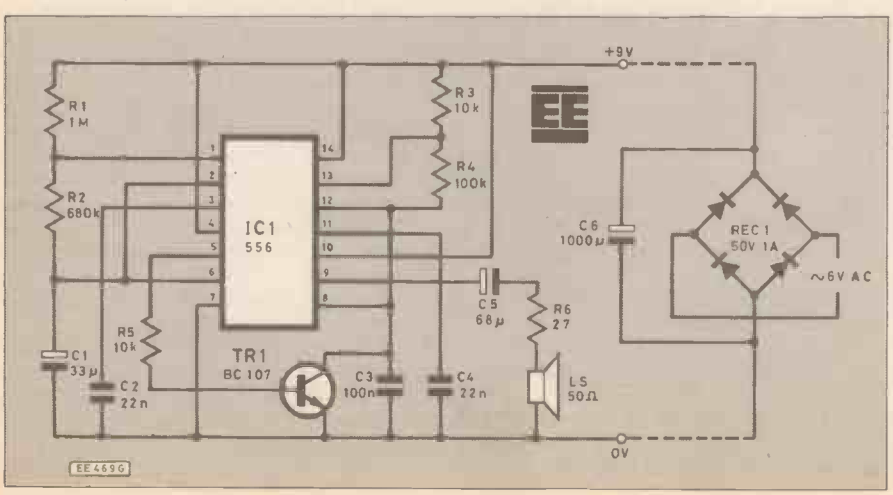
The heart of the scarecrow circuit is a 556 dual timer IC1 (Fig. 1). The pin out details of this and also of the 555 are given for interest in Fig. 3. The first half of the 556, timer 1, is used as an interval timer which keys the second timer which is connected as an audio oscillator giving an audio output at about 200Hz which drives a small speaker.

With the component values shown pin 5 of timer one (its output) is high for about 60 seconds and low for approximately 15 seconds. When it is high TR1 is switched on, goes into saturation and effectively sorts out C3. However when timer ones output goes low TR1 is cut off and C3 is allowed to charge, hence timer two can now operate as an oscillator.

Maximum audio output is obtained when R6 is replaced with a shorting link and a 75 ohm loudspeaker is used. However you may have difficulty obtaining this size. A more popular size is a two inch 50 ohm speaker which along with R6 will give quite adequate volume.

If you intend to use the unit up a mast

Fig. 1. Complete circuit diagram of the Electronic Scarecrow.



COMPONENTS

Resistors

R1	1M
R2	680k
R3	10k
R4	100k
R5	10k
R6	27

See Shop Talk page 367

Capacitors

C1	33μ 25V tant.
C2	22n polyester
C3	100n polyester
C4	22n polyester
C5	68μ 25V tant.
C6	1000μ 16V elect. (if required)

Semiconductors

IC1	NE 556
REC1	1A 50V bridge rectifier (if required)
TR1	BC107/8/9 etc.

Miscellaneous

LS1 Two inch 75 or 50 ohm loudspeaker; suitable case; wire; p.c.b. (available from the *EE PCB Service* order code EE528); wire, fixings, etc.

Approx. cost Guidance only **£5.50**

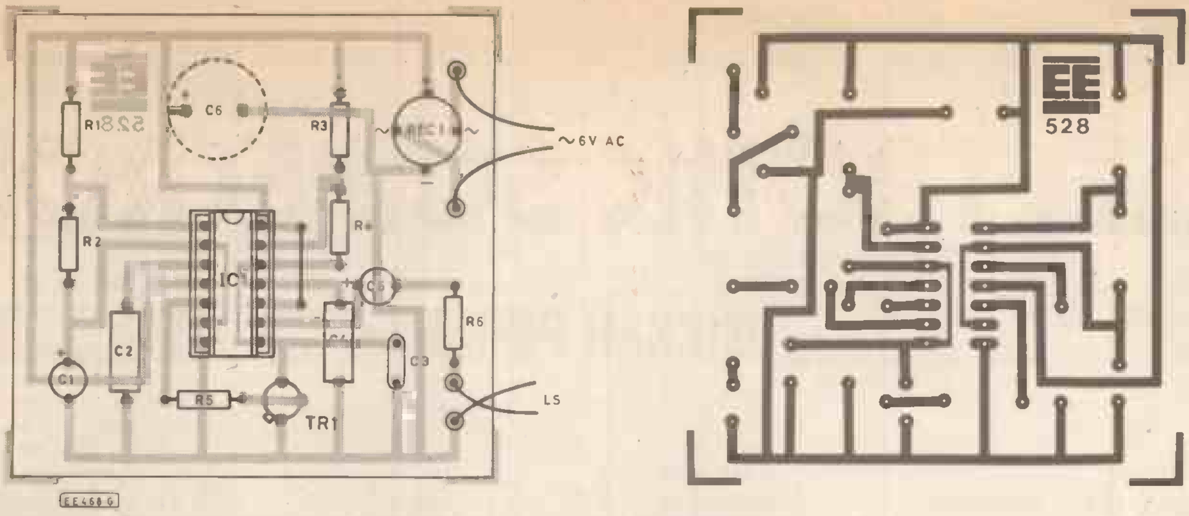


Fig. 2. Layout and wiring of the Scarecrow p.c.b.

then you will not want to have to keep going up a ladder to change batteries. The answer of course is to provide a supply from a remote position feeding it up two wires to the unit.

Because the volt drop on a run of cable is much greater using d.c. it is far better to use a.c. and then rectify and smooth it at the unit. This is the reason for REC1 and C6 and these components are only fitted when this method of supply is employed.

As the unit only requires about 6 volts a.c. a suitable transformer for the supply is a 3-0-3V 1·2VA transformer, and these are readily available. Alternatively you could use a calculator d.c. supply with a ready moulded 13A plug. With the internal diode and capacitor removed these are ideal.

CONSTRUCTION

Having made or obtained the printed circuit board (it is available from the *EE PCB service*) commence by fitting the resistors and capacitors. Make sure that the tantalum capacitors are connected the correct way round. Fig. 2 shows the component layout. Next insert the wire link between pins 10 and 14 of IC1. Do not forget this as the unit will not work without it. If you are using an IC holder then this should be fitted next. The bridge rectifier and C6 need only be fitted if the unit is to be used up a mast and fed from an a.c. supply. Transistor TR1 and IC1 can now be fitted, again watching for correct orientation.

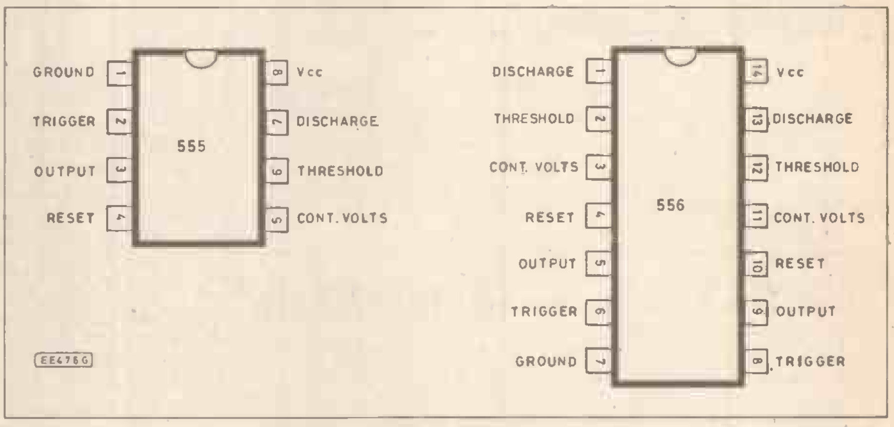


Fig. 3. Pin connections for the 555 and 556.

Having completed the construction check for dry joints and any shorting tracks. If all is correct then connect the speaker and supply to the unit.

DON'T PANIC

When you connect the supply you should hear a click in the loudspeaker and then nothing. Go make a cup of tea! Because of the nature of the circuit the timings of the first cycle of operation are not those that the unit will normally have. In fact the first off period may well be over two minutes. This is because all the capacitors are fully discharged. This side effect is of no consequence for our project.

By the time the kettle has boiled the unit should have made its first rude raspberry. If it hasn't switch off and check the construction carefully. If all is well the unit can be mounted in a weather proof box with a suitable cut out for the loudspeaker.

Put a layer of polythene between the speaker and the case to keep the dampness out of the speaker. □

LETTERS

Back to the beginning!

Sir—I have recently had my interest in electronics resurrected by my sons' wish to become an electronic/electrical engineer. I first became interested myself when the first issue of your magazine hit the bookshops. So impressed was I that I read those early issues from cover to cover, then re-read them again and again. I plucked up enough courage to "have-a-go" and was well pleased with the projects I made. These projects were, as the magazine name inferred, "everyday electronics".

As a comparative newcomer to the hobby I, surely like thousands of others, have no wish to know too much detail about how i.c.s. work and the like. Having said that, I accept that a certain amount of knowledge is desirable, but formulae, calculations and technical data I can do without. There are enough magazines around to give electronic and computer buffs their "fix" of technical information.

Your magazine is meant for beginners to the hobby, as your cover quite clearly states and we beginners have no interest generally in waa-waa pedals for guitars, high speed A to D converters, flux density transducers, ZX81 Eprom programmers or even bagpipe amplifiers!

What we do want, however, is to build projects for a car lights-on reminder, burglar alarms, electronic doorbells and novelty items. I realise that thousands of people own computers, but I would suggest the number who either do not, added to the number who do—but have no wish to build projects for it—is far, far greater.

You are therefore directing your magazine to a much smaller part of the possible market. You are taking up space with those kind of projects which could better be used to show us how, for example, to discover that we are about to drill through an electric cable or gas pipe, or how to play a simple electronic game with our children!

I implore you to return to your original format and produce the only magazine for complete beginners to the hobby, several of who may never have seen a transistor let alone solder one into a circuit. Put simply, as you used to do, the information would be far easier to understand and I feel many more people would "try their luck" and get hooked on the hobby.

I do hope that this letter gives you some food for thought and that you will give us more and more "everyday" items and less and less technical and specific ones.

David J.M. Lloyd,
London, SE5 7JN.

NEWS ...from the world of electronics

HOBBY FAIR

WEMBLEY '86

If you really cannot make your mind up about the excitement of radio and electronics as a hobby, or if you want to interest your children in the subject with an eye on a possible future career, then you should definitely get along to the Amateur Radio & Electronics Hobby Fair *at the Wembley Conference Centre, London.*

To be held on Saturday 5 and Sunday 6 July, there will be about 200 retail and manufacturers' stands all plying their wears and putting on working demonstrations. Electronic components will be on sale and other areas being highlighted are: satellite TV; amateur radio and amateur TV.

QUEEN'S AWARD

Bib Audio/Video Products, one of Europe's largest manufacturers of audio, video and computer care products has been granted the Queen's Award for Export Achievement this year.

Chairman and Managing Director, Brian Arbib says "he is absolutely delighted after all the hard work and effort that has been made by the company over the years to establish Bib as a worldwide name, synonymous with quality in relation to audio, video and computer maintenance care. Bib has only 40 direct employees and is proud of its export achievement, with last year's sales of over £1M."

Mr. R. C. Debnam, C.Eng, M.I.Mech.E., has been appointed Conference Chairman of the 1986 Test + Transducer Conference following the recent death of the previous Chairman, Peter Mansfield.

INVESTMENT

Some £20M is to be invested in the Mullard plant at Hazel Grove, Cheshire, to make it one of the most comprehensive technical and production centres in the world for all types of power semiconductors. The investment will be spread over 4 years and has been supported by the Department of Trade and Industry.

The Hazel Grove complex will become the only centre within Philips worldwide to develop and manufacture these products. The plant has a world lead in high voltage epitaxial rectifier technology and is the only centre in the world to produce high speed GTOs.

Compact Disc pioneers Philips and PolyGram have announced the formation of American Interactive Media Inc. (AIM), a new company that will spearhead the development of software for the new Compact Disc Interactive System.

COMPUTER GRAPHICS

The Displays specialist group of The British Computer Society is to hold an International Summer Institute on Computer Graphics at the University of Stirling, Scotland, on 29 June to 4 July. Co-sponsors include ACM, the Computer Graphics Society of Japan and the International Federation for Information Processing (IFIP).

Invited international experts and leaders in their fields will present leading edge topics in the techniques and applications of computer graphics. Subject areas to be covered include: workstations, graphics standards, image generation, human-computer interface issues, VLSI and graphics for design.

HI-TECH HOUNSLOW

Trying to find out information about your local area council services can often be a most difficult and frustrating task. If, however, you live in the London Borough of Hounslow, you can, using a ROCC videotex system, now access a database of local information at the touch of a button.

The Hounslow Viewdata Service, which opened to the public in February 1986, is a joint venture between Hounslow Council's Press and Information Division and Department of Arts and Recreation. Over two and a half thousand pages of information are available on the system.

The service contains a community information index under a total of ten headings such as information and Advice Services, Education, Housing and Planning and Employment. At present there are ten terminals attached to the system. Three are in the council's district libraries in Chiswick, Feltham and Hounslow; four are in the Hounslow's Civic Centre: one is in Hounslow's Citizens Advice Centre, one is in the Trading Standards Office, and one is in the area's largest comprehensive school, Feltham Community School.

The Polytechnic of the South Bank run a Microcomputer Advisory Centre, where among other things they organise courses in various subjects. This year they are covering such subjects as: Introduction to Microcomputing; Databases and Information Retrieval; Word Processing and Computing for Publishers and Microcomputers for Training.

Further details from: Polytechnic of the South Bank, Dept EE, Borough Road, London SE1 0AA.

LINK-UP

The UK electronic mail service MicroLink can now be accessed from anywhere in the World using the Psion Organiser II pocket computer.

The calculator-sized computer can be fitted with a Psion RS232 Link and modem to enable it to send and receive messages from literally anywhere from Bangkok to Brighton. Trials held by MicroLink are claimed to have shown that the 7·5in. by 3in. computer, costing under £100, can be used just as effectively as a £2000 telex machine.

Radio Luxembourg's first ever full-time female DJ is 24-year-old Liz West from Chicago, USA, who broke into the European music scene as Music Director on the pirate ship *Laser 558*.

Liz is the first 208 station's full-time female DJ since Radio Luxembourg started broadcasting 52 years ago. She presents her own show from half-past Midnight to 3 a.m. Mondays to Fridays.

DATABASE

Information Technology Minister, Geoffrey Pattie has appealed for teachers and industrialists to provide information for the department's new educational database.

The National Education Resources Information Service (NERIS) will give teachers and school children access to a wide range of educational material which is currently scattered around the country.

Mr. Pattie said: "Since the IT awareness project which put a micro in every school, the department has spent £1·5M on modems for schools. This database is the logical next step. One of the most urgent jobs is to identify people and organisations who produce resource materials deserving wider use."

Examples of data which could be included are class exercises, videos, leaflets, project notes and wall charts. Initially NERIS will concentrate on maths, science, geography and social and personal development, but other subjects will be added later.

NEW · NEW · NEW · NEW

PRODUCTS

NEW · NEW · NEW · NEW

RESISTOR NETWORK

THE FIRST SO (Small Outline) DIL Thick-Film Resistor Networks, designed and manufactured in the UK, for surface mount applications has been announced by **CorinTech**.

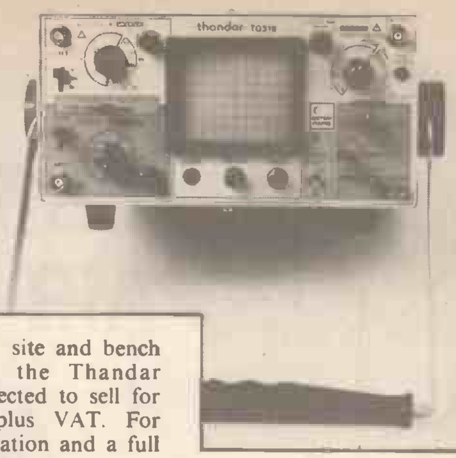
It is claimed that the resistor networks offer considerable savings on space and assembly time over normal discrete resistors. Two circuit configurations are available, either seven separate resistors, or 13 resistors with a common connection.

Suggested applications include pull-up/pull-down resistors, 7-segment l.e.d. current limiting and D/A conversion ladders.

Standard off-the-shelf values run from 10 ohms to 1 megohm on an E6 scale, with a tolerance of 2 per cent. Custom circuit configurations and values are available to special order.

CorinTech Ltd.,
Dept EE, Ashford Mill,
Station Road, Fordingbridge,
Hants, SP6 1DG.

PORTABLE SCOPE



A PORTABLE mains/battery oscilloscope has just been introduced by **Thandar Electronics.**

Designated the TO315, it offers a 15MHz bandwidth, a dual trace display and an input sensitivity of 2mV/div. Selection of chopped or alternate mode is automatic as is line or frame synchronisation.

Ideal for on site and bench applications, the Thandar TO315 is expected to sell for about £655 plus VAT. For further information and a full specification write to:

Thandar Electronics Ltd.,
Dept EE, London Road,
St Ives, Huntingdon,
Cambs, PE17 4HJ.

BUSINESS FUNCTION

A NEW business calculator from **Casio** combines the functions of a notebook, a diary and a commercial calculator in one compact package.

Facts like names and telephone numbers can be stored in an ordinary Data Bank. There is a separate calendar memory for noting events, automatically sorting them into date order to make an appointments diary.

To handle formulae—to work out interest or profit margins, for example—you usually have to enter details in a specific order so that the calculator can arrive at an answer. Not this one. It can effectively start with the answer and come up with the question!

You just feed in a formula, and the Casio BC300 handles it forwards, backwards or sideways. Provided there is only one unknown, you simply respond to prompts by feeding in figures or (one) blank, and it automatically fills in the blank.

Simple calculations can be "replayed", altered or corrected. Several different formulae may be stored in the Data Bank for recurrent use.

For handling ratios, you feed in a string of figures: the calculator adds them up and tells you the ratios, as percentages, and it ranks them in order, from largest to smallest. Nothing very startling so far. But it also lets you change one detail, for example, an amount or a percentage, and it tells you the effect on all the others. Most intriguingly for builders of pie charts, it lets you change the total, from 100 per cent to 360 degrees, and gives direct readout of all the ratios in degrees instead of percentages.

The Casio BC300 business calculator has a recommended retail price of £69·95 with 1K memory, which can be extended to 3K with an add-on RAM pack. For details of local stockists contact:

Casio Electronics Co. Ltd.,
Dept EE, Unit 6,
1000 North Circular Road,
London, NW2 7JD.

HANDIGRIP

A DEVICE designed to take the frustration out of positioning screws in those awkward corners has just been marketed by **Display Tiling Services.**

The Homelux Handigrip is a small plastic "spatula" which, it is claimed, holds the screw in a patented jaw and allows it to be accurately positioned, horizontally or vertically, before driving the screw home.

The point of the screw or pin is placed in the circular gripper until it is held by the special fingers. Then the spatula can be carefully positioned and the required screw fixed firmly in place.

Available in three sizes to suit a wide range of screws, nails or even solder pins, from the smallest pin to heavy duty self-tappers, the Handigrip comes in a pack containing a pair of each size and will retail for around 69p including VAT.

The Homelux Handigrip will be available through hardware stores, d.i.y. outlets and garage shops. For addresses of local stockists contact:

Display Tiling Services Ltd.,
Dept EE, Unit 24,
Enterprise Trading Estate,
Pedmore Road, Brierley Hill,
West Midlands, DY5 1TX.

ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month we shall be examining two of the Spectrum's "System Variables" and showing how one of these can be used as the basis of an accurate real-time clock. Our constructional project this month features an ultra-simple two-chip eight-channel output interface which is capable of driving relays, lamps, and low current motors.

System Variables

Avid readers of the "official" Spectrum User Guide can be excused for overlooking the two paragraphs entitled "System Variables". These, however, can be extremely useful since a knowledge of their behaviour can be instrumental in getting the best from your Spectrum and tailoring its performance to your own particular application. We shall, therefore, for the next few months be introducing some of the more useful system variables. This month we start by introducing PIP and FRAMES.

The Spectrum, like all other home computers, maintains a reserved section of random access memory (RAM) into which it places a number of important system parameters. In the Spectrum, this area of memory stretches from 23552 (decimal) to 23734 (decimal).

It is possible for the user to not only examine the contents of this area of memory but, since it is RAM rather than ROM, also to change the parameters stored. This allows the user to alter various aspects of the Spectrum's behaviour. An obvious example, and one with which most readers will already be familiar, is that of the system variable known as PIP.

PIP occupies the single byte stored at address 23609 (decimal). PIP defines the duration of the sound which is emitted from the Spectrum's internal loudspeaker. You can examine the contents of PIP by PEEKing the address using a BASIC command such as:

```
PRINT PEEK 23609
```

This will normally return 10 since the Spectrum's operating system initialises the value PIP whenever the system is brought up from cold. (For the curious, the ROM routine responsible for system initialisation is located between hexadecimal addresses 11B7 and 12A1.) The value contained in PIP may be changed to provide a longer, or shorter, tone duration. Note, however, that the maximum value cannot exceed 255 since PIP is contained in one single byte.

Readers can extend PIP to give a rather more noticeable tone by POKEing PIP with a value of, say, 100 using a command of the form:

```
POKE 23609,100
```

Now try pressing a few keys and note the difference!

FRAMES

Unlike PIP, FRAMES occupies no less than three bytes of the area reserved for system variables. The three locations are 23672, 23673 and 23674 (all decimal). The maximum value that can be stored in this three-byte location is 16777215 and the most significant byte is stored at 23674 whilst the least significant byte is at 23672.

FRAMES is, in fact, simply a counter which is incremented automatically every 20ms or 1/50 second. (In the USA this value is 16·667ms or 1/60 second.) The value of FRAMES is thus constantly changing. If you don't believe this try entering the following simple program which displays the value of FRAMES in the upper left hand corner of the screen:

```
10 PRINT AT 0,0;PEEK
   23672+256*PEEK
   23673+65536*PEEK 23674
20 GO TO 10
```

Now someone out there is probably thinking that a 20ms interval counter is not a lot of use. O.K., let's modify the program so that it counts in seconds instead!

```
10 LET t=PEEK 23672+256*PEEK
   23673+65536*PEEK 23674
15 PRINT AT 0,0;INT(t/50)
20 GO TO 10
```

There are two important differences between this program and the earlier one. First we have assigned the value of FRAMES to a variable, t. Secondly, we have taken the INTeger value of t divided by 50 which allows us to print the value of elapsed time in seconds rounded down to the nearest integer. You now have an "on screen" clock which counts in seconds and starts from zero when the Spectrum is first powered up!

To reset the clock it is, of course, merely necessary to set FRAMES to zero. For this we need to POKE a value of zero into all three of the system variable's addresses. We can achieve this by adding another line at the start of the program:

```
5 POKE 23672,0:POKE 22673,0:POKE
  23674,0
```

Now, each time the program is RUN, FRAMES will be set to zero and the timer will be reset.

For those of you wanting a fully blown clock reading in hours, minutes and seconds, Listing 1 shows a solution based on FRAMES. This program can be used "as is" for such applications as sports event timing, physics experiments, etc., or could form the basis of a more complex programmable alarm clock. Whatever you decide to do with it, however, don't forget to SAVE it to tape, or microdrive before RUNning it!

Readers should note that FRAMES is affected by one or two of the Spectrum's other functions hence, if you wish to keep accurate time, it is best to avoid the use of the BEEP, SAVE, LOAD, LPRINT, LLIST and COPY commands. Incidentally, FRAMES is unaffected by the NEW command.

Two-chip output interface

Now for our hardware project. This month I have tried to keep things as simple as possible. The interface uses only two

LISTING 1 SPECTRUM CLOCK

```
10 REM *** Clock Demonstration ***
15 REM Everyday Electronics July 1986
49 REM
50 REM *** Initialise ***
51 REM
55 PAPER 1: INK 7: BORDER 1
60 POKE 23658,8: REM Caps lock
99 REM
100 REM *** Clock Setting Routine ***
105 CLS
110 PRINT AT 21,0;"Enter correct time:"
115 INPUT "Hours   >";hours
120 INPUT "Minutes  >";mins
125 INPUT "Seconds  >";secs
130 CLS
135 PRINT AT 12,6;"Clock set for  ";hours;"  ";mins;"
";secs
140 PRINT AT 17,3;"Press <S> to start the clock,"
145 PRINT AT 18,3;"      <A> to set again,"
150 PRINT AT 19,3;"   or <Q> to quit."
155 LET r$=INKEY$
160 IF r$="S" THEN  GO TO 200
165 IF r$="A" THEN  GO TO 100
170 IF r$="Q" THEN  RANDOMIZE USR 0
175 GO TO 155
199 REM
200 REM *** Main Clock Routine ***
205 CLS
210 PRINT AT 19,2;"Press <R> to reset the clock."
215 PRINT AT 8,10;"Time now ..."
220 PRINT AT 10,10;"HOUR MIN SEC"
225 LET st=(60*60*hours+60*mins+secs)*50
230 LET sta=INT (st/65536): LET rem=st-(sta*65536)
235 LET stb=INT (rem/256): LET rem=rem-(stb*256)
240 POKE 23672,rem: POKE 23673,stb: POKE 23674,sta
245 LET t=PEEK 23672+256*PEEK 23673+65536*PEEK 23674
250  LET dt=INT (t/50)
255 LET hour=INT (dt/3600): LET rem=dt-(hour*3600)
260 LET min=INT (rem/60): LET rem=rem-(min*60)
265 LET sec=rem
270 PRINT AT 12,12;hour;"  ";min;"  ";sec;"  "
275 IF INKEY$="R" THEN  GO TO 100
280 GO TO 245
```

Table 1. Simplified Truth Table for UCN-5801

DATA INPUT	STROKE	PREVIOUS OUTPUT	OUTPUT
X	0	OFF	OFF
0	1	X	OFF
X	0	ON	ON
1	1	X	ON

X = don't care

integrated circuits so, if you haven't yet "had a go" at building one of our projects why not try this one?

The complete circuit of the two-chip output interface is shown in Fig. 1 and is based on a UCN-5801, IC1. This versatile device is a BI-MOS octal latch/driver consisting of eight CMOS data latches with clear, strobe and output enable functions coupled to eight bipolar Darlington driver transistors, as shown in Fig. 2. This type of construction provides an extremely low power latch with high current output capability.

All inputs to IC1 are CMOS, NMOS and PMOS compatible (thus permitting direct connection to the Spectrum's internal bus) and, whereas each of IC1's outputs are rated for loads of up to 500mA, they may be parallel connected for even larger load currents (subject, of course, to the rated load current of the power supply!).

A three-input NOR gate, IC2, provides minimal address decoding and ensures that IC1 is only enabled when an I/O write operation is performed. Table 1 shows the simplified truth tables for IC1 in which the output is simply represented as ON or OFF states (the outputs are effectively switched to the 0V rail). The UCN-5801 is housed in a 22-pin 0·4 inch d.i.l. plastic package and its pin connections are shown in Fig. 3.

Construction

The interface may be assembled on a piece of Veroboard measuring approximately 80mm × 80mm. The precise dimensions of the board are not critical and those quoted leave plenty of room for manoeuvre! The use of two low-profile d.i.l. sockets is highly recommended.

Component layout is uncricital though care should be taken to ensure that the three decoupling capacitors, C1 to C3, are distributed around the board. Links can be made, as necessary, between the components using short lengths of tinned copper wire on the upper surface of the matrix board and, on the underside of the board, using short lengths of insulated wire of the type commonly employed for wire wrapping.

The output connector should be a ten-way type; eight ways being used for output connections with two being reserved for the positive common rail. A variety of board mounting connectors are availabale which will meet this need.

COMPONENTS

Resistors

R1	270 0·25W 5%

Capacitors

C1	100u 16V p.c. elec.
C2	10u 16V p.c. elec.
C3	10n polyester

Semiconductors

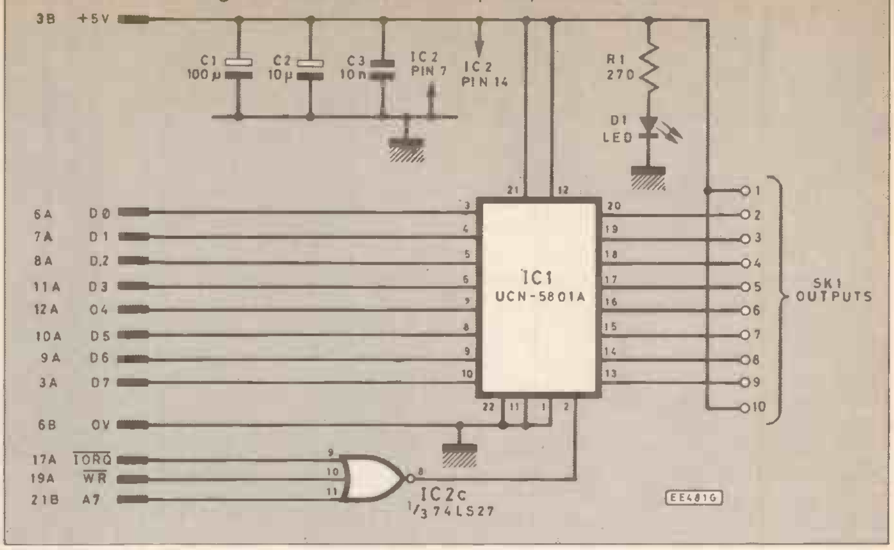
D1	Red l.e.d.
IC1	UCN-5801A
IC2	74LS27

Miscellaneous

14-pin and 20-pin d.i.l. sockets (1 of each), output connector (see text), 0·1 inch matrix Veroboard (or similar) measuring approximately 80mm × 80mm, 28-way open end double-sided 2·54mm pitch edge connector.

Approx. cost Guidance only £11.00

Fig. 1. Circuit of the two chip output interface.



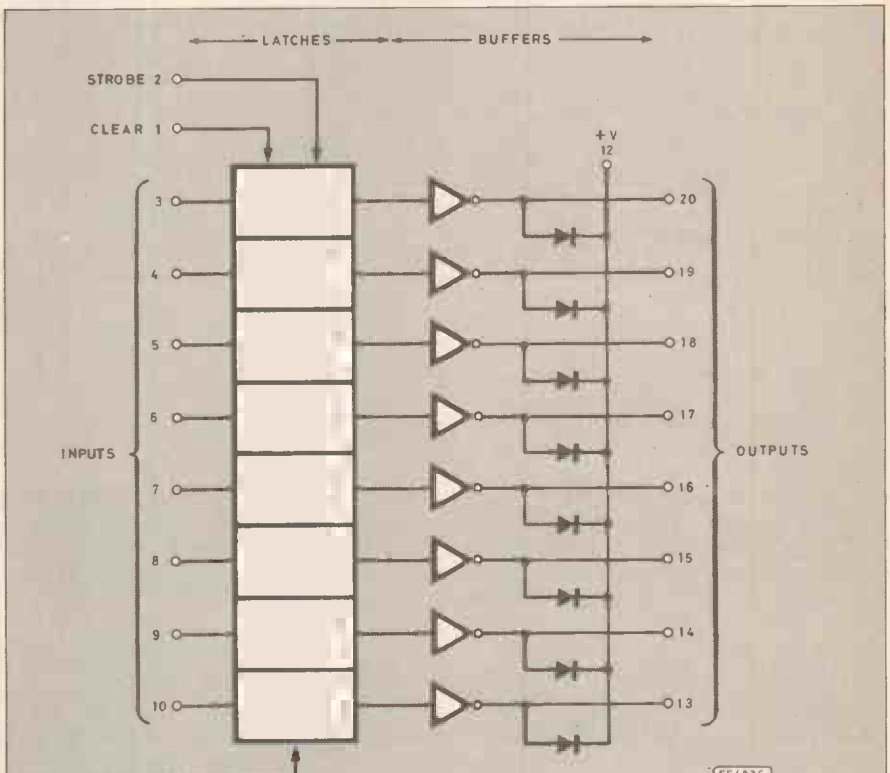


Fig. 2. The UNC-5801.

NEXT MONTH: We shall be describing the minimal software required to drive the two-chip interface together with a number of applications (including control for a simple buggy and a programmable darkroom timer). We shall also be delving into the Spectrum's memory with a useful memory display program—see you then!

If you have any comments or suggestions, please send them to:

Mike Tooley,
Department of Technology,
Brooklands Technical Collge,
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"!

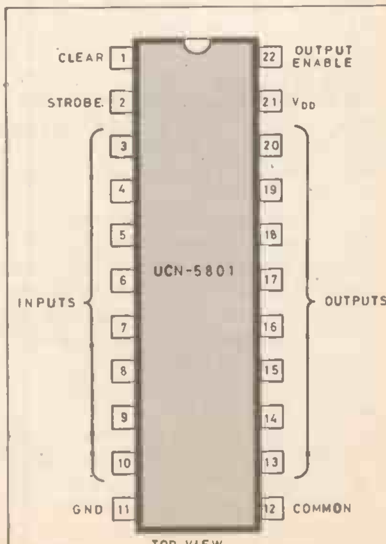


Fig. 3. Pin connections.

b...Beeb...Beeb...Beeb...Bee

OF THE BBC Model B computer's many interfaces it is perhaps the very versatile "User" port which has helped the most in making the machine so popular with those who are interested in building computer add-ons. The user post is situated on the underside of the computer, and it is the middle of the five IDC plugs. It is a 20-way type, and pinout details are provided in Fig. 1. To anyone who is unfamiliar with interfacing to computers many of the legends will be meaningless, with probably only "+5V" and "0V" having an air of familiarity. PB0 to PB7 are general purpose digital inputs/outputs, and each line is individually programmable to operate in either mode. CB1 and CB2 are what is termed "handshake" lines, and their primary role is to ensure that the flow of data into or out of the main user port lines is properly regulated. They can be used in other ways, but as they are somewhat less than straightforward in use we will not consider them further for the time being.

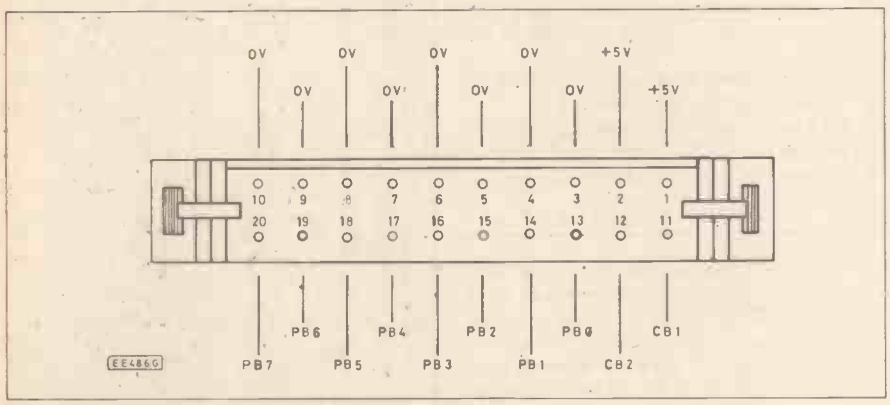


Fig. 1. Connections to the BBC user port are via a 20-way IDC connector.

Digital Basics

The user port is very different in concept from the analogue port, but it is not too difficult to understand. The input/output lines of the user port are digital types, and as such they can either be at logic 0 ("low", or around 0 to 1V), or at logic 1 ("high", or at about 3 to 5 volts). To someone who is only used to dealing with analogue circuits this can seem rather useless, but in control applications on/off switching is often all that is required. In measurement applications a digital input may have no obvious means of providing a representation of voltage, temperature, or something of this nature to the computer, and one line on its own cannot easily do this. However, a set of lines operating together can easily represent values other than 0 or 1, and an 8-bit type such as the PB* lines of the user port can represent any integer (whole number) from 0 to 255 (inclusive).

This is done by utilizing the binary numbering system where each digit can only be 0 or 1, rather than the 0 to 9 of the decimal system. It is not necessary to have a detailed knowledge of the binary numbering system in order to make effective use of a multi-bit digital port, and a convenient way of looking at things is to regard each digital line as representing a certain number, but only if it is set high. A line that is set low always represents zero. The table shown below gives the number represented by each user port line when it is set high.

PB0	PB1	PB2	PB3	PB4	PB5	PB6	PB7
1	2	4	8	16	32	64	128

There are 256 different combinations that the eight lines can take up, and each one of these gives a different integer from 0 to 255. PB0 is the "LSB" (least significant bit) and PB7 is the "MSB" (most significant bit).

The BBC computer is based on a version of the 6502 microprocessor which has memory mapped input/output devices that are accessed in exactly the same way as memory locations. BBC BASIC does not have the usual PEEK and POKE for reading from and writing to memory, but instead uses a system whereby a question mark ("?") added ahead of a number indicates that it is an address. The device which provides the user port (a 6522) occupies sixteen addresses from &FE60 to &FE6F. The peripheral register A of the 6522, which is effectively lines PB0 to PB7, is at address &FE60. At switch-on the 6522 is reset, making PB0 to PB7 all inputs. If you try entering this instruction to read the user port:

PRINT ?&FE60 RETURN

the value returned should be 255. This is due to the pull-up resistors at each input which result in each one floating to the high state.

Testing

If you wish to familiarise yourself with the operation of the user port, a good way of doing so is to obtain a 20 IDC header socket ready fitted with about one metre of ribbon cable (preferably the multicoloured "rainbow" which permits easy identification of each lead). Open out the free end of the cable and connect small pieces of tinned copper wire or 1mm plugs to the leads which connect to 0V and PB0 to PB7 (it is only necessary to use one of the 0V lines).

If you are unsure as to which lead connects to which terminal of the socket, a quick check with a continuity tester of some kind should sort this out. The 0V lead can be connected to one of the bus-bars of a breadboard, with the other eight lines connected to individual short bus strips.

With wire links you can then pull any of the PB* lines low by wiring them to the 0V rail. Try running this program and taking some of the lines low.

```
10 CLS
20 PRINTTAB(10,10) ?&FE60
30 FOR D = 1 TO 200:NEXT
40 PRINTTAB(10,10) "  "
50 GOTO 20
```

This merely prints returned values from the user port at a fixed point on the screen so that you can see the effect of pulling lines low. If PB7 is taken low, this will reduce returned values by 128 (from the original 255), giving 127. Pulling PB1 low as well will reduce the figure by two more, taking the readings down to 125, and so on.

Outputs

Whether each PB* line is designated an input or an output is determined by Data Direction Register B at address &FE62.

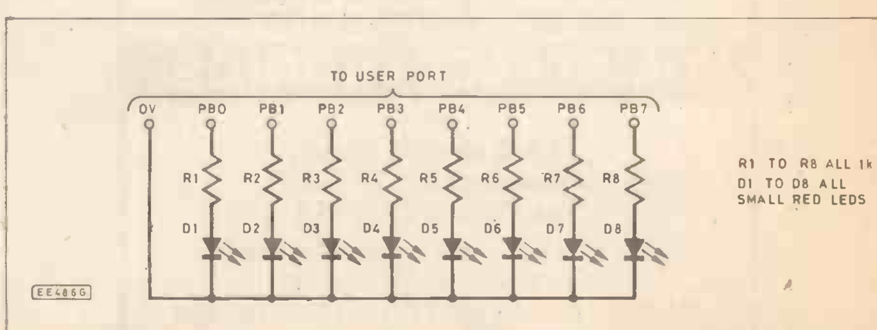


Fig. 2. Using eight l.e.d.s to monitor the user port's outputs.

REVIEW

All About Discs

Though you can use disc drives without knowing anything about their inner workings, you may feel more confident if you have some knowledge of what is going on "under the bonnet".

Books specifically on the disc system for the BBC computer are thin on the ground, but a new title should fit the bill. The Complete Disc Manual for the BBC Microcomputer by R. I. M. Sadek is exactly what the title says it is. The book starts with a diagram of a disc and an explanation of tracks and sectors, and goes all the way through to programming the 8271 controller chip.

This is not just a technical explanation, however. It also covers the operating system and file structures, and includes a number of substantial program listings, including examples of sequential, random access and indexed filing programs. Topics covered include filenames, the catalogue, directories, the operating system and language commands, and error messages.

There is a section on tape-to-disc transfer, covering BASIC and machine-code programs, as well as data files. This includes a section on the tricky topic of dealing with protected programs.

Dr. Sadek writes in an easily readable style, and the explanations are readily understandable and for the most part commendably complete. One exception to this, however, is the short section on keys and hashing. I felt this was rather glossed over, and that anyone who had not already met these concepts might be left none the wiser.

This is not a book for the complete beginner. You need a working knowledge of computers and programming, and to be familiar with the technical terms, as they are used freely without explanation. This is as it should be. Trying to write a book covering the subject in this sort of detail but understandable to a tyro would be a hopeless task.

Though this book is likely to be read consecutively when first purchased, thereafter it is likely to be used for reference on particular topics. As such, an index is of vital importance. Unfortunately, like so many books nowadays, the index is inadequate. It is barely more than 3 pages for a 200-page book. As an example, "data window" is mentioned in the text, but is not indexed.

On the whole, however, at a price of £7.95, this book is recommended.

All About Discs is a paperback, published by Macmillan the ISBN No. is 0 333 40930 2 it measures 231 by 153mm and has 200 pages.

Each of the eight bits at this register can be set low or high by writing data to it, and each bit corresponds to a user port line. Setting a bit high designates its user port line as an output—setting it low sets the line as an input. Looking at things as simply as possible, the correct value for the data direction register can be calculated with the aid of the table provided above.

Look up the numbers in the table for any lines which are to be set as outputs, and then add these together. This gives the value which must be written to ?&FE62. For instance, to set PB0, PB1, and PB2 as outputs, but to leave the other lines as inputs, the value written to ?&FE62 would be 7 (1 + 2 + 4 = 7). In most applications either all the lines are left as inputs or they are all set as outputs. In order to experiment with the port as an output type, remove all the link wires from the breadboard and then enter this command to set all the lines as outputs:

```
?&FE62 = 255 RETURN
```

Try writing various values to the port and then checking the logic levels with a logic tester or a multimeter set to a low voltage range. Alternatively (and preferably), wire in eight l.e.d.s and current limiting resistors as shown in Fig. 2 so that the states of all eight outputs can be monitored simultaneously. An output is high if its l.e.d. lights up, or low if it does not. There is not a very high drive current available, and unless ultra-bright l.e.d.s are used do not expect them to light up very brightly. As a quick check, try writing a value of 85 to the port (which should switch on alternate l.e.d.s). A value of 170 will give the complement of this.

While this may seem to be all rather simple and obvious to anyone who is familiar with computer hardware, it demonstrates two important points which must be understood by anyone who wishes to conquer computer interfacing. The relationship between the logic levels on a digital port and the decimal values put out or received by the computer, and the use of a register to control the function of the hardware, rather than control via physical switching of some kind.

NEXT MONTH: We will look at some of the ways in which the user and analogue ports can be used together.

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Satellite Broadcasting

So much is happening in cable and satellite, that the facts just won't stand still. In February the British Government did a spectacular U-turn on direct broadcasting by satellite, or DBS. By March, Mirror Group publisher Robert Maxwell looked like pulling the rug from under the British Government's DBS U-turn. Now France looks like pulling the rug from under Maxwell. Meanwhile British Aerospace and GEC Marconi are suing the BBC for £50 million, as compensation for what they say the BBC did to them on DBS.

In March 1982 the Home Office gave the BBC two of the five satellite channels which an international committee had allocated to the UK in 1977. But the Home Office added the proviso that the BBC must buy its satellite from a new company called Unisat, which was a hastily arranged joint venture between British Aerospace, British Telecom and GEC Marconi. The service was due to start in 1986. That's this year and there is of course no such service. The satellite was to be called Halley One. The real Halley has come and gone with no sign of a DBS Halley.

DBS didn't take off because the BBC got cold feet when the price asked by Unisat escalated to £80 million a year satellite rental over seven years. Don't forget the BBC also had to find several times that amount each year to pay for the programming. And in November 1982 an advisory panel chaired by Sir Anthony Part decided that the BBC and Unisat must use the IBA's new MAC (multiplexed analogue components) transmission system instead of the BBC's own modified PAL system. Under Government pressure the BBC signed what it called "heads of agreement" with Unisat in March 1983 and British Aerospace started to build satellite hardware. In December that year the BBC governors countered widespread speculation that the corporation would pull out of DBS, by saying that the BBC was still interested. So British Aerospace continued to build.

It took until May 1984 for the BBC to come out in the open and admit its loss of confidence in DBS. Direct General Alasdair Milne, speaking at the unlikely venue of the Rotary Club of Caversham, let slip that the BBC found Unisat's prices too high and the project no longer viable. The Home Office then let the BBC off the hook and said it need only have a part share in the project, with commercial TV and a consortium of private companies. This ploy also failed. So in February this year the Government announced that it was handing over full responsibility for running DBS to the IBA; this body is now looking for contractors who are willing to have a go with DBS.

The Home Office says hopefully that "the Government expects the IBA to take account of the overall economic implications for the UK". But facing up to reality, the Home Office has confirmed that the IBA and their contractors will "not be precluded from buying a foreign satellite if necessary". In other words they need not buy British from Unisat. This has left the way open for Unisat, British Aerospace and GEC to sue the BBC. And this is exactly what they are doing, claiming around £50 million lost while the BBC tried to keep the Home Office happy.

Maxwell

Meanwhile Robert Maxwell, publisher of the Mirror Group of newspapers with the slogan "Forward with Britain" has entered the confused picture. He has unveiled plans for direct broadcasting from a French satellite. Maxwell's plans look likely to wreck the IBA's plans. Why? The French and British satellites have been allocated quite different positions in orbit. The French satellite TDF-1 is due for launch later this year and Maxwell hopes to be broadcasting by early 1987. The IBA cannot hope to get a British DBS service running for at least another two years. By that time all aerials will be pointed at the French transmitter at 19 degrees West to pick up Maxwell's programmes and thus electronically unable to receive the official UK broadcasts coming from 31 degrees West. When this is widely recognised, the IBA may well find it impossible to interest anyone in putting money into a UK service.

The Maxwell satellite is not a Mirror Group solo venture. Maxwell is president of a consortium, called the European Satellite Television Broadcasting Corporation, which joins him with partners from Italy, Germany, France and eventually Spain. Bryan Cowgill, previously with Thames TV in Britain, is deputy chairman.

Just before the French elections, ESTBC negotiated a licence from the French Government which guaranteed it two channels on TDF-1. The contract runs for eight years and also gives Maxwell's corporation first refusal on the second generation of French satellites planned for the 1990's. ESTBC claims that the TDF-1 transmitter will be able to beam signals over virtually the whole of Western Europe, and some of Eastern Europe as well. This is far wider coverage for the French satellite than the original World Broadcasting Satellite Adminstrative Radio Conference (WARC) intended when it planned DBS in 1977. The wider coverage is possible because receiver design, especially low noise front end circuitry, has improved dramatically over the last ten years.

It was the WARC planners who gave Britain and France different orbital slots. Dish aerials have a very narrow reception pattern, of only around one degree. Viewers will have to pay up to £500 extra for a remote control motorized dish if they want to receive both satellites. There is a popular myth that there will soon be flat panel aerials which can be electronically steered. Engineers at both the BBC and IBA have been working on these for many years, but both labs warn that nothing will be ready for commercial sale until the next decade. Also these aerials will only work as intended if they are mounted on a house wall which conveniently faces both satellites.

On the face of things, it looks as if Maxwell's plans will finally kill all chance of Britain getting a DBS service. But after the French elections the new right wing government let it be known that Maxwell and his consortium would have to renegotiate terms for using the French satellite. I repeatedly phoned the Mirror Group offices, asking to speak with Bryan Cowgill about his plans for DBS and what they meant to Britain. Cowgill was always too busy to come to the telephone. But, through a spokesman, Robert Maxwell did comment. The stories about France renaging on the deal were—he said—"complete fabrication". Maxwell is confident he has a contract with the French Government and expects them to honour it.

At the National Association of Broadcasters Convention in Dallas in April, however, I discovered something which could change the whole picture yet again—and make Maxwell wish his contract with France is not binding!

At NAB seminars French broadcasters and the head of the European Broadcasting Union technical centre in Brussels, which controls radio and TV transmissions in Western Europe, separately confirmed that whatever Mr. Maxwell may think or want, they will insist on his using the MAC transmission system from French satellite TDF-1. It goes up in November on Ariane Flight 23, they say, with four transponders. And all will use the MAC system. A conventional British TV set, using the PAL system, cannot receive MAC signals.

The EBU chose MAC as the future standard for direct broadcasting TV by satellite for the whole of Europe. The French and West German governments are willing to subsidise the slow growth of the new standard to create a market for new TV sets and so help the European electronics industry. The UK government is not. Unwittingly Robert Maxwell may have cast himself in the role of broadcasting pioneer, willing to pay the subsidy needed to get MAC moving in Britain. It is the price of signing a deal first and worrying about the technical details later—the situation described to me by Maxwell's office earlier this year. He will be transmitting popular appeal TV programmes to a tiny audience.

In Dallas, Michel Oudin of SFP, Societe Francais de Production, involved in broadcast programming in France, and Jean Caillot, International Manager of the nationalised French electronics company Thomson, which will be supplying the transmission equipment for the French satellite TDF-1, confirmed that it will be transmitting only MAC signals. There will be no room on the satellite, say Oudin and Caillot, for an extra transmitter to broadcast programmes in the conventional UK PAL standard.

There are still no MAC chips available for TV set manufacturers to buy and build into receivers. The two firms with MAC chips under development, Mullard and ITT (the latter working in cooperation with Thomson), do not expect saleable quantities until late this year. Only then can TV set manufacturers start making receivers.

George Waters, Director of the European Broadcasting Union technical centre in Brussels told me; "There is no question about it. Robert Maxwell will have to use the MAC system. It is a requirement of the licences to transmit from satellites in Europe. This was done to support the European receiver industry. We know there will be only a very few receivers for quite some time. France and the EBU are quite clear on this. Even if Robert Maxwell isn't aware of this, someone in his organisation must know and should tell him." The IBA in Britain is equally sure that Maxwell is committed to MAC, whether he wants it or not.

Murdoch

Meanwhile Maxwell's publishing rival has his own problems. Rupert Murdoch owns Sky Channel, which beams cable programmes around Europe to 6 million viewers. Sky uses the Eutelsat F1 communications satellite, run by the Paris-based Eutelsat agency. Late last year F1 started to lose power on the Sky transmitter. In Britain British Telecom, compensated by doubling the power of the uplink signal. Eutelsat made contingency plans. They would hold a lottery if things got worse. Winners would get working channels, losers would have to stop transmitting.

Sky was decidely peeved to find out about this by reading it in the Dutch press. Under pressure from Sky, Eutelsat has now published a reassurance that the Sky transmitter is no longer losing strength. At the same time, Eutelsat reassured Sky about another technical problem which it did not previously know about. Apparently Eutelsat engineers suspected that one of the solar panels powering the satellite transmitter was developing a short circuit. Now Paris says the engineers realise they were wrong. There isn't a short circuit which they didn't tell Sky aboutl Behind all this there is a mystery.

When the in-flight electronics on Eutelsat F1 started to lose power, British Aerospace, which is main contractor for the satellite, checked and found that some of the vital amplifier tubes on board were made by AEG of West Germany and some by Thomson of France. Last year BAE thought the faulty tubes were French. Now BAE has found they were French. The Japanese already blame Thomson tubes for the failure of transmitters on board the Japanese satellite.

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EE MARKET PLACE JULY '86

DOWN TO EARTH

BY GEORGE HYLTON

MULTI SHUNTS AND MULTIPLIERS

A MOVING COIL d.c. meter made for measuring low current or voltage can usually be adapted to indicate a higher current or voltage. Easy, commonsense methods show how to do it.

CURRENT METERS

We'll start with current meters. Suppose you have a meter which reads 1mA full-scale. And you want to modify it for a full-scale deflection at some higher current.

The pointer moves because when current flows through the operating coil a magnetic field is set up which interacts with the field of the meter's built-in permanent magnet. The result is a force on the coil which makes it twist, carrying the pointer with it. In a linear-scaled meter (which is the easiest type to adapt) the indication is proportional to the current.

The coil has inductance, of no importance here, and also resistance, which is very important. By connecting an extra resistance across the coil, current can be diverted from the meter. This is what enables the sensitivity to be reduced. If for example an added resistance diverts four-fifths of the current, leaving only one-fifth for the coil, then the sensitivity is reduced five-fold; a 1mA meter is thus turned into a 5mA meter.

WHAT SHUNT RESISTANCE?

In Fig. 1, the meter is presented by the boxed-in part. Here R_m is the resistance of the operating coil. We'll suppose it to be 100Ω, a typical value for a 1mA meter. In practice the coil often has much less resistance but this is increased to a round value such as 100Ω by connecting an extra resistance is series inside the case. The added resistor is to reduce or "swamp" the effects of temperature changes and is called a swamping resistor or a "swamp".

We have to find out how to determine the value of parallel or shunt resistance required for a wanted sensitivity adjustment. In Fig. 1, a number of shunt resistances (R_{s1}, R_{s2}, etc.) can be switched across the meter one by one. Each shunt has the same resistance as the meter (100Ω in our example). If only R_{s1} is switched into circuit, any applied current (I) has a choice of two paths: R_{s1} or the meter, R_m. Since the resistance of the paths are equal, the current divides equally. Half goes through the meter, half through the R_{s1}. When I = 2mA, 1mA goes through the meter. So for practical purposes our 1mA meter is now a 2mA meter. If R_{s2} is now also switched in, the current splits three ways equally and the meter becomes, in effect, a 3mA meter. With R_{s1}–R_{s3} in it becomes a 4mA meter and with four shunts in circuit, 5mA.

In real life, if you want to convert a 1mA meter into a 4mA one you won't want to have to use three shunts. One will do so long as its resistance is correct. In our case it must have the same value as three 100Ω in parallel; i.e. 33Ω3. If you aren't too fussy about accuracy you can use 33Ω.

FRACTIONS

A rule emerges from all this. To halve the sensitivity (i.e., to double the full-scale current) you use a shunt equal to R_m. To multiply the full-scale current by three; i.e., to reduce sensitivity to $\frac{1}{3}$, you connect a shunt of $\frac{1}{2}R_m$. For a reduction to $\frac{1}{4}$ of the original sensitivity, $R_s = \frac{1}{3}R_m$. For $\frac{1}{5}$ sensitivity, $R_s = \frac{1}{4}R_m$. There is a pattern in these numbers. The denominator of the "sensitivity reduction" fraction is always one more than the denominator of the "shunt" fraction.

That's a bit of a mouthful, but an example will clarify it. If a 1mA meter has to be converted to 10mA, the required R_s must be $R_m \times \frac{1}{9}$, which is the same thing as $R_m/9$. With our R_m of 100Ω, R_s must be 11·1Ω. To convert the same meter to 100mA, R_s must be (100/99)Ω.

VOLTMETERS

To make a moving-coil meter read d.c. volts, you connect a resistance in series (Fig. 2). Taking our 1mA, 100Ω meter as an example again, if we put 900Ω in series then the total resistance is 1k. A voltage of 1V drives 1mA through 1k, so our meter now reads 0–1V.

To determine the required series multiplier resistance R_s for some other full-scale voltage you begin by finding the total resistance needed. Thus to convert our meter to read 10V full-scale the total resistance is 10V/1mA = 10k. The meter provides 100Ω of this so R_s must be 9k9. This is not a standard value but it can be made up by connecting 10k and 1M in parallel.

AC METERS

A moving-coil d.c. meter is converted to read a.c. by adding a rectifier. If it's a half-wave rectifier then only half the current goes through the meter. This is why the a.c. voltage ranges on many cheap multimeters are double the corresponding d.c. voltage ranges. It is better to use a bridge rectifier, from the point of view of sensitivity, but there are still problems.

If you try to use the same series resistance for, say, 10V d.c. and 10V a.c. you find that the a.c. reading is low. This is a waveform error. To make a meter read the same a.c. r.m.s. voltage as the d.c. voltage on the same range (10V in our example) the series multiplier resistance has to be reduced to 0·9 times the d.c. resistance. This assumes that the a.c comes in sine waves. Meters are usually calibrated for sine waves on their a.c ranges. With other waveforms there is an error. For square waves the meter reads high. For peaky waves it reads low.

Another problem with a.c. is the fact that the rectifier does not pass current freely until the voltage across it exceeds a certain value. For an ordinary silicone diode this is about 0·6V, and if a bridge rectifier is used there are always two diodes conducting so the meter is blind to voltages of less than about 1·2V peak and reads low at higher voltages unless the diode drops are allowed for. This is why, on all but high voltage a.c. ranges, meters need a separate calibrated scale for a.c. volts.

Electronic a.c. meters need not suffer from this problem and if well designed can give linear readings of even very small input voltages.

OVERLOAD PROTECTION

Voltmeters can be protected against

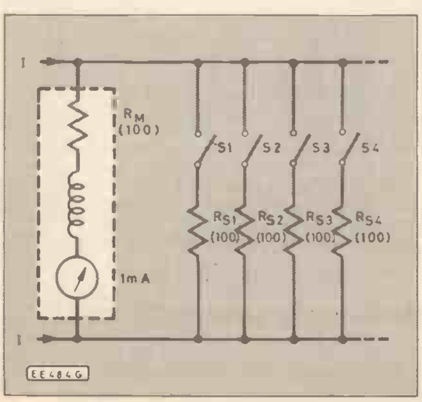


Fig. 1. Circuit to switch in various shunts.

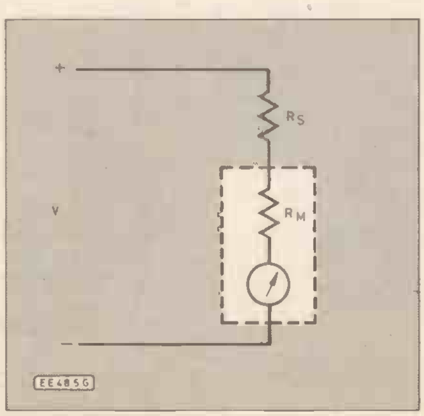


Fig. 2. Resistance in series to make a voltmeter.

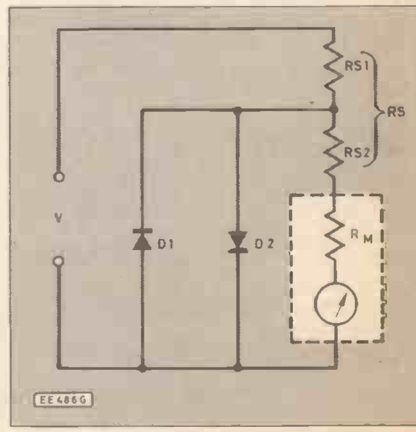


Fig. 3. Overload protection using diodes.

overload by means of shunt diodes. Diode protection circuits make use of the property of diodes which is such a nuisance in measurements, as noted above. If a diode is connected across the meter it passes no current at normal meter currents but is turned on when the drop across the coil exceeds a certain threshold. This shunts current past the coil. Often the coil resistance itself is insufficient to produce the turn-on voltage at a safe current. In this case extra resistance must be added (Fig. 3) and forms part of the range multiplier. The resistance (R_{s2}) is chosen so that the protection diode (D1 or D2, depending whether the overload is in the normal or reverse direction) starts to conduct when the current is, say, two or three times full scale, i.e. not enough to damage the meter.

Unfortunately, there is no such cheap way to protect a current meter, which is why low-cost multimeters often have no low-current ranges. High-current may be protected by a fuse. In expensive meters low-current protection may be provided by a sensitive electromagnetic cutout. It is arguable that if you can afford such a meter you would be better off spending your money on a digital meter, which is relatively easy to protect.

SOME EXAMPLES

1. A d.c. meter has a linear scale marked 0–40. Its full-scale current is 2mA and its resistance is 60 ohms. What series resistance is needed to make it read 0–40V d.c.? Answer: Since 40V must drive 2mA the total resistance must be 40V/2mA = 20k. The meter itself provides 60Ω so the series multiplier required is strictly 19,940Ω. If 20k is used the meter will read low by about 0·2 per cent, a negligible amount compared with meter and resistor tolerances. N.B. multiplier resistances should be of close tolerance, preferably one per cent or better.

2. The same 2mA meter is to be shunted to read 0–40mA. What shunt resistance is needed? Answer: The current multiplication factor is 40/2 = 20. The required shunt resistance is the meter resistance divided by one less than this; i.e. by 19. So R_s = 60/19 = 3·16Ω. Such a resistance could be made from a length of resistance wire of known "ohms per meter". It may however be useful to increase the meter resistance so as to make the shunt work out at a standard value. If a shunt of 3·3Ω were used the meter resistance would have to be 19 times this; i.e. 62·7Ω. Thus by adding a standard 2·7Ω to the meter a standard shunt becomes usable. Resistor values do not always work out as neatly as this, but with a bit of trial and error and a pocket calculator it is often possible to find convenient values without too much trouble.

BOOK REVIEWS

EE BOOK SERVICE

See Page 356

THE SINCLAIR STORY

Author	Rodney Dale
Price	£9.95
Size	229 × 165mm. 184 pages
Publisher	Duckworth
ISBN	07156 1902

WHAT is the secret behind that legendary figure of our time Sir Clive Sinclair, innovator extraordinary, the electronics enthusiast who became visionary trail-blazer for the electronics industry? A man of many successes but also many failures, yet despite the latter, a man who has repeatedly rebounded back into the forefront of the commercial arena and the public eye.

An electronics enthusiast from his teens, Clive Sinclair obtained his first employment at the age of eighteen as editorial assistant on *Practical Wireless*, next he worked for the technical book publisher B. Babani and afterwards for the trade journal *Instrument Practice*. During this period Sinclair acquired a unique store of information regarding semiconductor manufacturers.

He negotiated a deal with one manufacturer to buy their discarded MAT semiconductors at 6d each in boxes of 10,000. He carried out his own quality tests and marketed his renamed MAT100 and MAT120 at 7/9d each. Here must be the germ of that genius that was to amaze and startle the entire electronics world, from humble private constructors, all the way through to the largest industrial concerns, in the following years.

The stream of products bearing the Sinclair name ranged from the highly successful to some downright disasters. His career has shown a dogged determination to worry a problem though, not to be put off by set-backs or failure, as for example his unshakable faith in the Microvision.

The Sinclair story is a fascinating tale, particularly of interest to those thousands of home constructors or hobbyists. This book does not dodge its subject's failures nor shortcomings. Well-staged press launches of new products created large demand, but orders could not be immediately fulfilled.

Alas, this was all too typical of Sinclair and his business acumen must be questioned. Was it not reckless to act in this way, exciting the public's interest while knowing that the product was not yet in quantity production, and sometimes even worse, that his engineers were still working frantically behind the scenes to de-bug some basic design fault or to introduce some substitute component because supplies of the specified item had unexpectedly failed to materialise?

It says much for the public's tolerance and patience and also the general fund of goodwill that existed towards this entrepreneur that confidence was usually quickly restored. In a strange way, the difficulties seemed to engender a sympathetic affection towards Sir Clive, perhaps because he was seen as an example of the pioneering businessman that countless thousands would dearly love to emulate.

This profusely illustrated book lets you into many secrets about the caree of Sir Clive Sinclair and takes you behind the scenes concerning all his products. The story is not finished, of course. We can merely look forward to Volume Two in the course of the next two decades.

F.E.B.

TEACH-IN 86

The answers to the Problems set in the final instalment (Part 9) of *Teach In '86* will be given next month.

Details of how to obtain the Tape 3 software will also be included.

SQUEEKIE

I.P. KEMP

Tests resistors, diodes, l.e.d.s, transistors, capacitors, fuses, transformers, etc.

MOST forms of test equipment are expensive. For the newcomer to electronics a method of testing a wide variety of components is required. The device described in this article costs less than £3 and yet will test the following components: Resistors up to a value of approximately 10M, l.e.d.s, transformers, diodes, cables, switches, fuses, transistors and capacitors. It can also be used for testing continuity and insulation.

"Squeekie" was originally designed as a simple constructional project for pupils at the school where I teach, to enable them to test the components that they salvage from redundant and broken pieces of equipment. It has also served as a toy for young children, who find that by placing their fingers across the terminals, they can make the device squeek (hence the name *"Squeekie")*.

CIRCUIT DETAILS

The circuit diagram is shown in Fig. 1. Consider a connection between the Insulation and the Common terminals. Current will be able to flow through R2 and so charge capacitor C1. As the voltage across C1 increases a point is reached at which TR1 begins to conduct. This in turn makes TR2 conduct so producing a pulse of current through the earphone as capacitor C1 discharges. The discharge of the capacitor turns off TR1 and also TR2 so enabling the charging process of C1 to begin again. The circuit therefore supplies pulses of current to the earphone, the repetition rate being dependent upon the effective value of R2. If a resistor is placed between the Insulation and Common terminals then the effective value of R2 is increased and the note emitted from the earphone will be lower in pitch. The maximum value of resistance that can be placed between the Insulation and Common terminals is approximately 10M, and then a clicking noise is emitted from the earphone.

To use the device to check for continuity or low value resistance (up to approximately 10k), the component is placed between the Continuity and Common terminals. R1 limits the maximum current that can flow through the component to 9mA, and also has the effect of lowering the input impedance of the oscillator circuit. The earphone used in "Squeekie" is a normal eight ohm magnetic type with the earpiece removed, see Fig. 2. These were used in preference to piezo devices because they are smaller and cheaper. The sound emitted is easily audible.

No on/off switch is needed since the quiescent current is much less than 1µA. In practice a PP3 battery will provide approximately three years of reasonable use. The only problem that has occurred with any of the thirty or so "Squeekies" that have been made so far is one which began squeeking during the night while in a pupil's bedroom. After much investigation it turned out that the room became damp during the night and the moisture in the atmosphere provided a connection from the Insulation terminal.

CONSTRUCTION

The circuit is constructed on a piece of Veroboard of size 7 × 14 strips. It is recommended that the copper strips are broken, where required, and the mounting hole inserted prior to the insertion of the components. See Fig. 3. R1 does not fit on the circuit board but is soldered between the Continuity socket and the battery positive strip of the circuit board, once it has been inserted into the case; see photograph of inside of case. The case is a small ABS Verobox and there are five holes to be drilled. The circuit board is held in the box by a 6BA nut and bolt and the earphone is secured with a smear of a suitable glue (Evostick) once the earpiece has been removed.

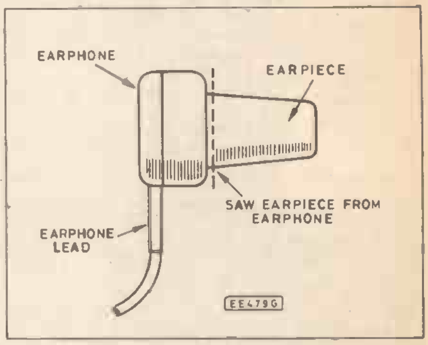
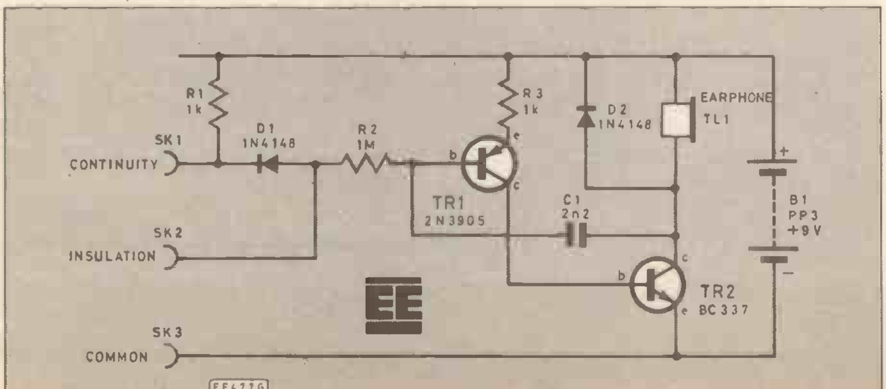


Fig. 2. Modification of the earphone.

Fig. 1. Complete circuit diagram of Squeekie.



COMPONENTS

See Shop Talk page 367

Resistors
R1,3 1k
R2 1M
Both ¼W carbon 5%

Capacitor
C1 2n2 ceramic

Semiconductors
D1,2 1N4148 (2 off)
TR1 2N3905
TR2 BC337

Miscellaneous
SK1,2 1mm red sockets
SK3 1mm black socket
B1 9V PP3 battery and connector; TL1 Eight ohm magnetic earphone; 6BA nut and bolt; Veroboard, 14 strips by 7 holes; box, 72mm × 50mm × 25mm

Approx. cost Guidance only **£3**

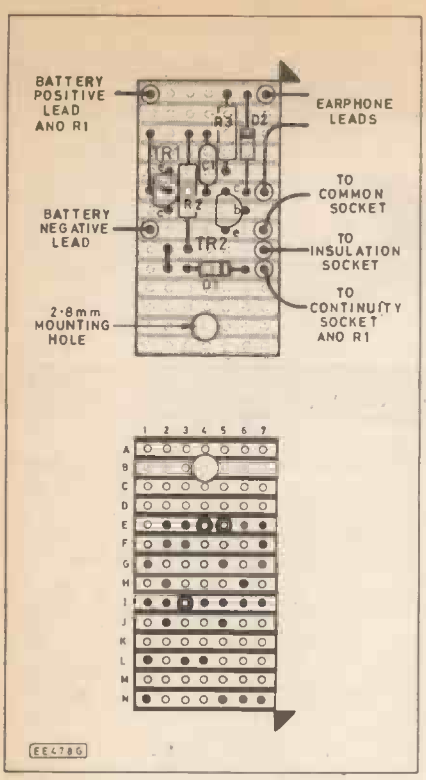


Fig. 3. Veroboard layout and wiring.

TESTING

Once the "Squeekie" has been assembled it can be tested by placing your fingers between the Insulation and Common terminals. If all is well a "squeek" should be emitted from the earphone. From the experience of having young pupils constructing these circuits the most common reason for a circuit not to work is poor soldering. This can be of two forms:

a) solder bridges between the copper strips,
b) components that are not properly soldered onto the copper strips. This is usually caused by the copper strip and the component lead not being heated sufficiently by the soldering iron.

COMPONENT TESTING WITH "SQUEEKIE": CONTINUITY TESTS

The following components can all be tested for continuity:
Fuses, leads, lamps, inductors, transformers, speakers, switches, etc. The component is connected between the Continuity terminal and the Common terminal. If the component is not open circuit then there will be a high pitched note emitted from *"Squeekie"*. It is also worth testing the leakage on leads, transformers, switches, etc. This is achieved by using the Insulation and Common terminals and connecting them between different windings on transformers, different leads on multi-lead cables or across the terminals of a switch when it is switched off. Any note emitted during these latest tests indicates poor insulation and the component or cable should be considered suspect.
NOTE. You should not hold the *"Squeekie"* leads when making insulation tests since the resistance of your body is much less than the insulation you are testing and so will produce inaccurate results.

CAPACITORS

To test capacitors use the Insulation and Common terminals. When first connected there may be a short squeek emitted but this should quickly cease. Any remaining note indicates a "leaky" capacitor. Electrolytic capacitors are naturally "leaky" and so these should be tested using the Continuity and Common terminals. Any remaining note on this range indicates a very leaky component.
NOTE. Electrolytic capacitors are polarised, i.e. they should be connected the correct way round in the circuit. On *"Squeekie"* the Common terminal is negative and the other two are positive.

An approximate value for the capacitor under test can be obtained by noting how long the intial note, emitted by *"Squeekie"*, lasts. The longer the note the larger the value, assuming very little leakage. By comparing the duration of the note with that produced by capacitors of known value an approximate measurement of the capacitance can be obtained. Remember to short the leads of the capacitor together to discharge it before repeating the tests.

RESISTORS

For resistors up to approximately 10k use the Continuity and Common terminals. The larger the value of the resistor the lower the pitch of the note emitted by *"Squeekie"*. As with capacitors, it is possible to obtain the approximate value of a resistor by matching the pitch produced by a resistor of known value with that of the unknown value. For resistors larger than 10k the Insulation and Common terminals should be used.

DIODES

Use the Continuity and Common terminals. When the band on the diode is connected towards the Common terminal there should be a squeek. When the connections are reversed there should be no sound at all. To check the leakage of the diode the Insulation and Common terminals should be used. The diode should be connected with the band towards the Insulation terminal. With a silicon diode there should be no note produced, but with a germanium diode there may be a low pitched note.

LIGHT EMITTING DIODES AND DISPLAYS

Use the Continuity and Common terminals. When connected one way round the l.e.d. should light and there should be a squeek. With the connections reversed there should be no light or sound. If a sound is produced without the l.e.d. lighting, the l.e.d. is faulty.

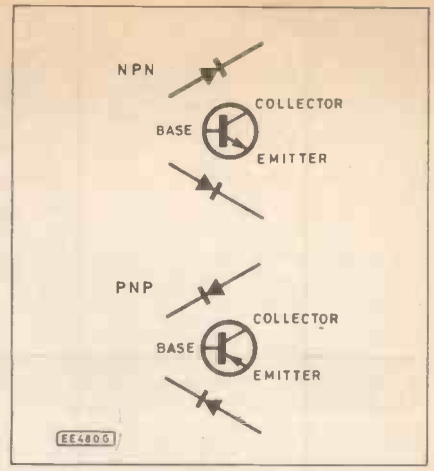


Fig. 4. The "diode junctions" of *npn* and *pnp* transistors.

TRANSISTORS

The Continuity and Common terminals are used to check the various "diode junctions" around the transistor. Fig. 4 shows the "diode junctions". The transistor is tested by carrying out the operations shown below, the results being for a working transistor.

NPN TRANSISTOR

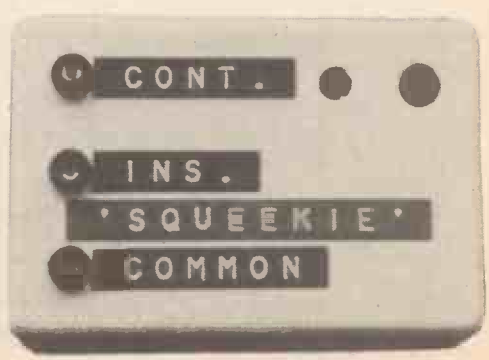
Continuity	Common		
	Base	Collector	Emitter
Base		Squeek	Squeek
Collector	No Squeek		No Squeek
Emitter	No Squeek	No Squeek	

PNP TRANSISTOR

Continuity	Common		
	Base	Collector	Emitter
Base		No Squeek	No Squeek
Collector	Squeek		No Squeek
Emitter	Squeek	No Squeek	

By labelling the various leads of unmarked transistors and carrying out the tests in the above tables it is possible to identify the leads of the transistor, i.e. which is base, collector and emitter and also whether it is *pnp* or *npn*. □

Photograph showing layout of the finished unit.



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.**

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The Man Behind the Symbol

N°11 Heinrich Rudolph Hertz

by Morgan Bradshaw

WE return to Germany for the final article in the present series, to meet the man who discovered the existence of wireless waves, and whose name has been adopted as the official unit of frequency. (See Table 1.)

Heinrich Rudolph Hertz, was born in Hamburg on 22nd February 1857. Heinrich's father was a lawyer and senator, and his mother the daughter of a physician. Hertz received every encouragement from his parents, and lived in a comfortable, cultural and academic atmosphere. Unlike so many of the other early pioneers he did not have to struggle against poverty, but he did suffer with ear trouble from an early age.

After leaving school he went, in 1878 at the age of twenty, to Munich to pursue an engineering career which he later abandoned in favour of physics. Heinrich enrolled in the Berlin University, where he specialised in the study of natural science, mathematics and magnetics. Here he came under the influence of the German philosopher and physicist Hermann L. Von Helmoltz who had contributed to the development of the electromagnetic theory of light and indicated its general possibilities.

WIRE-LESS

In 1879 the Berlin Academy of Science offered a prize for research on the problem of establishing experimentally a relation between electromagnetic forces and the dielectric polarization of insulators. Helmholtz drew the attention of Hertz to the problem. Hertz started to tackle it by studying the mathematical theories of Maxwell that electricity and light are fundamentally a single phenomenon: that both are waves of the same kind, differing only in wavelength. He also reasoned that if a moving electric charge could broadcast electromagnetic waves, a device similar to that which produced the waves should be able to receive them and change them back to an electric charge.

In 1885 Hertz married Elizabeth Doll, daughter of a professor, and was himself appointed professor of experimental physics at the Technical High School at Karlsruhe. It was here that he started his experiments of trying to generate radio waves by means of an electric spark.

Hertz constructed a transmitter that could make a strong electric spark jump between the knobs on the ends of two metal rods. He then placed a metal ring with a spark gap in it a few feet away. There were no wires between the transmitter and the metal ring which was in fact, the first "wireless" receiver.

Hertz held his breath, switched on the apparatus and made a spark jump across the spark gap between the rods. Immediately a spark jumped across the spark gaps of the metal ring. Electromagnetic waves produced by the first spark rod travelling to the ring had caused the spark to jump across the rings spark gap. By such means Hertz produced electromagnetic waves with wavelengths from a few metres to thirty centimetres (ultra short waves).

Photo Courtesy Science Museum

Hertz lived for his work and continued his experiments. Having proved that these waves existed, he proceeded to show that they could be reflected, and polarised just as light can; he measured the velocity of propagation and found it to be of the same order as that of light and radiant heat. Soon scientists all over the world were reproducing Hertzian experiments without realizing their commercial applications.

GRANDFATHER OF RADIO

In 1889 Hertz was appointed Professor of Physics at the University of Bonn: at the age of 32 he had achieved a position in the academic world not ordinarily attained until much later in life. He continued his work and carried out research into the discharge of electricity in rarified gases and also produced his treatise on the principles of mechanics, this was to be his last work.

In the summer of 1892 Hertz suffered an illness which developed into chronic blood poisoning. He died on New Year's Day 1894, at the age of 37; a premature death had robbed the world of the accomplishments of a man who has been described as "The Grandfather of Radio".

TABLE 1: HERTZ (Hz)

The Hertz symbolised by the letters Hz has gained world recognition as the official unit of frequency, and is equal to one cycle per second. It is often used with the prefix k (1kHz = one thousand cycles per second), and with the prefix M (1MHz = one million cycles per second).

The number of complete wavelengths that pass a given point in one second is the frequency of the waves. The frequency of radio waves varies from thousands to many thousands million Hz. All electromagnetic waves travel at a speed of approximately 186,000 miles per second.

The frequency of a sound wave governs its pitch, the frequency of a light wave governs its colours. The Hertz was adopted by the International Electrotechnical Commission in October 1933.

POST-SCRIPT

Hertz' experiments were described in a paper called "Electromagnetic Waves in Air and their Reflection", and were published in an electrical journal. One of the teenage sons of a rich land owning Italian family, vacationing in the Alps happened to read the article. For him it contained the germ of an idea. Why not use the sparks for signalling? The young man was so excited by the prospect he cut short his holiday, rushing back to his Bologna home and with the help of his brother set up his first experiment. The teenagers name: Guglielmo Marconi, the first man to make commercial use of Hertzian waves which signalled the start of the radio age.

Marconi demonstrated his "wireless apparatus" at a lecture held at Toynbee Hall in December, 1896.

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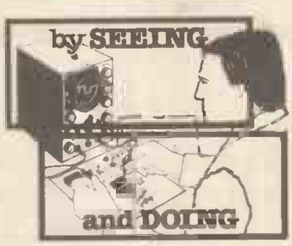

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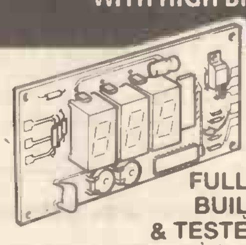

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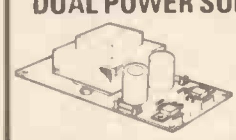

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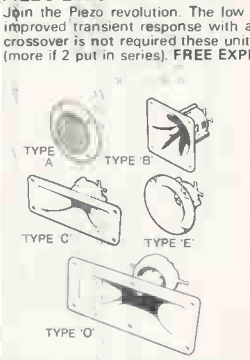

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