EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

MAY 1986 £1·10

TEACH IN '86 PROJECT

DIGITAL PULSE GENERATOR

MINI STROBE

JOYSTICK ADAPTOR

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
3. 25 – 13 amp fuses for ring mains
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 ½A secondaries
11. 1 – extension speaker cabinet for 6½" 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 ¼ 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.)
46. 1 – hour clock work time switch
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 × 6 amp changeover (s.h.)
54. 10 – rows of 32 gold plated IC sockets (total 320 sockets)
55. 1 – locking mechanism with 2 keys
58. 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 ¼ 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 ¾" stack – ¼ 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
97. 1 – infra red fire element 1000 watts
98. 1 – motorised stud switch (s.h.)
101. 1 – 2½ hours delay switch
103. 1 – mains power supply unit – 6V DC
104. 1 – mains power supply unit – 4½V 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 1¾ 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
130. 2 – centre zero panel meters 100-0-100 UA
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 – 6½" 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 ⅜ hole size
182. 1 – short wave tuning condenser 50 pf with ¼" spindle
184. 1 – three gang tuning condenser each section 500 pf with trimmers and good length ¼" 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.
198. 1 – rod thermostat for water heater etc. 11" rod
199. 1 – mains operated solenoid with plunger 1" travel
200. 1 – 10 digit switch pad for telephones etc.
201. 6 – 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) 6½" 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, ½ meg with dp switch
249. 1 – 13A switched socket on double plate with fused spur for water heater
266. 2 – mains transformers 9V ½A secondary split primary so ok also for 115V
287. 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 ¼ 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 ¼ 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 ¼" spindle
310. 2 oven thermostats
311. 1 Clare Elliot sealed relay

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

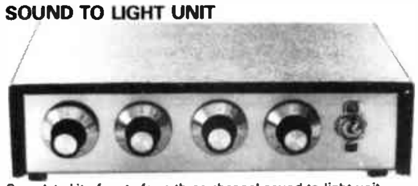
Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data **£16.50** or without case **£15.00** post paid.

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

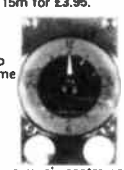


Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio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

FROZEN PIPES

Can be avoided by winding our heating cable around them – 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price **28p**/metre or 15m for **£3.95**.

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.

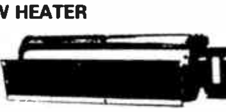
Some of the features are: long wave band 115 – 170KHz, medium wave band 525 – 1650KHz, FM band 87 – 108 MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod 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**.

TANGENTIAL BLOW HEATER



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

Please add post £1.50 for 1 or 3 for £20 post paid
2.5 Kw KIT Still available: £4.95 + £1.50 post or have 3 for £16 post paid.

CORDLESS TELEPHONES

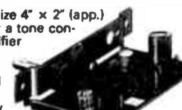
"IT'S FOR YOU-OU" even if you are in the bath, its an infinite extension any room and even in the garden – have one on approval or come and try one here. BT approved.

SOCKETS PLUGS ETC for BT phones

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, test 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 day or night. Haywards Heath (0444) 454563. **Bulk orders: phone for quote.**

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

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 Amplifiers
2P6 –100W mains to 115V auto-transformer with voltage tappings
2P7 –Mini key, 18 button membrane keyboard, list price over £12, as used on PRESTEL
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 BD218
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 burgler 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 sh
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 8 inch round 8ohm 12 watt
2P28 –Drill Pump – always useful couples to any make portable drill
2P29 –24 position Yaxley switch contacts rated 5A – ¼ spindle
2P31 –4 metres 98 way interconnecting wire easy to strip
2P32 –Hot Wire amp meter – 4½ round surface mounting – 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 –2½kw. 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 1½" stack and good length of spindle both ends
2P62 –1 pair Goodmans 15 ohm speakers for Unilox
2P63 –1 5Kv 20 mA mains transformer ex-equipment
2P64 –1 five bladed fan 6½" 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 5P28 speaker
2P77 –1 instrument box with key size 12" × 4½" 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 radialler
2P85 –20v–0–20v ½A 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 2½" × 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 4½" 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 appiications.
16. Control panel case, conventional design with hinged front and finished metallic silver, easily arranged as lockable size approx. 15" x 10" x 5½", wall mounting.
17. Two kits: matchbox size surveillance transmitter and 2 FM receivers.

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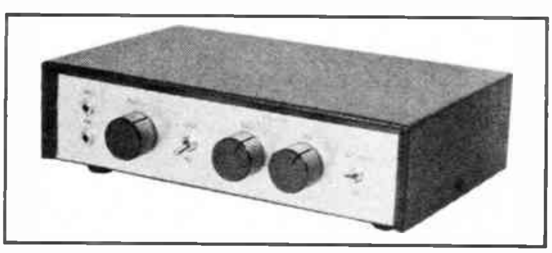
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .



EE BOOK SERVICE

See Page 247

Projects

Series

Features

Our June 1986 issue will be published on Friday, 16 May.
See page 261 for details.

E.E. PROJECT KITS

Full Kits inc. PCBs, or veroboard, hardware, electronics, cases (unless stated). Less batteries.
If you do not have the issue of E.E. which includes the project – you will need to order the instruction reprint as an extra – 70p each. Reprints available separately 70p each + p&p 60p.

THIS MONTH'S KITS
SAE or 'phone for prices

MINI STROBE May 86	£12.49
STEREO REVERB Apr 86	£23.98
VERSATILE PSU Apr 86	£22.39
CIRCLE CHASER Apr 86	£19.98
FREELOADER Apr 86	£7.70
STEPPER MOTOR DRIVER Apr 86	£4.66
BBC MIDI INTERFACE Mar 86	£25.34
INTERVAL TIMER Mar 86	£17.11
STEREO HI-FI PRE-AMP	£44.62
MAINS TESTER & FUSE FINDER Mar 86	£7.98
FUNCTION GENERATOR Feb 86	£22.53
POWER SUPPLY FOR ABOVE	£7.26
TOUCH CONTROLLER Feb 86	£11.67
pH TRANSDUCER (less Probe) Feb 86	£22.01
LIGHT EFFECTS/GAMES UNIT Feb 86	£10.37
SPECTRUM OUTPUT PORT Feb 86	£10.21
HEADLIGHT ONE SHOT Feb 86	£10.69
OPORT Jan 86	£6.80
TACHOMETER Jan 86	£23.40
MAIN DELAY SWITCH left case Jan 86	£17.93
ONE CHIP ALARM Jan 86	£7.90
MUSICAL DOOR BELL Jan 86	£16.98
TTL LOGIC PROBE Dec 85	£8.59
OPTICAL INTENSITY TRANSDUCERS Dec 85	£16.34
DIGITAL CAPACITANCE METER Dec 85	£35.98
DIODE/TRANSISTOR TESTER Dec 85	£15.98
UNIVERSAL LCR BRIDGE Nov 85	£23.49
FLUX DENSITY TRANSDUCER Nov 85	£26.15
FLASHING PUMPKIN less case Nov 85	£3.82
SQUEAKING BAT less case Nov 85	£8.63
SCREAMING MASK less case Nov 85	£9.98
STRAIN GAUGE AMPLIFIER Oct 85	£25.46
SIMPLE AUDIO GENERATOR Oct 85	£2.59
SOLDERING IRON POWER CONTROLLER Oct 85	£4.72
VOLTAGE REGULATOR Sept 85	£6.78
PERSONAL STEREO P.S.U. Sept 85	£8.99
R.I.A.A. PRE-AMP Sept 85	£14.49
CARAVAN ALARM Sept 85	£9.37
FRIDGE ALARM Sept 85	£6.82
SEMI-CONDUCTOR TEMP. SENSOR Sept 85	£18.93
RESISTANCE THERMOMETER Sept 85 Less Probe	£18.83
PLATINUM PROBE Extra	£22.00
LOW COST POWER SUPPLY UNIT Aug 85	£16.72
TRI-STATE THERMOMETER (Batt) Aug 85	£6.05
TREMOLO/VIBRATO Aug 85	£34.48
STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£13.99
1035 STEPPER MOTOR EXTRA	£14.50
OPTIONAL POWER SUPPLY PARTS	£4.67
EMERGENCY LIGHTS FLASHER less lamps July 85	£6.39
CONTINUITY TESTER July 85	£5.37
TRAIN SIGNAL CONTROLLER July 85	£8.78
AMSTRAD USER PORT July 85	£15.33
ACROSS THE RIVER June 85	£17.97
ELECTRONIC DOORBELL June 85	£6.55
COMPUTERISED SHUTTER TIMER June 85	£10.61
GRAPHIC EQUALISER June 85	£23.33
AMSTRAD CPC 464 May 85	£15.34
MAINS VERSION	£22.48
AUTO PHASE May 85	£16.39
INSULATION TESTER Apr 85	£16.96
LOAD SIMPLIFIER Feb 85	£16.98
SOLID STATE REVERB Feb 85	£39.98
GAMES TIMER Jan 85	£7.63
SPECTRUM AMPLIFIER Jan 85	£5.98
TV AERIAL PRE-AMP Dec 84	£12.36
Optional PSU 12V £2.03	24V £9.86
MINI WORKSHOP POWER SUPPLY Dec 84	£34.98
DOOR CHIME Dec 84	£14.91
BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£28.77
PROXIMITY ALARM Nov 84	£17.98
MAINS CABLE DETECTOR Oct 84	£4.39
MICRO MEMORY SYNTHESISER Oct 84	£47.98
DRILL SPEED CONTROLLER Oct 84	£6.89
GUITAR HEAD PHONE AMPLIFIER Sept 84	£6.38
SOUND OPERATED FLASH less lead Sept 84	£5.91
TEMPERATURE INTERFACE FOR BBC MICRO Aug 84	£19.70
CAR RADIO BOOSTER Aug 84	£13.87
CAR LIGHTS WARNING July 84	£7.99
VARICAP AM RADIO May 84	£10.43
EXPERIMENTAL POWER SUPPLY May 84	£18.72
SIMPLE LOOP BURGLAR ALARM May 84	£13.62
MASTERMIND TIMER May 84	£5.44
FUSE/DIODE CHECKER Apr 84	£3.45
QUASI STEREO ADAPTOR Apr 84	£10.90
DIGITAL MULTIMETER add on for BBC Micro Mar 84	£24.98
NI-CAD BATTERY CHARGER Mar 84	£9.85
REVERSING BLEEPER Mar 84	£6.78
PIPE FINDER Mar 84	£3.60
IONISER Feb 84	£23.90
ZX81 EPROM PROGRAMMER Feb 84	£14.48
SIGNAL TRACER Feb 84	£14.89
CAR LIGHT WARNING Feb 84	£3.76
GUITAR TUNER Jan 84	£17.73
BIOLOGICAL AMPLIFIER Jan 84	£19.16
CONTINUITY TESTER Dec 83	£9.99
CHILDREN'S DISCO LIGHTS Dec 83	£8.42
NOVEL EGG TIMER Dec 83 inc. case	£10.24
SPEECH SYNTHESIZER FOR THE BBC MICRO Nov 83 less cable + sockets	£21.98
MULTIMOD Nov 83	£16.98
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HOME INTERCOM less link wire Oct 83	£14.38
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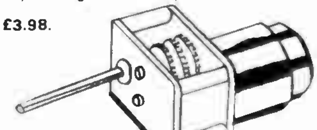

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TEACHING WITH THE TIMES

I FOUND it interesting to talk to a school teacher recently and discover that the school in which he teaches is just introducing some electronics to the syllabus. I suppose it is very easy for us to assume that electronics has been taught in all secondary schools for many years.

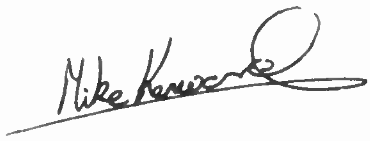
EE was introduced in 1971 to provide an introduction to electronics for everyone. It was immediately accepted into many schools in the UK and has for a number of years run a special service to provide copies for students (details available from the subscription department). With such interest from schools over so many years we felt we were well known and accepted in this area. However, what we did not realise was that many schools are only just getting interested in the subject. Apparently the problems have been lack of trained teachers and lack of money for components and equipment. Presumably most schools now have an interested—if not trained—teacher and, with help and pressure from parents, are beginning to get themselves equipped with at least some of the basics. While many schools have been gearing up with computers, it seems that some have rather neglected the technology behind the computer era; if your school is one of these, why not start asking a few questions!

RETIRING HOBBY

Of course EE caters for everyone interested in electronics and most of our projects are designed to interest readers of all ages. At the other end of the scale we find that we are gathering a number of readers who are retired and looking for an interesting hobby which will not only be rewarding but which will produce items of electronic equipment for use around the home. Many of these readers were introduced to the subject during the early days of radio and it is interesting to note that possibly the first piece of equipment many of them built used a semiconductor. The equipment I have in mind is the crystal set and a very interesting letter on this subject is published elsewhere in this issue. A reminder of just how our hobby got started is quite sobering at a time when we expect to be able to buy high technology devices cheaply off the shelf.

MOVE

Please note that our editorial and advertisement offices have recently moved. The addresses and telephone numbers given in this issue (and last month's issue) are correct but please remember not to refer to earlier issues for information.



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Binders to hold one volume (12 issues) are available from the above address for £5.50 (£6.25 overseas) inclusive of p&p. *Please allow 28 days for delivery.*

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

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PA AMPLIFIER

R.A.PENFOLD

Twenty watts r.m.s. output with mic. and line inputs. Powered by a car battery

READY-MADE PA (public address) amplifiers tend to be either simple types having only a very limited output power, or complex devices having a high specification and a price to match. This PA Amplifier design for the home constructor has a respectable specification but can be built for a relatively small outlay.

The unit has a microphone input which is designed to accept the output from inexpensive low impedance dynamic microphones (such as the types sold as replacements for cassette recorders). These offer adequate quality for this application and are also suitably rugged. A 12dB per octave lowpass filter is included, and this has a cut-off frequency which can be continuously varied from about 3·5kHz to 16kHz.

Restricting the upper frequency response of the system can give improved results by concentrating the output of the unit at frequencies that most aid intelligibility, and the excessive high frequency response of some microphones (and the exaggerated "sssssh" sounds this produces) can also be counteracted. Additionally it can help to eliminate problems with acoustic feedback and the all too familiar problem of "howl around".

The microphone preamplifier and filter can be switched out so that the input can be provided by a high level source such as a tape recorder or a musical instrument. A signal level of only about 40 millivolts r.m.s. is needed in order to drive the line input. The unit is powered from a 12 volt d.c. source such as a car battery, and produces an output power of about 20 watts r.m.s. into a four ohm impedance loudspeaker, or around 10 watts r.m.s. into an eight ohm impedance type. This is achieved using a bridge amplifier which avoids the need for any special output transformers or a supply voltage booster circuit.

SYSTEM OPERATION

A block diagram for the PA Amplifier is provided in Fig. 1. The output signal from a low impedance dynamic microphone is very low, with a signal level of only about one millivolt r.m.s. being typical even when speaking quite close to the microphone. A high degree of amplification is therefore needed in order to bring the signal up to an adequate level to drive the power amplifier circuit properly. Moreover, very low noise amplifiers are needed if the background noise level is to be kept down to an acceptable level. In this circuit a single stage of preamplification is adequate as the power amplifier is a quite sensitive type, and the preamplifier is based on a special low noise operational amplifier which gives excellent performance.

The output of the preamplifier is fed to the lowpass filter circuit, and the output of this stage is connected to the power amplifier via the line/mic selector switch. When this switch is set to the line position both the microphone preamplifier and the filter are switched out, but filtering would not normally be required with a signal source such as a tape recorder where the programme matter would usually be music rather than speech.

It is difficult to obtain a high output power with a nominal supply voltage of just 12 volts and using an ordinary four or eight ohm impedance loudspeaker. Even allowing for the fact that a 12 volt car battery will usually have an actual output voltage of about 13 to 14 volts, using an ordinary transformerless output stage, and assuming that the circuit is a high efficiency type, this represents an r.m.s. output voltage of only about 4·5V. In terms of output power this corresponds to around 2·5 watts r.m.s. into an eight ohm impedance loudspeaker, or five watts r.m.s. into a four ohm impedance type.

One way of obtaining higher output is to use an output transformer to give a voltage step-up, or an alternative is to have a circuit which gives a boosted supply voltage. Both are awkward for a home constructed design as suitable step-up transformers for either type could be difficult to obtain or to build. A much more simple system, and the one adopted here, is to use a bridge amplifier circuit. This permits only a relatively small increase in output power to be obtained, but the output power of this unit should be more than adequate for most practical purposes.

BRIDGE AMPLIFIER

A bridge amplifier is effectively two identical power amplifiers with one fed direct from the input and the other fed by way of an inverter. The loudspeaker is fed from the non-earthy output of each power amplifier and does not have either terminal connected to earth. Under quiescent conditions the output of both power amplifiers is at half the supply voltage, and the voltage across the loudspeaker is zero.

If the input swings positive, the output of one power amplifier will swing positive as well, but the output of the one that is fed via the inverter will go negative. If the signal fully drives the power amplifiers one loudspeaker terminal is taken to virtually the positive supply voltage while the other is taken to practically the negative supply potential. With a negative input signal the situation is much the same, but this time it is the output of the power amplifier that is fed direct with the input signal that has its output going negative, while the one fed via the inverter has its output swing positive. Again, if the circuit is driven to maximum output voltage the loudspeaker has one input at virtually the positive supply voltage and the other at little more than the negative supply potential.

The important point to note here is that the polarity of the signal across the loudspeaker depends on the polarity of the input signal, and that the loudspeaker can be driven with up to plus and minus 12 volts. This gives a maximum peak to peak voltage swing around 24 volts, or twice the supply voltage, giving an effective 2:1 voltage step-up without resorting to a transformer.

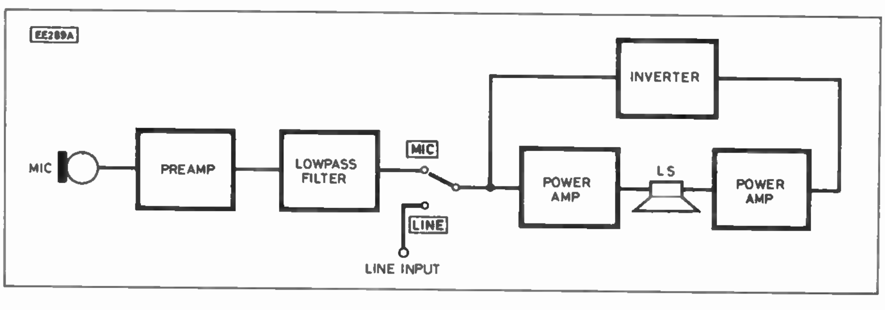

Fig. 1. Block diagram of the PA Amplifier.

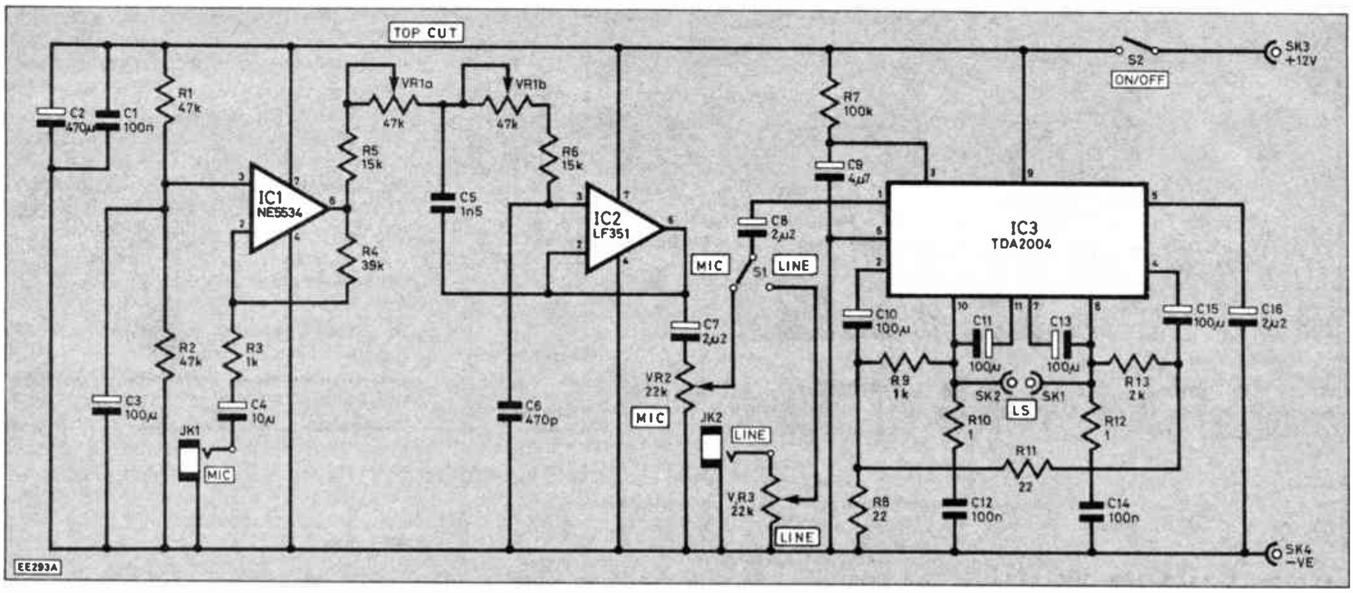

Fig. 2. Complete circuit diagram for the PA Amplifier.

In terms of output power this step-up gives a fourfold boost, bearing in mind that a doubling of output voltage also gives a doubling of the current flow, and that output power is equal to current multiplied by voltage. Accordingly the circuit can give the output powers of 10 watts r.m.s. into eight ohms and 20 watts r.m.s. into four ohms mentioned earlier. Provided a reasonably efficient loudspeaker is used this enables a substantial volume to be attained.

CIRCUIT OPERATION

The full circuit diagram of the PA Amplifier appears in Fig. 2. IC1 is an NE5534 operational amplifier, this is a high quality type which is primarily intended for audio applications. It has excellent distortion performance, but it was selected for this application because of its extremely low noise level. In a circuit of this type it gives a signal to noise ratio that is something approaching 20dB better than that obtained using an ordinary type such as a 741C. There is actually a version of the NE5534 which is superior for audio applications, and this device has an "A" suffix, but for the present circuit the lower cost standard version is perfectly adequate. In fact, if low cost rather than high performance is of most importance a 741C can be used in the IC1 position.

The preamplifier circuit is just a straightforward inverting amplifier which has its voltage gain set at about 40 times by negative feedback network R3/R4. Resistor R3 also sets the input impedance at one kilohm. If you wish to use a high impedance dynamic microphone with the unit, or a microphone having a similar output level and impedance, good results will be obtained if the value of R3 is raised to 18 kilohms and that of C4 is reduced to one microfarad. This boosts the input impedance and reduces the gain to suitable levels. Capacitor C3 decouples the bias voltage to the non-inverting input of IC1; a fairly high value is needed here in order to prevent feedback through the supply lines and consequent low frequency instability.

The lowpass filter is more or less a standard second order active filter. It only differs from the conventional configuration in that the two filter resistances have been made variable so that the cut-off frequency of the filter can be adjusted. The output of the filter is coupled to VR2, which is the volume control for the microphone input. There is a separate volume control for the line input (VR3), and this avoids having to keep readjusting the volume each time the position of the mic/line selector switch (S1) is altered.

A special dual power amplifier integrated circuit (IC3) which can be used as a stereo amplifier has been employed, but this is primarily intended to operate as a single bridge amplifier. Each amplifier has operational amplifier style inverting and non-inverting inputs. By using one amplifier in the inverting mode and the other in the non-inverting mode the need for an inverter stage is avoided. A number of discrete resistors and capacitors are required for biasing, decoupling, and to prevent high frequency instability. Capacitors C11 and C13 are bootstrapping capacitors which help to give a high output voltage swing and good efficiency from the circuit.

As the power amplifiers in IC3 both have class B output stages the quiescent supply current of the unit is quite low at typically about 50 milliamps. However, at high volume levels the current consumption rises to a much higher figure of around two amps. This is admittedly a substantial current, but a car battery can supply this with ease. Although NiCad batteries may seem to be a good alternative as the power source, even large types such as D size cells would probably give only an hour or two of operation between charges, and would

COMPONENTS

Approx. cost Guidance only **£20.00**

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R1,R2	47k (2 off)
R3	1k
R4	39k
R5,R6	15k (2 off)
R7	100k
R8,R11	22 (2 off)
R10,R12	1 (2 off)
R13	2k

All ¼W 5% carbon

Potentiometers

VR1	47k lin. dual gang carbon
VR2,3	22k log. carbon (2 off)

Capacitors

C1,C12, C14	100n ceramic (3 off)
C2	470µ 16V radial elect.
C3,C10, C11,C15	100µ 10V radial elect. (4 off)
C4	10µ 25V radial elect.
C5	1n5 carbonate
C6	470p ceramic plate
C7,C8, C16	2µ2 63V radial elect. (3 off)
C9	4µ7 63V axial elect.
C13	100µF 10V axial elect.

See Shop Talk page 246

Semiconductors

IC1	NE5534 low noise op. amp. (see text)
IC2	LF351 bifet op. amp.
IC3	TDA2004 dual power amp.

Miscellaneous

S1	s.p.d.t. miniature toggle
S2	s.p.s.t. miniature toggle
JK1,JK2	3·5mm jack sockets (2 off)
SK1,SK2	4mm sockets (2 off)
SK3,SK4	Twin spring terminal panel

Metal instrument case about 203 × 133 × 52mm; printed circuit board, available from the *EE PCB Service*, order code 511; three control knobs; 18 s.w.g. aluminium for heatsink; two 8 pin d.i.l. i.c. holders; 6BA or M3 fixings; wire; Veropins; solder, etc.

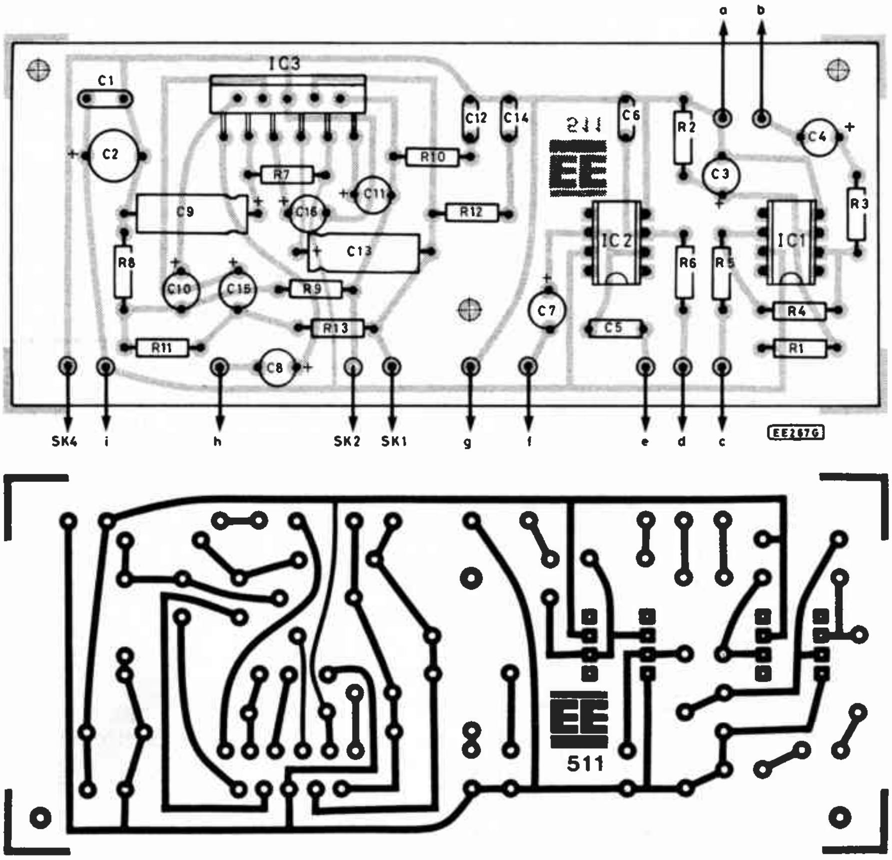


Fig. 3. PCB layout and wiring.

therefore probably not be suitable in practice.

CONSTRUCTION

Construction starts with the building of the printed circuit board. Fig. 3 shows the component layout and track pattern for the board.

Neither IC1 nor IC2 is a MOS input device, but the use of eight pin d.i.l. i.c. holders is still recommended for these, especially for IC1 which is a relatively expensive type. IC3 should fit onto the board without difficulty provided you make sure that none of the leadout wires are bent out of position, but make sure that it is pushed right down onto the board before soldering it in place. At this stage only pins should be fitted to the board at the points where connections to off-board components will be made.

A heatsink is needed for IC3, but as this device is very efficient and does not waste much power in the form of heat a small fin of aluminium is sufficient. The heatsink is made from 18 s.w.g. material, and full details are provided in Fig. 4. The finished heatsink is bolted to IC3 using a short M3 or 6BA screw plus fixing nut. Bear in mind that the heatsink is connected to the negative supply rail via IC3's heat-tab and an internal connection, and it must not be allowed to come into contact with any parts of the circuit that are at a different potential.

A metal instrument case which measures about 203 by 133 by 52 millimetres makes an excellent housing for this project. On the face of it this is far larger than is really necessary, but in practice a case of about this size is needed in order to provide sufficient panel space to comfortably accommodate all the controls and sockets.

Sockets SK1, SK2, SK3 and SK4 are mounted on the rear panel. On the prototype SK1 and SK2 are 4mm sockets while SK3 and SK4 are a pair of spring terminals. You can use any sockets that will be convenient, but remember that apart from SK4 these sockets must be insulated from the metal case. Also, it is advisable to use a red socket for SK3 and a black one for SK4 so that the risk of accidentally connecting the supply the wrong way around is reduced. Incidentally, it is a good idea to use an in-line fuseholder fitted with a 3 amp fuse in the positive supply lead which connects to SK3. The controls and the other two sockets are mounted on the front panel. The general layout can be seen from the photographs, but the positioning of the components is not critical.

The component panel is mounted at roughly the centre of the base panel of the case using M3 or 6BA fixing bolts. Spacers about six millimetres long must be included over the mounting bolts to prevent the connections on the underside of the board from short circuiting through the metal case.

To complete the unit the hard-wiring is added. This is shown in Fig. 5 in conjunction with Fig. 3. For example, point "a" in Fig. 3 connects to point "a" in Fig. 5, the two point "b"s are wired together, and so on. Ordinary multistrand p.v.c. covered connecting wire is used throughout and none of the leads need to be screened. Try to keep the wiring reasonably short and direct throughout.

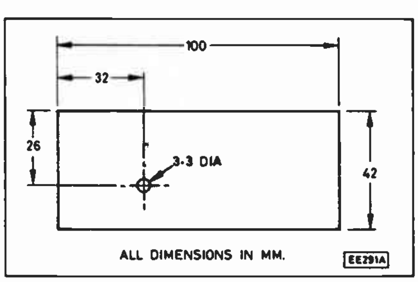


Fig. 4 (left). Heatsink construction.

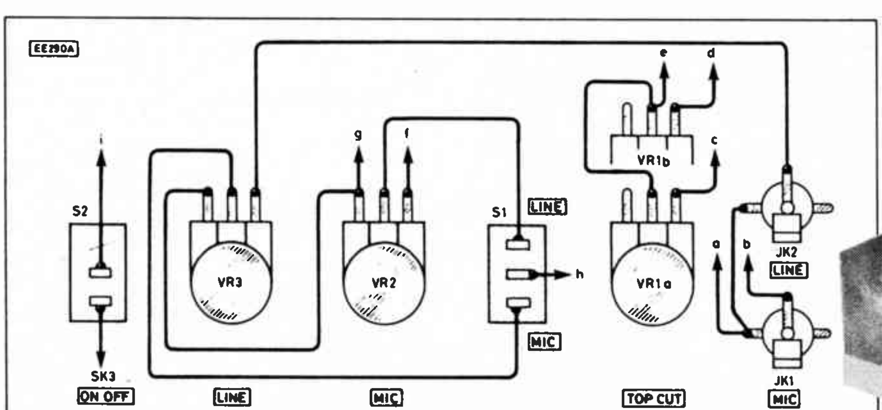
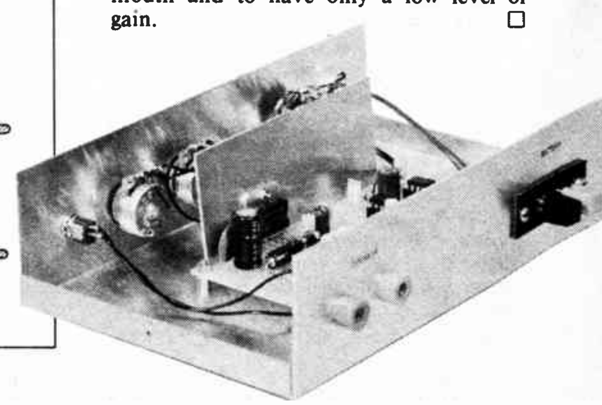


Fig. 5. Front panel wiring.

IN USE

Ideally the output from SK1 and SK2 should connect to the loudspeaker by way of quite short leads, but in practice it will almost certainly be necessary to use long leads here. Use heavy gauge cable to minimise the losses. In the interest of maximum output it is obviously better to use a four ohm impedance loudspeaker rather than an eight ohm type, or two eight ohm impedance loudspeakers connected in parallel can be used. Whichever method is adopted make sure that the loudspeaker or loudspeakers have an adequate power rating (at least 10 watts r.m.s. for eight ohm impedance types and 20 watts r.m.s. for four ohm types).

The amplifier should produce plenty of volume using any low impedance dynamic microphone. The amount of gain provided in the unit is not very high considering the type of microphone used, but due to problems with acoustic feedback it is better to have the microphone close to the user's mouth and to have only a low level of gain. □



MINI STROBE

MARK STUART

An ultra bright project with many illuminating applications

A STROBOSCOPE is a device which produces very brief flashes of light at pre-determined intervals. Most people will be aware of the "strobe" effect used as part of a disco light show. Also, the strobe light used for setting the speed of record player turn-tables gives a very good demonstration of how a moving component can appear stationary.

The strobe light is provided by an l.e.d. which is powered from unsmoothed bridge-rectified mains and so flashes on and off at 100Hz. Marks around the turntable are spaced so that at the correct speed the turntable moves by exactly 1 mark between flashes. The marks are identical and so it appears that they are stationary. If the turntable runs slightly fast or slow, the next mark is not quite in the same position as the last and so the mark appears to be moving slowly forwards or backwards.

Another common use is the "timing strobe" which produces a short flash of light synchronised to the firing of a spark plug in a petrol engine. A small timing mark on the crank shaft pulley is illuminated each time the spark plug fires. As the pulley is in the same position each time the light flashes, it appears to be stationary. The position of the timing mark relative to a fixed pointer on the engine indicates the ignition timing.

FREEZE ACTION

The most important feature of stroboscopes is that they enable fast moving machinery to appear apparently stationary or running in slow motion. If the light flashes are in exact synchronism with the mechanism being observed it appears to be stationary. If the flashes are slightly out of synchronism the mechanism will have moved by slightly more than one full cycle between flashes and so appears to be moving slowly forward. By observing the behaviour of machines in this way designers are able to study and control effects such as vibration which only occur when running at speed.

A good stroboscope needs to be able to produce very short, very bright flashes of light. If the flashes are not short the moving parts being examined will move significant amounts during the flash, and so will appear blurred.

The flashes need to be bright because the parts being examined are only lit for a fraction of the time. The eye averages the flashes and perceives an average light level which is much less than the level during the flash.

The light source which produces the flashes must be driven from an oscillator, the frequency of which can be varied to match the speed of the mechanism being observed. A facility to synchronise the oscillator to the mechanism is useful as it enables very precise timing of the flashes, giving a sharp, stable image.

LIGHT SOURCES

The best light source for generating flashes is a Xenon tube similar to those used in photographic flashguns. A good stroboscope using Xenon flash tubes can be expensive to build because the tubes need high voltages and heavy duty capacitors. Neon lamps and standard l.e.d.s can also be used to produce short flashes of light but are not very bright.

Recently a range of very bright "ultra bright" l.e.d.s have become available. The brightness of these has to be seen to be appreciated. Their brightness, and their ability to be flashed at high speed makes them ideally suited for use as stroboscope light sources. As l.e.d.s require low voltages

COMPONENTS

Approx. cost Guidance only **£14**

See **Shop Talk** page 246

Resistors

R1	10k
R2,R4	47k (2 off)
R3,R5	470 (2 off)
R6	100
R7	1k
R8	270
R9,R11	220 (2 off)
R10,R12	27 (2 off)

All 0·25W 5% carbon film

Potentiometer

VR1 470k (front) 4k7 (rear) dual reverse log.

Capacitors

C1,C4	100n poly C368 (2 off)
C2	1μ poly multilayer 100V
C3	1n ceramic plate
C5,C6	47μ elec radial 16V
C7	220μ elec radial 16V

Semiconductors

TR1	BC183 npn silicon
TR2	BC213 pnp silicon
IC1	555 timer
D1,D2	1N4001 silicon
D3,D6	HLMP3750 Red (2 off) — Ultra-bright l.e.d.s
D4,D7	HLMP3850 Yel (2 off) — Ultra-bright l.e.d.s
D5,D8	HLMP3950 Green (2 off) — Ultra-bright l.e.d.s

Clips to suit above (6 off)

Miscellaneous

SK1	3·5mm jack socket
S1	DPDT centre off slide switch

B1 12V (made up from two sets of four HP7's); PP3 type battery clips (2 off); 2 × 2 battery holders; Veropins (10 off); 8-pin i.c. socket; case; connecting wire; printed circuit board, available from the *EE PCB Service*–order code EE 522.

to operate it is possible to produce a useful stroboscope at low cost and with simple circuitry.

The Mini Strobe described here was designed on these principles. It is ideal for demonstrating stroboscope principles and operation. It produces a useful amount of illumination over short distances in daylight and becomes very effective under conditions of subdued light.

The flash rate is variable from 170 to 20,000 flashes per minute in two ranges. A socket is fitted so that the flash rate can be synchronised to an external source of pulses if required. When accurately calibrated the Mini Strobe can also be used as a tachometer to measure the speed of rotating parts.

CIRCUIT DESCRIPTION

The circuit diagram of the Mini Strobe is shown in Fig. 1. A standard 555 timer i.c operating in the astable mode is used to provide pulses which drive the l.e.d.s D3 to D8 via transitor TR2.

The frequency of oscillation is set by the dual potentiometer VR1a/VR1b. This component is unusual in that its two sections are of different values and are of the "reverse log" type.

In the astable mode used here the timing capacitor C1 or C2, depending upon the position of the Range switch S1, is charged via VR1a, R4, VR1b, and R5 in series. When the voltage across the capacitor reaches two thirds of the supply the i.c. switches over and the capacitor is discharged via R5 and VR1b. When the voltage has fallen to a third of the supply the i.c. switches back and the charge cycle begins again.

During the charge cycle the output on pin 3 is high so transistor TR2 and the l.e.d.s are turned off. During the discharge cycle the output is low and provides TR2 base current via resistor R7. TR2 is therefore turned on and the l.e.d.s are lit.

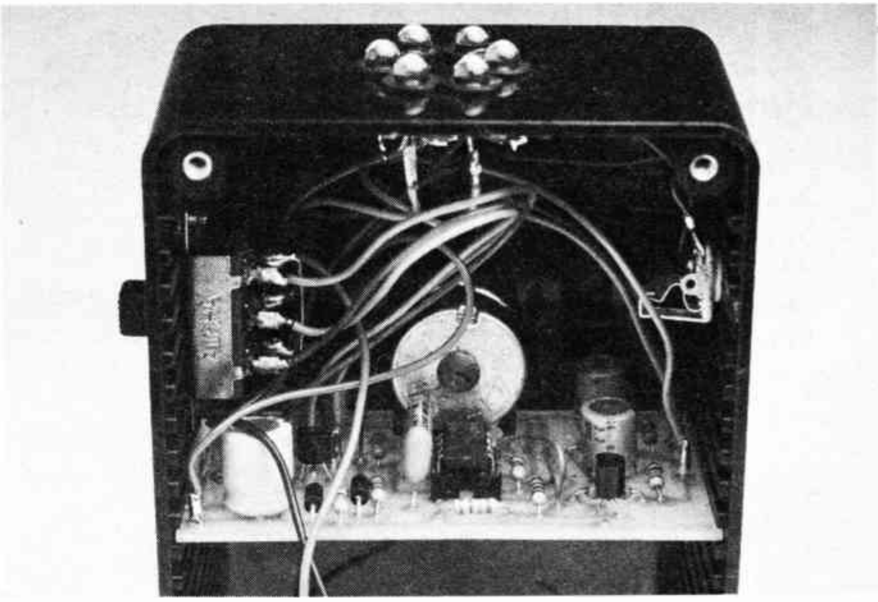
The values of VR1a and VR1b are such that the charge time is 100 times larger than the discharge time. This means that the l.e.d.s are lit for just 1 per cent of the time. As the two parts of VR1 share the same spindle the percentage applies regardless of the speed setting. This arrangement means that the l.e.d.s appear to be the same brightness at all speed settings.

The figure of 1 per cent is a compromise between the duration of the flash and the apparent brightness. Shorter flashes give a sharper image to the object being viewed at the expense of apparent brightness.

Capacitor C3 enables transistor TR2 to be turned on and off rapidly so that its power dissipation is minimised. Each l.e.d. has a forward voltage drop of about 2V and so each set of three diodes requires 6V. When TR2 is turned on it drops about 1V, leaving 5V across the current limiting resistors R9 to R12 and capacitors C5 and C6.

Resistors R9 and R11 provide a current of 20mA to each set of l.e.d.s. The main current path however is via the capacitor resistor networks C5 R10 and C6 R12. The capacitors behave like short circuits to the pulses and so an additional 180mA is passed to the sets of l.e.d.s during the pulses. The l.e.d.s are only designed to take a continuous current of around 40mA so in the event of a circuit fault that turns on TR2 permanently they would all be damaged.

Capacitors C5 and C6 allow the pulses to pass unimpeded but completely block any d.c. that would appear in the event of a fault. In this way the l.e.d.s are completely protected from circuit failure. Note that the 1 per cent pulse to interval ratio means that average l.e.d. currrent is only about 2mA.



Showing the printed circuit board mounted in guide slots in the sides of the case.

EXTERNAL SYNC

Synchronisation of the oscillator to external signals is achieved by applying pulses across resistor R6 which is in series with the timing capacitors C1, C2. A positive pulse which occurs near the end of a charge cycle lifts the capacitor voltage over the two thirds supply threshold and so triggers the discharge cycle.

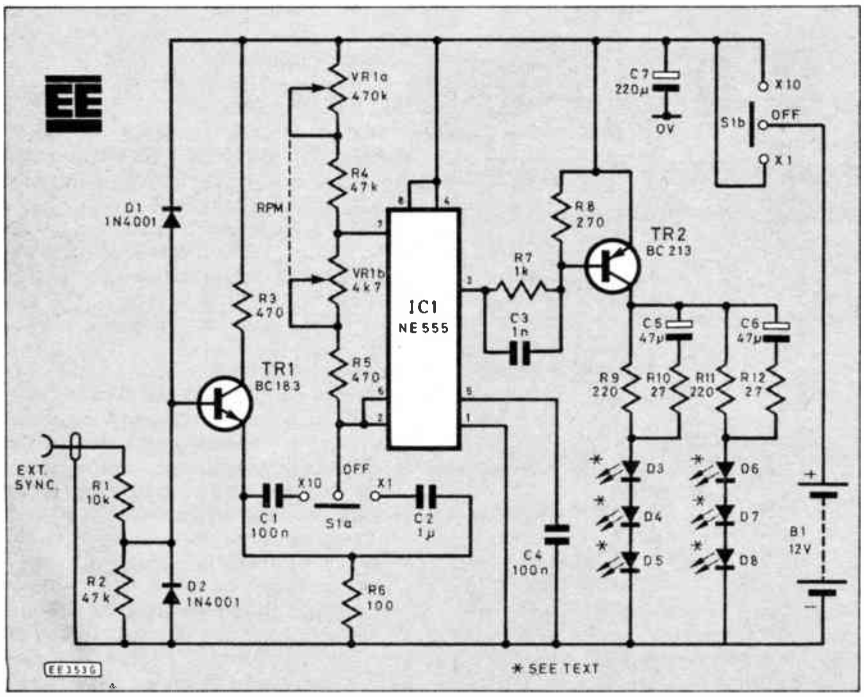
If the oscillator frequency is set just below the frequency of the synchronising pulses then these will take over and the frequency will be locked in synchronism. It is also possible to synchronise to the harmonics of the incoming pulses, especially if a high level input signal is used. This can be an advantage but must be taken into account when it is desired to lock on to the correct frequency. Synchronising pulses between 1V and 50V a.c. or d.c. can be used.

Diodes D1 and D2 protect transistor TR1 from very high positive or negative input signals. The dual potentiometer VR1 needs to have a "reverse log" law in order to give an evenly graduated scale. Standard linear tracks would give extreme cramping at the high speed end of the scale. S1 is a centre-off DPDT slide switch which enables the range selection and panel on/off functions to be combined.

CONSTRUCTION

The circuit is built on a single printed circuit board and fits neatly into the guide slots of the specified case. This board is available from the EEPCB Service: Code EE522. The p.c.b. component layout is shown in Fig. 2 and the track pattern (full size) in Fig. 3.

Fig. 1. Complete circuit diagram for the Mini Strobe.



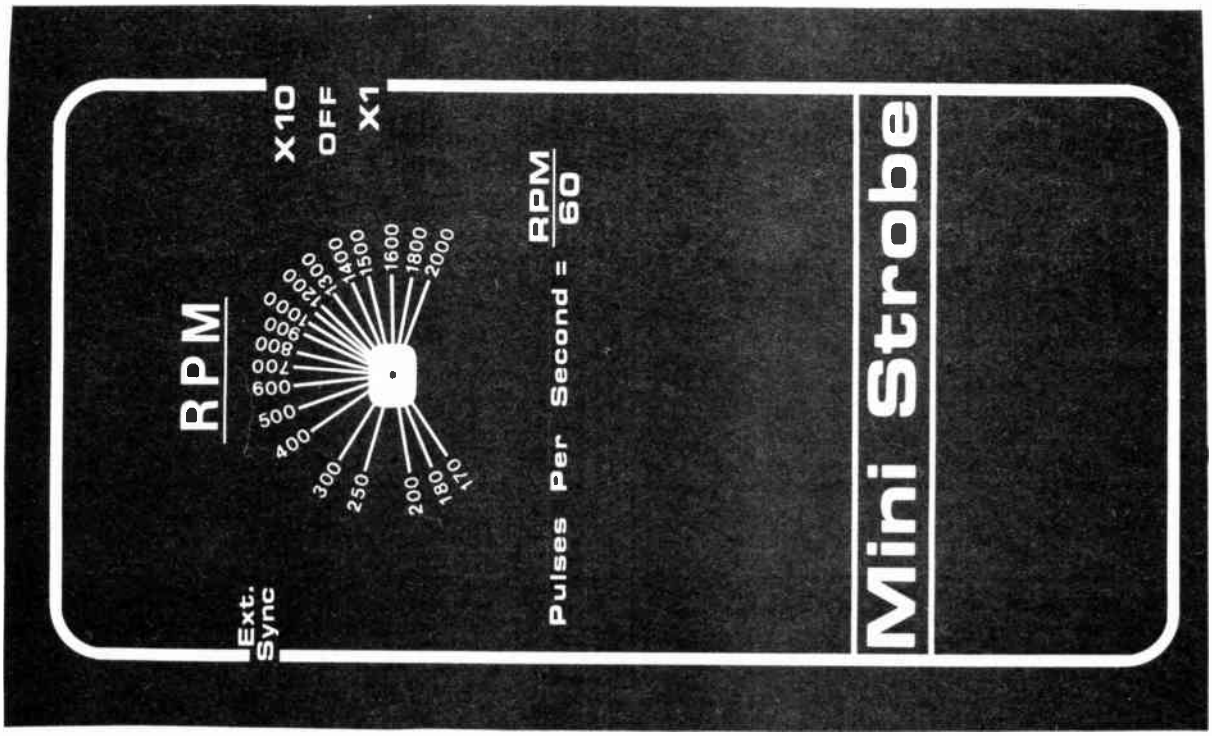


Fig. 5. Full size front panel label used on the prototype unit. This label can be cut out and stuck on the case.

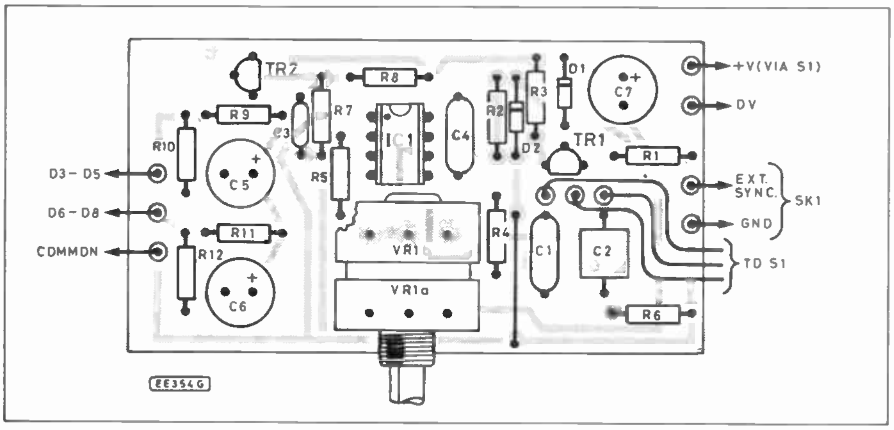


Fig. 2. Component layout on the printed circuit board. The integrated circuit IC1 should be mounted on the board via an i.c. socket.

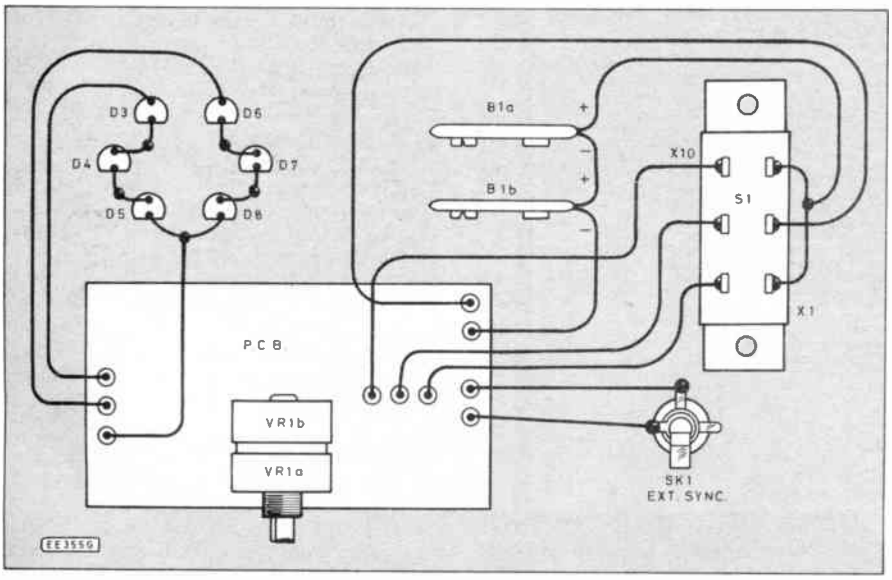


Fig. 4. Interwiring to "off-board" components. Be careful to connect the l.e.d.s correctly, the cathode connection is indicated by a "flat" on the body.

Begin construction by fitting the 10 terminal pins to the board. These should be pushed in from the foil side so that their spined sections engage with the board and then soldered.

Next fit the wire link, the resistors, and a socket for IC1. Then fit the capacitors and transistors. Ensure that capacitors C5, C6 and C7 are fitted the right way round and that the flats on the transistor bodies are positioned as shown. Note that the transistors are not interchangeable.

Complete the board assembly by fitting VR1a, VR1b. The specified potentiometer fits directly to the board. Alternative types may be mounted separately and connected with wire leads.

The board is mounted in guide slots in the case so that the spindle of VR1 passes through the bottom. The "lid" of the case therefore becomes the base. This arrangement is ideal because the batteries can be changed without disturbing any components.

INTERWIRING

The wiring from the board to the other components is shown in Fig. 4. The diodes D3 to D8 are arranged in a circle 18mm diameter. Their polarity is indicated by a flat on the body and a short lead on the cathode side. It is not possible to fit locking rings to the l.e.d. clips because of the thickness of the case. Instead a small amount of contact adhesive can be used.

The slide switch S1a S1b, is mounted in the side of the case and requires a rectangular cut-out for the slider. This can be made by drilling a number of small holes and filing out the corners with a rat-tail file. When the rectangular hole is cut the switch can be used as a template to mark the position of the two fixing holes.

The power supply is made up from two sets of four HP7 batteries mounted in "2 × 2" battery holders.

A full size front panel label is shown in Fig. 5. This can be cut out and stuck on the case. The flash rate or r.p.m. on the scale is from 170 to 20,000, in two switched ranges.

TESTING

Testing is very straightforward. Just switch on and check that the l.e.d.s are all lit. Switch to the X1 range and turn the speed control VR1 to minimum. The l.e.d.s should flicker at about 3Hz. Advance the control and check that the speed gradually increases. At the maximum setting the flickering will not be visible because of persistence of vision.

Check that the brightness of the l.e.d.s remains the same on both ranges and that both sets of three l.e.d.s. are equally bright. The supply current should be between 10mA and 20mA.

To check the synchronisation, a record turntable which has a built in strobe lamp is needed. Connect an a.c. signal of between 3 to 30V from a mains transformer and set the Mini Strobe to 300 on the X10 range. (3,000 flashes per minute = 3,000/60 = 50 flashes per second).

Set the turntable rotating and bring the Mini Strobe up to the strobe marks on the turntable. The marks should appear to be moving in exactly the same patterns as those lit by the built-in strobe lamp.

It should be possible to move the Mini Strobe speed control some distance in each direction without any change in the pattern of the strobe. Disconnect the synchronising signal and check that moving the speed control produces smooth changes in the observed pattern.

The strobe can now be used to illuminate some moving object. Such things as electric fans are ideal for demonstrations. In a darkened room it should be possible to make the fan blades appear to be completely stationary.

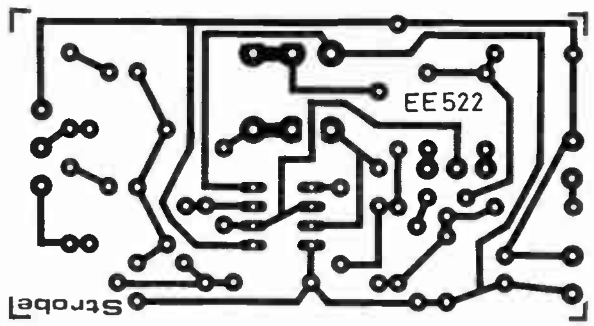


Fig. 3. Full size printed circuit board master for the Mini Strobe. This board is available from the *EE PCB Service*: code EE522.

TAKE CARE

Note that although mechanisms appear to be stationary they are actually moving at speed and cannot be touched. Keep this in mind whenever using stroboscopes of all types. □

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

ARCTIC ADVENTURE

When I talk about amateur radio to non-amateurs, they often express surprise when I mention Russian stations. "Surely they don't have amateurs there!" But they do. Amateur radio is a worldwide activity excluded from very few countries, with all of its participants sharing a common enthusiasm for radio communication.

A few years ago, I wrote an article in *Practical Wireless** about a famous Soviet amateur, Ernst Krenkel, call-sign RAEM, who was radio operator in a four-man scientific expedition, which drifted southwards form the North Pole, in 1937/8. As part of my research for this article I sought, and received, help from the Central Radio Club of the USSR which is named after Krenkel, and I was subsequently asked by the Soviet magazine "Radio", to describe how I became interested in him, and discovered so much about him.

This account appeared as an article in "Radio", translated into Russian, and some months later I received a mysterious parcel from Moscow. An amateur in Siberia, after reading my article, visited his local secondhand bookshop, bought an English language copy of Krenkel's autobiography, "RAEM is my callsign", and sent it to me via the magazine!

Needless to say, I was more than thrilled. It was a marvellous example of how amateur radio can break down artificial barriers separating one part of the world from another and, of course, the book now has pride of place on my bookshelf.

That was not the end of the matter. I subsequently worked a number of USSR amateurs who had seen the article, and who mentioned it in very friendly terms. QSL cards received from other stations also referred to it and, in some cases, provided me with additional information about RAEM. I still have a few items not yet translated. I would be delighted to hear from any Russian speaking reader who could help me with these!

MORSE TESTS

As from 1st April, the Radio Society of Great Britain is to be responsible for conducting amateur radio Morse tests on behalf of the DTI.

In the UK there are two types of amateur licence, class B—for v.h.f. and u.h.f. bands only, and class A—for all bands. The 12 w.p.m. (words per minute) Morse test is a pre-requisite for the class A licence, and until now has been administered by British Telecom.

The new arrangement includes a £7 test fee, to be held at this level for two years, and the establishment of at least 70 test centres throughout the UK, where tests will be held every two months.

Previously, tests were available at just 22 centres, half of which were coastal radio stations, normally during office hours. This often meant a long journey for candidates, and the need to set a whole day aside for the occasion. The new scheme, apart from reducing the fee by £8, will make tests available at more convenient times, with far less travelling involved.

Examiners, who are members of the RSGB, must themselves pass a 20 w.p.m. Morse test. Candidates do not have to be members. Each examiner will be personally appointed by the Council of the RSGB, and two will be present at each test. All examiners are volunteers. Several hundred will be appointed, and it is significant that within a week of the scheme being announced over 100 amateurs had already offered their services.

A great deal of work of the RSGB is undertaken by volunteers, and it is a particular feature of amateur radio that many opportunities exist to put something back into a hobby from which so much pleasure is derived.

FRIENDS IN HIGH PLACES

At a special celebration dinner last November, the Wireless Institute of Australia received the following radiogram: "It gives me great pleasure to extend my warmest greetings to the members of the WIA on the occasion of your 75th anniversary. Over the years ham radio operators have done enormous good work in generating international friendship and understanding. Their network has also been invaluable in times of emergency, and as the oldest network of such operations in the world, WIA can take justifiable pride in the good work you have done.

I compliment you on that and wish you all the best for the future. I have asked that this message be transmitted from Washington by a fairly well known ham, my good friend Senator Barry Goldwater, K7UGA. He, in turn, had it transmitted through a constituent in Phoenix, Arizona, Francis Marks KB7FE.

In this way, hams have again proven their ability and efficiency. Keep the good work and God bless you.

Signed. Ronald Reagan"

It was pleasure enough that the President of the United States had taken time out to recognise the achievements of both Australia's national organisation for amateurs and amateur radio generally. It was extra pleasing that he chose to do this via amateur radio third party networks, which exist to pass greetings messages on behalf of others to many parts of the world.

Senator Goldwater, who is a good friend of amateur radio in the legislature of the US, also sent greetings and congratulations to WIA, as did Mr R. J. L. Hawke, Prime Minister of Australia.

QUESTION CORNER

Q. What are QSL cards?

A. These are printed cards which radio amateurs send to each other confirming contacts over the air. A card usually gives the call-sign, name, and address, of the operator, details of the equipment used, date and time of contact, a signal report, and sometimes a personal message.

Some are simple, business-like, statements of information, while others have illustrations of various kinds. Some are personalised by a photograph or sketch of the operator or his station. Some are specially produced for members of particular clubs or organisations, and are overprinted with individual call-signs. Multi-operator families often have a single card used by all, and marked according to who is sending it.

Scenic views of the area where a station is located are popular, and some cards are humorous. Not all amateurs send, or want to receive, QSLs and those who do have a number of reasons for wanting them. Some simply like to adorn the walls of their shacks with exotic cards. It looks good, and if they receive a lot it's cheaper than wallpaper! More seriously, some operators go in for awards, which are certificates confirming, for example, that a certain number of countries have been worked, and the cards are then required as proof of contact. Sometimes they simply serve as reminders of rare, unusual, or particularly enjoyable contacts.

A number of printers specialise in QSL cards, and advertise in amateur magazines. They offer a range of designs to suit most tastes, or you can draw up your own design. Special bureaux exist around the world to avoid the necessity of posting cards individually, but I will have to tell you about those another time. 73 de G4FAI.

A mysterious panel from Moscow.

*PW January '83

TEACH-IN 86

PART 8 · Michael Tooley BA David Whitfield MA MSc C Eng MIEE

DIGITAL SIGNALS

THUS far in "Teach-In" we have dealt almost exclusively with analogue circuits. This month we shall turn our attention to digital signals and devices. Digital signals are very different in nature from their analogue counterparts. A digital signal does not change its level smoothly, nor does it vary freely over a range of levels. When the voltage level of a digital signal is not rapidly changing it remains steady at one of only two possible levels, or "states". Any transition between these two states occurs very rapidly (typically requiring only a small fraction of a microsecond) and is so fast that, for practical purposes, it occupies a negligible interval of time. Representative waveforms of analogue and digital signals are depicted in Figs. 8.1 and 8.2 respectively.

The two possible states for digital signals are commonly referred to as "low"/"high", "off"/"on", "false"/"true" or "0"/"1". Conventionally the two (binary) states in a digital system are defined so that high/on/true/1 refers to the higher voltage level whilst low/off/false/0 refers to the lower voltage level. This is known as "positive logic". In "negative logic" the two states are simply reversed. To keep things as simple as possible, we will just refer to 0 and 1 to describe the binary logic states. Furthermore, all our circuits will be based on positive, rather than negative, logic.

The majority of practical digital devices are designed so that 0 is represented by a voltage level near zero whilst 1 is represented by a voltage level just less than the supply voltage. A transfer characteristic for a typical logic device is shown in Fig. 8.3. The output voltage remains at the 0 level until the input exceeds a certain threshold value, at which point the output rapidly changes state from 0 to 1. This characteristic is in marked contrast with that associated with a conventional linear device shown in Fig. 8.4.

ADVANTAGES OF DIGITAL SYSTEMS

Digital circuits offer a number of important advantages over their analogue counterparts. In an analogue system changes in component values due to the effects of ageing and temperature can have a marked effect on circuit performance and considerable care must be taken to ensure that such changes are compensated for. Applications requiring high precision are particularly troublesome in this respect. Digital systems, on the other hand, use straightforward switching techniques and are very much less susceptible to individual component changes.

Another very significant advantage of digital circuits is their inherent immunity to noise and interfering signals. With analogue circuitry this is a particular nuisance when signal levels are very small and are thus easily contaminated by noise. Digital signals, however, have a very large amplitude and can thus be made relatively impervious to noise. The voltage levels used to denote the 0 and 1 states are separated by a "forbidden region" in which no valid signal can exist.

LOGIC FAMILIES

As part of the development of digital integrated circuits, a number of standard logic families have emerged. The importance of the concept of standard logic families cannot be over-stated. The basic gate in each range gives the name to the complete family of devices and determines the operational characteristics of the complete family. In this way, the

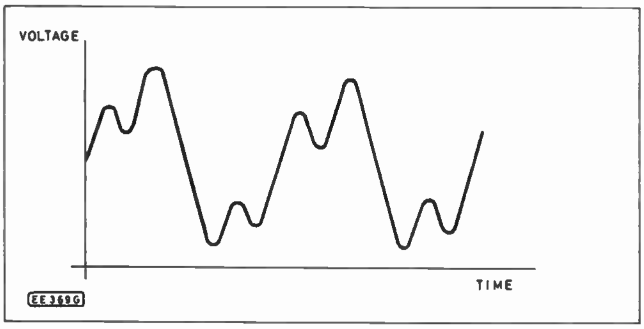


Fig. 8.1. Representative analogue signal waveform

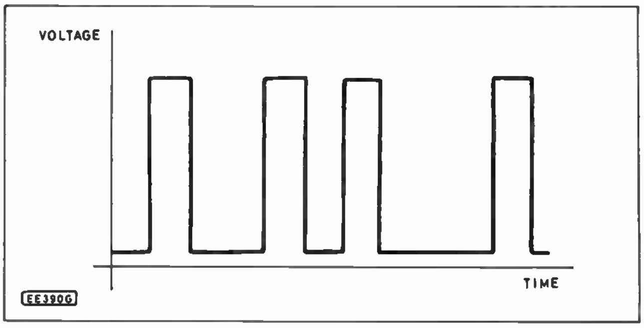


Fig. 8.2. Representative digital signal waveform

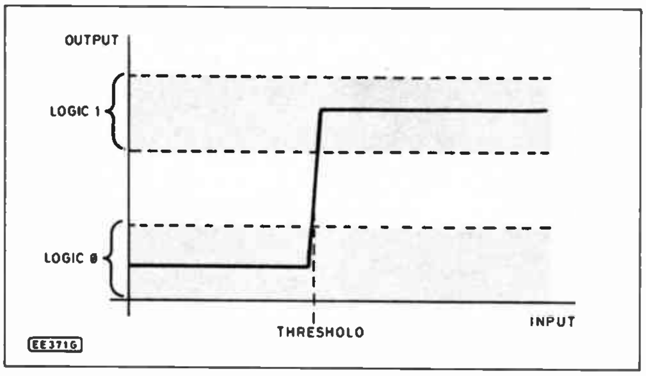


Fig. 8.3. Transfer characteristic for a typical logic device

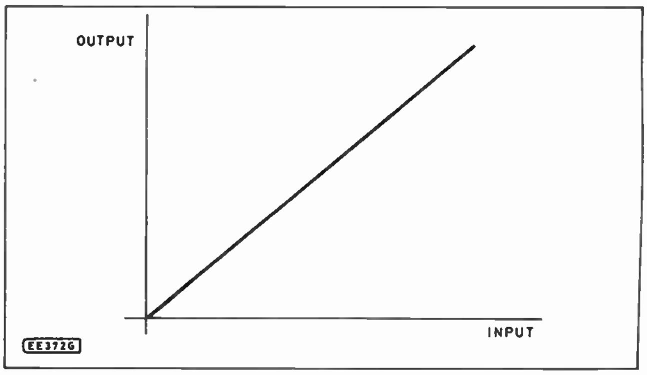


Fig. 8.4. Transfer characteristic for a conventional linear device

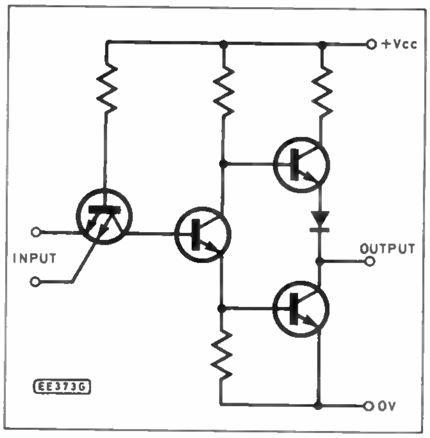


Fig. 8.5. Internal circuitry of a basic TTL gate

designer is freed from the problem of checking that the logic levels between gates are compatible; the logic levels, power supply requirements, and general rules for dealing with such points as unused inputs etc are common to ALL devices in a particular logic family. This then allows the designer to concentrate on the functional design of his circuit and, once the basic rules are understood, greatly simplifies the overall task.

Over the years a number of different logic families have become available but, in the light of developments in technology generally, many have become obsolete and have virtually dropped out of use. The main logic families to have emerged are listed below:

- Diode transistor logic (DTL)
- Transistor resistor logic (TRL)
- Resistor transistor logic (RTL)
- Direct coupled transistor logic (DCTL)
- Transistor transistor logic (TTL)
- Tri-state logic (TSL—a type of TTL)
- Emitter coupled logic (ECL)
- Complementary metal oxide semiconductor logic (CMOS)
- N-channel metal oxide semiconductor (NMOS)
- P-channel metal oxide semiconductor (PMOS)

Each of the logic families listed has its own special characteristics which may make it appropriate for particular applications. ECL, for example, is extremely fast but consumes considerable power. In current practice, the two most commonly used logic families are TTL (including TSL) and CMOS.

At this point it is worthwhile stressing that the theory of digital logic is the same for ALL logic families. The difference between the various families is simply confined to the practical aspects of implementing circuits, e.g. power supply voltages, logic levels, power consumption etc. A clear understanding of the theory of logic circuits is an essential pre-requisite to the successful design of real digital circuitry, regardless of the actual logic family employed.

THE 7400 TTL FAMILY

Of all the logic families to have emerged, TTL has earned by far the greatest popularity amongst designers of general purpose digital circuitry. The family is very commonly available, at reasonable cost, and in a variety of "sub-families" which offer significant advantages over the original "standard" family.

The internal circuit of a basic TTL gate is shown in Fig. 8.5. Readers should note the distinctive multi-emitter transistor which is associated with the input stage of TTL gates. Fortunately we do not need to understand the intimate details of this circuit in order to be able to make use of it, but it does serve to illustrate the equivalent discrete circuitry of a typical TTL gate.

Standard TTL devices require a single rail power supply which provides a well stabilised voltage of +5V, ±0·5%. A typical TTL power supply using a monolithic three-terminal regulator is shown in Fig. 8.6.

The commonest TTL family is known as the "7400 series". Each i.c. in the 7400 series family has a type number comprising either four or five digits and always starts with "74". Examples of the 7400 series would thus be 7407, 74107, and 74207. These three devices are, however, all quite different; the 7407 is a "hex open collector buffer", the

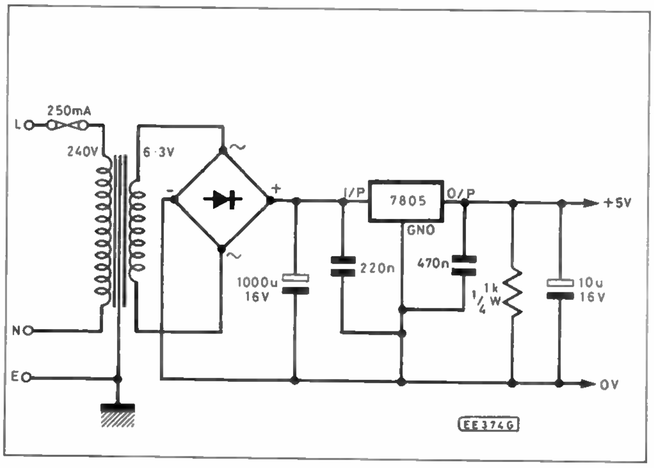


Fig. 8.6. A typical TTL power supply

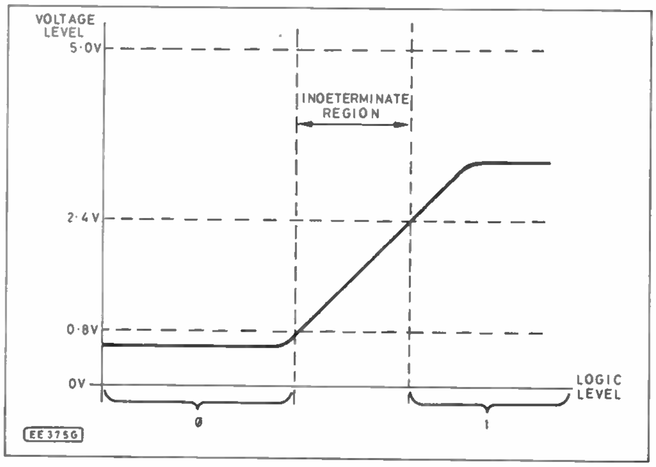


Fig. 8.7. Voltage characteristic for a TTL gate

74107 is a "dual J-K bistable", and the 74207 is a "1K-bit RAM".

Manufacturers add various prefix and suffix letters to indicate the origin and packaging of devices. The SN7407N, for example, is a 7407 gate manufactured by Texas Instruments and packaged in a 14-pin dual-in-line (DIL) encapsulation. Readers should note that i.c.s of the same number will ALWAYS have the same function regardless of the manufacturer and any suffix or prefix which may accompany the basic gate number.

The basic voltage characteristic for a TTL gate is shown in Fig. 8.7. As can be seen, there is a range of input voltages for which the output level will be "indeterminate". This simply means that any output produced by an input voltage within this range cannot be predicted in terms of logic level (0 or 1). Although possibly surprising, this is quite common in digital circuits and does not contradict the theory. A logic 0 is defined in TTL as a level of less than 0·8V (i.e. between 0V and +0·8V) whilst a logic 1 is defined as a level of greater than 2·4V (i.e. between +2·4V and +5V).

BUFFERS

The simplest of all active logic devices is the buffer. This device has only one input and only one output, and its logical output is exactly the same as its logical input. Given that this device has no effect on the logic levels within a circuit, readers can be excused for wondering what the purpose of such an apparently redundant device is!

Buffers are, in fact, quite useful and there are a number of situations in which they can be invaluable. The point to note is that, whereas the input and output voltage levels of the buffer are identical, the currents present at the input and output can be VERY different. The output current can be much greater than the input current, hence buffers are said to exhibit "current gain". In this way, buffers can be used to interface logic circuits to circuitry which demands so much current that the normal logic levels cannot be maintained by standard unbuffered logic devices. Another less obvious application of buffers is concerned with regularising and standardising the signals, in terms of logic levels, that are presented to, or are derived from, digital circuits.

When drawing logic circuits, the symbol used to present a buffer is shown in Fig. 8.8. In logic diagrams it is normal to show the input on the left hand side, and the output on the right hand side. Thus, in most logic circuits, the "progress" of a logical signal is usually from left to right across the page. At this juncture it is worth illustrating two points concerned with the rules which must be obeyed when connecting logic elements together (see Fig. 8.9). Whereas a single output may be connected to a number of different inputs, a single input cannot normally be connected to more than one output. To put this more simply; circuits cannot be expected to behave properly if several outputs are directly linked together!

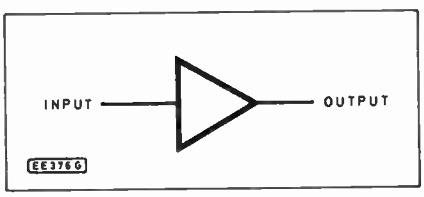


Fig. 8.8. Symbol for a buffer

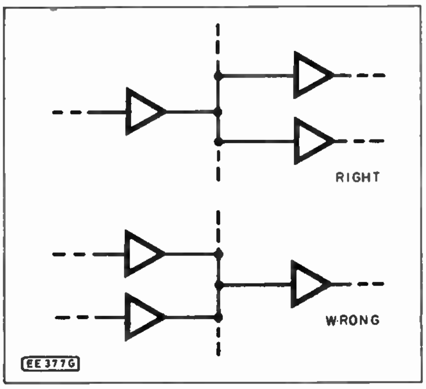


Fig. 8.9. Rules for connecting logic circuits

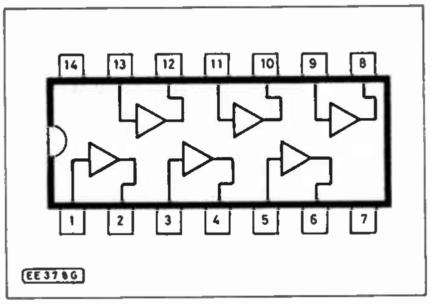


Fig. 8.10. Pin connections for a 7407 'hex' buffer

The 7407 is a typical example of a TTL buffer. This device actually comprises six separate inverters contained within the same 14-pin DIL package. The pin connections for the 7407 "hex" buffer are shown in Fig. 8.10. Readers should note that the conventional supply connections for a 14-pin DIL packaged TTL device are: pin 7 = 0V, pin 14 = +5V.

INVERTERS

An inverter, or inverting buffer as it is sometimes called, also has only one input and one output connection. Inverters are used to generate the logical opposite, or "complement", of a logic signal. The inverse (complement) of 0 is 1 whereas the inverse (complement) of 1 is 0. Hence when the input of an inverter is presented with a 0 its output will be 1, and vice versa.

The action of an inverter can be illustrated using the simple relay circuit shown in Fig. 8.11. When the logical input is at a 0 level, no current flows in the relay coil and the contacts remain in the state shown, producing a logical 1 output. When the logical input is a 1, current flows in the relay coil, the contacts change over, and a logic 0 is produced at the output.

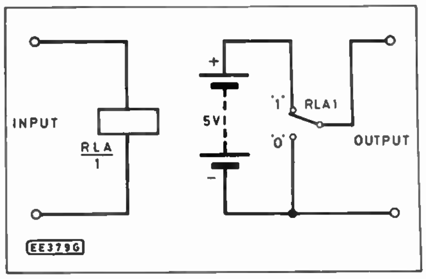


Fig. 8.11. Relay analogy of an inverter

The symbol for an inverter is shown in Fig. 8.12. Note that it is almost identical to that shown earlier for a buffer with the addition of a small circle shown on the output. This circle indicates inversion, i.e. the gate complements the input signal. Inverters share the same electrical properties as buffers with regard to current gain and thus can also be used in similar applications. If two inverters are connected together (in series, tandem, or "cascade"), as shown in Fig. 8.13, the result will be logically, as well as electrically, identical to that of a buffer.

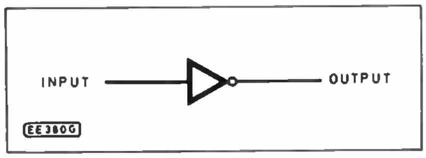


Fig. 8.12. Symbol for an inverter

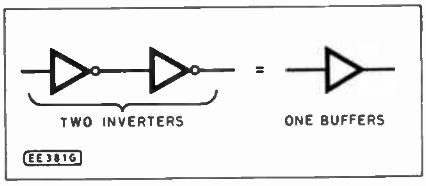


Fig. 8.13. Inverters connected in tandem

The 7404 is a typical example of a TTL inverter. This device actually comprises six separate inverters contained within the same 14-pin DIL package. The pin connections for the 7404 "hex" inverter are shown in Fig. 8.14.

TRUTH TABLES

The logical function of any given

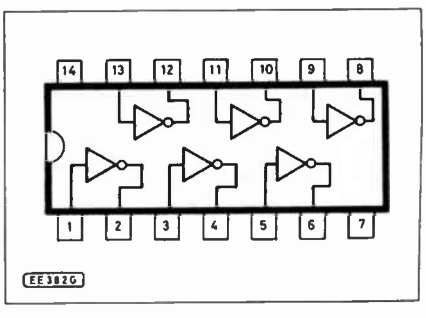


Fig. 8.14. Pin connections for a 7404 'hex' inverter

INPUT X	OUTPUT Y
0	0
1	1

EE383G

Fig. 8.15. Truth table for a buffer

INPUT X	OUTPUT Y
0	1
1	0

EE384G

Fig. 8.16. Truth table for an inverter

gate arrangement can be accurately defined using a "truth table". Such a table consists simply of lines representing all possible input states together with a column representing the logical state of the output. Figs 8.15 and 8.16 respectively shown the truth tables for a buffer and an inverter. For both of these gates, there is only one input which can exist in one of two possible states. Thus the truth table consists simply of two columns; input (X) and output (Y).

FAN-IN AND FAN-OUT

As mentioned earlier, the output of a TTL gate may be connected to the inputs of several other logic gates. The drive capability of a gate is known as its fan-out, and is usually expressed in terms of the number of standard input (loads) which can be driven by the gate. For most TTL gates the fan-out is ten i.e. one gate output can be safely expected to drive up to ten gate inputs.

The fan-in of a gate indicates its loading effect on a gate output, and is normally expressed as the number of standard inputs (loads) that it represents. The fan-in for most logic gates is therefore simply one for each available input.

TTL INPUT AND OUTPUT CURRENT

The limits on fan-out are caused by the currents which must flow to hold the input of a gate at logic 0 and at logic 1. In TTL, the logic 0 currents usually predominate in determining fan-out. A standard gate input requires 1.6mA to flow between the input and common (0V). Thus, to support a fan-out of ten, the gate must be capable of "sinking" a total current of 16mA. In the logic 1 state, the current flow is in the opposite direction and is substantially smaller. Standard TTL outputs are typically able to source 400µA whilst each input typically requires 40µA in the logic 1 state.

DRIVING LED

Light emitting diodes (LED) are

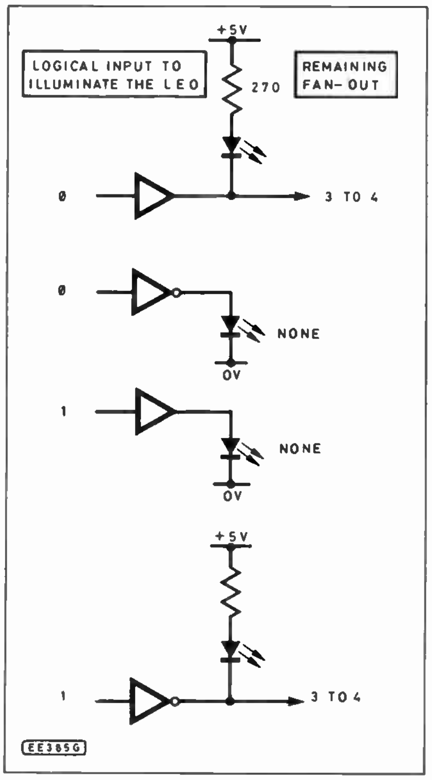


Fig. 8.17. Techniques for driving an LED

commonly used as indicators in digital circuits. A typical LED requires a current of around 10mA in order to provide a reasonably bright display. There are several methods of driving an LED directly from a TTL inverter or buffer. The actual method chosen depends on whether the diode is to be illuminated for a gate output of 0 or 1 and whether the gate is required to drive any other logic gates in addition to the diode. The various techniques are shown in Fig. 8.17 together with the logic input/output states required to illuminate the LED and the fan-out remaining to drive any other gates.

The remainder of this instalment of "Teach In" is concerned with four basic gate types; AND, OR, NAND, and NOR. The name given to each of these gates describes its logical function in terms of the operation which it performs. Gates with as many as thirteen inputs are in common use however their function is essentially the same as that of a gate having a similar function (i.e. AND, OR, etc) with fewer inputs. For this reason we shall confine our discussion to gates which have only two inputs.

THE TWO-INPUT AND GATE

The symbol for a two-input AND gate is shown in Fig. 8.18. In order to obtain a logic 1 output from this gate both inputs must be at logic 1. Any

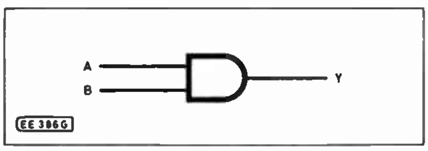


Fig. 8.18. Symbol for a two-input AND gate

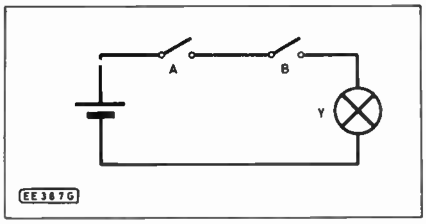


Fig. 8.19. Switch equivalent for a two-input AND gate

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

EE388G

Fig. 8.20. Truth table for a two-input AND gate

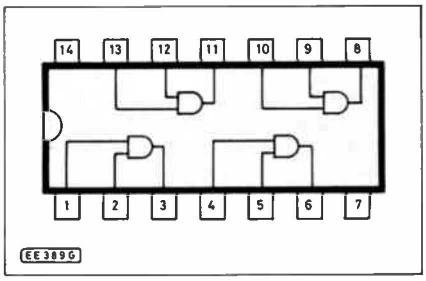


Fig. 8.21. Pin connections for a 7408 'quad' two-input AND gate

other input combination will produce a logic 0 output. The operation of the gate can best be understood by drawing a simple "switch equivalent" circuit like that shown in Fig. 8.19. In this circuit, a closed switch represents a logic 1 whilst an open switch represents a logic 0. In order for the lamp (Y) to light, both switch A AND switch B must be closed. Thus a logic 1 output is only obtained when both inputs are at logic 1.

The truth table for a two input AND gate is shown in Fig. 8.20. Note that, since there are two inputs and each input can exist in one of two possible states, there are four possible input combinations. To keep things neat we have arranged these in ascending order following a binary counting sequence where A is assumed to be the most significant binary digit (bit).

The 7408 is a typical example of a two-input TTL AND gate. The device comprises four gates (i.e. it is a "quad" AND gate) housed in the same 14-pin DIL package, the pin connections for which are shown in Fig. 8.21.

THE TWO-INPUT OR GATE

The symbol for a two-input OR gate is shown in Fig. 8.22. In order to obtain a logic 1 output from this gate any one, or more, of the inputs must be at logic 1. Putting this another

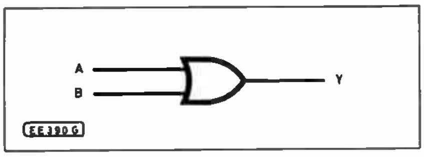


Fig. 8.22. Symbol for a two-input OR gate

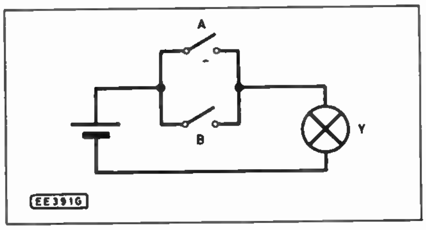


Fig. 8.23. Switch equivalent for a two-input OR gate

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

EE392G

Fig. 8.24. Truth table for a two-input OR gate

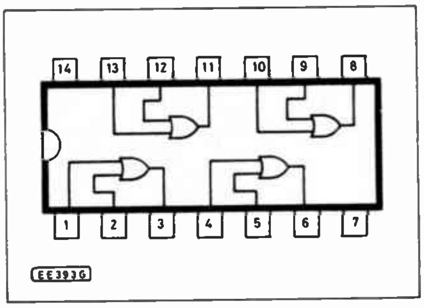


Fig. 8.25. Pin connections for a 7432 'quad' two-input OR gate

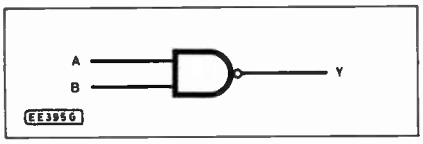


Fig. 8.26. Symbol for a two-input NAND gate

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

EE396G

Fig. 8.27. Truth table for a two-input NAND gate

way, a logic 0 output will only be obtained when both inputs are at logic 0. The "switch equivalent" of the two-input OR gate is shown in Fig. 8.23. The lamp will light when either switch A OR switch B (or both) are closed. The truth table for a two input OR gate is shown in Fig. 8.24. Again, since there are two inputs, there are four possible input conditions. The pin connections of a typical two-input TTL OR gate (the 7432) are shown in Fig. 8.25.

THE TWO-INPUT NAND GATE

The symbol for a two-input NAND gate is shown in Fig. 8.26. The output of this device is the logical complement of that produced by a two-input AND gate. The name stands for NOT-AND (i.e. an inverted AND). The truth table for a two-input NAND gate is shown in Fig. 8.27. Readers should compare this with that shown for the two-input AND gate (Fig. 8.20). The pin connections of a typical two-input TTL NAND gate (the 7400) are shown in Fig. 8.28.

THE TWO-INPUT NOR GATE

The symbol for a two-input NOR gate is shown in Fig. 8.29. Readers will not be surprised to learn that the output of this gate is the complement of that produced by a two-input OR gate. The name, of course, stands for NOT-OR (i.e. an inverted OR). The truth table for a two-input NOR gate is shown in Fig. 8.30. Readers should again compare this with the truth table of its non-inverted equivalent (Fig. 8.24). The pin connections of a typical two-input NOR gate (the 7402) are shown in Fig. 8.31.

NEXT MONTH

Next month we shall be concluding the Teach-In series with a brief look at practical applications of digital circuits.

PROBLEMS

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

8.1 Determine the logical state of the output of the gate circuit shown in Fig. 8.32. (e)

8.2 Devise an arrangement of logic gates which can be used to replace the switch circuitry shown in Fig. 8.33. (e)

8.3 Each of the logic gate arrangements shown in Fig. 8.34 can be replaced by a single gate. What type of gate should be used in each case? (e)

8.4 What is the logical function of the gate arrangement shown in Fig. 8.35? (e)

8.5 Derive the truth table for the logic gate arrangement in Fig. 8.36. (m)

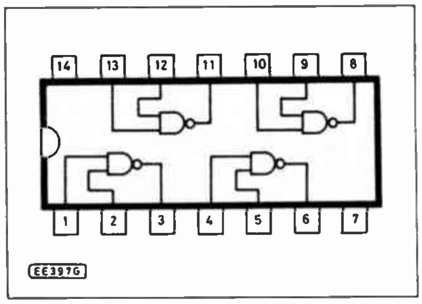


Fig. 8.28. Pin connections for a 7400 'quad' two-input NAND gate

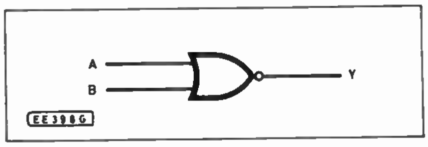


Fig. 8.29. Symbol for a two-input NOR gate

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

EE399G

Fig. 8.30. Truth table for a two-input NOR gate

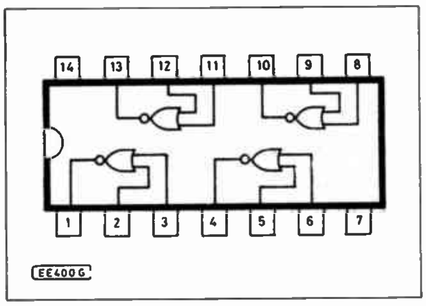


Fig. 8.31. Pin connections for a 7402 'quad' two-input NOR gate

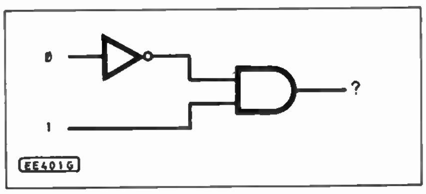


Fig. 8.32. Logic gate arrangement for problem 8.1

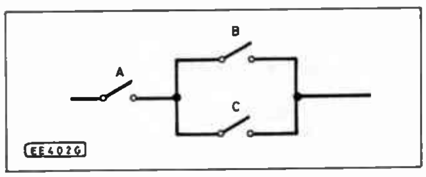


Fig. 8.33. Switch circuitry for problem 8.2

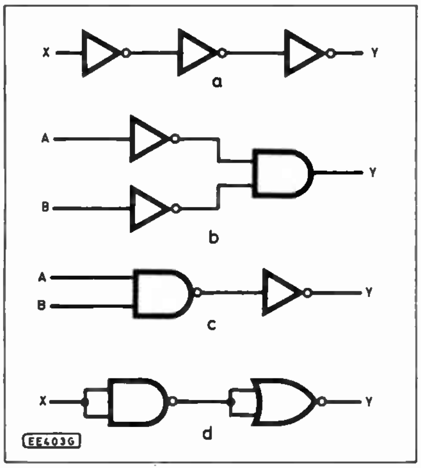


Fig. 8.34. Logic gate arrangements for problem 8.3

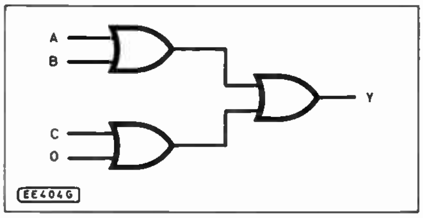


Fig. 8.35. Logic gate arrangement for problem 8.4

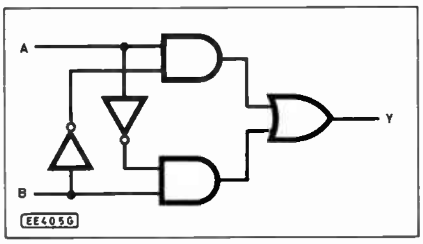


Fig. 8.36. Logic gate arrangement for problem 8.5

ANSWERS TO LAST MONTH'S PROBLEMS

7.1 100kΩ

7.2 Voltage gain = 2500, phase shift = 0 or 360 degrees

7.3 200

7.4 Your circuit should be similar to that shown in Fig. 7.15 with the following component values:
R_{in} = 5k (4·7k or 5·1k)
R_f = 200k (200k or 220k)
C_{in} = 79·5n (68nF or 82n)
C_f = 795p (680pF or 820p)
Suitable preferred values are shown in brackets.

Practical Assignments

COMPONENTS

Beside the items specified for earlier parts you will need a 470Ω resistor, a red l.e.d. and the following i.c.s: 7408, 7432, 7400 and 7402.

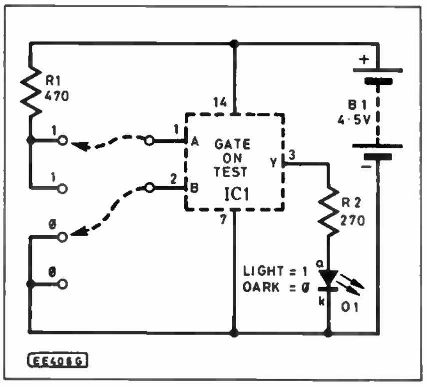
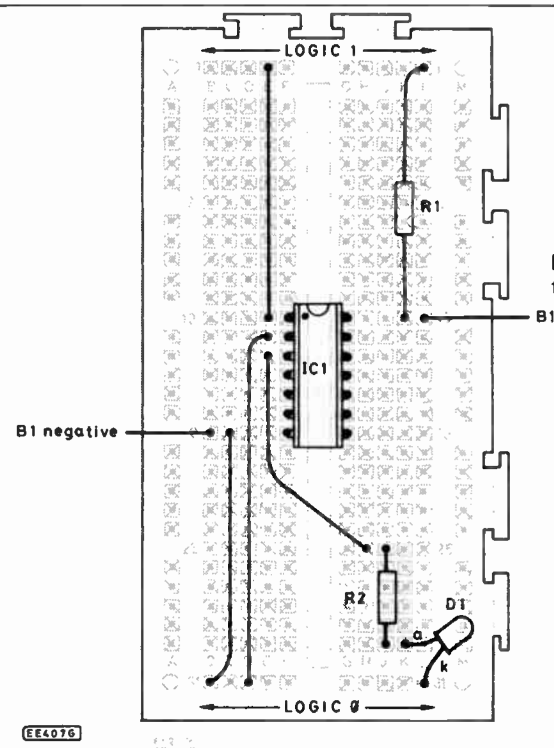


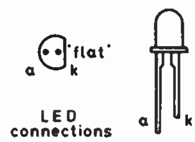
Fig. 8.37. Circuit used in Assignment 8.1



GATE ON TEST	PIN NUMBERS A	B	Y
7408	1	2	3
7432	1	2	3
7400	1	1	3
7402	2	3	1

Fig. 8.39. Pin connections for testing each type of logic gate

Fig. 8.38. Wiring diagram for Assignment 8.1



COMPONENTS			
IC1	7408	R1	470
	7432	R2	270
	7400	B1	4·5V
	7402		
D1	Red LED		

ASSIGNMENT 8.1

This assignment is designed to demonstrate the operation of each of the four basic two-input logic gates described earlier in the text.

PROCEDURE

Connect the circuit shown in Fig. 8.37 on your breadboard using the wiring diagram shown in Fig. 8.38. Each of the basic logic gates is to be connected in turn, starting with the 7408 "quad" two-input AND gate. Readers should note that the circuit diagram and wiring diagram both show the connections for this particular device. Later, when IC1 is to be replaced by each of the other gates, readers should refer to the table shown in Fig. 8.39 or, if preferred, the pin connections given previously in the main body of the text. In either case, readers should carefully check the orientation of the i.c. BEFORE connecting the 4·5V supply.

The wiring layout has been organised so that logic 1 is available along row 1 whilst logic 0 is available along row 31. R1 is appropriately known as a "pull-up" resistor and it serves to provide a logic 1 level without actually making a direct connection to the +5V supply. This is good practice when designing "real life" TTL circuits since it can be instrumental in protecting the inputs of gates against supply borne transient "spikes".

The output of the gate is displayed using an l.e.d. We have incorporated a resistor to limit the current to a safe value in the event of a misconnection to the positive supply rail. If readers would prefer a brighter output from the LED, the value of R2 may be reduced to, say, 100 ohm.

Readers should derive the truth tables for each of the gates in turn. It should be noted that *both* inputs *must* be connected in order to make the input logic levels valid. An unconnected input adopts a logic 1 level rather than the logic 0 level that might otherwise be expected! Results should be compared with those given in the text.

If time permits, readers may like to try the following:

(a) Construct a two input AND gate using an arrangement based upon two of the internal gates of a 7400 "quad" NAND gate.

(b) Construct a two-input OR gate using an arrangement based upon two of the internal gates of a 7402 "quad" NOR gate.

(c) Construct a two-input OR gate using an arrangement based upon three of the internal gates of a 7400 "quad" NAND gate.

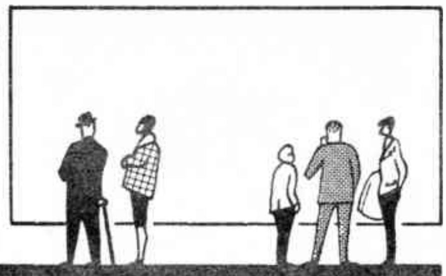
In each case confirm the operation of your circuit using a truth table.

NEXT MONTH

You will need the following additional components in order to carry out the practical assignments in next month's instalment of Teach-In:

A 22k ¼W, 5% resistor and a 555 timer i.c.

SHOP TALK



BY DAVID BARRINGTON

Work Station

We are always on the look out for new products that will be invaluable to constructors, particularly the newcomer where space or work area can be at a premium. The latest "foldaway" work bench from **Elek** is just such an item and should have wide appeal to our readers.

The Workdek is a purpose designed "work station" specifically aimed at miniature and model engineers, radio, radio control and electronics enthusiasts and professionals alike. The desk is built in sturdy melamine faced chipboard in a two tone chocolate and cream colour scheme.

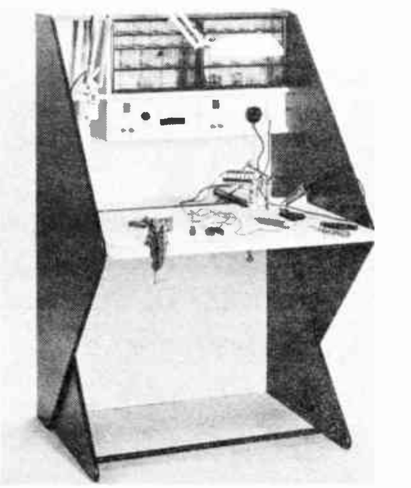
It is supplied in flat-pack form for easy self-assembly and includes a 30 drawer storage system and electrical supply panel. The power supply panel consists of two mains sockets and 12V d.c. unregulated output terminals suitable for miniature power tools. An optional extra power supply provides a smooth, regulated and variable d.c. supply up to 30V.

The work area includes interchangeable work surfaces of laminate and soft vinyl (other options are possible) together with provision for holding clamps. The hinged worktop also forms a "flap" which may be folded closed and locked for security.

The Workdek retails for £220 plus VAT and for further details and specifications contact: **Elek Ltd., Dept EE, PO Box 32, Winchester, Hants, SO22 5LX.**

Count Down

A novel new timer that will find many applications around the home and in the car has just been marketed by **Cobonic.** Weighing only 40 grams, the Handy-Timer features a combined count-down and count-up facility, with audible alarm. Repetitive identical time settings do not need to be re-entered as the preset period can be repeated from an internal memory.



The Workdek work station from Elek

Digital/Clock Timer from Cobonic

In the clock function, the liquid crystal display (LCD) will give a readout of time in hours, minutes and seconds in 12 or 24 hour mode. The timer is also very useful as a stopwatch.

During the count-down mode the time remaining is displayed and on completion an audible alarm sounds for one minute. After this period the timer goes into count-up mode indicating time lapsed since the alarm sounded.

The Handy-Timer has a spring clip for attaching to your clothing or it can be mounted on any steel surface by its magnetic pad. The timer costs £12.95 plus VAT and readers should write to the following address for details of nearest stockists: **Cobonic Ltd., Dept EE, 32 Ludlow Road, Guildford, Surrey, GU2 5NW.**

Bargain Time

This time of the year is usually set aside for the annual spring clean-up around the home and stock taking in the workshop. It's the same with component manufacturers and suppliers and they are often found to be offering "special purchase" packs which seem to be excellent value for money.

The "bargain packs" from several of our advertisers seem very reasonable at the moment, particularly from **J&N Bull, Bi-Pak, Greenweld, Marco, Elmwood** and **Amport.**

If you want to add that "quality" finish to your audio equipment then the veneer cabinet surround from **Amport** seems a bargain purchase. The "£5 Pounders" range from **J&N Bull** also contain some very good "buys".

CONSTRUCTIONAL PROJECTS

Mini Strobe

Most of the components for the *Mini Strobe* should be readily available from most of our advertisers. However, a couple of items may cause purchasing problems.

The two sections of the Rate potentiometer VR1 are of different values and being of the "reverse log" type may prove difficult to locate. This potentiometer can be purchased from **Magenta**.

The "super" or "ultra" bright l.e.d.s should be carried by the majority of our advertisers. If any difficulty is experienced, the ones used in our prototype were also obtained from the above mentioned company.

A full kit of parts (£13.09, including p&p) for the Mini Strobe is available from **Magenta Electronics Ltd., Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs, DE14 2ST.**

A printed circuit board for the Mini Strobe is available through the *EE PCB Service:* code EE522—see page 275.

Digital Pulse Generator

Components for the *Digital Pulse Generator*, this month's Teach In '86 Project 8, seem to be readily available and no purchasing problems should be encountered. However, note that the potentiometer VR1 should be a "log" type.

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

Logic Switch

When ordering the push switches for the Logic Switch, be sure to quote *both* the "push-to-break" and the "push-to-make" types as some suppliers only stock the latter.

The choice of relay used for RLA is left to the constructor but it must be capable of operating below 6V. Also the relay contacts must be rated for mains use.

It is most important that a mains relay is used for RLB. The coil of this relay must be capable of being connected directly to the mains supply continuously. It must also have mains rated contacts and at least two sets of changeover contacts. The contact current rating will depend on the equipment to be protected.

It is essential that the unit is housed in an earthed metal box, and that all mains connections are well insulated.

PA Amplifier

The dual power amplifier i.c., type TDA2004, is currently listed by **Cricklewood Electronics.** The rest of the components for this project seem to be standard "off-the-shelf" items.

Automatic Firing Joystick Adaptor

We do not envisage any component buying difficulties for the *Automatic Firing Joystick Adaptor*.

The D-type plug and sockets, for inter connecting computer add-on's, are quite common and should be stocked by any good component supplier. The printed circuit board may be purchased through our *PCB Service*: code **EE523.**

BOOK SERVICE

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

DATA AND REFERENCE

DIGITAL IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese digital i.c.s. Also includes details of packaging, families, functions, manufacturer and country of origin.
256 pages **Order code BP140** **£4.95**

LINEAR IC EQUIVALENTS AND PIN CONNECTIONS
A. Michaels
Shows equivalents and pin connections of a popular selection of European, American and Japanese linear i.c.s. Also includes details of functions, manufacturer and country of origin.
320 pages **Order code BP141** **£4.95**

INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE
A. Michaels
Helps the reader to find possible substitutes for a popular selection of European, American and Japanese transistors. Also shows material type, polarity, manufacturer and use.
320 pages **Order code BP85** **£2.95**

INTERNATIONAL DIODE EQUIVALENTS GUIDE
A. Michaels
Designed to help the user in finding possible substitutes for a large selection of the many different types of diodes that are available. Besides simple rectifier diodes, also included are Zener diodes, l.e.d.s, diacs, triacs, thyristors, OCIs, photo and display diodes.
144 pages **Order code BP108** **£2.25**

RADIO

AN INTRODUCTION TO RADIO DXING
R. A. Penfold
Anyone can switch on a short wave receiver and play with the controls until they pick up something, but to find a particular station, country or type of broadcast and to receive it as clearly as possible requires a little more skill and knowledge. The object of this book is to help the reader to do just that, which in essence is the fascinating hobby of radio DXing.
112 pages **Order code BP91** **£1.95**

INTERNATIONAL RADIO STATIONS GUIDE
Completely revised and updated, this book is an invaluable aid in helping all those who have a radio receiver to obtain the maximum entertainment value and enjoyment from their sets.
Clearly shown are the station site, country, frequency and/or wavelength, as well as the effective radiation power of the transmitter.
128 pages **Order code BP155** **£2.95**

PROJECT CONSTRUCTION

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold
We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.
96 pages **Order code BP110** **£1.95**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold
Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.
80 pages **Order code BP121** **£1.95**

BEGINNER'S GUIDE TO BUILDING ELECTRONIC PROJECTS
R. A. Penfold
Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.
112 pages **Order code No. 227** **£1.95**

CIRCUITS AND DESIGN

PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 1
PRACTICAL ELECTRONIC BUILDING BLOCKS–BOOK 2
R. A. Penfold
These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects, rather than simply following published project designs.
BOOK 1 contains: Oscillators—sinewave, triangular, squarewave, sawtooth, and pulse waveform generators operating at audio frequencies. Timers—simple monostable circuits using i.c.s. the 555 and 7555 devices, etc. Miscellaneous—noise generators, rectifiers, comparators and triggers, etc.
BOOK 2 contains: Amplifiers—low level discrete and op-amp circuits, voltage and buffer amplifiers including d.c. types. Also low-noise audio and voltage controlled amplifiers. Filters—high-pass, low-pass, 6, 12, and 24dB per octave types. Miscellaneous—i.c. power amplifiers, mixers, voltage and current regulators, etc.
BOOK 1 *128 pages* **Order code BP117** **£1.95**
BOOK 2 *112 pages* **Order code BP118** **£1.95**

HOW TO DESIGN ELECTRONIC PROJECTS
R. A. Penfold
The aim of this book is to help the reader to put together projects from standard circuit blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements are also provided.
128 pages **Order code BP127** **£2.25**

POPULAR ELECTRONIC CIRCUITS –BOOK 1
POPULAR ELECTRONIC CIRCUITS –BOOK 2
R. A. Penfold
Each book provides a wide range of designs for electronic enthusiasts who are capable of producing working projects from just a circuit diagram without the aid of detailed construction information. Any special setting-up procedures are described.
BOOK 1 *160 pages* **Order code BP80** **£1.95**
BOOK 2 *160 pages* **Order code BP98** **£2.25**

A PRACTICAL INTRODUCTION TO MICROPROCESSORS
R. A. Penfold
Provides an introduction which includes a very simple microprocessor circuit which can be constructed so that the reader can experiment and gain practical experience.
96 pages **Order code BP123** **£1.95**

HOW TO USE OP-AMPS
E. A. Parr
This book has been written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.
160 pages **Order code BP88** **£2.25**

COMPUTING

AN INTRODUCTION TO COMPUTER PERIPHERALS
J. W. Penfold
Covers such items as monitors, printers, disc drives, cassette recorders, modems, etc., explaining what they are, how to use them and the various types and standards. Helps you to make sure that the peripherals you buy will work with your computer.
80 pages **Order code BP170** **£2.50**

COMPUTER TERMINOLOGY EXPLAINED
I. D. Poole
Explains a wide range of terms that form the computer jargon used by enthusiasts. Includes a reference guide to the more commonly used BASIC commands.
96 pages **Order code BP148** **£1.95**

THE PRE-COMPUTER BOOK
F. A. Wilson
Aimed at the absolute beginner with no knowledge of computing. An entirely non-technical discussion of computer bits and pieces and programming.
96 pages **Order code BP115** **£1.95**

TO ORDER

Add 50p per order postage (overseas readers add £1, surface mail postage) and send a PO, cheque or international money order made payable to IPC (quoting the order code and quantities required) to **EE & EM BOOKS SERVICE, 6 CHURCH STREET, WIMBORNE, DORSET. BH21 1JH.**

PLEASE ALLOW 28 DAYS FOR DELIVERY

Actually Doing it!!

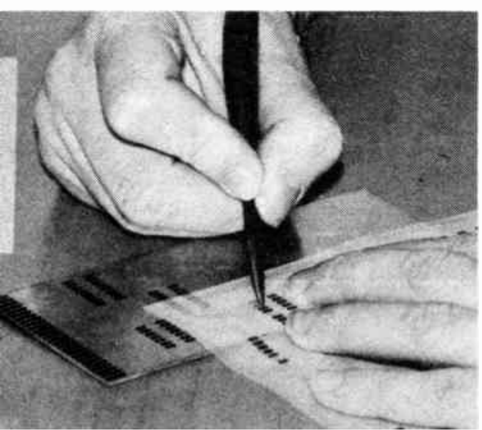
SO FAR in this guide to electronics it has been assumed that your projects will be built on either stripboard or a ready-made custom printed circuit board. There is an alternative to these, and this is to build your own printed circuit board. Initially it is probably best not to do this, so that you can concentrate your efforts on producing a solidly and accurately constructed project with no components out of place. However, sooner or later most constructors feel the urge to try their hand at making printed circuit boards, and it is certainly an interesting and rewarding aspect of the hobby in its own right.

Designing printed circuit boards falls outside the scope of this article, and we will only consider the construction of boards which are copied from published designs. There are several ways of producing printed circuit boards, or to be more precise, there are several variations on the same basic way of doing things. There are some quite sophisticated materials and pieces of equipment available these days which enable very high quality printed circuit boards to be built, but beginners would be well advised to settle for relatively simple methods at first. In fact it would not really be worthwhile investing in expensive materials and equipment unless you would be likely to construct a fairly large number of boards over a period of time. Anyway, here we will ignore photographic and other advanced methods of board construction and will deal only with simple ways of copying printed circuit designs.

THE METHOD

The embryo printed circuit board starts out as a sheet of fibreglass or SRBP (sheet resin bonded paper) covered on one side with copper. Either type will do, the fibreglass type being generally somewhat tougher but also a little more expensive. Board covered on both sides with copper is available, but this is only needed for double-sided boards, and you should definitely not start by trying to make one of these. You are unlikely to find a board of precisely the size you require on sale, but it is not difficult to cut a larger piece down to size using a hacksaw.

The basic way in which the board is produced is to first cover with "etch resist" the areas of copper which are to be left on the finished board. The board is then placed into a dish of "etchant" which removes the unwanted areas of copper, but the etch resist protects the wanted areas which are consequently left intact. The etched board is rinsed, the etch resist is cleaned off, and then the holes are drilled. This leaves a fully finished board which is ready to have the components soldered into place.



RESIST

Probably the most difficult job in the whole process is that of laying down the resist in the correct pattern and with suitable accuracy. Before starting it is essential to first make sure that the copper surface of the board has a clean and bright finish. If this is not done it might be found that grease and corrosion prevents areas of the board from etching properly. Special cleaning blocks are available but a scouring pad seems to be equally effective. Once the board has been cleaned you must try not to touch the copper surface as this will leave grease marks which might hinder the etching process.

There are two basic choices for the etch resist; rub-on transfers and ink or paint. A range of rub-on transfers are available from a number of component suppliers these days, and these include such things as clusters of pads for transistors and integrated circuits, as well as single pads and lines for interconnecting tracks. A good assortment of transfer sheets will cost at least a few pounds, but should be sufficient to make a number of boards.

Any water resistant paint could be used as the resist, but the complexity of modern printed circuit boards is such that with this method the use of a proper printed circuit pen is virtually obligatory. An etch resist pen represents what is probably the quickest and cheapest solution to the problem, but it is not the method I would recommend. Most modern printed circuit designs are quite intricate, and a fairly high degree of skill is needed in order to produce reasonably neat results. Good results using rub-down transfers are relatively easy to achieve. This is not just a matter of having a finished board which looks neat and tidy. Many contemporary components are designed for printed circuit mounting, and if the board is not accurate it will be difficult or impossible to fit their pins into the board properly.

Before the resist can be applied it is necessary to trace the printed circuit design onto the copper side of the board. There is more than one way of doing this, but the method which I have found to be most accurate is to carefully position the board underneath the actual size track pattern diagram in the magazine or book. This is easier if the pattern can be cut out and removed from the magazine, but obviously you may not wish to mutilate the magazine, and you must then do the best you can with the diagram in-situ. It is important that once the board and the diagram are aligned that they should remain so while the tracing is made, and some small pieces of Blu-Tack are useful for holding the two temporarily together. With the two fixed together, a bradawl or other pointed instrument is used to mark the positions of the mounting holes through the diagram and into the board, leaving small indentations in the board. With d.i.l. i.c. clusters it is only necessary to mark the positions of the four corner pads. Obviously this method results in slight damage to the magazine, but not serious damage. If you are still worried about this it would be possible to take a photocopy and use this as the template, but the photocopier would have to be a type which gives a precise one to one copy. Obviously there are other ways of transferring the design to the board, and you might like to experiment with alternatives, but the directness of this method makes it difficult to better as far as accuracy is concerned.

TRANSFERS

With the indentations marking the positions of the holes, it is then quite easy to copy the track pattern using rub-on transfers. Put all the pads in place first and then add the tracks. It seems to be well worthwhile buying the special spatula for applying the transfers (see photo) as good results seem to be much easier to obtain using one of these rather than something like an old ball-point pen. The tracks must be carefully cut to length prior to laying them down, and they should overlap each pad slightly. However, avoid an excessive overlap with the holes at the centres of the pads being covered or even partially obscured. This would make things difficult when the drilling stage is reached. With some printed circuit designs straight tracks are all that are required. With others slight or even acute curves are called for. An approximation to slight curves can be obtained by laying two or three short tracks at a slight angle to one another. For tighter curves there are curved track transfers available.

Having completed the track pattern, check it over very thoroughly making sure that there are no cracks anywhere, and all the tracks and pads are properly flat against the board. Any cracks can be repaired by adding a new pad or piece of track over the original, striving for the most accurate alignment that can be obtained. Where a pad or track has not adhered to the board properly it is usually adequate to place a vacant area of a transfer sheet over the offending part of the board, and then go over it firmly with the spatula. If in doubt as to the goodness of any track or pad, remove it using some adhesive tape and apply a new transfer. Try to get the resist as perfect as you can as it is much easier to repair the resist at this stage than it is to repair the copper track on the finished board.

When you are sure that the resist pattern is correct and in good condition the board is ready for etching and drilling, which we will deal with in the next *Actually Doing It*.

Robert Penfold

a regular feature for the Spectrum Owner...

by Mike Tooley BA

IN AN earlier *On Spec* I suggested that the weakest link in the Spectrum was the power supply. Correspondence received from readers has indeed confirmed this to be so. Designers of the new Spectrum-128 have made some attempt to cure the problems of overheating associated with the Spectrum and Spectrum-Plus by simply bolting on a huge metal heatsink in place of the right hand side of the case!

Whilst this might please anyone looking for a budget priced central heating system, it can hardly be described as an elegant solution. Principal culprit in all of this is the Spectrum's external mains adaptor which generally provides far too much input voltage for the Spectrum to cope with.

Excessive Voltage

The unregulated d.c. input is nominally supposed to be 9V but in reality it is rarely less than about 10·5V and may even exceed 11·5V. The supply is regulated internally to +5V using a monolithic three-terminal voltage regulator (7805). The voltage drop across this regulator is thus around 6V, or so, and its power dissipation is excessive for the size of the heatsink provided. (If you don't believe me, try opening up your Spectrum and holding your finger on the regulator!).

Now there are some good reasons for providing more voltage than is strictly necessary. The first is to allow some margin for whatever external devices are connected and which make use of the unregulated d.c. supply available at the edge connector. This supply (available at 4B of the edge connector) is simply the raw d.c. input voltage from the mains adaptor routed to the edge connector.

The second reason for producing a somewhat excessive input voltage is to allow for the vagaries of the domestic mains supply. Happily, in the UK we are reasonably fortunate in this respect, however the same cannot be said for many overseas countries where variations in mains voltage may regularly exceed 10 per cent.

A Pre-Regulator

The pre-regulator circuit shown in Fig. 1 is an attempt to solve the problem of excessive internal power dissipation without resorting to excessive heatsinks. At the outset we should perhaps stress that the solution is **only appropriate to an unexpanded Spectrum**—it will not operate correctly when Interface One and Microdrives are connected.

The pre-regulator keeps the d.c. input voltage to the Spectrum constant at approximately 8·2V. The output voltage of the pre-regulator varies by typically no more than 6 per cent for a 30 per cent change in input voltage and it operates correctly over an input range of anything between 190V and 270V.

The typical variation of d.c. output voltage with a.c. input voltage for the unregulated and pre-regulated supplies are shown in Figs. 2 and 3. Figs. 4 and 5 show typical load characteristics for the unregulated and pre-regulated supplies.

The pre-regulator reduces the power dissipation of the Spectrum's internal voltage regulator by at least 60 per cent. The net result is that the Spectrum runs *much* cooler and the internal regulator is very much less prone to problems associated with thermal shutdown.

Construction

Construction of the pre-regulator is extremely straightforward. The prototype unit was built on a small strip of Veroboard measuring only 50mm × 80mm. The 2N3055 does not require any heatsink (in normal operation it dissipates approximately 2W).

Readily available low-cost components have been used throughout and the total cost of the pre-regulator should not exceed £1.50; a very small price to pay for the added peace of mind and reliability of operation!

In use, the pre-regulator is simply connected in series with the d.c. input lead. It is probably best to cut the existing lead at approximately 200mm from the d.c. input connector, then insert the pre-regulator taking care to observe the correct polarity as marked on the circuit diagram. It appears that the striped lead on the Spectrum d.c. supply lead is usually negative but readers **should not rely on this** and a check should be made using a d.c. voltmeter to confirm the polarity of the input before connecting the pre-regulator.

Stepper Motor Software

Last month we described a simple stepper motor driver using the SAA1027 i.c. This month we shall show how the motor can be controlled using simple routines written in BASIC and FORTH.

The interface requires only three inputs; RESET, DIRECTION and STEP. These inputs have been made TTL compatible by means of transistors, TR1 to TR3 (the direct inputs of the SAA1027 are not compatible with conventional TTL devices).

The three input signals may be conveniently derived from three Port A data lines of the Z80-PIO (see February 1986 *EE*). Where readers are using an alternative output port (e.g. that described in June 1985 *EE*) the only difference will be the actual port addresses. The data lines should be connected as follows.

RESET	PA0 (Data line 0 of Port A)
DIRECTION	PA1 (Data line 1 of Port A)
STEP	PA2 (Data line 2 of Port A)

At this stage it is worthwhile explaining the function of each of the above signals.

RESET, as its name implies, resets the stepper motor interface. This line is "active high" which simply means that a logic 1 (high) is required to reset the interface. During normal operation the RESET input must be held low (logic 0).

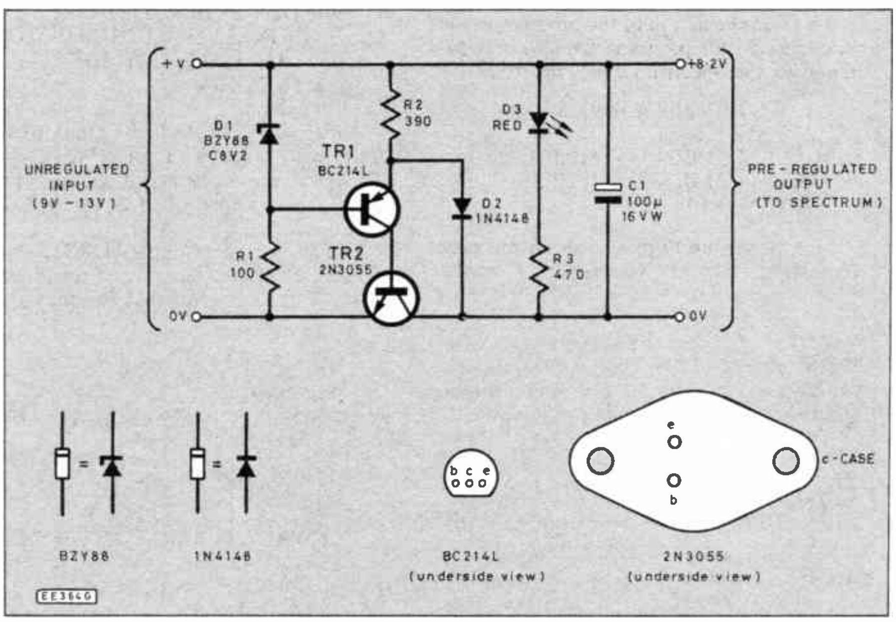
The **DIRECTION** input determines the sense of rotation of the motor. When this input is low (logic 0) the motor rotates in a clockwise direction, and vice versa.

The **STEP** input is pulsed low (i.e. it must change from high to low) in order to make the motor move through one step (7·5 degrees rotation with the motor specified). Note that the motor does not react to a low to high transition on the STEP input.

Three basic steps are required in order to obtain continuous rotation:

(a) ensure that the RESET line is taken low by placing a logic 0 on PA0
(b) select the direction of rotation by placing a logic 1 or logic 0 as required on PA1
(c) output a train of pulses to PA2 whist, at the same time, ensuring that conditions (a) and (b) are maintained.

Fig. 1. Complete circuit diagram for the pre-regulator.



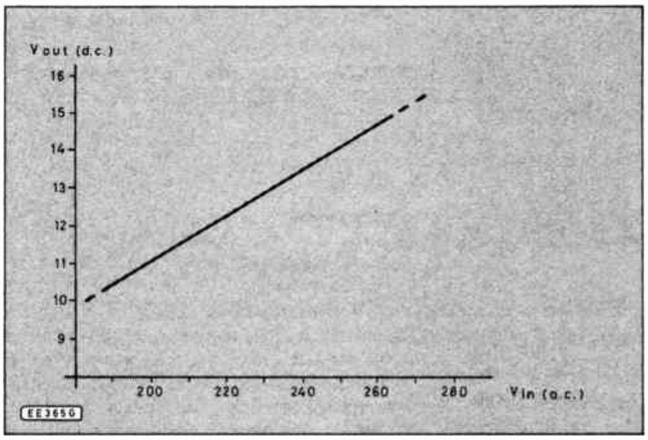


Fig. 2. Typical variation of d.c. output voltage plotted against a.c. input voltage for the Spectrum's unregulated d.c. supply.

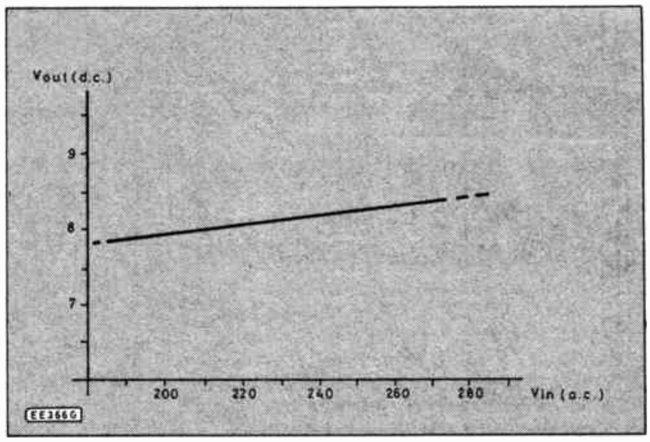


Fig. 3. Typical variation of d.c. output voltage plotted against a.c. input voltage for the Spectrum's pre-regulated supply.

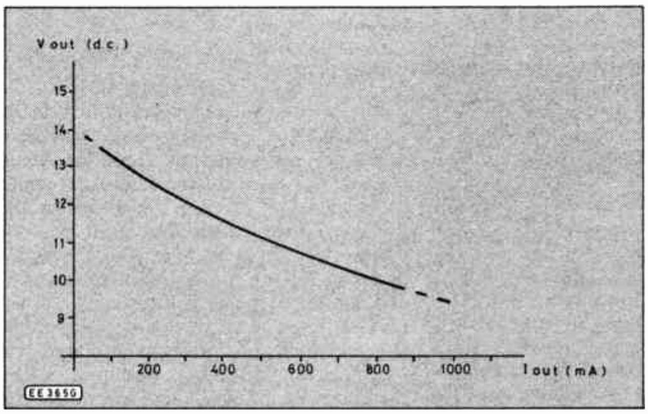


Fig. 4. Load characteristic for the Spectrum's unregulated d.c. supply.

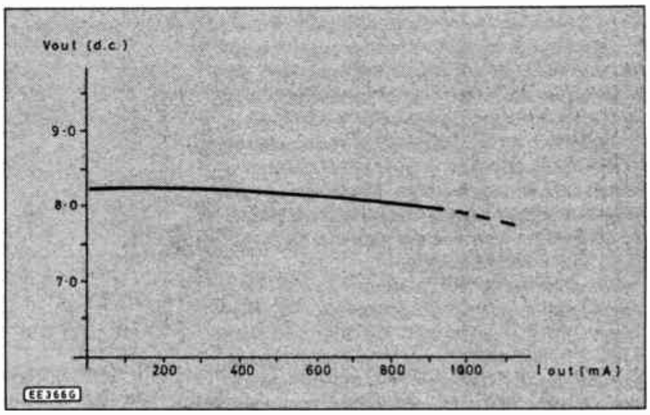


Fig. 5. Load characteristic for the Spectrum's pre-regulated d.c. supply.

A train of pulses can be easily produced by setting up a simple loop. The loop could be conditional or unconditional depending upon the circumstances. The byte sent to Port A on each pass through the loop should, of course, satisfy all three conditions (a) to (c).

The following example shows how a single key depression can be made to produce an anticlockwise step:

```
10 OUT 93,15
20 PAUSE 0
30 OUT 31,252
40 OUT 31,250
50 GOTO 10
```

To make the action of the program easily understood, this program can also be written using the Spectrum's BIN function:

```
10 OUT 93,BIN 00001111
20 PAUSE 0
30 OUT 31,BIN 11111100
40 OUT 31,BIN 11111010
50 GOTO 10
```

Line 10 sets up Port A as an output port by writing the binary word 00001111 to the control register for Port A. Lines 30 and 40 are responsible for sending a pulse to the STEP line. The three least significant bits of the word sent to the Port B data register (address 31) in lines 30 and 40 determine the motor action on the following basis:

Bit Number	2	1	0
Port Line	PA2	PA1	PA0
Function	STEP	DIRECTION	STEP
Action	Changes from 1 to 0	Stays at 0	Stays at 0

Line 30 uses the Spectrum's PAUSE statement to wait for any key depression (with the exception of BREAK!) before continuing with the loop. Clockwise rotation can be selected by simply ensuring that bit 1 is a 1 rather than a 0.

Here is a simple BASIC program which allows continuous clockwise or anticlockwise rotation to be selected from the keyboard:

```
10 OUT 93,BIN 00001111
100 OUT 31,11111010
110 IF INKEY$="c" THEN GOTO 200
120 OUT 31,BIN 11111110
130 GOTO 100
200 OUT 31,BIN 11111000
210 IF INKEY$="a" THEN GOTO 100
220 OUT 31,BIN 11111100
230 GOTO 200
```

Anticlockwise or clockwise rotation can be selected by pressing "a" or "c" respectively. To reduce the motor speed, an appropriate delay can be added by means of a PAUSE statement.

Finally, here is a simple FORTH routine which will produce a cycle of ten alternate clockwise and anticlockwise 360 degree revolutions of the motor:

```
31 CONSTANT DATA
93 CONSTANT CONTROL
: INIT 15 CONTROL OUTP ;
: PUT DATA OUTP ;
: CWSTEP 248 252 PUT PUT ;
: ACWSTEP 250 254 PUT PUT ;
: DELAY 200 0 DO LOOP ;
: CWREV 48 0 DO CWSTEP DELAY
  LOOP ;
: ACWREV 48 0 DO ACWSTEP
  DELAY LOOP ;
: RUN INIT 10 0 DO CWREV
  ACWREV LOOP ;
```

INIT initialises all Port A lines as outputs. PUT simply outputs TOS (top of the stack) to the Port A data register. CWSTEP and ACWSTEP respectively produce single 7·5 degree clockwise and anticlockwise steps whilst CWREV and ACWREV respectively produce complete 360 degree clockwise and anticlockwise revolutions. The complete program is defined by the word RUN. Simply enter the program (including the constant definitions) and type RUN.

Those of you requiring some intelectual stimulation may like to try coding the program in BASIC. Subject to the response from readers, I will publish the best solution in a forthcoming *On Spec*. In any event I doubt whether the code could be very much simpler or more compact than the FORTH version —but perhaps I'm biased!

Your comments and suggestions should be sent, as usual, to:

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

P.S. Don't forget to include a large (A4 size) stamped addressed envelope if you would like to receive a copy of our *Update!*

Next Month: A constructional project devoted to an external power unit for use with outboard circuitry.

TEACH-IN 86

PROJECT 8

DIGITAL PULSE GENERATOR

Michael Tooley BA **David Whitfield** MA MSc CEng MIEE

DIGITAL techniques are now used in an ever-increasing range of applications. The basic principles involved in such digital circuits are introduced by the *Teach-In '86* series, which appears elsewhere in the magazine. This last project in the current series of Teach-In projects is concerned with test equipment for just such digital circuits.

Testing digital circuits is quite different in a number of important aspects from the testing of analogue circuits. However, much of the same test equipment can still be used, although in many cases it is more convenient if an appropriate digital instrument is available. In other cases, there are additional needs which call for test equipment which caters specifically for the needs of digital troubleshooting.

The unit to be described this month is a digital pulse generator. It produces digital signals in four switched frequency ranges giving an overall coverage of 1Hz to 10kHz. At any given frequency, four independent outputs are available with duty cycles of 25%, 50%, $\overline{50\%}$ and 75%, respectively. This allows a number of signals of known phase relationship to be used for testing a digital circuit. All of the outputs are at TTL levels, and the unit operates from a single +5V supply.

CIRCUIT DESCRIPTION

A block diagram for the digital pulse generator is shown in Fig. 1, with the corresponding circuit diagram in Fig. 2. IC1 is a monolithic timer arranged in an oscillator configuration. This oscillator is set to run at four times the output frequency. The output from this oscillator has alternating "high" (near +5 volts) and "low" (near 0 volts) periods. The durations of these "high" and "low" periods (T_H and T_L, respectively) are determined by the following equations:

$$T_H = 0{\cdot}693 \times (VR1 + R1 + R2) \times C$$
$$T_L = 0{\cdot}693 \times R2 \times C$$

The values of time are in µsec, for resistances in Ω and capacitances in µF. The capacitance, C, is the value of the capacitor currently selected by S1. From this it can be seen that the "low" period of the waveform will always be less than the "high" period; often very much less. For any given range, the "low" period is fixed,

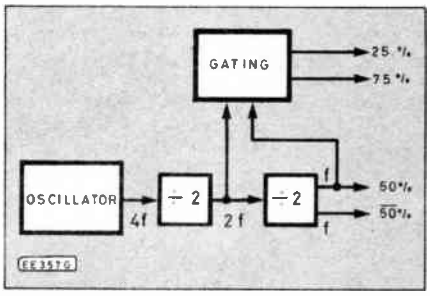


Fig. 1. Block diagram of the Digital Pulse Generator.

and it is the "high" period which varies as the setting of VR1 is altered. With the components selected, the frequency of the oscillator varies over a range of approximately 10:1 as VR1 is adjusted. The oscillator provides decade frequency ranges, with slight overlaps between the ends of adjacent ranges.

DIVIDER

The oscillator output is applied to the clock input of a D-type flip-flop, IC2(b), which is configured as a divide-by-two circuit. The output from IC2(b) is a square wave signal at half of the oscillator frequency. This output is then fed to a second divide-by-two circuit which uses a second flip-flop, IC2(a), to produce a square wave at a quarter of the oscillator frequency. The D-type flip-flops each have two output signals which are logical inverses of each other. Thus, while the Q output is "high", the $\overline{Q}$ output is "low", and vice versa. The

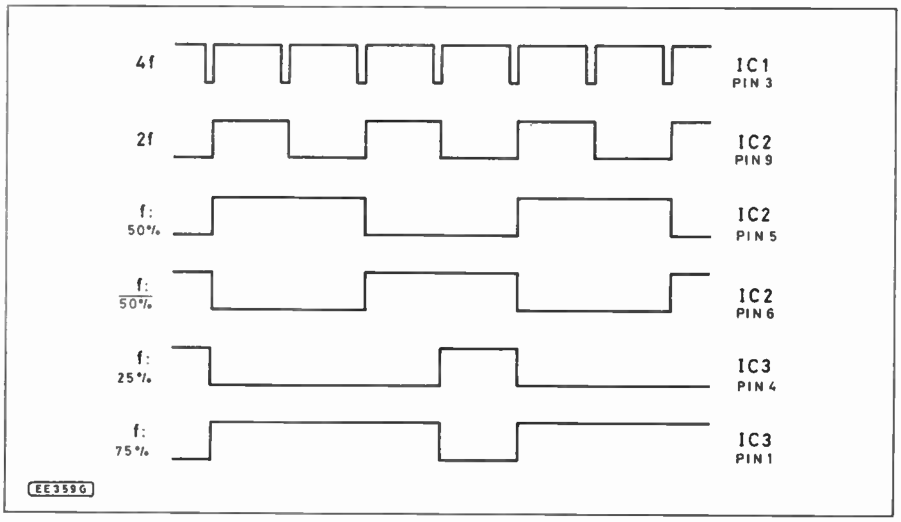
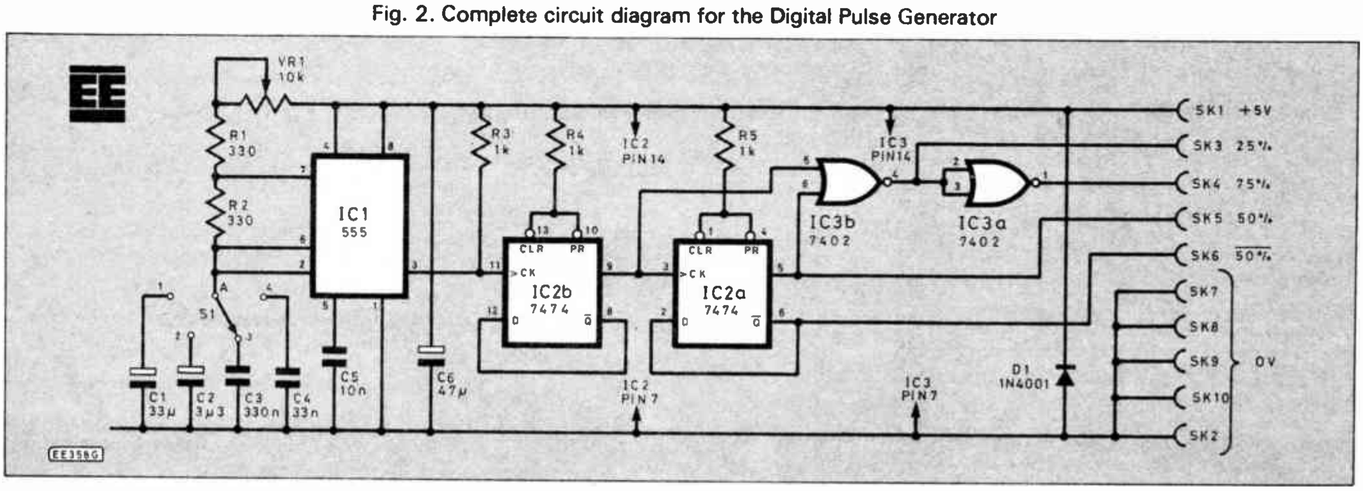
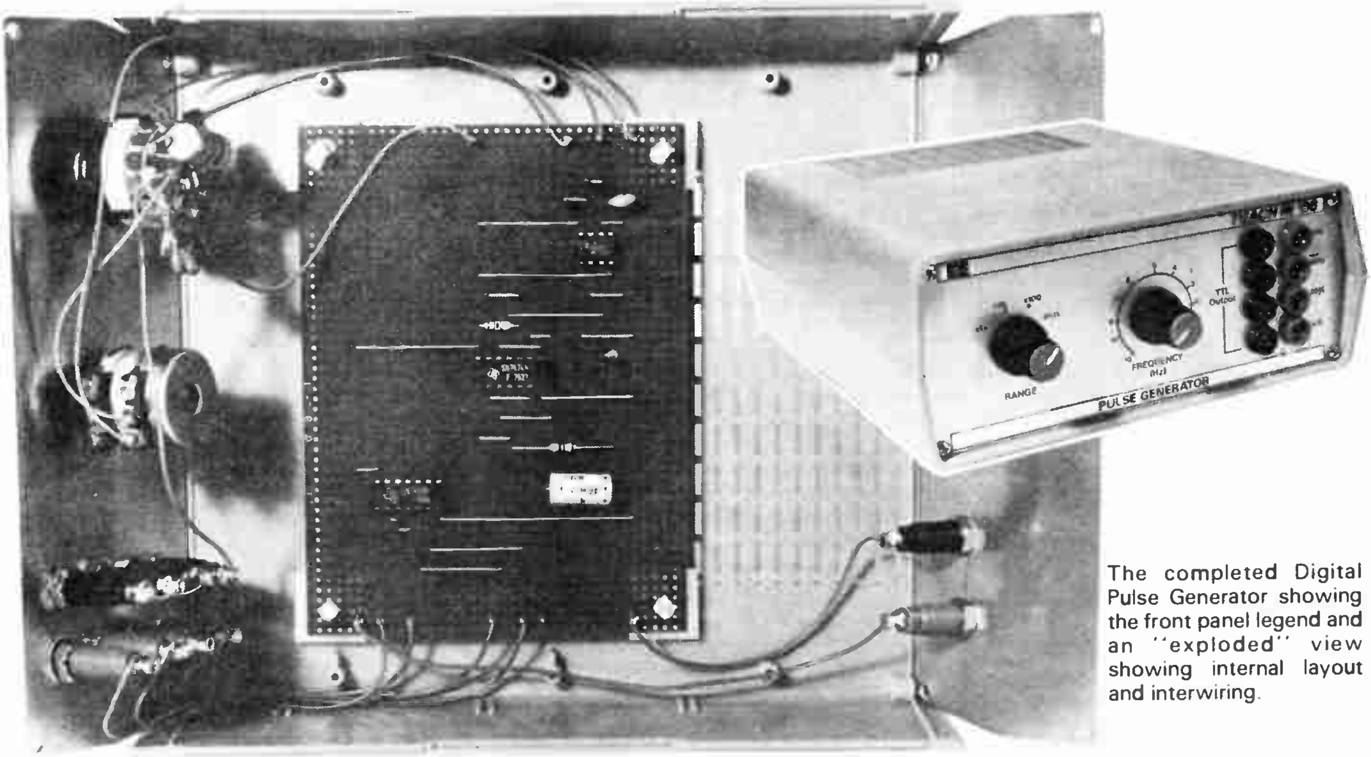


Fig. 3. Overall timing diagram for the Pulse generator.

Fig. 2. Complete circuit diagram for the Digital Pulse Generator





The completed Digital Pulse Generator showing the front panel legend and an "exploded" view showing internal layout and interwiring.

50% and $\overline{50\%}$ outputs are therefore taken directly from the outputs of IC2(a). The 25% and 75% output signals are then derived by gating the 50% signal and the signal at twice the output frequency. Two NOR gates, IC3(a) and IC3(b), are used for this purpose; the result is illustrated in the overall timing diagram for the unit in Fig. 3.

The power supply for the pulse generator is a single +5 volt rail. This should ideally be kept within 250mV of its nominal level. Protection against reverse polarity is given by D1, which will behave as a short-circuit under such conditions. C6 provides l.f. decoupling. If a suitable stabilised power supply is not available, a higher voltage supply may be used in conjunction with an integrated circuit fixed regulator. The first project in this series included a suitable circuit using a 7805 fixed regulator and two capacitors.

CONSTRUCTIONAL DETAILS

The unit is built in the standard project case, and uses a circuit board for mounting most of the small components. The layout for the main circuit board is shown in Fig. 4. However, before soldering any components in place on this board, four mounting holes of suitable diameter need to be drilled. In order to accommodate the integrated circuits, 18 track cuts are required between the rows of pins on each device. These are best made using a proprietary track cutter, or a large diameter sharp drill rotated slowly by hand.

When the board has been prepared, the components may be fitted in the positions shown. The order of assembly is not critical, but a methodical approach (e.g. left to right across the board) is to be recommended. Constructors may wish to use d.i.l. sockets for the integrated circuits, but these are not essential. Care should be taken to correctly orientate the polarised components (the integrated circuits, electrolytic capacitor

COMPONENTS

Approx. cost Guidance only £14

Resistors

R1,R2 — 330 0·25W 2% (2 off)
R3,R4,R5 — 1k 0·25W 10% (3 off)
All carbon film

Potentiometer

VR1 — 10k logarithmic potentiometer

Capacitors

C1 — 33µF 16V electrolytic (preferably tantalum)
C2 — 3·3µF 16V electrolytic (preferably tantalum)
C3 — 330nF polyester (10% or better)
C4 — 33nF polyester (10% or better)
C5 — 10nF polyester or ceramic
C6 — 47µF 16V elec.

Semiconductors

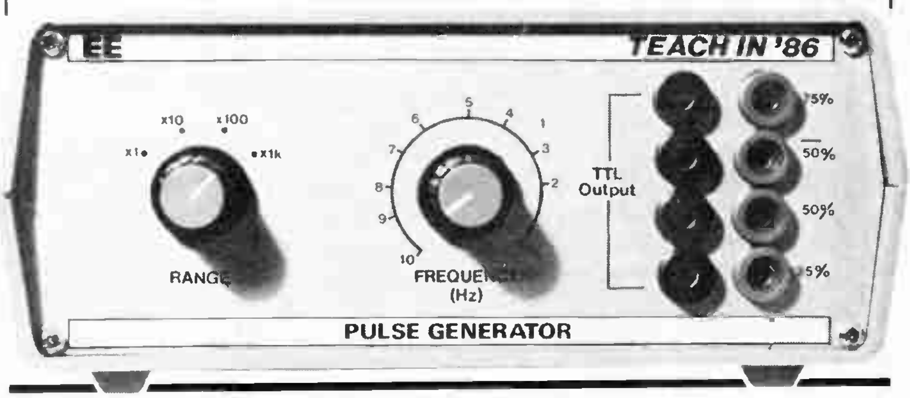
D1 — 1N4001
IC1 — 555 8-pin
IC2 — 7474
IC3 — 7402

See **Shop Talk** page 246

Miscellaneous

S1 — Three-pole four-way rotary switch
SK1,SK3, SK4,SK5, SK6 — 4mm socket red (5 off)
SK2,SK7, SK8,SK9, SK10 — 4mm socket black (5 off)

Two knobs with pointers, four stick-on plastic feet, Veroboard 0·1 inch pitch 5in. x 3·75in. and mounting hardware, Vero terminal pins (10 off), case; West Hyde Developments type TEK A22, available in black, grey or lobster red.



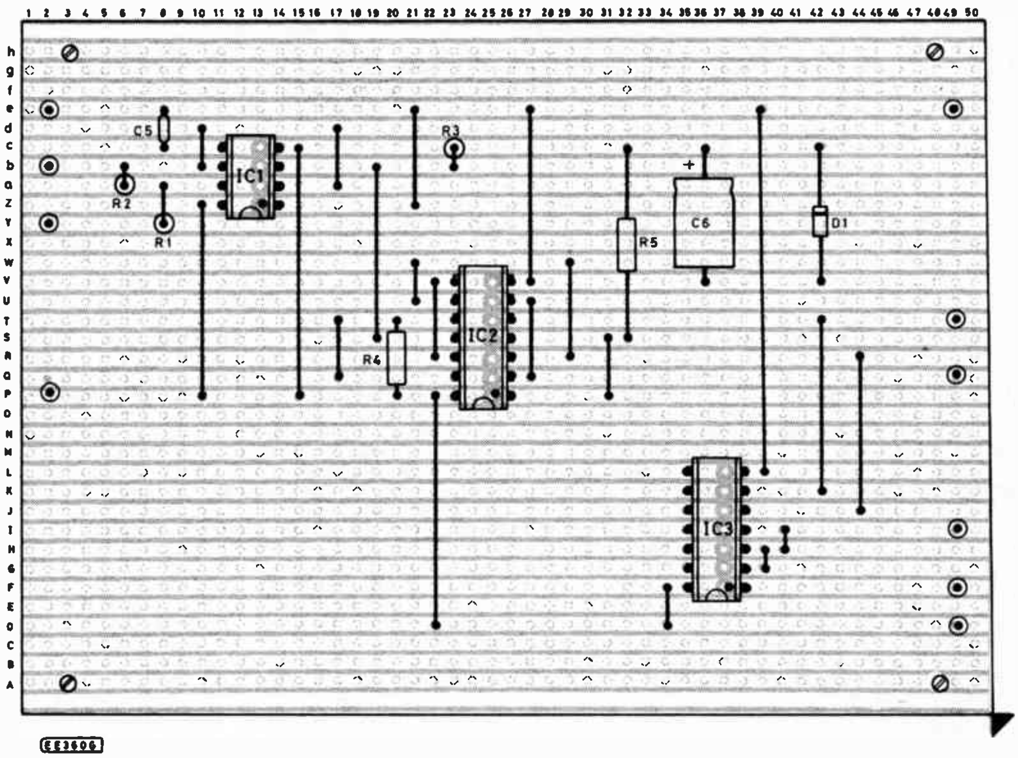


Fig. 4. Circuit board component layout and details of breaks to be made in the underside copper strips. Breaks are required at the following locations: *F*37, *G*37, *H*37, *I*37, *J*37, *K*37, *L*37; *P*25, *Q*25, *R*25, *S*25, *T*25, *U*25, *V*25, *Z*13, *a*13, *b*13, *c*13 (total of 18 cuts).

and the diode). The wire links are best made using lengths of tinned copper wire; 22 s.w.g. or similar is quite suitable. This is usually much easier than using insulated/stranded connecting wire. The use of terminal pins is recommended for all off-board connections, since this will simplify the later installation of the interconnection wiring.

Before moving on, it is well worth spending a few moments at this point making a careful visual inspection of the completed board. Particular points to look for are: missing wire links, wrongly fitted components, solder splashes and short circuits caused by accidental solder bridges on the track side of the board. A little time spent in checking at this stage can save many hours of troubleshooting later on. After the check, the board should be mounted in the base of the case. Enough space should be left to ensure adequate clearance for all panel mounting components. Plastic feet on the base of the case will prevent the mounting hardware from scratching bench or table surfaces.

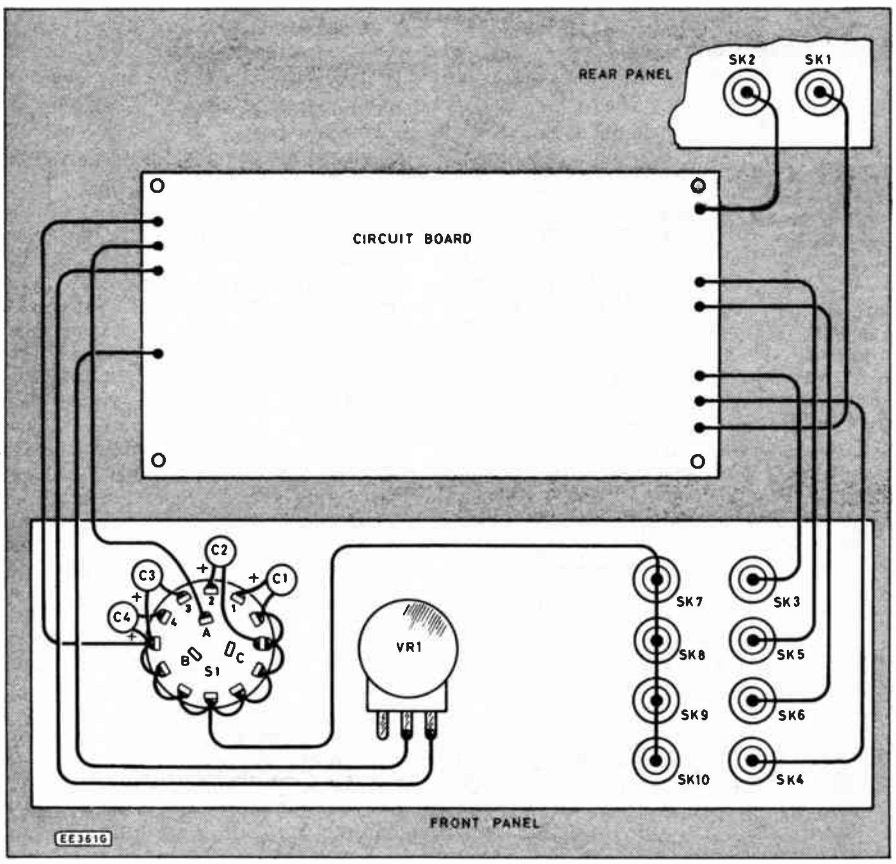


Fig. 6. Assembly and interwiring details.

FRONT PANEL

The next step is to drill the front panel in accordance with the layout given in Fig. 5. The hole diameters required may vary slightly from those shown, depending on the exact dimensions of the components used. Once the panel has been drilled, the overlay in Fig. 5 (or a photocopy) should be fixed to the panel; a layer of self-adhesive transparent library film can then be used for protection. The rear panel requires two holes in any convenient position to allow mounting of SK1 and SK2. The panel mounting components (i.e. the sockets, potentiometer and switch) can then be fitted as shown in Fig. 6.

The remaining components (which should only comprise C1 and C4) are fitted directly to the tags of S1. The interconnection wiring should then be installed as shown in Fig. 6. The front and rear panels should then be attached to the top and base of the case using the screws provided. The unit is now ready for testing and use.

TESTING

The first step is to measure the supply current drawn by the unit. This should typically be in the range 30 to 40mA for a +5V supply with no loads connected to the outputs. The higher current figure is to be expected when VR1 is set to the maximum frequency end of its range, and the lower figure when it is set to the minimum frequency. Any significant deviation from these figures should be investigated before

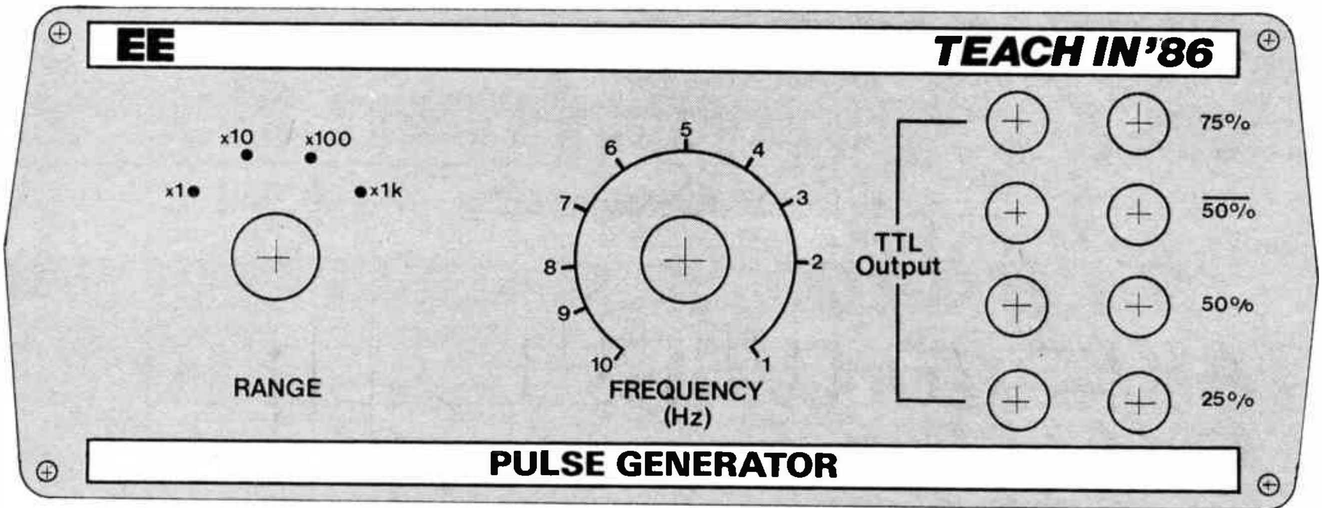


Fig. 5. Full size front panel layout. The final calibration may vary slightly to that shown.

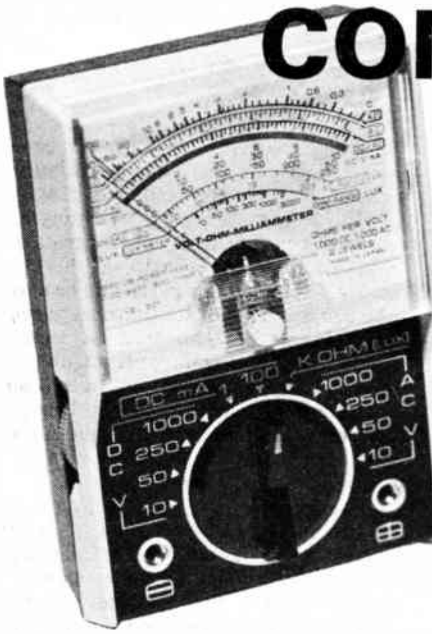
proceeding. Particular attention should be paid to the orientation of the ICs and D1, and to the interconnection wiring. If the supply current is significantly higher it is possible that the supply has been connected with the incorrect polarity, and that D1 is conducting.

The next step is to set the instrument to the lowest frequency range and adjust VR1 to give the lowest frequency. A multimeter connected to SK3, SK5, SK6 and SK4 in turn should then indicate a 1Hz output signal, but with different duty cycles. If an oscilloscope is available, the output waveforms may be checked against the timing diagram shown in Fig. 3. Alternatively, four l.e.d.s can be connected in a forward biased configuration (one for each output) directly between the outputs and 0V; the cathode of each diode should be connected to 0V. At the lowest frequency, the timing relationships will then be visible for all four outputs at the same time. Constructors should note that this technique is only suitable for standard 74 series TTL. In addition it should be noted that, although the logic states indicated by the diodes (i.e. "on" = "high") are correct, the levels themselves will not be correct TTL levels while the diodes remain connected. The l.e.d.s cannot, therefore, be left permanently connected in this fashion. If such permanent indicators are required, the outputs to the diodes will need to be buffered by additional gates. If a frequency counter is available, the unit may finally be checked on all four ranges. Any frequency errors between ranges are likely to be due to component tolerances, particularly of C1 to C4.

In use, the unit is capable of driving up to ten standard TTL loads from each output. This in practice means that up to 800μA may be sourced in the "high" output state, while up to 16mA may be sunk in the "low" state. A "low" output here is any level below +0·8V, while a "high" output is any level above +2·4V (typically it is +3·4V).

This completes the *Teach-In '86 Projects* and you should now have a suite of excellent test gear. However, next month we shall be publishing a simple *"Personal Radio"*. This should appeal to all followers of the *Teach-In Series* and employs two i.c.s.

COMPETITION *Results*



IN OUR Christmas issue *Fun Competition* we asked entrants to place eight listed captions in the order they thought were most apt and amusing for the photograph featured on the page.

When the coupons were examined the judges decided that the best order submitted was that from Mr. W. Stapleton of Basingstoke who put:

1–*D*, 2–*E*, 3–*J*, 4–*C*, 5–*K*, 6–*L*, 7–*B*, 8–*A*.

As one of our hundred prizewinners he receives an Ishii 301 Multimeter, with compliments of **West Hyde Developments**.

These are our 100 winners (each receive an Ishii 301 Multimeter):

Mr. K. Archer, Eastbourne: D. N. Askey, Telford: Ms. S. Azam, Birmingham: Mr. C. Bainbridge, West Boldon: Mr. E. Baines, Skipton: Mr. G. W. Baker, Ticknall: K. R. Balls, Inverurie: V. W. Bartlett, London SW16: Miss L. Baxter, Montrose: B. K. Black, Wirral: Mr. J. Black, Glasgow: Mr. D. Bodalia, Leicester: Mr. R. Bowron, Romsey: Mr. P. Brettle, Neath: Mr. D. Broadhurst, Evesham: Mr. A. J. Cain, Kirkby Thore: Mr. J. Campion, Cheltenham: Mr. B. E. Casey, St. Albans: G. H. Clapperton, Colchester: Mr. P. J. Clark, Benfleet: Mr. N. W. Clarke, Kings Lynn: Mr. J. Classey, Rugby: D. Clements, Chelmsford: Mr. D. H. Clyde, Winchester: C. P. Coad, Wadebridge: Mr. J. Coe, Whisby: M. Cohen, Manchester: Mr. E. A. Cook, Cwmbran: Mr. G. Cooke, Coleraine: Mr. G. Copping, Ilkley: Mr. N. J. Cummins, Stafford: Mr. F. Dallaway, Birmingham: Mr. C. Dell, Rickmansworth: Mr. M. Dickson, Newthorpe: B. Dynan, Camberley: L. Elliott, Bungay: Mr. S. Emson, Barnsley: Mr. M. Evans, Port Talbot: Mr. R. Fielding, Skegness: Mr. M. Flaherty, Wolverhampton: Mr. A. Fletcher, Abergavenny: F. H. Forrest, Manchester: Mr. D. M. Foster-Bazin, Blandford Forum: W. G. Gardiner, Hornsea: Mr. R. Gelstharp, Cardiff: Mr. A. Hall, Rochester: Mr. S. Hancock, Bangor: G. Harper, Wallsend: Mr. C. Harvey, Nottingham: Mr. N. Harvey, South Wirral: G. V. Haylock, Sidcup: Mr. N. Heald, Huddersfield: Mr. G. Hunter, Dalgety Bay: Hasanath Jamal, Birmingham: A. Kerslake, Tiverton: A. Klieve, Prescot: Mr. C. Lawrence, Middlesbrough: D. Lazenby, Scarborough: Mr. P. D. Lewin, Isle of Man: T. Lewis, Newmarket: J. R. Lockwood, Christchurch: J. W. Mackay, Whitehaven: Mr. D. Marshall, Loughborough: Vic Martin, Whitwick: Jayson McCollough, London NW10: Richard Missen, Southampton: G. Montague, Epsom Downs: Lloyd Moore, Sundridge: T. Neylon, Wolverhampton: Mr. J. Norman, Corby: H. M. E. Parker, Maidstone: Mr. G. A. Pearse, Harpenden: Mr. P. J. Pollard, Newcastle upon Tyne: Mr. W. J. Pullar, Murthly: Paul Quinn, Belfast: J. Rayne, Livingston: Mr. N. Reeves, Stockton-on-Tees: Mr. B. Reid, Lytham St. Annes: J. Rudrum, Eastbourne: Mr. S. Rylands, Wigan: Mr. J. C. Semple, Market Rasen: Mr. B. T. Shotton, Solihull: J. A. Shryane, Battle: Mr. A. C. Smart, Forfar: Mr. C. J. Smith, Bideford: L. J. Snow, Wokingham: Mr. W. Stapleton, Basingstoke: Miss V. Starr, Guildford: Mr. G. Stuart, Edinburgh: Mr. M. Thomason, Lymm: Mr. B. J. Thompson, Kings Langley: J. V. Thompson, Bognor Regis: D. Trembath, Holmrook: Mr. J. Walker, Burnley: Ms. R. Watson, Southampton: Miss L. Wigzell, Luton: Mr. D. Williams, Blacon: D. N. Williams, Foulden: Mr. R. Williams, Borehamwood: Mr. A. Willmott, Ipswich.

RICHARD TAKES UP THE CHALLENGE —AGAIN

AFTER last year's gallant attempt to secure the Blue Riband for the fastest Atlantic crossing by a passenger boat—*See News page Dec '85 issue*—comes news that Richard Branson, head of Virgin, is to try again.

Racal is backing the 1986 *Virgin Atlantic Challenger II*'s attempt and as well as supplying radar and electronics for the new craft they will be providing service support during sea trials.

Among the marine electronics and radar equipment from Racal are two MNS2000 navigation systems and the CVP3500 colour video plotter. These, together with satellite transmissions from Decca Navigator, Loran-C, Omega and Satnav, will be used to pin-point the vessel's location.

The Challenger I craft undergoing sea trials before its fatal mission

Last year's crew before they set out on their epic voyage

COMPUTER '86

The computer show for business and industry, **Computer '86,** ***will open at the G-Mex Exhibition Centre in Manchester from 24 to 26 June, 1986. On display will be the latest developments in computer technology from all areas of industry.***

Satellite TV Antenna Systems of Staines and Builth Wells, Powys, has received a bulk order to supply complete satellite television receiving systems to Thorn-EMI Ferguson Ltd.

Commenting on the order, Peter Gray, Satvrn's MD claimed that "this was the largest order for satellite receiving systems that had been placed in the UK".

HIGH-TECH IN THE HOME

Today's evidence shows that tomorrow's home owners will be just as reliant on television as their elders. For first-time home-buyers the most attractive developments foreseen in the next ten years are satellite television receivers—33 per cent—and flat-screen television to hang on the wall—32 per cent.

These findings are part of a MORI research study commissioned by Philips Electronics and conducted during the two weeks prior to the start of this year's Ideal Home Exhibition at Earl's Court, London.

The "new" appliances which people expect to have in their homes ten years from now are headed by microwave ovens—47 per cent, video recorders—42 per cent and cordless phones—30 per cent.

When it comes to what people think will be common in homes in ten years' time, a third of respondents picked the compact disc and as many as 23 per cent the video disc, a product which has barely come into their homes.

"The British are always ready to take up new technology," explains Ric Foot of Philips. "The British consumer leads the way with his requirements for video recorders, just as earlier with electronic calculators. Philips' interest in such a study is obvious: we invest in Britain's future to the tune of over £100 million a year on research, development and plant. We are committed to satisfying the next generation of consumer aspirations."

AIR CALL

British Telecom International (BTI), British Airways and Racal-Decca Advanced Development are teaming up to conduct trials of what is believed will be the world's first satellite telephone service for air travellers.

The trials, which will begin in 1987, will be conducted initially from Racal's Jetstream aircraft. Later, they will be extended to scheduled British Airways flights.

Passengers will make calls by inserting a credit card into a specially adapted payphone. This will unlock the handset and connect the caller with a ground-based operator in the UK who will connect the call.

Racal Decca Advanced Development, in consultation with British Airways, will apply its expertise in satellite technology to produce airborne transmitter/receiver equipment and develop specialised aircraft antennas. The company has already demonstrated an air-to-ground telex-type link.

BT ACQUIRES ITT

British Telecom announced in New York recently that it has signed a letter of intent with the ITT Corporation to acquire its subsidiary, ITT Dialcom Inc. Completion of the purchase, which is subject to ITT Board of Directors' approval, is expected this month.

As part of the purchase BT will acquire all of Dialcom's electronic mail and messaging business, including relevant software, licences, and copyrights.

The consideration of the acquisition, which will be satisfied in cash, will amount to less than one per cent of BT's net assets.

BICC Telecommunication Cables has helped to establish the UK's most advanced optical fibre communications link, capable of carrying nearly 8,000 telephone calls simultaneously.

The 72km link, between Sheffield and Nottingham, uses 8 single mode optical fibre cable made at BTCL's factory in Blackley, Manchester.

Electronic Brokers, recently appointed as the exclusive UK distributor for the Grundig range of high-quality test and measurement instruments, has produced a new 6-page colour shortform catalogue covering Grundig products.

Digitally Assisted TV

Digitally assisted television (DATV) is a new concept proposed by BBC research engineers. It involves the transmission of analogue picture signals together with high data rate digital signals carrying control or supplementary information about the picture.

DATV is a bandwidth compression technique intended for use with high quality television signals. The essential role of the digital component is to provide the receiver with control information to assist in reconstruction of the picture without significant degradation in quality compared with the original.

One application of DATV might be to reduce the bandwidth of a high definition television (HDTV) signal so that it can be accommodated within a single DBS channel, previously planned for 625-line TV services.

Early results from the experiments at the BBC's Research Department at Kingswood Warren indicate that the DATV concept can offer HDTV picture quality in the home, even when the bandwidth of the signal has been reduced by a factor of between two and four.

Charles Sandbank, Deputy Director of Engineering at the BBC, said *"DATV is a powerful technique to squeeze HDTV signals through the bottleneck of transmission channels using the sort of technology which will be in our homes in the 1990's. I am confident that it will play an important role in establishing a European broadcasting strategy for HDTV."*

MODEMS FOR SCHOOLS

The DTI is to spend one million pounds providing a modem for every middle and secondary school in Britain. The modems will allow pupils and teachers to connect their micros (supplied under previous DTI schemes) to databases of educational resource material.

Chief Education Officers throughout the country have received a letter from the DTI giving news of the offer which is part of the Department's "Industry Year" programme.

The initial aim is to ensure that every secondary and middle school has at least one modem. It may also be possible to provide additional modems for special schools, teacher centres, primary schools and further education institutions.

During the coming year the DTI will establish a national computerised information service (NERIS). The first curriculum areas to be covered will include maths, science and geography, and later other areas will be added. The modems will also allow schools to have access to the "Times Network for Schools" and "Prestel Education".

PATENTS AWARD

The outstanding career of Mr. R. F. Oxley is recognised in the award by Patent Agents W. P. Thompson & Co. of a unique certificate commemorating the granting of 100 worldwide patents.

Many of these patents are used in the manufacture of high quality components and systems at Oxley Developments, Cumbria, which was founded by Mr. Oxley in 1941.

PLEASE TAKE NOTE

UNIVERSAL LCR BRIDGE *(Nov '85)*

Pages 605/6. The value of R25 was shown to be 1kΩ in the Component List, when it should have been 100Ω as shown in the main circuit diagram.

The value of the standard capacitor used in the project to produce the Inductance range given in Table 2.1 should be 1nF and not 1μF. Hence, in order for the circuit to function correctly, two different values of C8 must be used, one for the Inductance range (1nF) and one for the Capacitance range (1μF). This problem can be overcome by using a spare pole of S1 (the FUNCTION switch) to switch the value of C8 to 1nF on the Inductance range.

There is an error in the component layout (Fig. 2.5), whereby the labels on the SK3/SK5 leads have been incorrectly transposed. The wiring diagram is correct.

There have been some cases of difficulty with obtaining substantial oscillation from the oscillator transistor, TR1. This device needs to be a high gain device (hence the BC109), but some samples seem to have inadequate gain. The use of a selected-gain type (such as a BC109C), combined with reduction of R6 to 270Ω should work.

CARRYING on from last month's brief discussion of the BBC computer's analogue port and its function as a joystick port, in this article an alternative to a conventional joystick will be considered. The design in question is a Touch Controller, similar in concept to the controller described in the February 1986 issue of this magazine. However, the original design was for use with computers which have an Atari/Commodore style joystick port, and these are intended to operate with joysticks that contain four switches rather than two potentiometers. The original circuit is therefore totally incompatible with the BBC machine's analogue port.

VOLTAGE CONTROL

The touch controller could be designed to mimic the potentiometers of a conventional joystick, but in practice it is much easier to design a circuit which directly supplies suitable voltages to the analogue inputs. The touch controller circuit of Fig. 1 operates in this manner.

Horizontal control is provided by IC1a and its associated components, while vertical control is provided by IC1b, and the two circuits operate in exactly the same way. If we consider operation of the horizontal control circuit, IC1a operates as a straightforward unity voltage gain buffer amplifier. The important feature of IC1a is that it has a MOSFET input stage which provides an extremely high input resistance (over one million megohms in fact). This prevents it from providing a significant discharge path for C1, despite the fairly low value of the latter. R2 is a merely a protection resistor for the input of IC1a.

By touching the upper pair of touch contacts the charge on C1 can be increased, as C1 then charges from the 1.8 volt reference source by way of R1 and the skin resistance of the user. Similarly, operating the lower pair of touch contacts results in C1 discharging. By means of the touch contacts the charge on C1 can therefore be varied from 0 to 1.8 volts, taking the CH1 analogue input over its full voltage limits. In practice it may well be found that the extremes of the voltage range cannot be achieved, but this is not important as many joysticks fail to do so as well, and software is normally designed to utilize slightly less than the full range.

FIRE

A fire button is needed in most joystick applications, and the analogue port has two digital inputs for use with these (one input for each joystick). PB0 is the input for use with joystick 1, and this must be pulled low when the fire button is activated. In this circuit the fire button is replaced with a pair of touch contacts and the simple trigger circuit based on IC2. IC2 operates as a voltage comparator, and under stand-by conditions the non-inverting input is biased slightly positive while the inverting input is tied to ground. The output accordingly goes high. If the touch contacts are activated the inverting input is taken more positive than the non-inverting input, sending the output low and taking PB0 to the active state.

The fire buttons are read using the ADVAL(0) function, and this should be ANDed with 1 to read the fire button on joystick 1, or 2 to read the firebutton on joystick 2. For instance, PRINT ADVAL(0) AND 1 will return a value of 0 if fire button 1 is being activated, or 1 if it is not. Similarly, PRINT ADVAL(0) AND 2 will return a value of 0 if fire button 2 is not being operated, or 2 if it is.

Simply build up two controller circuits if twin touch controllers are required, but the outputs of the second circuit should connect to CH3, CH4, and PB1 respectively, instead of CH1, CH2, and PB0.

Careful thought needs to be given to the placement of the touch contacts, and we found the arrangement of Fig. 2 to be a good one. The two sets of direction control contacts can be operated with one's thumbs, with a forefinger being used to operate the "fire" contacts. The latter are probably easier to operate if they are positioned on the top end of the case rather than at the top of the front panel. The unit can be housed in practically any small plastic case, with the use of a plastic type being important as it provides insulation between the touch contacts. Special touch contacts can be obtained, or they can simply be large panel-head screws. In either case the connections to the contacts are made by way of solder-tags. Connection to the computer is via a 15-way D plug, and connection details were given in last month's article.

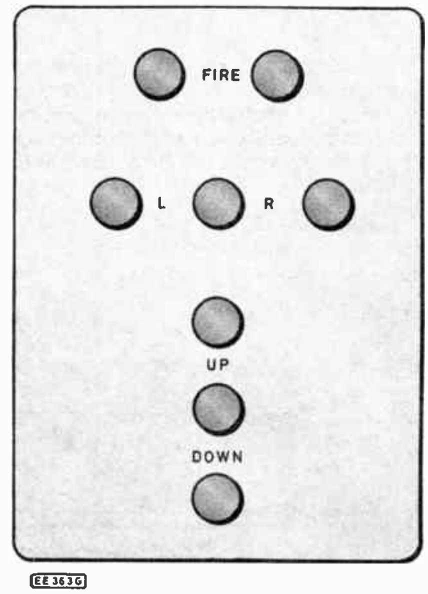
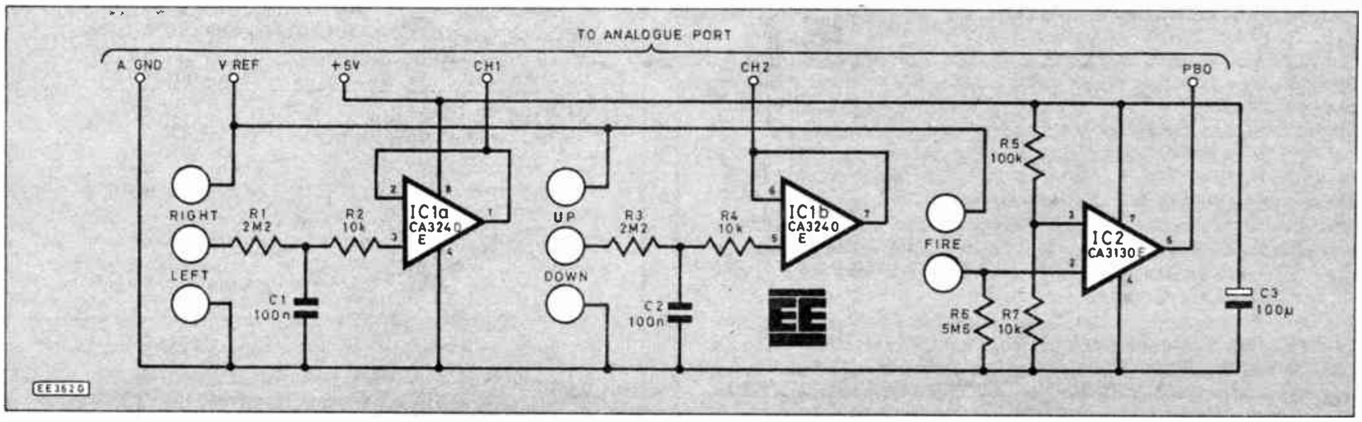


Fig. 2. Suggested touch pad layout.

The charge/discharge time of the controller has to be something of a compromise. For arcade style games it needs to be quite short in order to permit suitably rapid responses to be made to the on-screen happenings, but it must be long enough to enable accurate placing of the on-screen character that is being controlled. If necessary the response time can be increased by making C1 and C2 lower in value, or increase by using a higher value. A little practice is needed before fluency can be achieved with any new type of controller, but after a little practice the unit should be quite easy to use.

Fig. 1. Circuit diagram of the Touch Controller.



TEST PROGRAM

It is not difficult to roughly scale the readings from the analogue port to suit the required screen mode. The accompanying test program enables Controller 1 to be tested in mode 4. It simply enables an on-screen character to be moved around the screen, and prints "FIRE" when the fire contacts are activated. Of course, the controller should operate perfectly well with any software written for use with a standard BBC joystick.

The analogue port, although primarily intended for operation with joysticks, can be used in applications where accurate electronic measurements are required, and this is a topic which will be covered in the next article.

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  10 REM TOUCH CONTROLLER TEST
  20 MODE 4
  30  PRINT "PRESS <SPACE> TO END"
  40 VDU5
  50 OX=640:OY=512
  60 D$=""
  70 ON ERROR GOTO 180
  80 REPEAT
  90 MOVE OX,OY
 100 GCOL 0,0:PRINT D$
 110 IF ADVAL(0) AND 1 THEN D$="F":VDU19,1,1,0,0,
0: ELSE D$="*":VDU19,1,7,0,0,0
 120 X=1279-ADVAL(1) DIV 51
 130 Y=ADVAL(2) DIV 64
 140 MOVE X,Y
 150 GCOL 0,1:PRINT D$
 160 OX=X:OY=Y
 170 UNTIL INKEY-99
 180 VDU4
>
```

REVIEW

HEAD ALIGNMENT TAPE

Cassette loading is something which still troubles many people. Often, problems can be traced to inaccurate head alignment, which causes reduced output, especially of the higher frequencies.

The Azimuth Head Alignment Tape from Interceptor Software is designed to simplify the adjustment of head azimuth, and so help to end loading problems.

As well as the tape, you get an instrument type screwdriver, and two arrows printed on card, which you have to cut out (you only need one for the adjustment, the other presumably being a spare). You also need two matchsticks. The screwdriver is a cross-head type, which is correct for the official BBC data recorder, but many other makes use a normal slotted screw for this adjustment. The arrow is mounted on the screwdriver.

To use, you load and run the program on the tape. The tape continues running, and the program displays a counter on the screen. You turn the adjustment screw on the tape deck anticlockwise until the computer beeps and the counter resets, and then you turn the screw back until the counter starts again. You then mark the position of the arrow with one of the matchsticks. You then repeat this, turning the screw initially in the clockwise direction.

You have then found the two extreme positions in which the head will read the tape. The optimum setting is then found by setting the arrow midway between these two points. The only slight problem here is that the angle between the two matchsticks can be more than 360 degrees.

The matchsticks and card arrow may sound a bit Heath-Robinson, but in fact work quite well, and should certainly improve loading of commercially-recorded tapes. The only problem may be that if you have recorded a lot of your own programs with the head misaligned, you may have difficulty loading them back after adjusting the head.

As a reward for this effort, you get to play a game called "Tales of the Arabian Nights", which comes free on the B side.

Interceptor Software are at Mercury House, Calleva Park, Aldermaston, Berks. The telephone number is (07356) 71145, and the price for the head alignment kit is £8.99 inclusive of VAT and postage.

FREE! READERS' BUY & SELL SPOT

EE MARKET PLACE

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Heathkit oscilloscope 10-103. New mains transformer. Assembly and setting up manual. £60. Buyer collects. Phone 0227 362286. W. J. F. Winkley, 25 Osborne Gardens, Herne Bay, Kent CT6 6SH. Tel: 0227 362286.

Desoldered diodes Unmarked. 10p for thirty. Send s.a.e. P. Booth, Caldewell House, Stoulton, Worcs. WR7 4RL.

Laser 2mW Spiro head and control desk £300. Also 5mW and 2mW laser tubes and P.S.U. £275 and £200. Mr. D. J. Grubb, 2 Blanquettes Avenue, Worcester. Tel: 0905 51150.

Scopes Tektronix 533A 15 MHz £65. 555 30MHz £90. Marconi 801D/8 signal generator 10–485MHz £75. AF. Gen £30. G. Beal, 115 Southdown Road, Portslade, E. Sussex BN4 2HJ. Tel: Brighton 416963.

Wanted *Everyday Electronics* August 1976 and November 1983. A. Griffiths, 12 Blenheim Drive, Great Barr, Birmingham B43.

Polaroid ultrasonic ranging system designers kit, detecting presence and distance of objects 0·9–35 feet £45. Tel: 0484 25589.

Diablo printer with power supply £225. Tektronix 'scope dual trace 15 MHz £105. Pulse generator 3nS risetime £55. T. Haley. Tel: 01-868 4221.

Wanted circuit diagram for speak and spell or pinout details of CD2303, CD2304 and NA7949 i.c.s. Mr John Murphy, 2 Morden Gardens, Mitcham, Surrey CR4 4DH. Tel: 01-646 1733.

CBM C16 with recorder P.U. tapes and manual. New. £50. Wanted data on Rochar A1149 counter. J. Galvin. Tel: Crudwell (06667) 7820.

Public address re-entrant horn speaker 25W 15 ohm new. £25. Tel: 01-524 3606.

Box approx. 1,000 ¼W resistors mixed. Several packs surplus to requirements. £4 per box incl. postage. Mr P. J. Warwick, 34 Heather Shaw, Trowbridge, Wilts BA14 7JS. Tel: Trowbridge 67077.

Ultraviolet exposure unit attractive wood box. Mains ultraviolet neons timer. Phone for details. £45. Paul Reed, 7 Shirley Gardens, Hornchurch, Essex RM12 4NH. Tel: 04024 41579.

Maplin frequency counter 10Hz–600MHz 8 digit variable time gate mains/battery. Fully calibrated with manual £140 (o.n.o.). D. Pratt, 2 Slades Lane, Meltham, Huddersfield, W. Yorks. Tel: 0484 850327.

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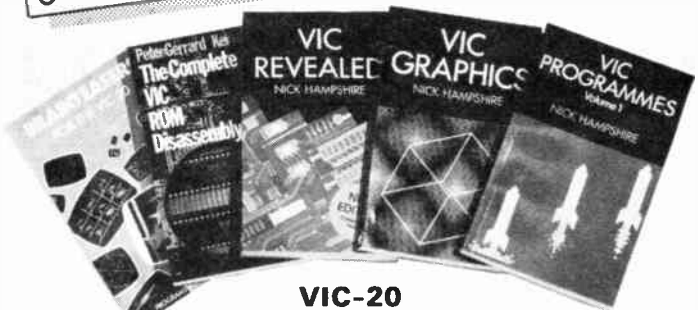

VIC-20

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Vic Programmes Vol. 1 Pub. Price £6.95
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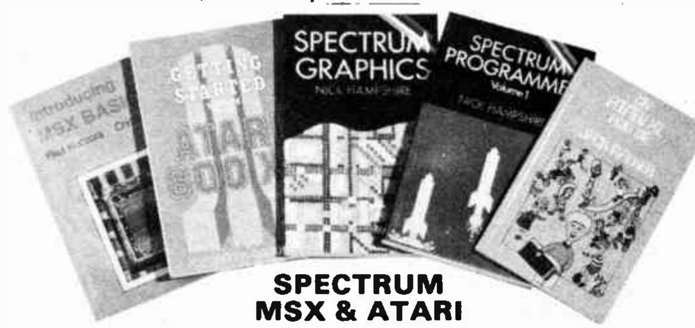

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Introducing MSX Basic Pub. Price £6.95
Paul Kuzora & Christine King. Size 210 × 150mm 242pp
First steps in MSX BASIC, sound and graphics, sprites + 5 programming projects. Essential guide for all MSX owners.

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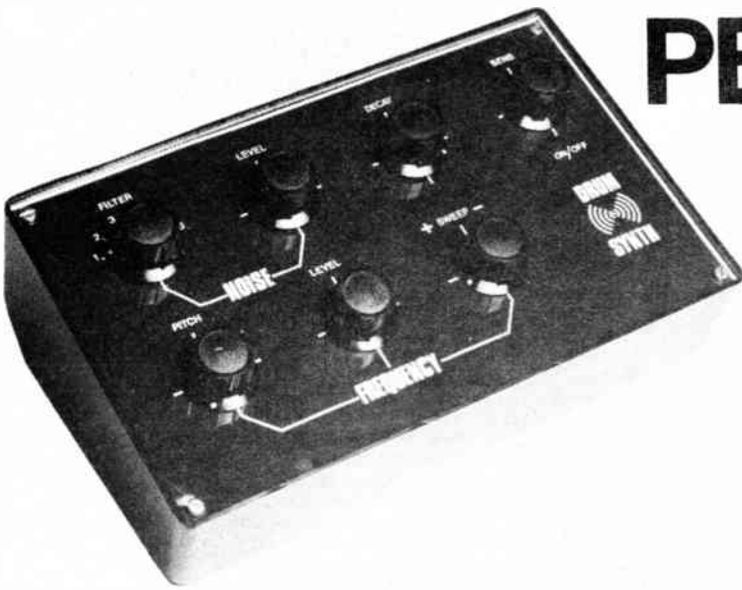
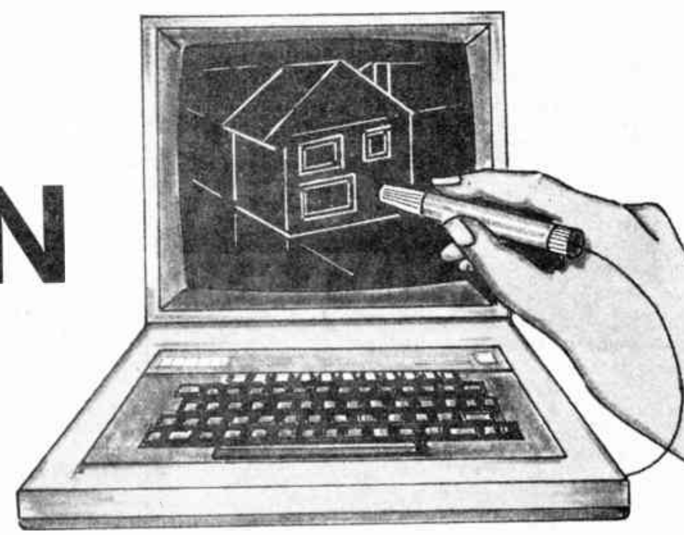
JUNE FEATURES...



PERCUSSION SYNTH

This single channel synthesiser is capable of producing a wide range of percussion sounds. It can be set up to mimic real percussion instruments or to produce synthetic "electronic" percussion sounds. The sound may be triggered by positive pulses from a sequencer or by tapping a piezo electric pick-up device. In the latter mode the circuit is touch sensitive the sound level varying according to how hard the pick-up is hit. A versatile synthesiser for around £30.



LIGHT PEN

If you own a BBC micro, you have a computer with the facility to accept a light pen. But if you try to go and buy a ready-built unit you will be amazed at the cost. This is partly due to the difficulty in manufacturing a reliable piece of hardware. Some manufacturers have attempted to produce such a device, but owing to marketing considerations, i.e. cost and potential sales, the resulting hardware leaves a lot to be desired. In this article we present a light pen which in component parts will cost around £5.00, yet give excellent resolution and accuracy.

PORTABLE RADIO

Just the project to build ready for those long hot summer months laying on the beach listening to your favourite station. This inexpensive personal radio is fun to build and use. It employs two i.c.s plus a handful of discreet components to provide a simple high performance receiver.

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

JUNE ISSUE ON SALE FRIDAY, MAY 16

Make sure of your copy—place an order with your newsagent NOW!

AUTOMATIC FIRING JOYSTICK ADAPTOR

R. J. EVANS

"Machine gun" your way to stardom with this quick fire addition for your computer

WHEN playing a "zap" type computer game involving joysticks, it is often found that the rate of fire is insufficient, especially at the closing stages of the game. This is usually due to the fire button finger becoming tired by then.

What is required therefore, is a device which will effectively press the button for the player. A device which did this continuously, throughout the game, would be pointless and rather useless in games where energy reserves were depleted during firing. The solution lies in a device that will provide a continuous stream of fire, at a presetable rate, when the fire button is pressed.

The circuit described here fits the bill perfectly. It fires at a rate from three to thirty times per second. Often at the faster speed firing is in salvoes, which can give a very pleasant effect. The device plugs between the joystick and the computer, eliminating alterations to the joystick.

APPLICATIONS

The circuit operates with games which fire a shot as soon as the fire button is pressed. Games like "Aviator" (Acornsoft), where the gap between potential shots is large, and "Starship Command" (Acornsoft) where the gun already fires at the maximum rate are not suitable for it, though the games can still be played with the unit in circuit.

This leaves a multitude of games where such a device is invaluable, when used with these, the player is free to concentrate on using the joystick for movement, resulting in higher scores. Many claims are made for commercial joysticks that "rewrite high score tables", but this device achieves the effect at much lower cost.

THE CIRCUIT

The circuit is built around a 555 monolithic precision timer, wired up in the astable mode. The frequency given by the basic circuit (see Fig. 1) is:

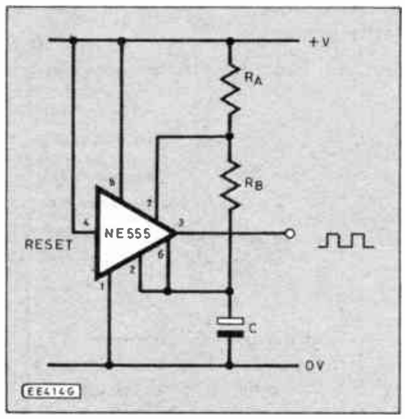


Fig. 1. Basic 555 timer astable.

$$f = \frac{1}{1{\cdot}4 R_B C}$$

$$\text{if } R_B > R_A$$

The required range of the oscillator is from 3Hz to 30Hz, so if C is rated as 1µF:

For 3Hz,
$R_B = 1/1{\cdot}4fC$
$= 238k$
For 30Hz
$R_B = 23k8$

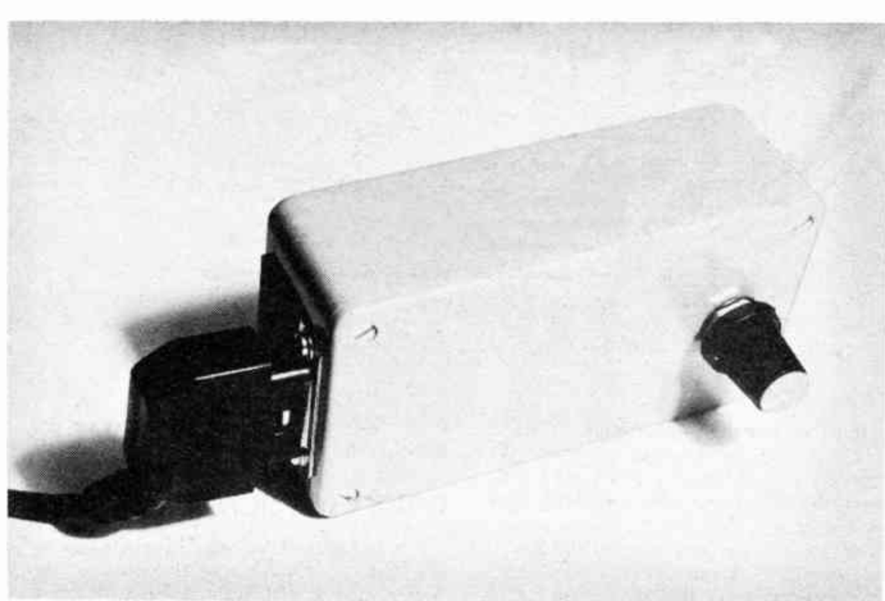
Having calculated the required values exactly, then a compromise has to be reached between the required values and values readily available. The resistance network was finally built out of a 22k resistor in series with 220k variable resistor (Fig. 2).

The reason a smaller capacitor is not used is that this would make the resistances much larger, and more difficult to select from standard components.

The reset (pin 4) on the chip, will prevent operation when pulled low, and this is connected to the fire button. However, the fire button itself operates by giving a logic 0 signal, so the output must be inverted. The output of the chip will both sink and source current, but it is safest to mimic the fire button as accurately as possible, so the output is passed through an open collector type inverting gate. The open collector output will provide only a logic 0 signal or be an open circuit. To minimise chip count, both inverting gates required are in the same package and of the open collector type. Resistors R1 and R2 are used as pull-ups, to provide a logic 1 signal at the open circuit condition.

The rest of the circuit is standard—R3 acts as R_A and R4 together with VR1 as R_B, and C2 is C. Capacitor C1 is connected to the control pin on IC1, and provides stability. All the spare inputs on IC2 are grounded.

The two connectors (Figs. 3 and 4) are 15-way "D" types, a line plug and a p.c.b. mounting socket. The joystick line plug fits into the socket, and the unit line plug fits



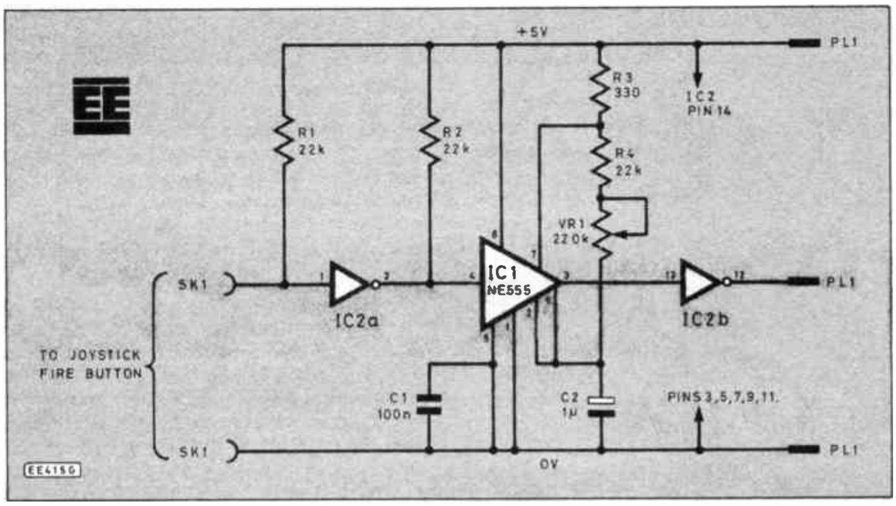


Fig. 2. Circuit diagram of the adaptor.

COMPONENTS

See **Shop Talk** page 246

Resistors
R1,R2,R4 22k (3 off)
R3 330

Potentiometer
VR1 220k lin.

Capacitors
C1 100n disc
C2 1µ radial elec. 12V

Semiconductors
IC1 NE 555 timer
IC2 7406 or 7405

Miscellaneous
SK1 p.c.b. mounting 15 way D socket
PL1 line 15 way D plug with cover
Small plastic box approx 120 × 65 × 40mm; p.c.b. available from the EE PCB Service, order code 523; 1m seven core cable; control knob; nuts; bolts; solder; connecting wire etc. Single pole changeover switch for Bypass Switch—if required.

Approx. cost Guidance only £12.00

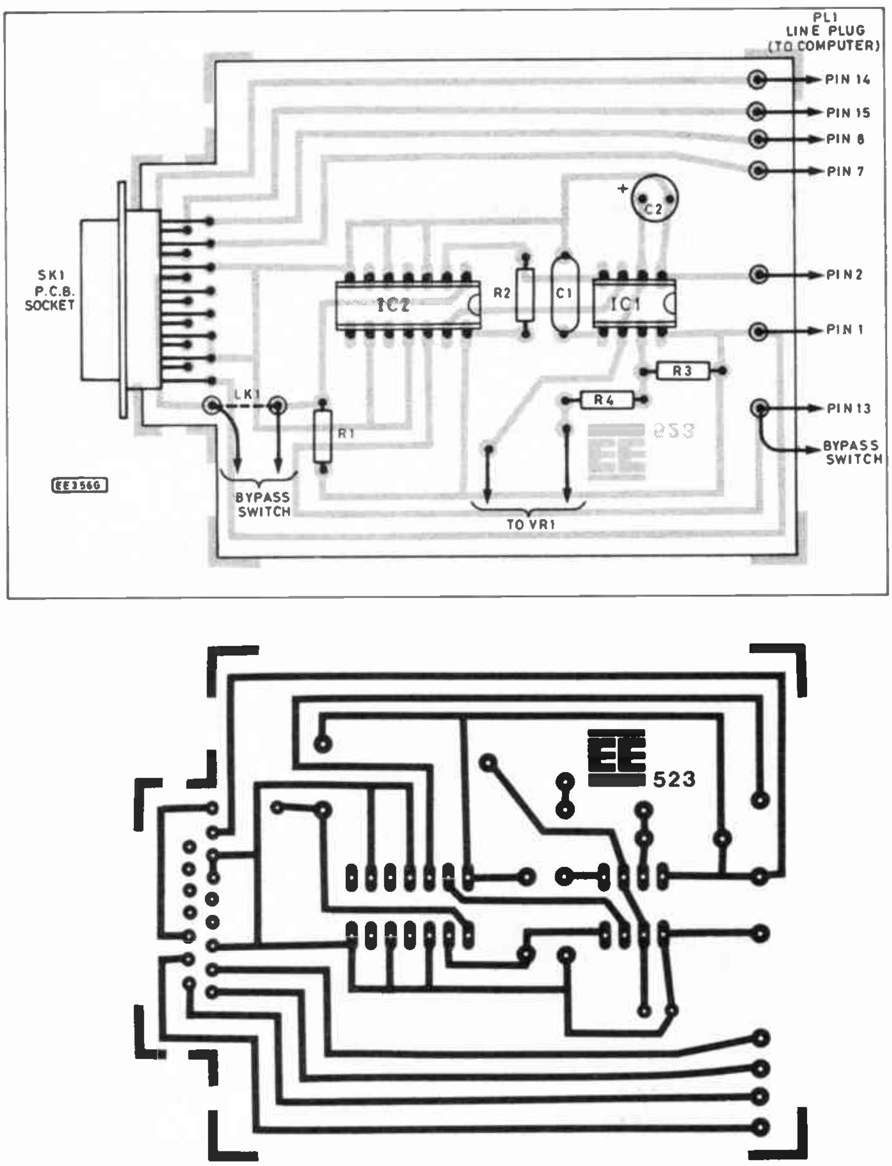


Fig. 5. Layout and wiring of the p.c.b. for the Joystick Adaptor.

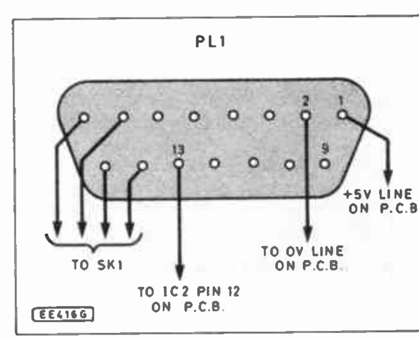


Fig. 3. Line plug wiring.

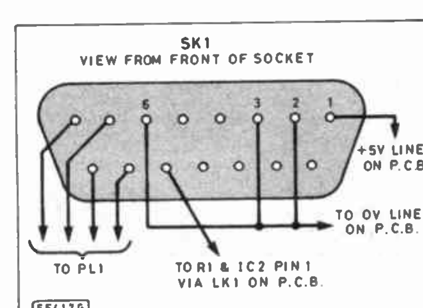


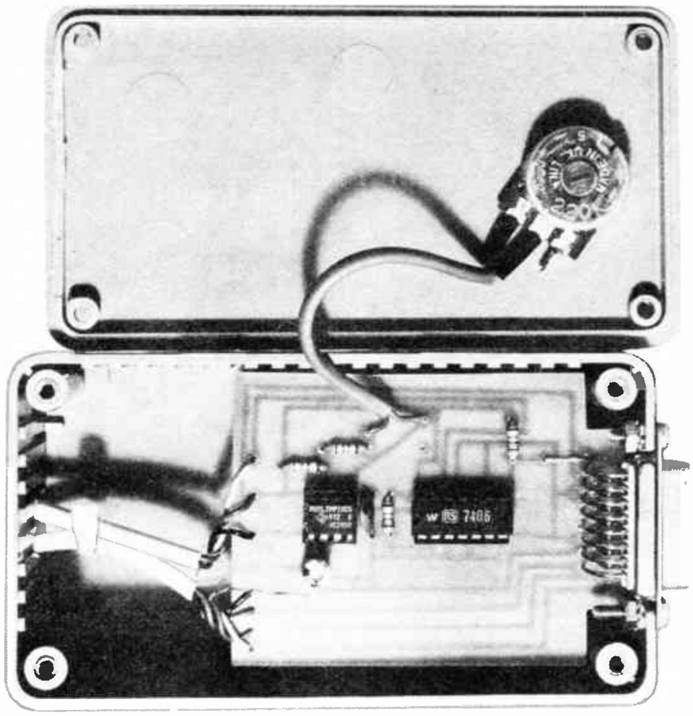
Fig. 4. P.c.b. socket wiring.

into the computer. In the design of this attachment, the use of single joystick is assumed. The four lines directly connected between the two connectors, therefore, are for one joystick only.

Wiring details are provided for the BBC micro but the unit can be used with any microcomputer where the fire button connects down to the 0V line and a +5V supply is available.

CONSTRUCTION

Use of the p.c.b shown is strongly recommended, if only because the pins on the socket do not fit into stripboard holes. Assembly of the p.c.b. is very straightforward, as there are so few components on it. Details of the p.c.b. and component layouts are given in Fig. 5. The wire link LK1, can be replaced with a bypass/ inhibit switch if required. This should be wired to connect pin 13 on SK1 to pin 13 on PL1 and break the connection to R1.



```
10REM AUTOFIRE TEST PROGRAM
20*KEY1 RUN|M
30*KEY10 OLD|M RUN|M
40MODE1
50PRINT"Readings from Analogue input channels"
60PRINT
70PRINT"RED-1     YELLOW-2"
80MOVE1280,0:DRAW5,0:DRAW5,900
90PRINTTAB(35,30)"time"
100B=0:C=0:D=0
110FORX=1TO1280 STEP4
120M=ADVAL(1)/64
130N=ADVAL(2)/64
140P=(ADVAL(0)AND3)*500+10
150MOVEX-4,B:GCOL0,1:DRAWX,M
160MOVEX-4,C:GCOL0,2:DRAWX,N
170MOVEX-4,D:GCOL0,3:DRAWX,P
180B=M:C=N:D=P
190 NEXT
200 GOTO 40
```

When fitting the socket to the board make sure that the end face is perpendicular to the board, and that the surface plate protrudes about 3mm from the edge of the board. Fit the 7-way cable to terminal pins mounted at one end of the board.

Use a small plastic box to house the project, cut a deep notch into one end and then assemble the unit as shown. The faceplate of the p.c.b. mounted socket is mounted *outside* the box, and VR1 is mounted at the other end of the box. The bolts used are M3 types—remember to use lockwashers as a loose nut inside the box will act as a mobile short circuit. The circuit board is perfectly well supported by the socket pins alone, no further support is necessary. All that remains is to fit the line socket to the end of the lead and check the unit before connecting it to the computer.

TESTING

Type in the program shown below and plug in the unit, with a joystick attached. You should see three horizontal straight lines on the screen. If one or more of the lines is oscillating around the top of the screen, there is no connection between that channel on the joystick and the computer. If the lines are all straight, press the fire button. You should see a square wave appear on the screen. If you see no change, check that the wire link on the board (or optional bypass switch if fitted) is in place. If it is, check that pin 4 becomes high when the fire button is pressed, if it does not, check IC2 and its connections. If pin 4 does go high check the R3, R4, VR1 and C2 network.

BOOK REVIEWS

RATE EQUATIONS IN SEMICONDUCTOR ELECTRONICS

Author J. E. Carroll
Price £25 hardcover
Size 233 × 155mm; 177 pages
Publisher Cambridge University Press
ISBN 0 521 26533 9

IN THIS attractively-presented new book, Professor Carroll adopts a new approach to the actions of semiconductors. *Rate Equations in Semiconductor Electronics* is not a book that can be recommended for beginners. However, it ought to be compulsory reading for everyone (including some teachers) who still thinks that all engineers wear dirty overalls, have a hammer in one hand and a screwdriver in the other.

The opening chapter is engaging; how to work out the rate of change of probability of being able to exchange contracts when house-hunting is briefly analysed. Chemical reactions are considered, and a fresh, modern approach is taken to the traditional problems of information transmission and arrival.

The bulk of the book is then concerned with rate equations to describe the movement of electrons, and hence the action of semiconductor and optoelectronic devices. Included are dynamic models of the rate of change of stored charge in p-n junctions and bipolar transistors and an analysis of the rates at which electrons and holes can reach equilibrium. This relates directly to the time required for any device to switch. More advanced topics, including the photon statistics of injection lasers are then considered, and, finally, rate equations are developed from Maxwell's equations to show how quantum and classical concepts tie together.

This is an ideal text-book for Higher-Education students, and is worth looking at by anyone who is interested in the theory behind the techniques used by today's engineers. D.A.B.

MICROCHIP

Author T. R. Read
Price £9.95
Size 214 × 132mm. 243 pages
Publisher Collins
ISBN 0 00 217 040X

THIS book can be read for sheer enjoyment, it is the story of two Americans, Robert Noyce and Jack Kilby who invented the microchip. It also traces the evolution of the microchip from Fleming's diode to the present day and explains the working of the digital watch and pocket calculator in a language the complete novice can understand.

It deals with the fight for patent rights between the two inventors, which occupied the courts for ten years and ended in a draw, and it also touches on the work of W. Edwards Deming, an American who taught quality control to the Japanese so successfully, that for several years the United States couldn't compete with them for producing reliable integrated circuits

The invention of the microchip effects everyone's lives, as much as the telephone or electric light, and yet the two inventors are relatively unknown even in America. This splendid book should help to put the record straight. A.S.

See Page 247

FOR YOUR ENTERTAINMENT

BY BARRY FOX

BBC In Secret Deal

The BBC and Acorn computers are pathologically secretive about their deal on the BBC Micro. By an unhappy coincidence Acorn unveiled the new range of BBC Micros on the same day that the BBC announced its latest round of cuts in the engineering and research departments. Education is also being cut. Manchester, Bristol and Southampton will lose their radio and TV officers. They usually go round schools, promoting programmes and gathering feedback.

So I asked again about how much the BBC earns from the Acorn Micro, because if it weren't for the BBC's technical and educational departments there wouldn't be a Micro and any earnings from Acorn. Once again both BBC and Acorn refused to comment.

Fortunately there are some other good guidelines to read from.

In 1981 BBC engineers drew up the specification for a BBC computer. Acorn won the contract and so far has sold 0.7 million at an average of £400 each. The first generation of micros is in over 70 per cent of British schools. The new generation of Acorn computers carry the BBC name and will generate further income for the BBC.

Acorn pays a royalty on each machine for the original design work and the right to use the BBC name and Owl logo. The BBC's revenue is disguised amongst income from the sale by BBC Enterprises of radio and TV programmes, as well as records and tapes. But when the BBC licences an invention it charges up to 15 per cent, which is well above the normal going rate of around 5 per cent for a patent or technology licence.

The BBC also jealously guards its name because it is arguably the most valuable trademark commodity in Britain. Buying something which the BBC has blessed feels safe.

A middleman, who spends his life negotiating licensing deals of this type, believes that if the BBC gets less than 10 per cent from Acorn it has been missing out. This puts the BBC's revenue from the Acorn Micro at nearly £30 million.

There is much more to come because the BBC will go on plugging its Micro both on and off the air. No wonder Sinclair, Apricot and Commodore wanted to pick up the BBC Micro contract when Acorn hit financial problems last year.

Commodore was ruled out because it wasn't a UK company. For the same reason the government wouldn't put Commodore on the list of computers which schools could buy with a grant. But that didn't stop that same government giving Commodore public money to build a new factory in Corby to make computers. Two years later Commodore has now said it will axe 250 jobs in Corby and stop manufacturing computers in Britain.

Selective Assistance

In this business, memories fade fast so here are a few facts for the record.

Jack Tramiel, now with Atari, was president of Commodore when the US company started to negotiate with the UK Government in 1983. The DTI was eagerly pushing Corby as a site for anyone willing to build a factory because when British Steel closed its plant there in 1980, 9,000 people lost their jobs. Unemployment in some areas touched 30 per cent.

To create new jobs the UK Government offered Commodore a mouth-watering package. Because of Corby's connection with steel, Commodore could borrow money at 5 per cent below normal interest rates from the coal and steel community fund. This is Euromoney which helps create jobs for ex-miners or ex-steel workers.

Because Corby is designated a "development area", Commodore qualified for a regional development grant of 15 per cent on new buildings and production plant machinery. This money is untaxed so is worth around twice the paper value.

On top of that there is "selective financial assistance" from the Department of Industry. This comes under the Industrial Development Act of 1982 (section 7) and is based on the minimum cash necessary for a project to proceed. It tops up other grants by between 10 and 20 per cent.

In 1981 the Government decreed that anywhere in Britain which is classified as an "enterprise zone" wins a holiday from all rates for the next ten years. Corby is classed as an enterprise zone so Commodore won that concession too.

In March 1984 Kenneth Baker, then Minister of State for Industry and Information Technology, puffed the Commodore deal at a press conference. By then Tramiel had left and was en route to rival Atari. These companies are such bitter rivals that Tramiel will only now talk of "another computer company" when he means Commodore.

At the Commodore press conference, Kenneth Baker explained that giving Commodore public money for Corby was all part of a grand government plan to save Britain's economy when the North Sea oil runs out.

"We need to build a strong technology base" said Baker. *"The business climate in the UK is now so favourable that more American investment takes place here than in any other European country"*. Judging by the Corby package, it wasn't surprising.

Promises, Promises

Commodore will not say how much money it has received from British and European tax payers to create the Corby manufacturing base which it is now closing. In March 1984 Commodore was equally cagey. But both Commodore and the DTI made the same boasts.

They announced that initial investment was to be £6 million rising to £20 million. "It will provide up to 600 jobs this year and up to 1,000 jobs over the next two years" said Howard Stanworth, Commodore's general manager at the time.

Significantly Commodore also pledged that *"although initially the factory will carry out assembly of mainly imported components, action has already been taken to increase the UK manufactured element"*. Stanworth explained: *"Britain is the place to be if you are the world's leading microcomputer manufacturer"*.

So what happened in the next two years?

Before the new year axe fell, Commodore employed 420 people at Corby. Only 250 were making computers. They will go. A staff of 170 will remain in the factory, as a sales and marketing team. So much for the 1,000 jobs.

Particularly ironical, in the light of Commodore's promises and Baker's plans, is the explanation for the shut down now given by Commodore's current president, Thomas Rattigan.

"We need fewer and higher technology plants—Corby being essentially an assembly plant does not fit easily into this strategy".

—Zap That Tune

Let's join together and fight the music-on-hold menace. Twice recently I've phoned British companies and had horrible electronic music piped down the line while the telephonist tried to ring an internal extension. When this happens I always ask the same question. Why are you inflicting snatches of low fi music on me?

In each recent case the answer has been interesting. The firms don't like their own music-on-hold. It comes with the telephone equipment, e.g. from Panasonic, and the telephonist can't switch it off. Nor can anyone else. Zapping the chip with static does the trick, but you have to know which chip to zap.

The long term answer is for anyone who hears music-on-hold to complain to the firm they are phoning. It's an insult to everyone, especially composers who do not write music for it to dumped into a chip and sent down a telephone line in segments whose length depend entirely on how long it takes for someone to pick up their extension.

If enough callers complain, then the people who buy the systems will complain to the manufacturers. Then they might do us all the favour of installing an on-off switch on the hardware.

Spike Milligan has his own answer to music-on-hold. As soon as he is put through after suffering unsolicited sound he says "Thank you very much for your music, now I will give you some of my own in return". He then sings the National Anthem, very loud down the line.

Honourable Return

Tetsuo Tokita has gone back to Japan. Tokita ran Sony's TV manufacturing plant at Bridgend in Wales.

So what's the big deal, I hear you ask?

The big deal is that Tetsuo Tokita has the letters OBE after his name. In 1980 the British Government gave Sony's Welsh factory the Queen's Award for exports, and made Tokita the first Japanese citizen in the UK to be awarded an OBE. He got it for services to the British electronics industry.

There has to be a moral there somewhere, if only for Bob Geldof.

LETTERS

Do's & Don'ts

Sir—We have had some correspondence in the past and you were kind enough to accept a project of mine. There was another idea of printing a "Do's & Don'ts" for beginners which I imagine is now lost in your files, since I have heard no more from you about it.

You may remember that I am a 75 year old who has found your magazine most helpful over the past 6 years in studying for my 'O' and 'A' levels in Electronics. Pleased to say I got an 'A' level 'B' pass this year.

I see that you are taking an interest in the teaching of Electronics, I was not very impressed. It consisted of purchasing notes from a University and reading through them, followed by discussion. There was very little demonstration. We did get our hands on computers and did some logic experiments.

Needless to say only one other got a 'D' pass. I must say that I had the advantage of unlimited time and was able to set up a workshop equipped with scope, meters, function generator, frequency meter, logic probe and variable power supply, all except the scope were made up from designs in your magazine and others.

I would think that the "practical" Course Director should be backed up by a more academic type and an assistant to set up demonstrations. It is a pity that shortage of cash makes these courses so sparse.

I am now doing a "teach yourself" computer course and have bought Commodore equipment, chiefly because it suited my pocket and also for the built-in word processing and file management, etc., but there is a snag! *EE* only gives information applicable to BBC or Spectrum. Could we have some information about the application of the projects and listings for other popular computers?

Incidentally, what is the point of using "the speed of light" to drive slow, cumbersome relays? I would have expected solid state switching. (Jan. '85 *EE* Page 8.)

T. A. Priest MBE
Bristol.

Looking Back

Sir—The simple crystal receiver shown in *Teach-In '86* in March issue of Everyday Electronics took me back many years to 1923 when as a 13 year old schoolboy I built my first crystal set from details in *"Amateur Wireless"*, a magazine of that era.

It was quite impossible at that time to buy a ready built set, at least, not in this area understandably as there were only two transmitters operating then, both on low power, 2LO (London) and 5NO (Newcastle) and as the latter was 30 miles from my home town it was with super optimism that I decided to have a go.

A small shop had just opened nearby which supplied all the bits and pieces required by wireless amateurs so off I went with my list of parts. First a piece of Ebonite $\frac{1}{4}$in. thick by 9in square for a baseboard, which was cut for me from a large sheet and charged by the square inch. Secondly, a crystal detector in two sections, a brass cup about $\frac{1}{2}$in diameter with a triangle of screws to hold the crystal, and a sliding brass arm in a ball and socket joint, which allowed the "Cat's Whisker" on the arm's end to be traversed all over the crystal to find, as we called it, a "sensitive spot". Thirdly, all the bits and pieces to make a variometer, 32 gauge cotton covered wire, 2BA brass rod and nuts, ebonite knob, pointer and numbered scale and finally four post type terminals.

Incidentally, the "Cat's Whisker" was never of spring steel, it was either copper or brass or, if you could afford it, silver or gold wire. Different crystals were available including Galena but I found Hertzite at a shilling or so gave best results.

The variometer was constructed from two cardboard rings about 2in wide, a large outer ring about 5in diameter and a smaller ring to turn inside, quite readily available then as most foods were packed in cardboard containers not cans. Both rings were wound with the 32 gauge wire and assembled by the brass rod and nuts. I might add that even the shellac varnish to anchor the wire to the rings was unavailable, a trip to the chemist for shellac flakes and methylated spirits to dissolve them in was needed to make the varnish.

It only took a few hours to construct the set and mount it in a suitable wooden box and then to set about providing an Aerial and Earth, the latter being a copper clip bolted to a well polished brass cold water tap. As for the aerial this had to be a 100ft coil of 7/22 gauge copper wire slung from a flagpole at the bottom of the garden to the house eaves with two bobbin type porcelain insulators at each end and down in an inverted L to an ebonite lead-in tube through the kitchen window.

Now in those days the potential hazard from lightning striking the aerial was unknown so a single pole double throw switch was advised to switch aerial direct to earth when the set was not in use and also the switch incorporated a spark gap from aerial to earth on the assumption that if the set was in use lightning would take this nearest path to earth rather than incinerate the set and the listener.

One stumbling block now remained, the headphones, Brown's Featherweight at 2000 ohms each earpiece and priced at thirty shillings. No way could I afford these on my meagre pocket money, however, I had a school pal whose father was head of the telephones for our area and I was able to borrow a single telephone ear piece from him which, although a lot lower resistance, I hoped would work.

Eventually all was ready and I eagerly waited for darkness to fall as I read that reception would be better then when the Heavyside layer came down. Agog with excitement I scraped the "Cat's Whisker" down the crystal and twiddled the variometer knob and suddenly I picked up faint morse code—"Eureka" it worked! More twiddling and scraping and at last I heard a man's voice faint but distinctly reading the news, "5NO Newcastle calling" said the voice and my ambition became reality.

Soon I had a stream of friends and neighbours calling to listen-in on this new fangled contraption built by a mere schoolboy which could pick up voices and music from 30 miles away, and numerous requests to make a set for them which I did at cost price for the materials plus a few shillings for myself which enabled me after a week or two to purchase the Brown's headphones from the shop window where I had looked at them wistfully for so long.

I must salve my conscience by admitting that my aerial was on pulleys at each end so that it could be lowered down out of sight in daytime as a wireless receiving licence had been introduced of ten shillings per annum. Who knows, I might have been the first "Pirate"?

In conclusion I must say that although the tremendous technological advance over the past 60 years is unbelievable I doubt if anyone today would experience the thrilling excitement we early amateurs got from our humble efforts.

Les Porter,
Middlesbrough, Cleveland.

EE SPECIAL OFFER

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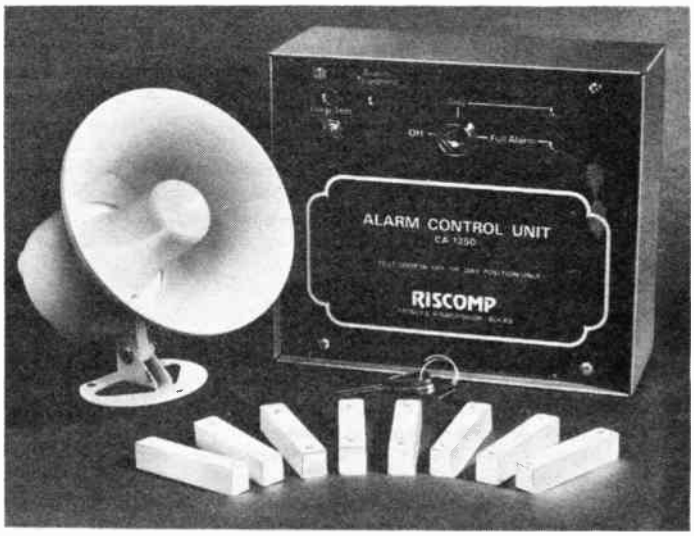

Provides alarm sensing for four doors or windows, may be easily extended and can include panic buttons. Kit contains: 1-off CA1250 Alarm Control Module together with the necessary enclosure and hardware kit and including Key Switch and l.e.d.s, etc. 4-off Magnetic Switches MS1025 and 1-off Alarm Horn HS588.

The Control Unit requires a limited amount of mechanical assembly with a little wiring to the key switch and l.e.d. indicators. Full constructional details are provided. Where required the system may be extended at a later date according to needs, and can be linked to both ultrasonic and infra red sensors. It provides two modes of operation with timed alarm and entry and exit delays.

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The Man Behind the Symbol

No 9 Michael Faraday *cont*

by Morgan Bradshaw

LAST month we left Michael Faraday successfully demonstrating the first dynamo to the Royal Society, but he was to be criticised for not putting his discoveries to practical use.

Indeed Sir William Gladstone then Chancellor of the Exchequer on a visit to the Royal Institute to witness a Faraday "Electrical Experiment" was heard to remark ". . . but after all what use is it." Faraday's immediate response: "Why Sir, there is every probability that you will be able to tax it."

Faraday had not finished. When he was made Director of the Royal Institute laboratories he said "I must continue to discover new facts."

ELECTROLYSIS

His earlier European journeys with Sir Humphrey Davy had attracted him to the work of Ampere and Volta.

Michael's very first experiment recorded as early as 1812 had been to make a voltaic pile with seven halfpennies, seven discs of sheet zinc and six pieces of paper moistened with salt water. With this pile he decomposed magnesium sulphate. This was the start of his work on electrolysis and his electro-chemical experiments, which later led him to introduce the apt terms "Electrolyte", "Electrode", "Anode" and "Cathode", which are still in use today.

He also carried out numerous electrostatic experiments and he found that the electric charge induced between one conductor and another depended on the material or "dielectric" between them. In recognition of this discovery, the name Farad was given to the unit of electrical capacitance. (See Table 1.)

Photo: Courtesy Science Museum

Table 1: FARAD (*F*)

The farad is the unit of electric capacitance. A capacitor has a capacitance of one farad when a charge of one coulomb raises the potential between its plates to one volt, hence

$$\text{farads} = \frac{\text{coulombs}}{\text{volts}}$$

For everyday use the farad is too large a unit, and smaller units called microfarads (symbol $\mu F = 10^{-6} F$), nanofarads (symbol $nF = 10^{-9} F$) and picofarads (sometimes called "puffs"—symbol $pF = 10^{-12} F$) are used.

The farad was adopted as the unit of electric capacitance at the first meeting of the International Electrotechnical Conference in 1881.

OVERWORKED

Overwork was starting to take its toll and in 1841 Faraday was ordered to take a complete rest in Switzerland. Then in August 1845 he started to examine the relationship between light and electricity. For this he conducted a magnificent experiment with a horseshoe magnet and a Nicol crystal prism. He passed a beam of polarized light through the crystal along the direction of the magnetic field. He found that the plane of polarization of the light was rotated as it passed through the crystal.

In the same year he also discovered that all substances have magnetic properties in some degree. Some bodies tend to move in a magnetic field towards the stronger parts of the field, this effect he called "paramagnetism". Other bodies tend to move into the weak parts of the field—this he called "diamagnetism".

His three volumes "*Experimental Researches in Electricity*" covering his discoveries from 1831–1855 are accepted as classics and have been described as "One of the richest treasures of knowledge which has ever been presented to the world by a single intellect".

HONOURS

By now Faraday was a world famous figure and honours were showered upon him, but he declined a knighthood and the Presidency of the Royal Society for fear they would interfere with his experiments and lecturing. His lectures to children at Christmas had become almost a national institution, two regular patrons being The Prince Consort and the young Prince of Wales.

Commemorative Faraday lectures are still given today. They were introduced by the IEE in 1924 with the object of informing the general public of recent advances in the applications of electricity.

Faraday never relied on his memory, which was always bad, and wrote everything down, ideas, lectures, notes and experiments. His diaries were later edited and published in 1932 in seven volumes.

Faraday's experimental work ended in 1855 when he retired. He shunned publicity preferring to live a simple Christian life.

Since childhood he had belonged to a small religious sect, the Sandemanians and always found time to attend their meetings. At the age of thirty he had made a public confession of his faith.

Faraday delivered with some difficulty his last public lecture at the Royal Institution in June 1862. Accidentally burning his notes he realised he was gradually becoming paralysed, he bade a pathetic farewell to his audience saying he had been before them too long.

In 1858 Queen Victoria had placed at his disposal a Grace and Favour apartment in the precincts of Hampton Court, and it was here that he died on 25 August 1867, sitting quietly in his chair.

A grateful nation wanted to honour him with a national funeral at Westminster Abbey, but in accordance with his own wishes he was buried in perfect silence at Highgate Cemetery, London.

Photo: Courtesy Science Museum

Diorama showing Faraday in his laboratory.

NEW · NEW · NEW · NEW
PRODUCTS
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CLEAN MOVIES

With the increase in sales of 8mm video cameras and recorders, **Bib** are now making available in the UK the new VE-42 8mm Automatic Video Cleaner which was a great success in the USA recently.

The cleaner features abrasive-free Polyester spun bonded material that can be used wet or dry. Oxide particles, dust and other contaminants are removed by simply running the "cassette" forward in any 8mm machine for ten seconds.

Each portion of the cleaning material passes through the tape travel path only once ensuring that no debris is redistributed in the machine. It is claimed that each cleaner is good for 25 fresh cleanings.

The cleaner and fluid are packed in handy "bubble" packs and sell for around £9.98, inclusive of VAT. For details of nearest stockists contact:

Bib Audio/Video Products Ltd., Dept EE, Kelsey House, Wood Lane End, Hemel Hempstead, Herts, HP2 4RQ.

DIGITAL MULTIMETERS

Four new digital multimeters have been added to the **Maplin Professional Supplies** range of Precision Gold meters.

The M105 offers the basic ranges a.c. and d.c. volts, d.c. current and resistance with a $3\frac{1}{2}$ digit l.c.d. display and basic accuracy of 0·5 per cent. Push-button range selection.

The M6000 is a push-button selection meter offering d.c. volts up to 1000V, a.c. volts up to 750V, d.c. and a.c. current to 20A and resistance from 0·1 ohm to 20 Megohms. The meter has a $3\frac{1}{2}$ digit l.c.d. display and a basic accuracy of 0·25 per cent.

The M7775 is an auto-ranging meter which will read a.c. or d.c. volts and amps, and resistance. The meter reads up to 1000V d.c., 750V a.c. and 10A a.c. or d.c. A continuity buzzer is also included. The meter has a $3\frac{1}{2}$ digit l.c.d. display and a basic accuracy of 0·5 per cent.

The M5010EC is a multi-purpose digital multimeter with a $3\frac{1}{2}$ digit l.c.d. display and rotary range selection. The meter features d.c. volts to 1000V, a.c. volts to 750V, d.c. and a.c. current to 10A, and resistance to 20 Megohms.

In addition to these basic ranges, the meter can measure temperature from −20°C to 1370°C (thermocouple probe included), capacitance from 1pF to 20µF, and conductance from 0·1nS to 200nS equivalent to increasing the resistance range up to 10,000M. The meter has a diode tester, transistor tester and continuity buzzer. It has a basic accuracy of 0·25 per cent. The meter costs just £56.47.

For further information and prices write to:

Maplin Professional Supplies, Dept EE, PO Box 777, Rayleigh, Essex, SS6 8LU.

LOGIC SWITCH

T.R. de Vaux Balbirnie

Security for electrical equipment without the use of a key

UNLIKE an ordinary switch, a logic switch will only work for the person who knows the secret "logic". It may be likened to a bicycle combination lock which will only open when the correct sequence of numbers are entered into it. Although this, of course, is a purely mechanical device the same effect is produced by the electronic design to be described. Although it could easily be used as a true lock and allow a door to open this was not the purpose of this project. It was, in fact, designed to enable a piece of mains-operated equipment to be used only by authorised persons.

Electronic musical instruments, T.V. sets in hotels and guest houses, school equipment and office photocopy equipment are all examples of possible applications and other ideas should readily spring to mind.

Although the same effect could be given by a key-operated switch these suffer from several disadvantages. Unless the switch is of a high quality the degree of security is likely to be limited. To operate this type of switch the key must be carried on the person and this is not always convenient—and could prove disastrous if forgotten! There may also be times where many people may be authorized and a key would need to be supplied to each one.

In contrast this system needs no keys—only a four digit code carried around in the person's head. As many people as need be may be told the code and it may be changed quite easily at a future date if the code falls into the wrong hands or if the set of authorized persons should change.

IN USE

To use the particular piece of equipment a mains switch is operated. Nothing will happen, however, until a correct code of four digits are entered into a group of miniature push-button switches. The equipment will then switch on. When the mains switch is switched "off" at the end of a session the device automatically reverts to its original state and will not operate again until the code has been re-entered. It should be noted that switching off at a switch on the equipment itself will not do this so that, for instance, an organist may switch off from time to time at his console without having to operate the logic system again.

The keyboard panel carries ten miniature push-button switches. Four of these are to be used for the code. Five are used as "disabling" buttons which means that any *incorrect* number entered will interrupt the sequence and give little chance to a person trying his luck at finding the code. The purpose of the tenth button will be given later. Nine buttons are arranged in three rows of three and the tenth is placed below as shown in the illustration. Although the buttons could be labelled with digits 0 to 9 as in a calculator it was thought that the space occupied by them could be reduced by using plain buttons (which in any case are cheaper) and remembering the code as a sequence of positions rather than as actual numbers. For the purpose of description, however, a numerical code is given.

If we assume the code to be 2347. Only pressing the buttons in this order will do—3742 for instance, will not. Even if an unauthorized person stumbled upon 23 . . . then any other wrong digit, e.g. 6, will spoil the whole affair. The degree of security is quite impressive as four buttons pressed out of a total of nine give 6561 combinations—only one will operate the system. As the unauthorized person does not know the use of the tenth button either, then the security is even higher than this.

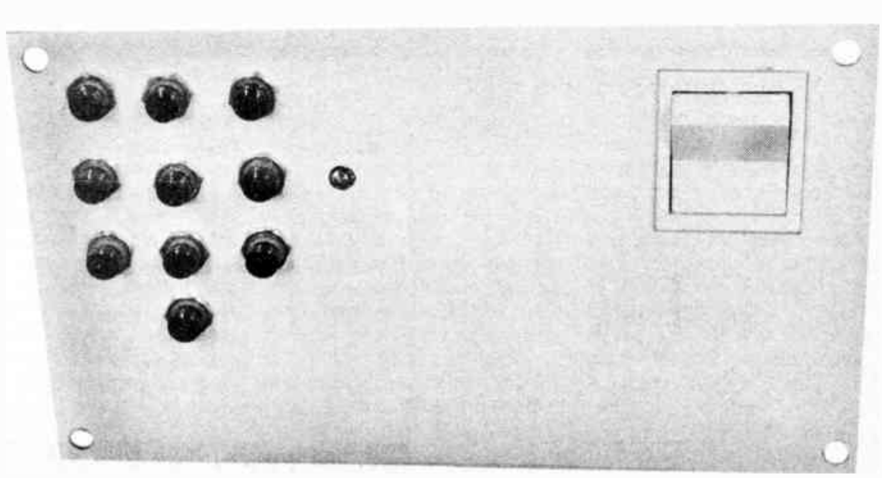
It must be stated here that the circuit suffers from one drawback. It is not possible to use the same number twice in the code, e.g. 2337 could *not* be used. The mathematician will realise, therefore, that the number of combinations is not really as high as given above but the point is academic as the unauthorised person will not know this, neither will he know the number of digits in the code—not unless he is a reader of *EE*, that is!

One point of design was considered most important. For reasons of cost and safety it was thought essential to make the "logic" circuit battery-operated. No mains current flows at all until the correct buttons have been pressed. After mains current has been established the battery operated part, having done its job, switches off. This means that battery drain is extremely small as battery current flows only during the button pressing stage and even then it is very low. A small battery may therefore be used to power the circuit and even with regular use its life should be long.

Of course, as the device was designed for switching mains equipment, it is necessary to make certain mains connections. Constructors must feel quite competent to do this. The current from a nine volt battery is perfectly safe but a slip with mains connections can be fatal. Having said that, however, the connections have been kept to a minimum and are straightforward.

THE CIRCUIT

Operation of the circuit is based on silicon controlled rectifiers (SCRs) often called thyristors. In the author's opinion these do not receive the attention they deserve among amateur circuit builders. They look just like transistors having three connections but their function is different. A transistor is a three layer device (*pnp* or *npn*) whilst an SCR has four layers (*pnpn*). The SCR behaves like a diode in the sense that current can only flow in one direction. Unlike a diode, however, no current will flow at all unless a small positive pulse is applied to the "gate". Once conduction has been established by this "trigger" pulse, the diode will not turn off even when the pulse has been removed. That is, it will not do so unless the main current in the anode/cathode circuit falls below a certain



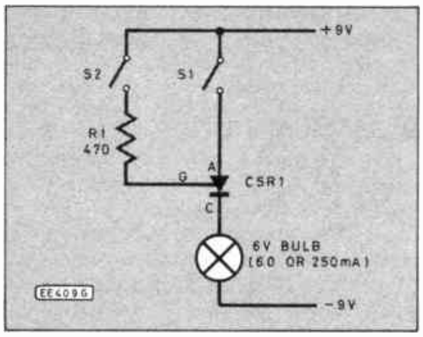


Fig. 1. Experimental SCR circuit.

"threshold" value. If this happens the SCR reverts to its original state.

In many ways the SCR may be used as a solid-state relay. To make this clear Fig. 1 shows an SCR connected in an experimental circuit. The constructor may like to experiment along these lines before he builds his SCRs into the final circuit. The push-button switches could just be pieces of wire touched together. With S1 closed, the bulb will not light because the SCR has not yet been triggered into conduction. When S2 is operated—even momentarily—the bulb will light and continue to do so. R1 limits the current flowing in the gate circuit. The bulb consumes a current well in excess of the threshold value for the SCR so it will not turn off unless the main circuit is broken with S1. It then goes back to its original state. If the anode and cathode connections are interchanged then the SCR does not work at all—like an ordinary diode. Although the SCR has a few more tricks these are the most important and interesting ones.

If two SCRs are cascaded as shown in the second diagram (Fig. 2) the second one can only be triggered if the first is already conducting. Attempting to trigger the second alone will not work as the second can only draw current from the positive supply-line through the first. When an SCR is "on" it is effectively short circuited across anode and cathode. Clearly, further SCRs should be connected in this cascade arrangement so that each one is "enabled" by the previous one. This is the way in which the logic switch works. In this, four SCRs are in cascade, see Fig. 3. The last one in the chain carries the coil of a relay as its load. Only if push-button switches 1 to 4 are operated in that order will successive SCRs switch on and allow the relay to finally energise. Any fault in the sequence will keep the relay off.

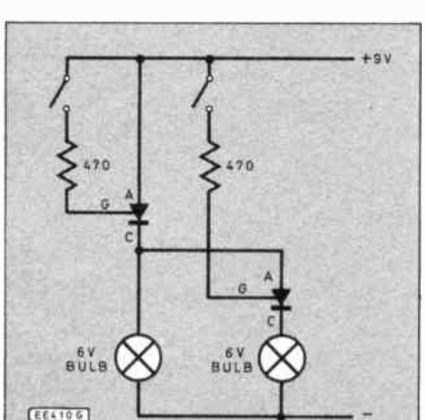


Fig. 2. Cascaded SCR's.

Resistors R5, 6 and 7 are of a sufficiently low value to allow currents in excess of the threshold value to flow while keeping the battery current down. There is a voltage drop across the anode/cathode of each SCR and these add together to give a final voltage across the relay coil of much less than nine volts. The relay used must be reliable at coil voltages of less than six volts. It must switch properly even when the battery becomes a little old.

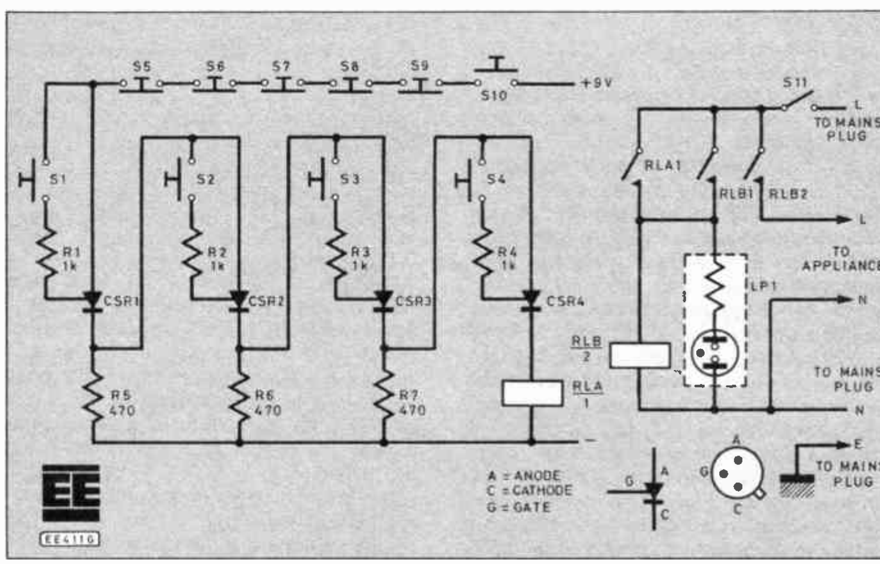
The four buttons just mentioned could, of course, be placed in any pattern on the panel or, if they are numbered, any code of numbers could be chosen. All the "false" buttons are wired in series so that any wrong number entered will break the main battery line and any SCRs already conducting will instantly switch off.

SWITCHES

Push button switches S5 to S9 in the diagram could therefore be called "disabling" switches, they give good protection from unauthorized people who might otherwise hit on the correct code by a long process or random button pressing. Note that the disabling switches are of the push-to-break type whereas the code switches are of the push-to-make type. The author noticed that, although the appearance was identical, the two types had a slightly different "feel" in operation. If this is thought to be a problem the solution is to buy all switches of the push-to-changeover type. These may be wired as either push-to-make or push-to-break as appropriate. This would ensure that all switches had the same "feel" but would increase the cost of the project.

At this stage the function of S10 should be explained. This is the "go" button. It must be held down with one finger while the other buttons are pressed. It is just a push-to-make switch in the main battery supply line and nothing can happen until it is pressed. Without it, it is just possible for a determined fiddler to leave the three correct digits 234 on the keyboard then give up. This would mean that CSRs 1, 2 and 3

Fig. 3. Circuit diagram of the logic switch.



COMPONENTS

See **Shop Talk** page 246

approximate cost £15.50

Resistors

R1 to R4	1k (4 off)
R5 to R7	470 (3 off)

Semiconductors

CSR1 to 4	1A, 50V thyristors

Switches

S1 to 4, S10	miniature push to make switch (5 off)—see text
S5 to 9	miniature push to break switch (5 off)—see text
S11	s.p.s.t. mains rocker switch

Miscellaneous

RLA	6V relay with normally open contacts rated for mains use—see text
RLB	240V a.c. relay with two sets of normally open contacts rated for mains use—see text
LP1	miniature mains neon indicator

0·1 inch matrix stripboard 26 × 17 holes, 4-way mains rated terminal block, metal case, connecting wire, fixings, etc.

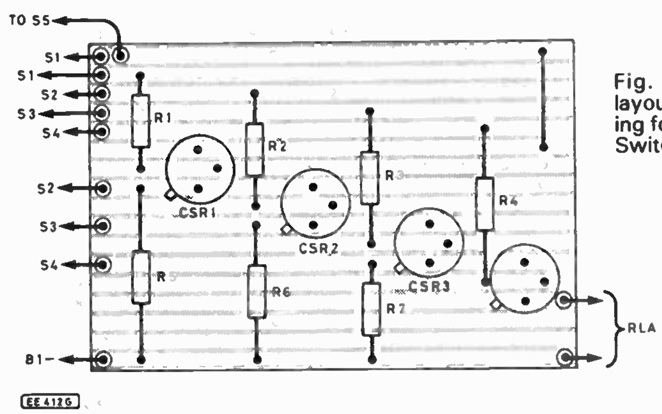


Fig. 4. Board layout and wiring for the Logic Switch.

would be conducting and waiting for the final digit which would not arrive. Battery current would be wasted until the next time the device was used. It was thought that S10 was an essential feature of the prototype. When it is released everything must switch off and battery drain return to zero.

RELAYS

The final part of the logic chain is the relay RLA. As mentioned earlier this must have a coil which will operate reliably on less than six volts. Good quality relays advertised as six volt types will do this as there is a comfortable margin in manufacture. The relay used in the prototype was a 12 volt type but the manufacturer stated that it would operate at under six volts. This relay should have at least one set of normally open contacts and, as mains current flows in these, **they must be rated for mains use** although the rated current may be very low. The resistance of the coil used in the relay for the prototype was 185 ohms but any value near to this should prove quite satisfactory.

Relays are often provided with more contacts than are required and these are frequently of the changeover type. These may be wired as normally open contacts and a simple battery and bulb circuit will quickly tell which contacts are which in cases of difficulty.

The first relay contacts, RLA1, allow mains current to flow through the coil of the second relay RLB. Although RLA and RLB may appear very similar they are completely different relays. RLB is a relay with a *mains* coil. This is very important and the constructor **must resist any temptation to try any old relay for this.** The coil of this relay **must be capable of being connected direct to the 240 volt mains supply continuously.** Like RLA, RLB must also have **mains rated contacts** and at least *two* sets of normally open (or changeover) contacts must be provided. The current rating of these ultimately depends on the use to which the project is put. If it is assumed that the load will be low—less than 240 watts—one amp contacts will be suitable. It is as well to buy high quality components for both RLA and RLB.

One set of contacts (RLB1) on RLB "lock" it on by allowing mains current to flow through its coil continuously and this brings us to the second purpose for S10. When the operator releases this after operating the correct logic buttons, RLA will drop out but RLB will stay on due to the self-locking action. This means that when the logic part switches off, battery drain is zero. Battery current only flows during the button-pressing stage so the small self-contained battery should provide good service. The second pair of contacts (RLB2) feeds mains current to the actual equipment to be protected—T.V., electronic organ, etc.

It will be seen that the two relays were grouped together in the prototype away from the battery operated part of the circuit. This keeps all mains connections together.

CONSTRUCTION

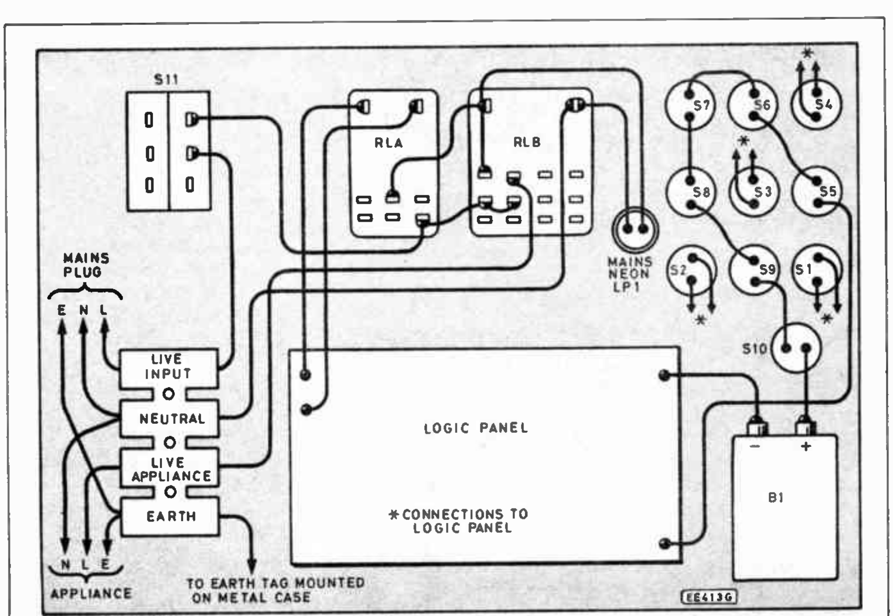
The logic panel is built on 0·1 inch matrix stripboard and, although the layout is not critical, a suggested scheme is given in Fig. 4. There are no breaks to be made in the copper strips in this project, but care should be taken to prevent bridging between the strips whilst soldering.

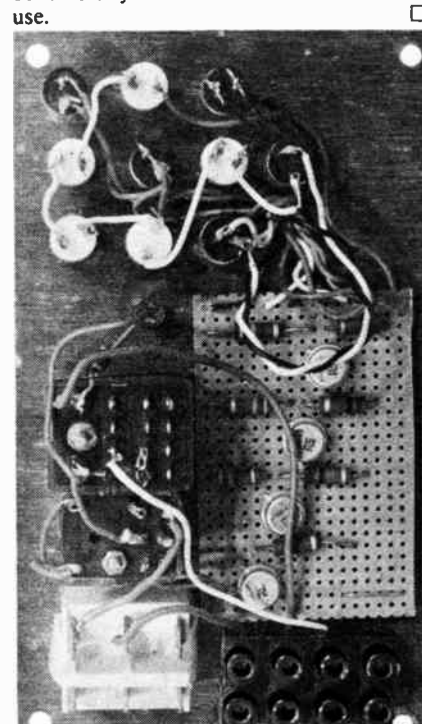
In the prototype, the relays were secured to the top panel using strong adhesive and this proved serviceable. This must be checked, however, as there **must be no chance at all of the relays breaking free** during the course of operation. If security is doubtful it would be better to use aluminium brackets. All mains connections must be made with special care. It is assumed that there will be a fuse in the mains plug of the correct rating. In cases where a fuse is not present a separate one must be provided. Take care over the live and neutral connections. The neutral wire (blue or black) goes straight through from mains to equipment but the live wire (brown or red) leads to the relay panel. A segment of block connector is available for the earth wires which must be preserved and connected to the metal case used to house the unit. A strip of terminal block was used in the prototype for all the external connections and these must be secure so that they do not pull free. **It is essential for the sake of safety that the unit is housed in an earthed metal box, and that all mains connections are well insulated.**

A refinement is a small neon LP1 wired across the coil of RLB. This will illuminate when the circuit is operating. **It is essential that a proper mains neon indicator is used in this position**, these devices incorporate a series limiting resistor.

When the circuit has been built and is ready for testing it is better not to connect the mains. When the battery is connected and the buttons operated a distinct click should be heard from RLA and a second click when S10 is released. Once this has been established the mains connections can be carefully made and the unit tried in use. □

Fig. 5. Layout and wiring diagram for the Logic Switch—refer to the text regarding mains wiring.





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DOWN TO EARTH

BY GEORGE HYLTON

MAINS transformers can sometimes be connected in pairs to provide modified voltage or current outputs. But there are pitfalls and limitations.

One useful arrangement (Fig. 1) enables a pair of identical transformers to deliver half their normal secondary voltage but something approaching twice the normal current. Each primary sees a resistance equal to the actual load resistance (R_L) times the square of the turns ratio (n). So if R_L = 12 ohms and n = 10 the load seen by each primary is 1200 ohms. The mains current thus passes through two resistances of 1200 ohms in series, making 2400 ohms in all. For a supply of 240V each primary receives 120V, giving a secondary voltage of 120/10 = 12V.

If the whole 240V mains is applied to one primary (normal use), the secondary voltage is 24V. So Fig. 1 is a way of halving the output voltage. In theory the output current from each transformer could be doubled. With practical transformers, the winding resistances usually cause the output voltage to drop more rapidly than usual as the current increases and this puts a limit on the extra current which can be drawn in most cases.

POLARITY

The blobs at one end of each secondary indicate points of the same polarity. If points of opposite polarity are connected in parallel each secondary drives a large current through the other and the transformers are destroyed. To safeguard against this fatal error leave a break at point X and connect the broken ends to an a.c. voltmeter or a low voltage low current lamp. With correct polarity the lamp stays out and the meter reads zero. If there is an error (lamp lights, meter reads about the nominal output voltage of the transformer) reverse connections to any *one* winding.

Even with correct connections, trouble can occur if the two secondary voltages are not equal. The difference voltage then drives current round and round the secondaries. In practice the only sure way to avoid this is to use transformers which are physically identical: same size, same make, same ratings.

PARALLEL PRIMARIES

A rather more versatile arrangement is to connect the primaries of two identical transformers in parallel (Fig. 2a). The secondaries then deliver their normal voltage. The user has the option of either connecting the secondaries in parallel to give normal voltage but up to twice normal current (Fig. 2b), or in series to give normal current but twice normal voltage (Fig. 2c). Observe polarity! With the series connection, incorrect polarity doesn't harm the transformers but it does reduce the output voltage to zero.

With parallel primaries, series secondaries, some relaxation of the "identical transformers only" rule is permissible. The point is that since each primary is straight across the mains it can draw as much or as little current as it likes without affecting the other primary. And with series secondaries there's no risk of one secondary driving current round and round the other. The load receives the sum of the secondary voltages, V2 + V3. Care is needed in keeping the current within safe limits. The feebler transformer (with the lower current rating) fixes the maximum output. If, for instance, the two secondaries are rated at 9V, 100mA and 6V, 200mA the output is 15V at a maximum of 100mA.

REDUCED VOLTAGE

If two secondaries are connected "series-opposing" instead of series-aiding, the output voltage is the difference between the secondary voltages. So with our examples of 9V, 100mA and 6V, 200mA, the output would be 3V, still at 100mA because this is all that the weaker partner can manage.

SEPARATE LOADS

A method of interconnection which is almost sure to give bad results is shown in Fig. 3. Here two identical transformers have their primaries in series but their secondaries used separately. If the loads R1 and R2 are exactly equal the arrangement delivers half the normal secondary voltage to each. But any departure from equality causes the voltages to change wildly. A few practical numbers illustrate the point. Suppose the transformers are rated at 240V primary, 24V secondary; i.e., a step down of 10:1. If R1 and R2 are each 24 ohms, the primaries see 2400 ohms each so 120V appears across each, giving a secondary output of 12V each. This drives 0·5A through the 24 ohm loads. If R1 now changes to 20 ohms—a modest load variation—T1 sees 2000 ohms while T2 still sees 2400 ohms. Result: T1 delivers less than 12V, T2 more. The actual figures are 10·9V and 13·1V. In a word, any load variations (caused, for example, as an amplifier draws more or less current in response to volume changes) makes the output voltages see-saw in a potentially dangerous fashion. The series-primary, separate-secondary configuration has no practical value and should be avoided.

RECTIFIERS

This example of what can go wrong illustrates a general rule; when transformers are used with series primaries the load must be arranged in such a way that any variations affect both transformers equally. When there are multiple loads this means that they should be connected in parallel so that each receives the same voltage.

The rule needs to be defined more strictly, however. There is a time element. We are dealing with a.c. and therefore with time-varying voltages. It is important that the load seen by the transformers on one half cycle is the same as on the next half cycle. With resistive loads this is no problem. But in general the first thing connected to a secondary is a rectifier, which does not conduct all the time. It may be tempting to try to connect the two secondaries of Fig. 1 in such a way as to provide a centre-tapped supply to drive a push-pull rectifier. Resist this temptation! When one rectifier conducts its associated transformer sees a reduced load and the result is a situation rather like Fig. 3 when the loads are unequal. Also, d.c. flows through the secondaries, which is bad practice anyway. This leads to another rule: use bridge rectification so that current flows on both half cycles. Push-pull rectification can, however, be used if both transformers have centre-tapped secondaries, so that the centre taps can also be interconnected.

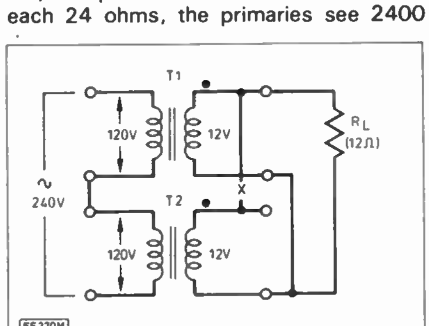

Fig. 1. Transformers connected to give double-current working.

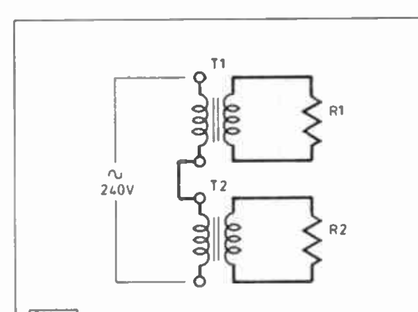

Fig. 3. Separate secondaries—to be avoided.

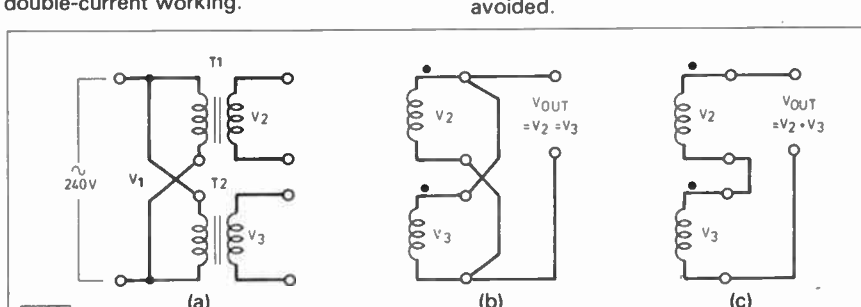

Fig. 2. (a) Parallel primaries; (b) parallel secondaries; (c) series secondaries.

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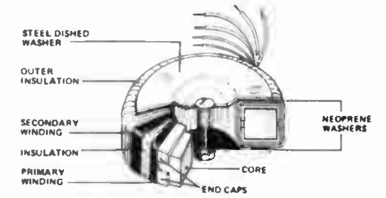

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TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
15VA Regulation 19%, 62 x 34 (See diagram), 0.35 Kgs, Mounting bolt M4 x 12	03010	6 + 6	1.25
	03011	9 + 9	0.83
	03012	12 + 12	0.63
	03013	15 + 15	0.50
	03014	18 + 18	0.42
	03015	22 + 22	0.34
	03016	25 + 25	0.30
	03017	30 + 30	0.25
30VA Regulation 18%, Size A B C 70 35 37, 0.45 Kgs, Mounting bolt M5 x 50	13010	6 + 6	2.50
	13011	9 + 9	1.66
	13012	12 + 12	1.25
	13013	15 + 15	1.00
	13014	18 + 18	0.83
	13015	22 + 22	0.68
	13016	25 + 25	0.60
	13017	30 + 30	0.50
50VA Regulation 13%, Size A B C 80 40 43, 0.9 Kgs, Mounting bolt M5 x 50	23010	6 + 6	4.16
	23011	9 + 9	2.77
	23012	12 + 12	2.08
	23013	15 + 15	1.66
	23014	18 + 18	1.38
	23015	22 + 22	1.13
	23016	25 + 25	1.00
	23017	30 + 30	0.83
	23028	110	0.45
	23029	220	0.22
	23030	240	0.20
80VA Regulation 12%, Size A B C 95 40 43, 1.0 Kgs, Mounting bolt M5 x 50	33010	6 + 6	6.66
	33011	9 + 9	4.44
	33012	12 + 12	3.33
	33013	15 + 15	2.66
	33014	18 + 18	2.22
	33015	22 + 22	1.81
	33016	25 + 25	1.60
	33017	30 + 30	1.33
	33028	110	0.72
	33029	220	0.36
	33030	240	0.33
120VA Regulation 11%, Size A B C 95 45 50, 1.2 Kgs, Mounting bolt M5 x 50	43010	6 + 6	10.00
	43011	9 + 9	6.66
	43012	12 + 12	5.00
	43013	15 + 15	4.00
	43014	18 + 18	3.33
	43015	22 + 22	2.72
	43016	25 + 25	2.40
	43017	30 + 30	2.00
	43018	35 + 35	1.71
	43028	110	1.09
	43029	220	0.54
	43030	240	0.50

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
160VA Regulation 8%, Size A B C 110 45 50, 1.8 Kgs, Mounting bolt M5 x 50	53011	9 + 9	8.89
	53012	12 + 12	6.66
	53013	15 + 15	5.33
	53014	18 + 18	4.44
	53015	22 + 22	3.63
	53016	25 + 25	3.20
	53017	30 + 30	2.66
	53018	35 + 35	2.28
	53026	40 + 40	2.00
	53028	110	1.45
	53029	220	0.72
	53030	240	0.66
225VA Regulation 7%, Size A B C 110 50 55, 2.2 Kgs, Mounting bolt M5 x 60	63012	12 + 12	9.38
	63013	15 + 15	7.50
	63014	18 + 18	6.25
	63015	22 + 22	5.11
	63016	25 + 25	4.50
	63017	30 + 30	3.75
	63018	35 + 35	3.21
	63026	40 + 40	2.81
	63025	45 + 45	2.50
	63033	50 + 50	2.25
	63028	110	2.04
	63029	220	1.02
	63030	240	0.93
300VA Regulation 6%, Size A B C 110 57 62, 2.6 Kgs, Mounting bolt M5 x 60	73013	15 + 15	10.00
	73014	18 + 18	8.33
	73015	22 + 22	6.82
	73016	25 + 25	6.00
	73017	30 + 30	5.00
	73018	35 + 35	4.28
	73026	40 + 40	3.75
	73025	45 + 45	3.33
	73033	50 + 50	3.00
	73028	110	2.72
	73029	220	1.36
	73030	240	1.25
500VA Regulation 5%, Size A B C 135 60 65, 4.0 Kgs, Mounting bolt M8 x 70	83016	25 + 25	10.00
	83017	30 + 30	8.33
	83018	35 + 35	7.14
	83026	40 + 40	6.25
	83025	45 + 45	5.55
	83033	50 + 50	5.00
	83042	55 + 55	4.54
	83028	110	4.54
	83029	220	2.27
	83030	240	2.08

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
625VA Regulation 4%, Size A B C 140 70 75, 5.0 Kgs, Mounting bolt M8 x 90	93017	30 + 30	10.41
	93018	35 + 35	8.92
	93026	40 + 40	7.81
	93025	45 + 45	6.94
	93033	50 + 50	6.25
	93042	55 + 55	5.68
	93028	110	5.68
	93029	220	2.84
	93030	240	2.60

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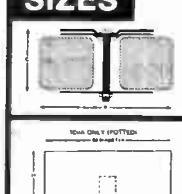

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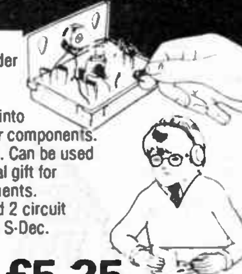
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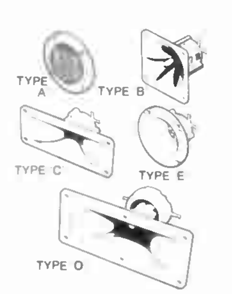

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