EVERYDAY ELECTRONICS

JANUARY 1987

INCORPORATING ELECTRONICS MONTHLY

£1·10

8 EXTRA PAGES

MORSE DECODER

LOGIC PULSER

RANDOM LIGHT UNIT

HANDS OFF INTERCOM

Special Feature... BUILDING with VERO

The Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

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

1. 5 – 13 amp ring main junction boxes
2. 5 – 13 amp ring main spur boxes
4. 5 – surface mounting
5. 3 – electrical switches, white flush mounting
7. 4 – in flex line switches with neons
9. 2 – mains transformers with 6V 1A secondaries
10. 2 – mains transformers with 12V $\frac{1}{2}$A secondaries
11. 1 – extension speaker cabinet for 6$\frac{1}{2}$" speaker
13. 12 – glass reed switches
17. 2 – ultrasonic transmitters and 2 receivers with circuit
19. 2 – light dependent resistors
25. 4 – wafer switches – 6p 2 way, 4p 3 way, 2p 6 way, 2p 5 way, 1p 12 way small one hold fixing and good length $\frac{1}{4}$ spindle your choice
28. 1 – 6 digit counter mains voltage
30. 2 – Nicad battery chargers
31. 1 – key switch with key
33. 2 – aerosol cans of ICI Dry Lubricant
34. 96 – 1 metre lengths colour-coded connecting wire
39. 1 – long and medium wave tuner kit
41. 8 – rocker switch 10 amp mains SPST
45. 1 – 24 hour time switch mains operated (s.h.)
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
54. 10 – rows of 32 gold plated IC sockets (total 320 sockets)
55. 1 – locking mechanism with 2 keys
56. 1 – miniature uniselector with circuit for electric jigsaw puzzle
60. 5 – ferrite rods 4" × 5/16" diameter aerials
61. 4 – ferrite slab aerials with L & M wave coils
63. 1 – Mullard thyristor trigger module
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
77. 1 – time reminder adjustable 1-60 mins clockwork
85. 1 – mains shaded pole motor $\frac{3}{4}$" stack – $\frac{1}{4}$ shaft
89. 1 – mains motor with gear box 1 rev per 24 hours
91. 2 – mains motors with gear box 16 rpm
96. 1 – thermostat for fridge
98. 1 – motorised stud switch (s.h.)
101. 1 – 2$\frac{1}{2}$ hours delay switch
103. 1 – mains power supply unit – 6V DC
104. 1 – mains power supply unit – 4$\frac{1}{2}$V DC
107. 1 – 5" speaker size radio cabinet with handle
112. 1 – heating pad 200 watts mains
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
124. 25 – clear plastic lenses 1$\frac{3}{4}$ diameter
127. 4 – pilot bulb lamp metal clip on type
128. 10 – very fine drills for pcbs etc.
129. 4 – extra thin screw drivers for instruments
132. 2 – plastic boxes with windows, ideal for interrupted beam switch
134. 10 – model aircraft motor – require no on/off switch, just spin to start
137. 1 – 6$\frac{1}{2}$" 4 ohm 10 watt speaker
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
154. 1 – 12V drip proof relay – ideal for car jobs
155. 3 – varicap push button tuners with knobs
169. 4 – short wave air spaced trimmers 2-30f
172. 10 – 12V 6W bulbs Philips m.e.s.
178. 3 – oblong amber indicators with lilliputs 12V
180. 6 – round amber indicators with neons 240V
181. 100 – p.v.c. grommets $\frac{3}{8}$ hole size
182. 1 – short wave tuning condenser 50 pf with $\frac{1}{4}$" spindle
184. 1 – three gang tuning condenser each section 500 pf with trimmers and good length $\frac{1}{4}$" spindle
188. 1 – plastic box sloping metal front, 16 × 95mm average depth 45mm
193. 6 – 5 amp 3 pin flush sockets brown
195. 5 – B.C. lampholders brown bakelite threaded entry
196. 1 – in flex simmerstat for electric blanket soldering iron etc.
197. 2 – thermostats, spindle setting – adjustable range for ovens etc.
199. 1 – mains operated solenoid with plunger 1" travel
200. 1 – 10 digit switch pad for telephones etc.
201. 8 – computer keyboard switches with knobs, pcb or vero mounting
206. 20 – mtres 80 ohm, standard type co-ax off white
211. 1 – electric clock mains driven, always right time – not cased
216. 1 – stereo pre-amp Mullard EP9001
232. 2 – 12V solenoids, small with plunger
236. 1 – mains transformer 9V 1 amp secondary C core construction
241. 1 – car door speaker (very flat) 6$\frac{1}{2}$" 15 ohm made for Radiomobile
241. 2 – speakers 6" × 4" 4 ohm 5 watt made for Radiomobile
243. 2 – speakers 6" × 4" 16 ohm 5 watt made for Radiomobile
244. 1 – mains motor with gear-box very small, toothed output 1 rpm
245. 4 – standard size pots, $\frac{1}{2}$ meg with dp switch
249. 1 – 13A switched socket on double plate with fused spur
266. 2 – mains transformers 9V $\frac{1}{2}$A secondary
267. 1 – mains transformers 15V 1A secondary p.c.b. mounting
291. 1 ten turns 3 watt pot $\frac{1}{4}$ spindle 100 ohm
296. 3 car cigar lighter socket plugs
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
305. 1 tubular dynamic microphone with desk rest
308. 1 T.V. turret tuner (black & white T.V.)
310. 2 oven thermostats
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
453. 2 – 2$\frac{1}{4}$in. 80ohm loudspeakers
454. 2 – 2$\frac{1}{4}$in. 8ohm loudspeakers

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

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

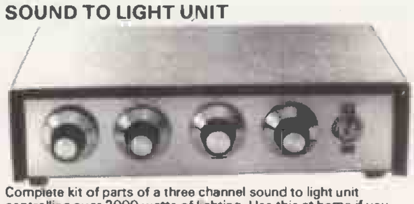
Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £14.50 or without case £18.50 post £2.

Ex-Electricity Board. Guaranteed 12 months.

VENNER TIME SWITCH

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

SOUND TO LIGHT UNIT

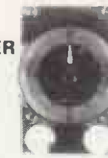


Complete kit of parts of a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio Input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

12 volt MOTOR BY SMITHS

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

25A ELECTRICAL PROGRAMMER



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

THIS MONTH'S SNIP

is a 2$\frac{1}{2}$kW tangential heater, metal box to contain it and 3 level switch to control it. Special January price £7.50 post paid.

INSTRUMENT TURNTABLE

Very well made with unique coiled arrangement for Hitachi video unit, also suitable for most modern scopes and many other instruments. Price £5 plus £2 post, order ref 5P72.

LIGHT BOX

This when completed measures approximately 15" × 14". The light source is the Phillips fluorescent 'W' tube. Above the light a sheet of fibreglass and through this should be sufficient light to enable you to follow the circuit on fibreglass PCBs. Price for the complete kit, that is the box, choke, starter, tube and switch, and fibreglass is £5 plus £2 post, order ref 5P69.

TANGENTIAL HEATERS?

We again have very good stocks of these quiet running instant heat units. They require only a simple case, or could easily be fitted into the bottom of a kitchen unit or book case etc. At present we have stocks of 1·2kw, 2kw, 2·5kw, and 3kw. Prices are £5 each for the first 3, and £6.95 for the 3k. Add post £1.50 per heater if not collecting.
CONTROL SWITCH enabling full heat, half heat or cold blow, with connection diagram, 50p for 2kw, 75p for 3kw.

FANS & BLOWERS

5" £5 + £1.25 post. 6" £6 + £1.50 post
4" × 4" Muffin equipment cooling fan 115V £2.00
4" × 4" Muffin equipment cooling fan 230/240V £5.00
5" Plannair extractor £5.50
9" Extractor or blower 115V supplied with 230 to 115V adaptor £9.50 + £2 post.
All above are ex computers but guaranteed 12 months.
10" × 3" Tangential Blower. New. Very quiet – supplied with 230 to 115V adaptor on use two in series to give long blow £2.00 + £1.50 post or £4.00 + £2.00 post for two.

IONISER KIT

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

TELEPHONE BITS

Master socket (has surge arrestor – ringing condenser etc) and takes B.T. plug	£3.95
Extension socket	£2.95
Dual adaptors (2 from one socket)	£3.95
Cord terminating with B.T. plug 3 metres	£2.95
Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 BT extension sockets	£11.50
100 mtrs 4 core telephone cable	£8.50

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

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

J & N BULL ELECTRICAL

Dept. E.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

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

£2 POUNDERS*

2P2 –Wall mounting thermostat, high precision with mercury switch and thermometer
2P3 –Variable and reversible 8-12v psu for model control
2P4 –24 volt psu with separate channels for stereo made for Mullard UNILEX
2P6 –100W mains to 115V auto-transformer with voltage tappings
2P8 –Mains motor with gear box and variable speed selector. Series wound so suitable for further speed control
2P9 –Time and set switch. Boxed, glass fronted and with knobs. Controls up to 15 amps. Ideal to program electric heaters
2P10 –12 volt 5 amp mains transformer
2P12 –Disk or Tape precision motor – has balanced rotor and is reversible 230v mains operated 1500 rpm
2P14 –Mug Stop kit – when thrown emits piercing squawk
2P15 –Interrupted Beam kit for burglar alarms, counters, etc.
2P17 –2 rev pr minute mains driven motor, ideal to operate mirror ball
2P18 –Liquid/gas shut off valve mains solenoid operated
2P19 –Disco switch motor drives 6 or more 10 amp change over micro switches supplied ready for mains operation
2P20 –20 metres extension lead, 2 core – ideal most Black and Decker garden tools etc.
2P21 –10 watt amplifier, Mullard module reference 1173
2P22 –Motor driven switch 20 secs on or off after push
2P26 –Counter resettable mains operated 3 digit
2P27 –Goodmans Speaker 6 inch round 8ohm 12 watt
2P28 –Drill Pump – always useful couples to any make portable drill
2P31 –4 metres 98 way interconnecting wire easy to strip
2P32 –Hot Wire amp meter – 4$\frac{1}{2}$ round surface mounting 0–10A – old but working and definitely a bit of history
2P34 –Solenoid Air Valve mains operated
2P38 –200 R.P.M. Geared Mains Motor 1" stack quite powerful, definitely large enough to drive a rotating aerial or a tumbler for polishing stones etc.
2P43 –Small type blower or extractor fan, motor inset so very compact, 230V
2P46 –Our famous drill control kit complete and with prepared case
2P49 –Fire Alarm break glass switch in heavy cast case
2P51 –Stereo amplifier, 3w per channel
2P55 –Mains motor, extra powerful has 1$\frac{1}{2}$" stack and good length of spindle
2P62 –1 pair Goodmans 15 ohm speakers for Unilex
2P64 –1 five bladed fan 6$\frac{1}{2}$" with mains motor
2P66 –1 2Kw tangential heater 115v easily convertible for 230V
2P67 –1 12v–0–12v 2 amp mains transformer
2P68 –1 15v–0–15v 2 amp mains transformer
2P69 –1 250v–0–250v 60 mA & 86.3v 5A mains transformer + 50p post
2P70 –1 E.M.I. tape motor two speed and reversible
2P72 –1 115v Muffin fan 4" × 4" approx. (s.h.)
2P75 –1 2 hour timer, plugs into 13A socket
2P82 –9v–0–9v 2 amp mains transformer
2P84 –Modem board with press keys for telephone redialler
2P85 –20v–0–20v $\frac{1}{2}$A Mains transformer
2P88 –Sangamo 24 hr time switch 20 amp (s.h.)
2P89 –120 min. time switch with knob
2P90 –90 min. time switch with edgewise engraved controller
2P94 –Telephone handset for EE home telephone circuit
2P95 –13A socket on satin chrome plate
2P97 –mains transformer 24V 2A upright mounting
2P98 –20m 4 core telephone cable, white outer
2P99 –500 hardened pin type staples for telephone cable
2P101 – 15V mains transformer 4A upright mounting
2P105 – capillary type thermostat for air temperature with c/o switch
2P107 – membrane keyboard, telephone type
2P108 – mains motor with gear box giving 110rpm
2P109 – 5" wide black adhesive pvc tape 33m, add £1 post if not collecting

OVER 400 GIFTS YOU CAN CHOOSE FROM

There is a total of over 400 packs in our Baker's dozen range and you become entitled to a free gift with each dozen pounds you spend on these packs.

A classified list of these packs and our latest "News Letter" will be enclosed with your goods, and you will automatically receive our next news letters.

£5 POUNDERS*

5P1. 12 volt submersible pump complete with a tap and switch, an ideal caravan unit.
5P2. Sound to light kit complete in case suitable for up to 750 watts.
5P3. Silent sentinel ultra sonic transmitter and receive kit, complete.
5P5. 250 watt isolating transformer to make your service bench safe, plus £3 postage if you can't collect.
5P6. 12V alarm bell with heavy 6" gong. suitable for outside if protected from direct rainfall. Ex GPO but in perfect order.
5P12. Equipment cooling fan – mini snail type mains operated.
5P13. Ping pong ball blower – or for any job that requires a powerful stream of air – ex computer. Collect or add £2 post.

5P15 –Uniselector 4 pole, 25 way 50 volt coil
5P18 –motor driven water pump as fitted to many washing machines
5P20 –2 kits, matchbox size, surveilance transmitter and FM receiver
5P23 –miniature (appr. 2$\frac{1}{2}$" wide) tangential blow heater, 1·2kw
5P24 –$\frac{1}{4}$hp motor, ex computer, 230V, mains operation 1450rpm. If not collect add £3 post
5P25 –special effects lighting switch. Up to 6 channels of lamps can be on or off for varying time periods
5P27 –cartridge player 12V, has high quality stereo amplifier
5P28 –gear pump, mains motor driven with inlet and outlet pipe connectors
5P32 –large mains operated push or pull solenoid. Heavy so add £1.50 post
5P34 –24V 5A toroidal mains transformer
5P35 –modem board from telephone auto dialler, complete with keypad and all ICs
5P37 –24 hour time switch, 2 on/offs and clockwork reserve, ex Elec. Board loading up to 50A. Add £1 post
5P41 –5" extractor fan, very quiet runner (s.h.), gntd 12 mths.
5P45 –pack of 6 cooker clock swtiches
5P48 –telephone extension bell in black case, ex-GPO
5P50 –box of 20 infra red quartz glass enclosed 360W heating elements
5P51 –200W auto transformer 230V to 115V torroidal
5P52 –mains transformer 26V 10A upright mounting, add £2 post
5P54 –mains motor with gear box, final speed 5rpm
5P58 –Amstrad stereo tuner FM and LM and S. AM
5P60 –DC Muffin type fan 18 to 27V, only 3W
5P61 –drill pump mounted on frame, coupled to mains motor
5P62 –2$\frac{1}{2}$kw tangential blow heater, add £1.50 post if not collecting

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

VOL 16 No.1 JANUARY '87

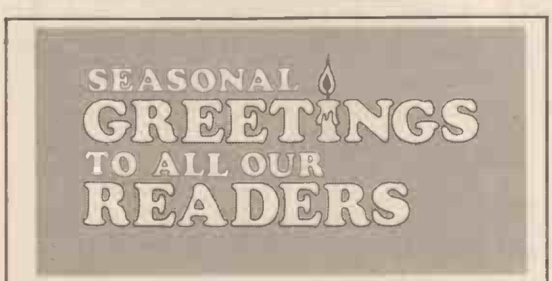
EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

ISSN 0262–3617

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



Projects

MORSE DECODER by John M. H. Becker 8
Automatic decoding of Morse signals with the aid of your micro
ANALOGUE TO DIGITAL CONVERTER 18
Low cost converter circuit for the BBC Micro
LOGIC PULSER by Mike Tooley BA 26
Useful logic fault finding probe; TTL and CMOS compatible
RANDOM LIGHT UNIT by C. J. Bowes 32
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SIMPLE BUZZER 38
An "Exploring Electronics" project
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Low budget system with good speech quality
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Don't let your batteries run down

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Our February 1987 issue will be published on Friday, 16 January 1987. See page 31 for details.

Readers' Services ● Editorial and Advertisement Departments 7

BI-PAK BARGAINS

RESISTORS

Pak No	Qty	Description	Price
VP1	300	Assorted Resistors mixed values & types	£1.00
VP2	300	Carbon Resistors 1/4–1/2 watt pre-formed, mixed	£1.00
VP3	200	1/8 watt Min. Carbon Resistors mixed values	£1.00
VP4	200	1/2–1 watt Resistors mixed values & types	£1.00
VP16	50	Wirewound Resistors mixed watt values	£1.00
VP112	1	Sub Resistance Box. 36 values 5ohms – 1Kohm	£4.75
VP140	50	Precision Resistors 1% Tol.	£1.00
VP181	100	1 and 2 watt Resistors, assorted values	£1.00

CAPACITORS

Pak No	Qty	Description	Price
VP5	200	Assorted Capacitors all types	£1.00
VP6	200	Ceramic Capacitors. Min. mixed values	£1.00
VP8	100	Mixed Ceramic Disc. 68pf–.015pf	£1.00
VP9	100	Assorted Polyester/Polystyrene Capacitors	£1.00
VP10	60	C280 Capacitors. Metal foil, mixed values	£1.00
VP11	50	Electrolytics all sorts	£1.00
VP12	40	Electrolytics 47mf–150mf mixed volts	£1.00
VP13	30	Electrolytics 150mf–1000mf mixed volts	£1.00
VP15	25	.01/250V Min. Layer Metal Caps	£1.00
VP146	25	Solid Tantalum Caps. mixed values	£1.00
VP180	25	Tantalum Bead Caps. assorted values	£1.00
VP182	4	1000uf 50v Electrolytics	£1.00
VP192	30	Min. Electrolytics mixed values .47mf–1000mf 6–16v	£1.00
VP193	6	Sub Min. Electrolytics. 2×1000/2200/3300mf 10–16v	£1.00

OPTOS

Pak No	Qty	Description	Price
VP24	10	.125" Clear Showing red LED's	£1.00
VP25	10	Mixed shape and colours LED's	£1.00
VP26	15	Small .125" red LED's	£1.00
VP27	15	Large .2" red LED's	£1.00
VP28	10	Rectangular .2" red LED's	£1.00
VP57	25	Opto Special Pack. Assorted. Super value	£5.00
VP130	6	RED 7 Seg. CC 14mm × 7.5mm RDP FND353 LED Display	£2.00
VP131	4	GREEN 7 Seg. CA .6" LDP XAN6520 LED Display	£2.00
VP132	5	RED 7 Seg. CC .6" LOP XAN6940 LED Display	£2.00
VP133	6	RED Overflow .6" 3 × CA 3 × CC 6630/50 LED Display	£2.00
VP134	5	GREEN Overflow .6" CA XAN6530 LED Display	£2.00
VP135	5	RED 7 Seg. CA .3" XAN3061 LED Display	£2.00
VP136	3	DUAL RED 7 Seg. .5" CA DL527 DPR LED Display	£2.00
VP137	3	DUAL RED 7 Seg. .51" CA DL727 DPR LED Display	£2.00
VP138	20	Assorted LED Displays – Our mix, with data	£5.00
VP147	1	Pair Opto Coupled Modules	£0.60
VP199	4	DL707R LED Displays CA	£1.00
VP203	15	Triangular shape LED's. Mixed colours	£1.00
VP204	10	Large Green LED's, 5mm	£1.00

Pak No	Qty	Description	Price
VP205	10	Small Green LED's, 3mm	£1.00
VP206	10	Large Yellow LED's, 5mm	£1.00
VP207	10	Small Yellow LED's, 3mm	£1.00
VP208	10	Large LED's Clear showing red .2"	£1.00

DIODES & SCRS.

Pak No	Qty	Description	Price
VP29	30	Assorted volts Zeners 250mw–2w	£1.00
VP30	10	Assorted volts Zeners 10w, coded	£1.00
VP31	10	5a SCR's T066 50–400v, coded	£1.00
VP32	20	3a SCR's T066 Up to 400v, uncoded	£1.00
VP33	200	Sil. Diodes like IN4148	£1.00
VP34	200	Sil. Diodes like 0A200/BAX13–16	£1.00
VP35	50	1a IN4000 Diodes, all good, uncoded	£1.00
VP49	30	Assorted Sil. Rects. 1a–10a, mixed volts	£1.00
VP141	40	IN4002 Sil. Rects. 1a 100v preformed pitch	£1.00
VP142	4	40a Power Rectifiers, silicon, T048 300PIV	£1.00
VP143	5	BY187 12kV Sil. Diodes in carriers, 2.5mA	£1.00
VP184	3	4a 400v Triacs, plastic	£1.00
VP187	10	SCR's 800MA 200v 2N5064, plastic, T092	£1.00
VP194	50	OA91 point contact Germ. Diodes, uncoded	£1.00
VP195	50	OA47 gold bonded Ger. Diodes, uncoded	£1.00
VP196	50	OA70–79 detector Diodes, Germ.	£1.00
VP197	50	OA90 type Germ. Diodes, uncoded	£1.00
VP198	40	BA248 Sil. Diodes, 350v 2a, fast recovery	£1.00
VP222	20	3a Stud Rectifiers, 50–400v	£1.00

TRANSISTORS

Pak No	Qty	Description	Price
VP38	100	Sil. Trans. NPN plastic, coded. With data	£3.00
VP39	100	Sil. Trans. PNP plastic, coded. With data	£3.00
VP45	50	BC107/8 NPN Transistors. Good, uncoded	£1.00
VP46	50	BC177/8 PNP Transistors. Good, uncoded	£1.00
VP47	10	Sil. Power Trans. Similar 2N3055, uncoded	£1.00
VP48	5	Pairs NPN/PNP plastic Power Trans, 4a, data	£1.00
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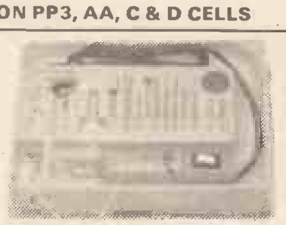

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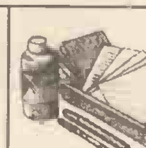

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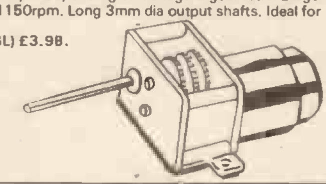

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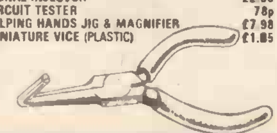

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

VOL 16 Nº1 **JANUARY '87**

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DORSET BH21 1JH
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SEASONS GREETINGS

FIRST of all may I take this opportunity, on behalf of all the staff at EE, of wishing all our readers, contributors, and advertisers the very best for Christmas and the New Year. We have all enjoyed producing the magazine for the past year—perhaps more than ever before since we left the somewhat restricting influence of IPC at the end of January. Our next issue will mark the completion of our first year "on our own", a year which has seen some renewed interest in project construction following a period when many potential electronics hobbyists were getting to grips with home computers.

It has been an interesting year for the hobby and for EE and we intend to build on the firm base EE has established, with new ideas and continuing value for money which we believe the magazine represents. We are working on what should be a breakthrough for electronics magazines, to be published as a series later in 1987.

So much for our plans—what about the present? You may well have noticed our changed logo this month. We believe the time has come to alter our cumbersome *Everyday Electronics and Electronics Monthly* title; it has served its purpose since EE took over EM back in November '85. The new logo is neater and we will now refer to the magazine as simply *Everyday Electronics* as we did when it was launched back in November '71. We have also changed the style of our covers to bring them right up to date with the use of computer graphics for backgrounds. This does not mean we will be going further into computing—we simply feel the image is right for the magazine. We hope you agree that the use of computer graphics provides an eye catching and unusual cover.

OFFERS AND EXTRAS

We are continuing to bring you a range of special offers. These have proved to be very popular with readers and we will run them as long as we feel that they provide excellent value for money. The offer in this issue is unusual and should be of great interest to a number of readers, educational institutions and companies; next month we will be offering oscilloscopes. Also next month EE will carry a brand new 24 page Kit Catalogue from Greenweld

Finally, just one "frustration" left over from last month! Please make sure of your issue by placing an order for it with your newsagent, or by taking out a subscription. So often readers phone us to say they have been unable to get a copy because the newsagent has run out, or because he claims he did not receive any. We have not had any publishing problems for a very long time now—all issues have been published on time for the last three or four years. Please make sure of your copy!

Mike Kenward

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Certain back issues of EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY are available price £1.50 (£2.00 overseas surface mail) inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. In the event of non-availability remittances will be returned. *Please allow 28 days for delivery.* **(We have now sold out of Oct. and Nov. 85 and April 86.)**

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

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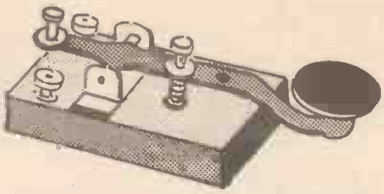
MORSE DECODER



JOHN M.H. BECKER

Decode Morse with this unit and your home computer. Instant readout without any "learning"

The unit described here has been designed as a simple interface for use with a computer to decode Morse signals. The program is primarily written in PET and Commodore C64 BASIC, but a separate listing is available for the BBC. The program can probably be modified for use with other 8-bit machines.

MORSE PIONEERING

Samuel Morse is the man most likely to be remembered for his pioneering work in coding information into a form suitable for long distance transmission. He, after much trial and tribulation, established communication links across parts of America in the mid 19th century. His method of coding was based upon the length of time that an electrical switch was held on and off. This method is still in use today, and although the codings have been slightly changed to meet international requirements, it is essentially the same system of dots, dashes, and long and short pauses.

Originally the sender would press a switch key, and an electrical path would be connected with the receiver at the far end. This energised an electro-magnet which could deflect a needle or activate a pen on a moving strip of paper. The rate and duration of the deflections was noted by the receiving operator who translated the information into alphabetic or numeric characters. Exceptionally experienced operators are reported to have been able to handle up to 46 words a minute, though the more normal rate was about 20 to 25 words a minute. It soon became noticeable to trained operators that they could actually "read" the letters by listening to the sound of the electromagnet without looking at it. From this ability was born the equipment to send more-audible signals by switching a frequency tone on and off.

Once radio transmitting techniques were developed, it was natural that the same system of communication should be used. Although speech could be transmitted by early radio equipment, the clarity of speech was often far below that achievable by tone switching as in Morse. The ear can more readily distinguish vague tones being modulated, than it can interpret poor speech reception on a defective radio link.

LOGICAL BITS

The logic behind Morse coding played a significant effect on modern binary data transmission which still relies on whether a signal line is at a high or zero level, and the spacing between the ups and the downs. Binary data transmission is based on the order in which eight precisely-spaced bits are sent up and down, and their accurate reception and interpretation depends on the exact rate at which they are sent. For this system to operate successfully, the rates of transmission and reception need to be accurately controlled, and usually relate to a fixed rate, called the baud rate. Different systems may use different rates, but generally the baud rate of transmitter and receiver need to be previously set for the correct synchronisation.

In this respect Morse code is very different, for the human ear is capable of rapidly discerning a dot from a dash, and a short pause from a long one, even though the relative lengths may be somewhat inconsistent. Additionally, whereas binary transmission is normally on a fixed quantity of 8 bits being set to produce one character, Morse code uses varying numbers of spaced bits being set long or short, varying basically between one bit and six bits, though the "ERROR" message consists of eight.

TRANSMISSION RATES

The rate at which Morse is transmitted is free to vary between operators, though of course the sender must always take into account the rate at which the receiver can decode the signals. Good operators can receive and send at rates in excess of 25 words a minute, each word being regarded as five characters. Although the rate can vary, international conventions lay down ideals for the relative lengths of the dot, dash and space components. The dot is taken as the primary unit of measurement, a dash is then specified as being three times the length of the dot. The space between the signals that form a character is equal to one dot. The space between two characters is equal to three dots and the space between two words is equal to seven dots. Even to unpractised ears, these spacings are readily discernable even at quite fast rates.

COMBINATIONS

With practise though, experienced operators will not necessarily be listening for individual letters, but rather will recognise the pattern produced by several letters being sent consecutively. Regularly heard configurations such as those spelling "the", "ing", "ment", "for", "of", etc, being typical examples. The content of the preceding information also helps in speedy decoding since the operator can perhaps anticipate subsequent characters.

Some combinations of three letters are regarded as messages in their own right. The best well known is probably "SOS", meaning "help", though actually stemming from the initial letters of the message "save our souls". Others, usually commencing with "Q" are also used, such as "QRL"—"is this frequency in use", "QRZ"—"who is calling me?", "QRS"—"send more slowly".

Shipping also uses specific meanings for Morse codes when sent on the ships siren, such as "GU"—"it is not safe to fire a rocket", "KR"—"all is ready for towing", "A"—"I have a diver down, keep well clear at low speed". The full lists are lengthy, and probably only of significance to Morse experts, and specific disciplines.

MOTIVATION

There must be many people uninitiated in Morse code who have listened to transmissions, usually on short wave radio, and wondered in interest just what messages are being sent. Some are probably quite mundane, and little more than domestic chit-chat. Others are probably military, and are a code within a code. Even though this technological era has provided us with satellite phone links and computer data transmissions, Morse is still used by many people for many reasons. Military and commercial shipping are principal users, but amateur radio hams use Morse to a very great extent, and frequency channels are allocated for Morse use only. Morse can often penetrate bad atmospheric conditions far better than clear speech, enabling amateurs to communicate world wide.

In Britain, before you can become a qualified radio amateur, (not CB radio), it is still necessary to pass examinations involving both transmission and reception of Morse.

MICRO MORSE

However, with the current generation of home computers, it is not necessary to know Morse in order to decode it. Since the coding rules are formalised, a computer can readily be programmed to perform the decoding. Within certain limitations, this can be done directly by the computer without any significant electronic interface. Such a system can consist simply of a radio linked to a computer data line. The main requirement is that the signal should swing up and down between about zero and five volts, with a limiting network to prevent adverse signal voltages from damaging the computer.

The author has written such a program for his own amusement, but although in machine code, it is somewhat limited in the rates of decoding, due to the time taken by the relative spacing analysis. A better method is presented here, in which the signal is partially decoded electronically before final deciphering by the computer. This increases the reception rates possible by allowing the electronics to distinguish between dots, dashes and spaces, leaving a machine code routine to relate them to look-up tables. Varying reception rates from as low as 20 words per minute, to over 110 words per minute are achievable. Obviously though, the Morse signal must be much stronger than any background noise received.

OPTIONAL BYTES

In contemplating the circuitry for this article, there appeared to be three ways that can be used to decode the signals once within the computer. Firstly by direct pattern matching of the signal against a library of patterns, and involving many conditional or "IF" statements. Alternatively the code can be translated into one of two forms of binary code. One form results in a code of up to 16 bits long, the other involves the derivation of two eight-bit codes. Both ways are equally valid, but the second requires less subsequent decoding via look-up tables and is thus a little faster and needs fewer program statements.

In the 16 bit conversion method, a dot is represented by binary "01" and a dash by binary "11". As each group of two bits is received, the previous two are shifted left in the memory register. At the end of the letter received, the empty spaces to the left of the 16 bit number are considered to be zeros.

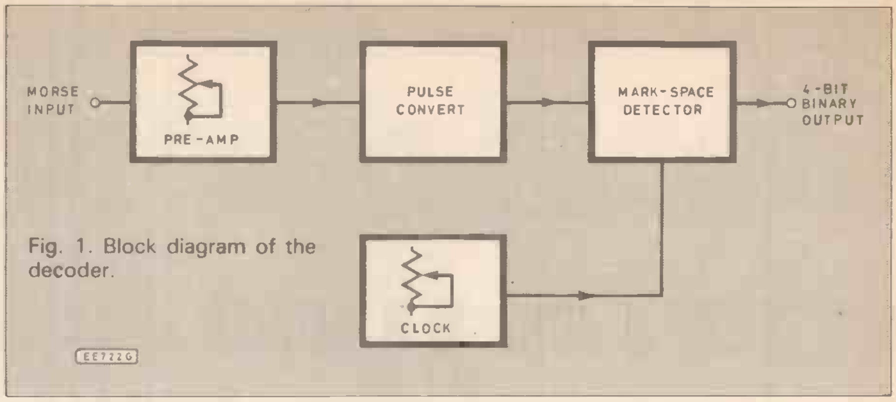


Fig. 1. Block diagram of the decoder.

Thus one dot (letter "E") would produce binary "0000000000000001" (15 zeros and a "1"). Letter "L" (dot-dash-dot-dot) would appear as "0000000001110101". Numeral "0" (five dashes) would be "0000001111111111". These binary numbers can be readily translated to decimal and the character corresponding with that decimal number can be printed.

In the two-by-eight bit method, a dot is counted as zero, and a dash as "1". Each bit is shifted left as the next is entered, thus forming the first byte. The second byte simply counts the number of times that the signal goes up and down, irrespective of the pulse length. With letter "C", dash-dot-dash-dot, the first byte would be "00001010", decimal ten, and the second byte would count four ups and downs. Letter "S" dot-dot-dot, would decimal zero, but byte two would have counted three ups and downs.

LOOK UP TABLES

If the first byte is considered as a line address, and the second as a column address, the look-up table would hold "C" at line 10 column 4, and letter "S" at line 0 column 3. However, as some messages are complete words or phrases, the look-up table actually gives another number, referring to a second table in which the character or message is held as a string. With the exception of the 'ERROR' message code, the conventional Morse code primary look-up table can be held within a block six columns across, and 56 lines down.

Since some codes can be imprecisely received though, the effective table size is in fact 256 × 256, but unrecognised codes will be displayed as a query mark. When codes represent complete words or phrases, these are displayed bracketed by asterisks to indicate their nature. A full table of twin byte decimal codes is shown with the Morse code table. This also includes six international character variations, plus six phrase codes. Note that a colon and a semicolon are both returned as a semicolon.

INTERFACE CHOICE

For the electronic separation of a dot, dash and space lengths two alternative solutions were conceived. The first measures relative lengths by comparing the rates of charge and discharge of capacitors, deriving a binary output by triggering comparators. The second solution, and that described here, is to adopt a digital comparison technique, counting pulses and comparing with a known clocking rate (Fig.1).

PRE-AMP

Before the Morse signals can be decoded, their levels need to be brought to an amplitude suitable for triggering the count stages. Since the unit is to drive a computer input, the maximum level must swing between 0V and no more than 5V. In practice, a lesser swing will still trigger the computer, but the fuller swing is readily achievable. VR1 (Fig. 2) is a normal volume control that selects the maximum input level of the Morse code signal. IC1 then provides initial amplification to it, and can satisfactorily raise levels of only a few milliamps. Amplification gain is switchable by S2 to between approximately ×10 and ×100. The output passes via C3 to the high gain transistor stage TR1. When the output of IC1 produces a swing of greater than about 0·7V, the collector load of TR1 allows a voltage swing of practically full line level, between 0V and 5V.

PULSE DETECTOR

The Morse code signal really consists of two signals, a high frequency modulated by a low one. The latter is simply the one that turns the high frequency tone on and off as the Morse key of the sender is pressed, and its rate depends on the operator's sending speed. The high frequency is the pitch of which we are normally aware, coming and going in bursts of sound. In theory this can be any pitch within the audio spectrum, though transmitter bandwidth restrictions narrow the range. The high pitch signal is made up of repeated peaks and troughs, which by definition, occur at the frequency rate. Obviously the unit must distinguish between these short duration variations, and the longer information containing changes. These short duration changes need to be removed, leaving only the low frequency ones.

This function is performed by IC2a, which is a retriggerable monostable. On receipt of a negative going change on its input at pin five, the chip is triggered so that its twin outputs at pins six and seven change state. They will remain in the secondary state until a pre-determined time has elapsed, as set by the combination of C5 and R9. However, each time the input goes low after a preceding high, the chip can be retriggered to the start of the timing cycle, irrespective of the point in the current cycle. With the correct selection of timing components for a given input triggering rate, the chip can be held in its secondary condition until the input signals cease. When they do, the outputs revert to the primary state. The output from IC2a consequently only contains the low pulse rate frequency, and effectively ignores the pitch of the original. The outputs of IC2a are used to signal directly to the computer, and also to control two counters IC3a and IC3b.

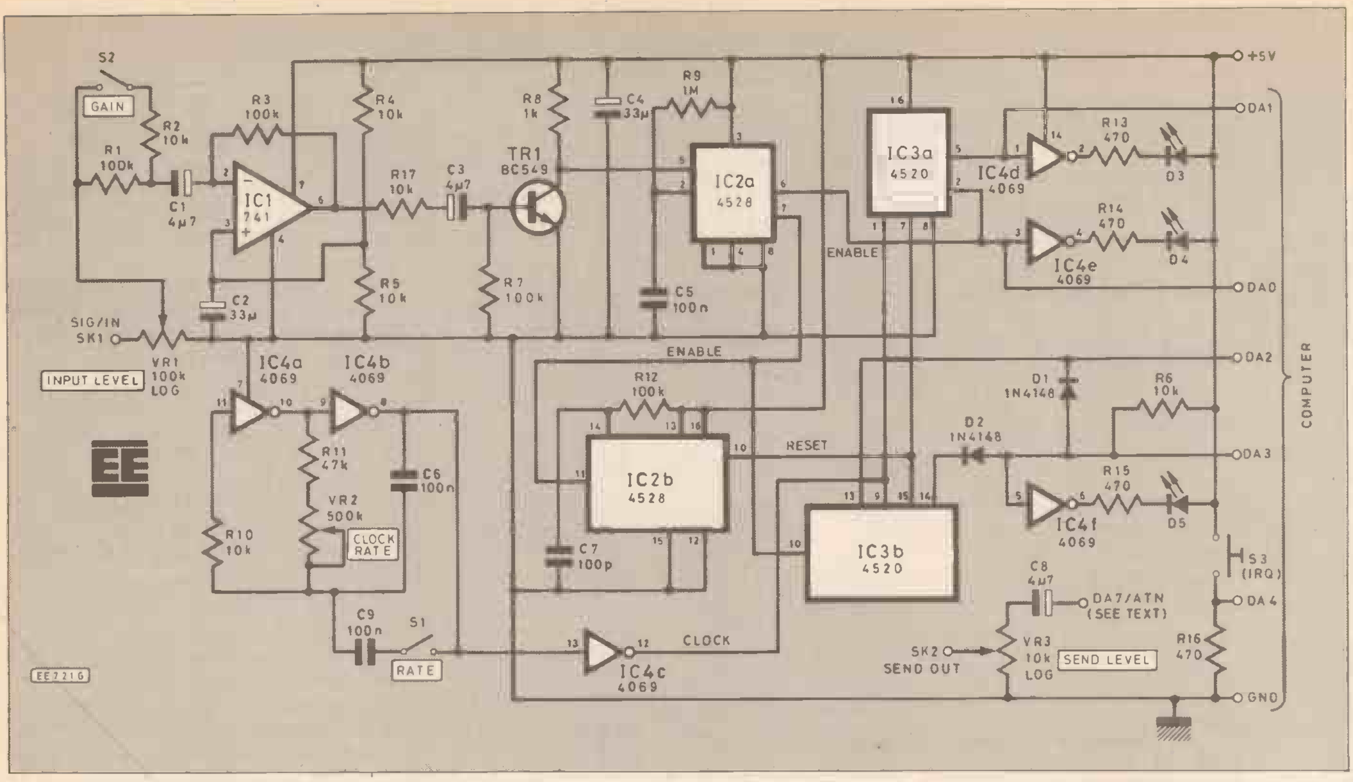


Fig. 2. Complete circuit diagram of the Morse Decoder.

COMPONENTS

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Resistors

R1,R3,R7,R12	100k (4 off)
R2,R4 to R6,R10,R17	10k (6 off)
R8	1k
R9	1M
R11	47k
R13 to R16	470 (4 off)
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Capacitors

C1,C3,C8	4µ7 elect. 63V (3 off)
C2,C4	33µ elect. 6V (2 off)
C5,C6,C9	100n polyester (3 off)
C7	100p polystyrene

Potentiometers

VR1	100k log. mono rotary
VR2	500k mono rotary
VR3	10k log. mono rotary

Semiconductors

D1,D2	1N4148 (2 off)
D3 to D5	red l.e.d. (3 off)
TR1	BC549
IC1	741
IC2	4528
IC3	4520
IC4	4069

Switches

S1,S2	min. s.p.d.t. (2 off)
S3	s.p. push make

Miscellaneous

SK1,SK2	mono jack sockets (2 off)
SK3	3.5mm jack socket

P.c.b. mounting clips (4 off); p.c.b.; knobs (3 off); l.e.d. mounting clips (3 off); 8-pin i.c. socket; 14-pin i.c. socket; 16-pin i.c. socket (2 off); wire; fixings; case approx 150 × 120 × 50mm.

See **Shop Talk** page 43

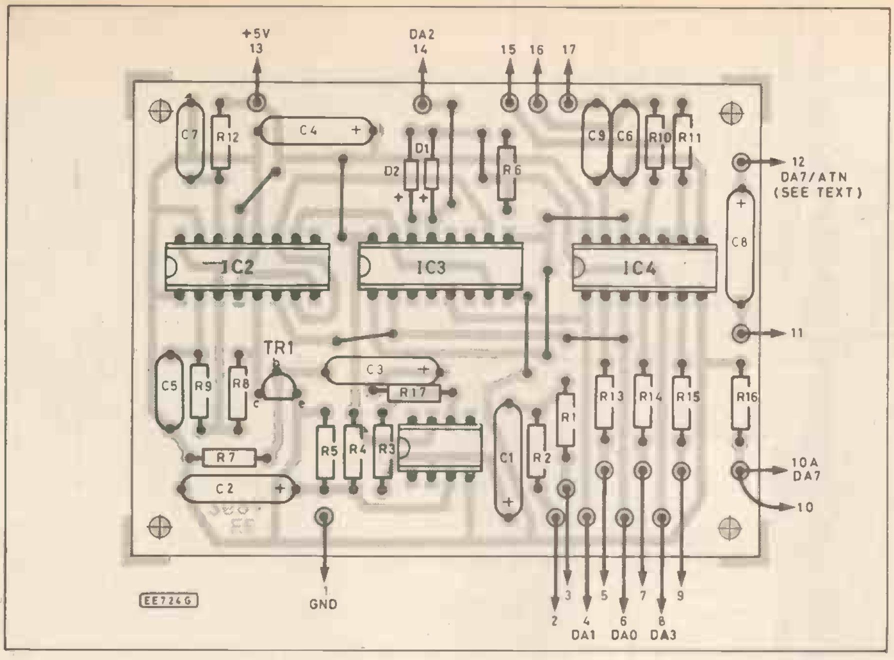
CLOCK COUNTING

The information that they count is derived from a variable frequency clock around IC4a and IC4b. The frequency rate is controlled by C6 and the total resistance across R11 and VR2, a low resistance producing a higher frequency. A slower rate can be switched in by S1 connecting C9 in parallel with C6. IC4c buffers the clock frequency, and feeds it simultaneously to both counters.

Counting of dot and dash durations is performed by IC3a, while IC3b signals pause durations. During the presence of a dot or dash, pin six of IC2a enables IC3a to count the clock pulses. It is a binary ripple counter, each stage dividing the clock by two. At the start of the count, the enable signal controlling IC2a also signals to the computer via line DA0 that the count has started. The computer now waits for one of two conditions, either DA0 going low again, or pin five of IC3a going high. With the correct clocking frequency, the former will occur if the signal is the duration of a dot. The output five of IC3a will only be triggered if the signal is a dash, allowing sufficient clock pulses through the counter to trigger the selected output. The latter information is read on line DA1. When DA0 goes low as IC2a reverts back, whether it is before or after IC3a and DA1 being triggered, the computer stores the data in a temporary memory. Simultaneously, IC3a stops counting, and IC3b is enabled by pin seven, IC2a going high.

SPACED OUT

The "b" section of IC3 is identical to IC3a, and the two outputs selected are triggered by long and very long pauses respectively. The presence of a short pause is not directly measured since the act of IC2a reverting back is taken as sufficient indication of this. The outputs are chosen so that a long pause, marking the end of a letter, appears as an output at IC3b pin 13, signalling to the computer via line DA2. On



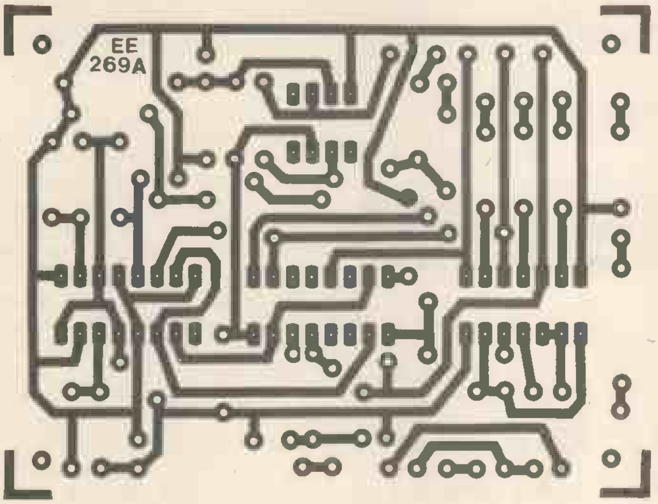
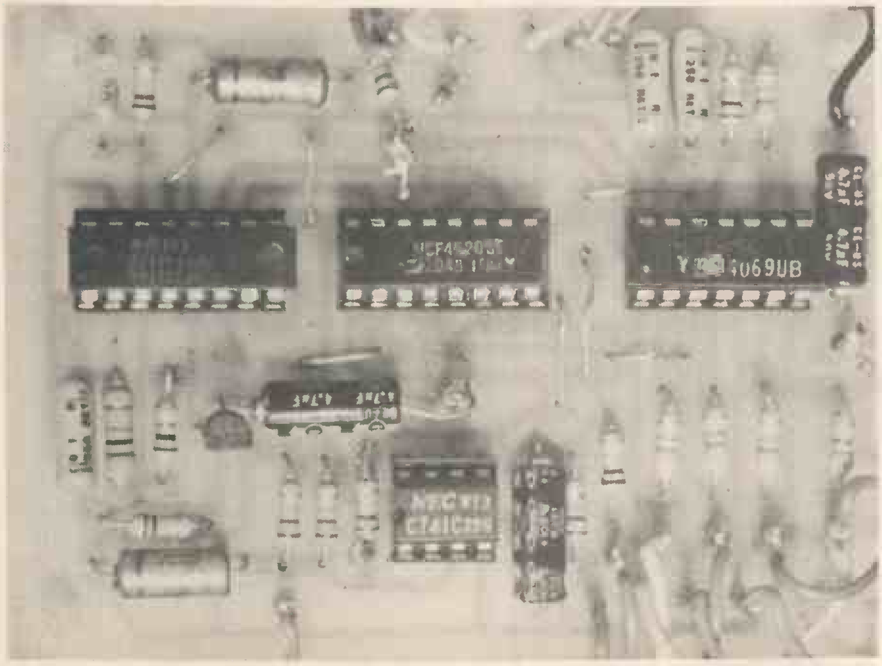


Fig. 3. Printed circuit board layout and wiring.

Prototype p.c.b. layout.



receipt of this signal the computer takes the data from its temporary store and reads the number held.

Concurrent with this store being accessed during data acquisition, a second store has been incremented by one each time DA0 has gone high. The number of elements in the character is thus known. From these two numbers, the relevant address in the look up table of rows and columns is accessed, and the relevant decoded character displayed on the screen. The computer now watches both DA0 and DA3 lines. Should the pause be long enough for output pin 14 to go high at the same time as pin 13, the ANDed output at D1 and D2 sends DA3 high. The computer then assumes that this length of pause represents a pause between words, and so prints a blank space. When DA0 goes high, the computer loops back to obtain the next set of character factors.

The conditions of DA0 to DA2 are visually signalled to the user by D3 to D5, buffered by IC4d to IC4f.

RESETTING

At the moment of DA0 going high at the start of the next sequence, pin seven of IC2a falls, triggering IC2b. This produces a very short duration pulse set by C7 and R12, and this immediately resets both counters back to zero. The pulse duration is too short to affect the count assessment.

The acquisition of data from the unit is performed in machine code since BASIC is far too slow for decoding at realistic rates, though the printing to the screen is in BASIC. During the machine code routines access to the computer by its keyboard is automatically shut off, and control can only be regained by pressing the interrupt switch S3 on the unit itself. This is fed via DA4 back to the computer. Periodically during the machine code routine, this line is read. Normally it will be found to be low, and so no action is taken. If S3 is pressed, then the line will go high, the data receipt mode will be aborted, and the program returns to the menu display.

PROGRAM OPTIONS

In the published program, the menu allows for a second option to be selected in addition to reception decoding. All three computers for which this program is suitable have an additional data line that can put out a frequency tone and which can be turned on and off under program control. On the PET and BBC, this is the ATN line, and on the C64 is line DA7. The relevant Morse codes for alphanumeric characters are stored in memory from data statements within the program, and the combination of these two facilities provides for testing of the unit itself. The option cycles through all stored Morse codes transmitting each in turn on a loop. Some international variations for some letters have also been included in this coded data library. The audio output generated and passed via volume control VR3, can be stored on an audio taperecorder or cassette, then subsequently played back to the computer via the unit for decode checking.

Experienced programmers will recognise that this second facility can be adapted to produce other options. These include automatic translation and transmission of alphanumeric data entered on the keyboard, or sent from data files on disc or tape. Creation of a screen display showing all characters and their codes is another possibility. As is creating a tutorial test sub-

DECODER PROGRAM

```
100 REM MORSE DECODER PROG269 SHORT 02AUG86. THIS PROG CAN BE USED WITH THE
110 REM BBC, C64 AND PET COMPUTERS. BBC USERS SEE END NOTES BEFORE TYPING IN.
120 REM C64 & PET USERS TYPE IN AS PER THIS LISTING.
130 DATA1-PET USER":REM SUBSTITUTE RIGHT NO & NAME IN THIS LINE = 2-C64, 3-BBC
140 GOTO330
150 PRINTCHR$(CC):PRINT:PRINT:PRINT:PRINTTAB(10)"MORSE UNIT OPTIONS"
160 PRINT:PRINTTAB(10)"1 DECODE RECEPTION
170 PRINT:PRINTTAB(10)"2 TEST SEND CODES
180 PRINT:PRINTTAB(10);:INPUT"WHICH";Z$:Z=VAL(Z$):IFZ=2THEN280
190 IFZ<>1THEN150
200 PRINT:PRINT"WAIT RECEPTION":PRINT:POKEDRT,0:A=Z(0):B=Z(1):C=Z(2)
210 SYS(SY):PRINTL$(PEEK(B))L$(PEEK(A));:IFPEEK(C)THEN210
220 GOTO150
230 REM TRANSMIT ROUTINE
240 C=ASC(A$):IFC>128THENC=C-128:A$=CHR$(C)
250 PRINTA$;:IFC=32THENFORF=1TOH*6:NEXT:RETURN
260 FORD=2TOLEN(A$(C)):E=VAL(MID$(A$(C),D,1))*H:POKEFR,W
270 FORF=1TOE:NEXT:POKEFR,0:FORF=1TOH:NEXT:NEXT:FORF=1TOH*3:NEXT:RETURN
280 PRINTCHR$(CC):PRINT:PRINT"TEST SEND ALL STORED CODES":PRINT
290 PRINT"PRESS ANY KEY TO RETURN TO MENU":GOSUB600
300 FORC=0TO128:IFLEFT$(A$(C),1)="?"ANDC<>13THEN320
310 PRINT"    "A$(C):GOSUB260:GETZ$:IFZ$<>""THENFORC=1TO1:NEXT:GOTO150
320 NEXT:PRINT:FORF=1TOH*6:NEXT:GOTO300
330 READA$:A=VAL(A$):ONAGOSUB810,850,890:PRINTCHR$(CC):PRINT:PRINT:PRINT
340 PRINTTAB(12)"MORSE DECODER":IFA<3THENSY=PEEK(MM)*256+PEEK(ML):GOTO360
350 SY=HIMEM
360 POKEDRT,0:A$="":FORC=0TO4:A$=A$+CHR$(PEEK(SY+C)):NEXT:IFA$="CODER"THEN390
370 B=SY-700:HIMEM=B:IFA<3THENHI=INT(B/256):LO=B-(HI*256):POKEML,LO:POKEMM,HI
380 A$="CODER":FORC=0TO4:POKE(B+C),ASC(MID$(A$,C+1,1)):NEXT:CLR
390 RESTORE:READA$:A=VAL(A$):ONAGOSUB810,850,890
400 SY=HIMEM+5:IFA<3THENSY=PEEK(MM)*256+PEEK(ML)+5
410 DIMA$(128),L$(255):PRINT:PRINTTAB(14)"SETTING UP":FORB=7TO255:L$(B)="#"
420 NEXT:FORB=12TO128:A$(B)="?113311":NEXT:FORA=1TO5:READA$
430 L$(A)=" *"+A$+"* "+CHR$(13):NEXT:L$(A)="CH":L$(16)=" ":L$(32)=" "
440 READA$:IFA$="#"THEN470
450 B=VAL(MID$(A$,2,1))*64+VAL(MID$(A$,3))+SY+150:A=ASC(A$):POKEB,A
460 L$(A)=CHR$(A):GOTO440
470 READA$:IFA$="#"THEN500
480 B=VAL(MID$(A$,2,1))*64+VAL(MID$(A$,3))+SY+150:A=VAL(LEFT$(A$,1)):POKEB,A
490 GOTO470
500 READA$:IFA$<>"#"THENA$(ASC(A$))=A$:GOTO500
510 FORA=0TO11:READA$(A):NEXT:A=SY-1
520 READA$:A=A+1:IFA$<"A"THENPOKEA,VAL(A$):GOTO520
530 IFLEFT$(A$,1)="Z"THENB=VAL(MID$(A$,2)):POKEA,Z(B):GOTO520
540 IFA$="INP"THENB=IN:GOSUB590:POKEA,LO:A=A+1:POKEA,HI:GOTO520
550 IFA$="END"THEN150
560 IFA$="LSB"THENB=SY+150:GOSUB590:POKEA,LO:GOTO520
570 IFA$="MSB"THENPOKEA,HI:GOTO520
580 STOP
590 HI=INT(B/256):LO=B-(HI*256):RETURN
600 PRINT:INPUT"SEND RATE 20 - 120 LPM";A$:A=VAL(A$):IFA<20ORA>120THEN600
610 H=130-A:RETURN
620 DATAUNDERSTOOD,WAIT,END OF WORK,STARTING SIGNAL,ERROR,?612,!613,'630
630 DATA(522,)645,+510,651,-633,.621,/518,=517,<618,",651",":656",A45,A513
640 DATAE54,N527,O414,U43,0531,1515,257,353,451,550,6516,7524,8528,9530
650 DATAA21,B48,C410,D34,E10,F42,G36,H40,I20,J47,K35,L44,M23,N22,O37,P46,Q413
660 DATAR32,S30,T11,U31,V41,W33,X49,Y411,Z412,#,152,258,365,4521,580,6415,#
670 DATAA13,B3111,C3131,D311,E1,F1131,G331,H1111,I11,J1333,K313,L1311,M33,N31
680 DATAO333,P1331,Q3313,R131,S111,T3,U113,V1113,W133,X3113,Y3133,Z3311
690 DATA113333,211333,311133,411113,511111,631111,733111,833311,933331,033333
700 DATA'133331,<131131,?113311,!113313,(31331,)313313
710 DATA=31113,+13131,-311113,/31131,",331133",":333111",";333111",.131313,#
720 DATAA1313,A13313,E11311,O3331,U1133,N33133,*11131,*13111,*111313,*31313
730 DATA*11111111,*3333
740 DATA162,0,134,Z0,134,Z1,134,Z2,134,Z3,134,Z4,173,INP,170,41,8,5,Z4,133
750 DATAZ4,138,41,16,208,106,138,41,1,240,236,173,INP,170,41,16,208,93,138
760 DATA41,8,5,Z4,133,Z4,138,41,1,208,236,6,Z0,230,Z1,138,41,2,240,2,230,Z0
770 DATA173,INP,170,41,16,208,62,138,41,8,5,Z4,133,Z4,138,41,4,208,7,138,41
780 DATA1,240,231,208,198,169,LSB,133,Z2,169,MSB,133,Z3,166,Z1,24,165,Z2,105
790 DATA64,133,Z2,144,2,230,Z3,202,208,242,164,Z0,177,Z2,133,Z0,169,1,133,Z2
800 DATA165,Z4,240,2,169,32,133,Z1,96,169,0,133,Z0,133,Z1,133,Z2,96,0,0,END
810 REM PET USER
820 CC=147:CH=19:ML=52:MM=53:DRT=59459:IN=59457:CTL=59467:OSC=59464:SRL=59466
830 Q=128:FORB=0TO3:Z(B)=B:NEXT:Z(4)=5:POKECTL,PEEK(CTL)AND227OR16:POKESRL,0
840 POKEOSC,Q:FR=SRL:W=15:RETURN
850 REM C64 USER
860 CC=147:CH=19:ML=55:MM=56:DRT=56579:IN=56577:CTL=56591:OSC=56582:SRL=56583
870 Q=95:Z(0)=251:Z(1)=252:Z(2)=253:Z(3)=254:Z(4)=2:POKECTL,0:POKEOSC,95
880 POKESRL,4:FR=CTL:W=7:RETURN
890 REM BBC USER
900 CC=12:CH=30:DRT=&FE62:IN=&FE60:CTL=&FE6B:OSC=&FE68:SRL=&FE6A:Q=128
910 Z(0)=112:Z(1)=113:Z(2)=114:Z(3)=115:Z(4)=116:SY=HIMEM
920 POKECTL,PEEK(CTL)AND227OR16:POKESRL,0:POKEOSC,Q:FR=SRL:W=15:RETURN
930 REM BBC USER NOTES
940 REM THE BBC USES '?' INSTEAD OF 'PEEK' AND 'POKE', THUS 'POKEA,VAL(B$)'
950 REM WOULD BECOME '?A=VAL(B$)'. FOR 'PEEK' THE '?' CAN BE SUBSTITUTED
960 REM DIRECTLY, THUS 'L$(PEEK(2))' BECOMES 'L$(?(2))'. 'SYS(SY)' BECOMES
970 REM 'CALL(SY)'. 'GETZ$' BECOMES 'Z$=INKEY$(0)'. 'CLR' BECOMES 'CLEAR'.
980 WHEN TYPING IN THE NORMAL BBC REQUIREMENTS FOR A SPACE BETWEEN SOME
990 STATEMENTS SHOULD BE OBSERVED.
```

MORSE CODES AND COMPUTER CONVERSION

	MORSE CODE	BINARY	COUNT	NO
:	– – – . . .	00111000	6	56
;	– – – . . .	00111000	6	56
=	– . . . –	00010001	5	17
?	. . – – . .	00001100	6	12
!	. . – – . –	00001101	6	13
'	. – – – – .	00011110	6	30
"	. – . . – .	00010010	6	18
(	– . – – .	00010110	5	22
)	– . – – . –	00101101	6	45
+	. – . – .	00001010	5	10
,	– – . . – –	00110011	6	51
-	– . . . . –	00100001	6	33
.	. – . – . –	00010101	6	21
/	– . . – .	00010010	5	18
0	– – – – –	00011111	5	31
1	. – – – –	00001111	5	15
2	. . – – –	00000111	5	7
3	. . . – –	00000011	5	3
4	. . . . –	00000001	5	1
5	. . . . .	00000000	5	0
6	–	00010000	5	16
7	– – . . .	00011000	5	24
8	– – – . .	00011100	5	28
9	– – – – .	00011110	5	30
A	. –	00000001	2	1
A#	. – . –	00000101	4	5
A♦	. – – . –	00001101	5	13
B	– . . .	00001000	4	8
C	– . – .	00001010	4	10
CH	– – – –	00001111	4	15
D	– . .	00000100	3	4
E	.	00000000	1	0
E#	. . – . .	00000100	5	4
F	. . – .	00000010	4	2
G	– – .	00000110	3	6
H	. . . .	00000000	4	0
I	. .	00000000	2	0
J	. – – –	00000111	4	7
K	– . –	00000101	3	5
L	. – . .	00000100	4	4
M	– –	00000011	2	3
N	– .	00000010	2	2
O	– – –	00000111	3	7
O#	– – – .	00001110	4	14
P	. – – .	00000110	4	6
Q	– – . –	00001101	4	13
R	. – .	00000010	3	2
S	. . .	00000000	3	0
T	–	00000001	1	1
U	. . –	00000001	3	1
U#	. . – –	00000011	4	3
V	. . . –	00000001	4	1
W	. – –	00000011	3	3
X	– . . –	00001001	4	9
Y	– . – –	00001011	4	11
Z	– – . .	00001100	4	12
↑	– . . . –	00001000	4	8
●1	. . . – .	00000010	5	2
●2	– . –	00000101	3	5
●3	. – . . .	00001000	5	8
●4	. . . – . –	00000101	6	5
●5	– . – . –	00010101	5	21
●6	....	00000000	8	0

A# = A. A♦ = A. E# = E. N# = N.
O# = O. U# = U. ! = UNDERLINE.
UNRECOGNISED CODES RETURNED AS '?'.

↑ = LONG BREAK (SPACE)
●1 = 'UNDERSTOOD'.
●2 = 'INVITATION TO TRANSMIT'.
●3 = 'WAIT'. ●4 = 'END OF WORK'.
●5 = 'STARTING SIGNAL'. ●6 = 'ERROR'.

routine to display characters in a random order and check that dots and dashes entered as "." and "–" produce the correct code sequence. The programming for these options is quite simple to work out for yourself. Alternatively an extended software listing is available from the kit supplier—see Shop Talk.

UNIT ASSEMBLY

P.C.B. assembly should be carried out in the usual methodical fashion, double checking that joins are adequately soldered, and that no shorts exist between tracks. IC2 to IC4 are MOS devices, and normal static precautions should be observed whilst handling them. This is easily done by touching a grounded (earthed) metal surface. Pot and switch holes should be drilled in the box at evenly spaced intervals. In the prototype, mounted in a box 15·3 × 11·3 × 4·5 cm, the spacing was 3cm apart, and 2cm above the base. The computer socket should be bought and wired to suit the computer lead to be used. Primary connection data is shown in Fig. 5.

The unit only draws about 10mA at 5V and so can be powered directly by the computer from the points shown. Although the computers can deliver more power than this, do not exceed 100mA consumption without consulting data handbooks. SK3 is only needed with the PET and C64, or with a separate power supply, since the BBC has +5V available on its user port socket.

PROGRAM COMPATIBILITY

The program listings have been written to be compatable with the PET, C64, and BBC computers, including the latest BBC which reportedly is compatible with the previous model. The author's experience of the new machine tends to confirm this. When typing in the program for the PET or C64, remember to insert the correct name and number into the 4th program line. It is from this data statement that the correct codes are obtained to suit the machine in question. The BBC program can be directly typed in as listed.

FINAL DOTS

Two notable points, the input level should be set so that signal background noise is not allowed to trigger the circuit —noisy reception should be put through a tight bandpass filter first. Secondly, when freshly acquiring Morse data, the rate control should be rotated from the left until characters start to make sense, then adjust it carefully so that word spaces (if they exist) become apparent. If the rate is incorrectly set, random series of "T", "E", "I" and "S" will probably be displayed. □

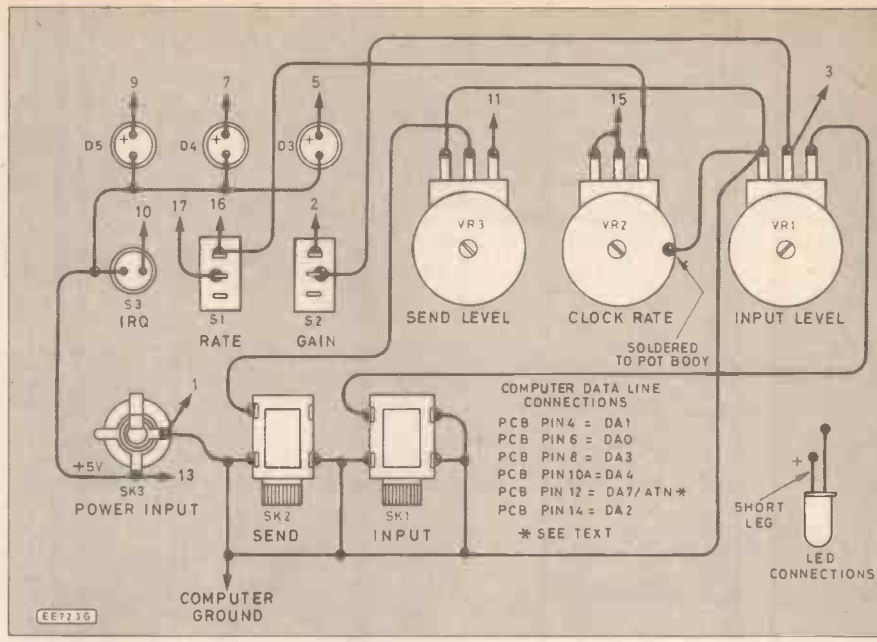


Fig. 4. Wiring of panel mounted components.

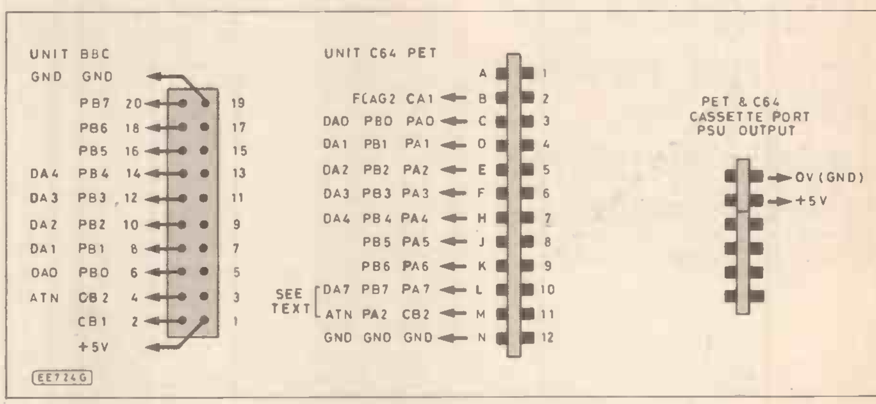
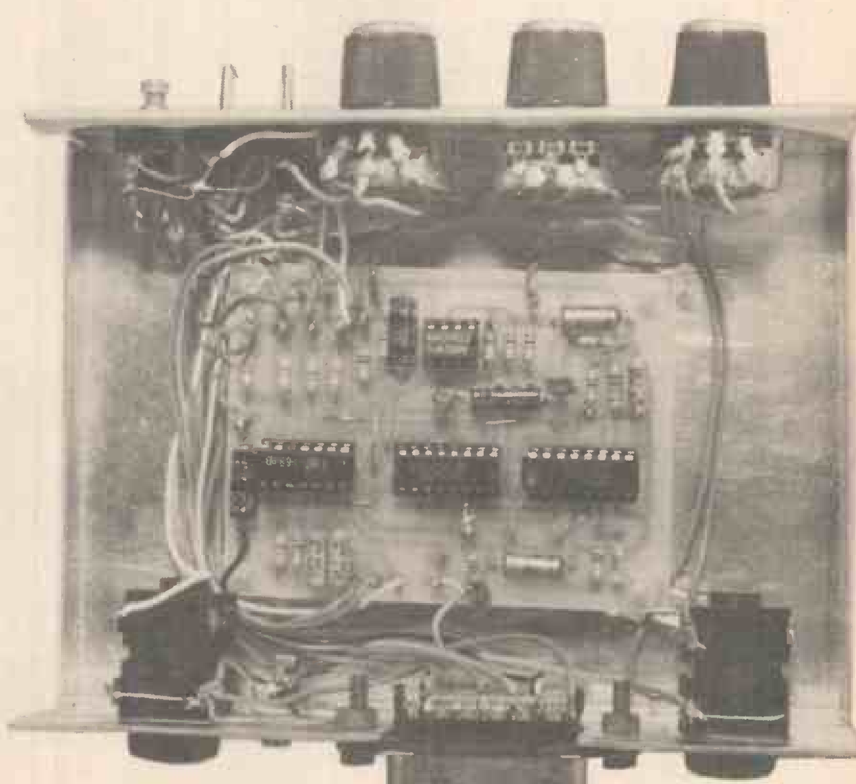


Fig. 5. Connections to the computer.



Front and rear panel layout and lettering for the Morse Decoder.

BUILDING with VERO

VIVIAN CAPEL

Veroboard is a familiar material to most constructors. Here are some facts you may not have known, along with plenty of hints and tips for its use

THE best and easiest way of building a circuit is undoubtedly by using a ready-made, custom-designed, printed-circuit board. All the layout problems have been solved by someone else, all the components will fit providing they are as specified, so all that is required is to mount them and solder.

But a ready-made board may not be available, and will not be if the design is your own. The next option is to etch one yourself. For this you will need etching solution, a suitable plastic bath, an etch-resist pen or transfers, and a drill to make the holes for the component wires. If you make a lot of p.c.b.s all these will be to hand and you will take the job in your stride. But if your project building is less frequent, making a one-off board is expensive and something of a chore.

So we turn to the humbler Veroboard, which consists of a board printed with copper strips along its length and drilled with a matrix of holes. The strips can be cut at any desired point, so a wide variety of circuit configurations can be created. Many experienced constructors tend to look down on Veroboard, and indeed it has some disadvantages, but this distain is unjustified, for most of the snags can be overcome with considered layout.

The pitch of the strips and that of the holes along them is 0·1 inches (however did this escape metrication?), which means that i.c. pins can be inserted readily in the board. There is also a 0·15 matrix which is less popular now because it is incompatible with i.c. pins. It is useful, though, for larger discrete components if you can get hold of it.

Some variants of the normal Veroboard are Verostrip in which the strips run across the width of the board instead of the length, and V-Q board. The latter has the strips cut after every four holes thus avoiding the need of cutting (Fig. 1). It also saves space because you lose a hole with each cut on Veroboard, whereas the V-Q cuts are between holes. The snag is that there are no complete uncut strips which are needed for supply and earth lines. An improvement would be to have every fourth or fifth strip uncut for this purpose; perhaps the makers will take note!

ELECTRICAL CHARACTERISTICS

There are two factors which are sometimes queried with matrix board, and these are the capacitance between strips, and their resistance. Neither are mentioned in the supplier's catalogues. It may be thought that the inter-strip capacitance would be quite large; however, capacitance is proportional to the facing area of the adjacent conductors. As the strips are laid edge-to-edge, the facing area is quite small.

Actual capacitances measure 2·5p per inch between adjacent strips for the 0·1 matrix, and 1·6p for the 0·15. The smaller capacitance of the latter is because the conductors are farther apart.

Capacitances of this order should prove no problem for any circuit other than those involving the higher radio frequencies in the megahertz range. It should be remembered, though, that transient pulses can contain frequencies in the r.f. spectrum and a sensitive part of the circuit could be triggered by a large pulse on an adjacent strip. The rule is, then, to keep such ill bedfellows well apart.

The other factor is resistance. If you connect an average ohm meter across a Vero track it will read zero resistance. That doesn't mean that there isn't any, only that it is too low for the meter to register; most will not indicate readings below around half an ohm.

The disadvantage with Vero, is what is said to be an advantage with a certain popular domestic product—all those little perforations! Each hole takes up over half the track and so conductivity is reduced at each one.

The resistance for 0·1 matrix is 10 milli-ohms per inch length. For the 0·15 matrix it is 7·5 milli-ohms per inch. If, for example, a one-amp signal current flowed along a five-inch length of 0·1 vero, there would be a 50mV drop across it. Currents of several amps are by no means unusual in output or even driver stages, so supply or earth lines common to earlier stages could be feeding back sizeable signals, resulting in instability and other ills.

There could be significant feedback with much smaller currents, such as between the input and output circuits of high-gain op. amps with common tracks. Another possibility is that decoupling capacitors could actually inject unwanted signals on an earth run common to another part of the circuit. One very troublesome fault experienced by the author on a prototype proved to be due to this very cause.

In power circuits, earthing points must be carefully chosen, especially for reservoir capacitors. These carry ripple current which is equal to the total supply current, so appreciable hum voltages can be developed over quite short print runs.

For vulnerable tracks, such as those for supply and earth, the resistance can be lowered by running solder along the entire length of the track. This has been found to drop the resistance by nearly a half, from ten to six milli-ohms per inch. Another solution is to use two adjacent tracks for the same supply but link them only at the supply end. One should feed the output or high current stages and the other the input sections.

LAYOUT

The first thing to do when devising the layout for a circuit is to plan it out

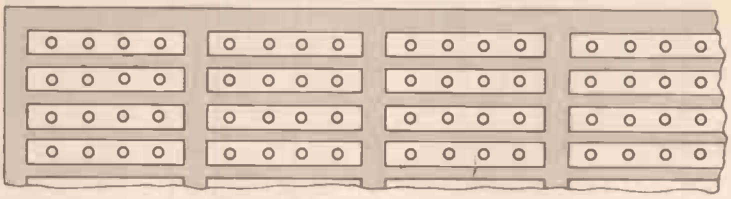


Fig. 1. VQ board consisting of matrix board divided into groups of four holes.

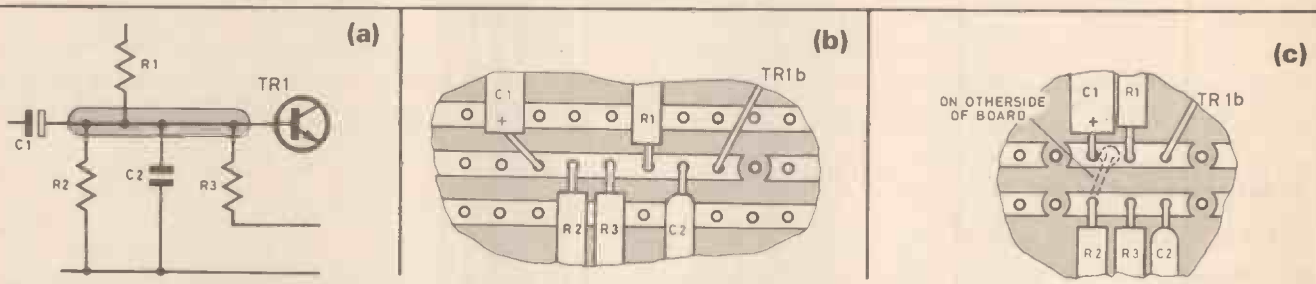


Fig. 2. When several connections have to be made to a single point as in circuit (a), the result on Vero can be elongated as in (b). A more compact and convenient group can be made if two adjacent strips are used. A link can be made by soldering a wire from one component across the two strips (c).

Fig. 3. Above-board connections can be made by making a wire spiral on a screwdriver shaft (a), slipping it over the free wires of the components and soldering (b).

on paper. To construct it "as you go" rarely works out unless the circuit is a very simple one or you have plenty of board space to spare. Usually you find that an extra hole or connecting strip is needed where there isn't one, so several components must be re-sited to make room.

It would be nice if pads of Vero planning paper were available so that components could be sketched in, just as it is for Veroblock, the solderless prototype breadboard system. Unfortunately none has been produced as yet; perhaps some enterprising maker will take the hint and fill the need, but until then paper planning means ruling your own. This is quite a chore, but well worth it as once you have got it right on paper, construction is much easier.

It helps to make the plan larger than the actual board, say twice normal size. Components too will have to scaled up proportionately. When ruling the paper make several carbon copies to save repeating the job if more plans are needed. Better still, if you have a computer and printer with graphics capability, make a plan and store it for future use.

A common pitfall is to allow too little space for some components, so check in advance how many holes are covered by each. Resistors and capacitors can be mounted either vertically or horizontally. When resistors are mounted horizontally they span about three or four holes, but when fitted vertically they can usually be connected across adjacent ones. Vertical mounting is more economical, but horizontal fitting can be useful when the component must bridge across to another part of the board.

Capacitors are generally available in two formats: radial, with the wires coming from the same end for vertical mounting, and axial, with a wire at both ends for horizontal fitting. Axials can be mounted vertically, but take an extra hole in this position than their radial counterparts.

PLANNING

Having determined the space required for each component, positioning on the plan can commence. The first step is to establish the power supply and earth strips. It is usually most convenient to put these at the two edges of the board. If there are two supply lines, a positive and negative, these could go on opposite edges of the board, and the earth conductor along the middle. Alternatively, the two supply lines can be two adjacent strips at one edge with the earth at the opposite edge. With this layout there is less likelihood of confusing them when the board is turned over than if they were at opposite edges.

Next, sketch in the components lightly in pencil so that alterations can be made, and ink in when finalised. Remember to mark in the polarity of diodes, transistors and electrolytics. Position the major components in such a way that their associated small components can be mounted around them and link easily with their feed circuits. Usually this means orientating the component with its positive electrode toward the positive supply line, and the negative and earth wires toward their respective supplies. Sometimes a sideways aspect facilitates the connection of other related components without hindering the connection to the supply strips.

Remember that the board has to be supported, so extra room must be allowed for fixing screws or stand-off posts. Alternatively, Veroboard can be obtained with the strips terminated with edge-connector contacts. These can be plugged into a mating connector which both connects and supports the board. This is ideal for equipment where boards need to be quickly changed to provide alternative functions or for quick substitution servicing.

Connections to conventional boards should be brought out as near to the edge as possible to make the later soldering of connecting leads easier. Terminal points buried amid a forest of components are not easy to locate or connect.

One of the drawbacks with matrix board is that all connections to a single point in the circuit are strung out in a line, instead of being grouped in a cluster as they are with custom-made p.c.b.s. This means that stages tend to spread horizontally, merging with other parts of the circuit, thereby making later circuit identification difficult.

A cluster can be achieved with Vero by using two adjacent strips (Fig. 2). The snag is that they have to be linked and this means the loss of one hole form each for the linking wire. To avoid this, one of the wires from a component can be extended from its hole to a hole in the adjacent strip, thus losing only one hole, or it can just be soldered flat on the adjoining strip without losing any. Other holes would be lost, though, because four cuts, each using a hole, would be needed to isolate the two strips instead of only two for the single one. Cuts between holes can be made with a sharp knife if space is at a premium, but it is better to use a cutting tool on the hole.

It is not essential that all connections be made via the print; if two or three small wire-ended components are vertically mounted close together, their free ends can be easily connected. Instead of twisting the wires which makes them difficult to free later if required, a spiral wire connector can be made up and fitted. This is formed by winding a short length of 22 s.w.g. wire on a small screwdriver shaft to make a spiral some 5mm in length (Fig. 3). Slip this over the wires and solder. To remove a wire, just melt the solder and lift of the spiral. All the connections in pre-war Philips radios were made in this manner.

But back to our planning. Give particular regard to the possibility of common-impedance coupling discussed earlier. Avoid it by arranging the return from any high current components to be as close to the supply end of the connecting strip as possible, or as suggested, split the supply along two strips. This applies to the earth connections just as much as to the "hot" pole of the supply, because the same current flows through both.

No doubt there will have been a number of changes and re-arrangements to your drawing, but when it all fits in place, then is the time to ink in the final positions. It is useful now to count off the rows of holes and mark them on the plan along the edge in increments of five. Do the same for the strips but label each one and use letters for these. Thus every hole has an identification. This will prove a big help during the construction, and will minimise the chance of connecting a wire to the wrong hole.

CONSTRUCTION

Believe it or not, although you have as yet nothing constructed, you have completed the biggest part of the job. Popping the components in the holes according to the plan and soldering is much easier than working out the layout and drawing it. Don't be too complacent, though; there are pitfalls.

The first step is to make those cuts. A special tool is available which when centred in a hole on the print side and rotated takes out a neat circular section of print. The same function can be served by using a 5mm twist drill, though not having a handle it is slightly less convenient. If cuts between holes have been planned to save space, make two parallel cuts with a sharp knife and take out the narrow portion between. A single cut is unreliable because the edges can easily re-connect when the metal expands.

Before you start wielding that cutter, though, remember that your plan shows the component layout. When you turn the board around to make the cuts you see the print layout which is a mirror image of the other. All cuts then should be made counting the holes from right-to-left, instead of from left-to-right as numbered on your plan. The track designations from top to bottom remain the same.

Identify each hole to be cut alphanumerically from the plan then find it on the board and cut. When you have finished, count up the number of holes in your plan and check with the number you have actually cut. It is very easy to miss one, so this count-check should bring any discrepancy to light. The pattern of holes and their spatial relationship should also provide a check as to the accuracy of their positions when compared with that of the plan.

It is prudent furthermore to examine each one under magnification; tiny

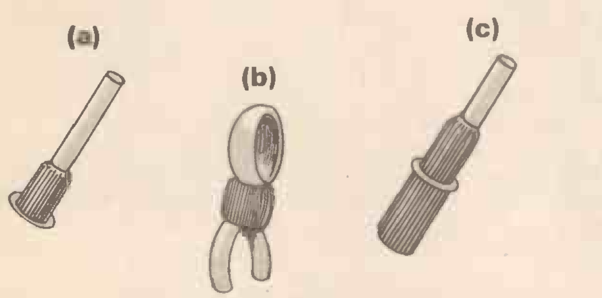


Fig. 4. Types of terminal post. (a) Single-sided. Inserted from the print side, the serrated boss holds the post firm in the hole while the bottom stud is soldered to the print. (b) Eyelet post inserted from component side. (c) Double-sided post.

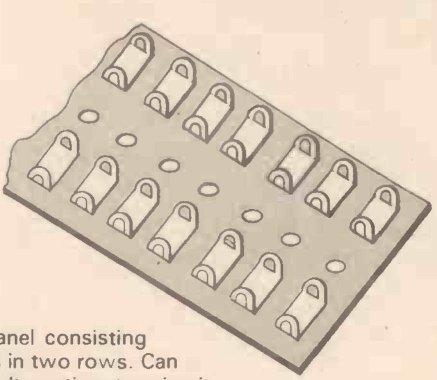


Fig. 5. Tag panel consisting of double tags in two rows. Can be a useful alternative to circuit boards for simple assemblies.

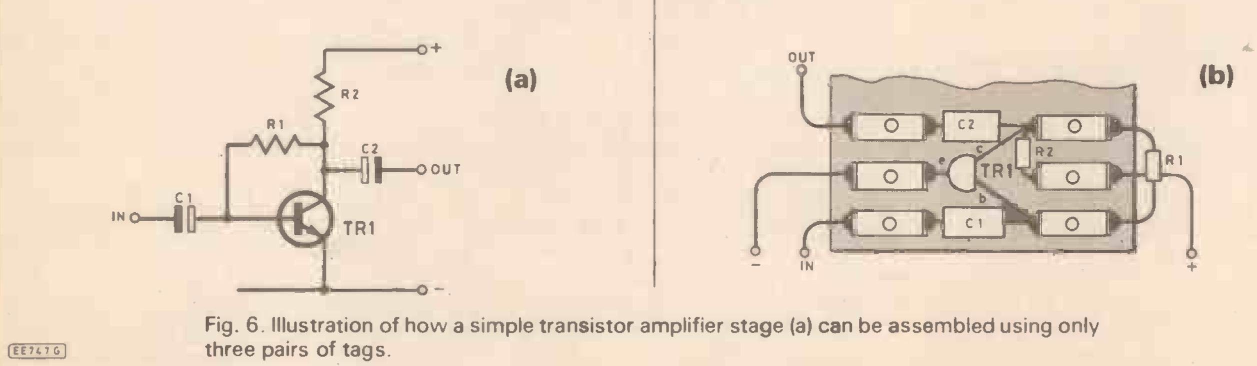


Fig. 6. Illustration of how a simple transistor amplifier stage (a) can be assembled using only three pairs of tags.

slivers of copper can often be found bridging what appeared to be a clean cut. Time spent checking is never wasted, it is much easier to spot and correct a defect during construction than try to trace baffling faults later.

FITTING COMPONENTS

Now is the time to fit the components, a satisfying task because it proceeds quickly and it really looks as if you are getting somewhere. Leave the semiconductors except diodes to the last to avoid repeatedly subjecting them to heat as other components are soldered in. Although i.c.s can be soldered in directly, it is best to use an i.c. holder. This prevents any heat applied to the device, and permits a quick change if a fault is suspected later.

A variety of terminal posts are available which make good press-fit into the hole before soldering (Fig. 4). Some are double sided, so permitting connections to be made on both sides of the board, but most are single. Others have eyelets at the top to accept thicker connecting wires or to hold "select-on-test" components.

Insert the wires of wire-ended components, checking the alphanumeric identity of each hole carefully, and bend the wires slightly at the board to hold the component in place. If the circuit is a simple one with few components, all can be fitted before any are soldered. With larger circuits it is best to complete a section otherwise some may drop out and the forest of wires will impede the mounting of further parts.

Soldering should be done before the wires are cropped because as well as holding the component in place, the excess wire helps to dissipate some of the heat. While most components apart from semiconductors are not too fussy about heat, it is not a bad thing to minimise their exposure to it.

After soldering and trimming is complete, it pays to examine the board carefully under magnification just as we did for the holes. Scan along each track in turn, checking that each joint is sound and that there are no whiskers of solder across to adjacent strips. With the close proximity of Vero 0·1 tracks, these are highly probable, however careful you were in soldering. Many incipient faults can be prevented in this way.

Finally, run the soldering iron along the earth and supply tracks, completely coating them. This reduces the resistance and helps in their identification.

TAG-BOARDS

Printed circuits have become so much a part of the electronic scene that we tend to think that they are indispensable and there is no other valid method of circuit building. Yet they are comparative newcomers; before 1960 all equipment was built with the use of tag strips. That method soon dropped out of favour, the strips were cumbersome, and hand-wiring became too expensive for repetitive production runs.

Modern tags are mounted on boards in parallel rows and are quite compact (Fig. 5). One type has two rows of eighteen tags, each having two solder points, on a panel approximately 115mm by 40mm. Each tag can accomodate several wires, and small components can be mounted across the rows or adjacent tags. Quite a variety of possible component and wiring combinations are thereby possible.

For small, simple, circuits without i.c.s, tag boards offer a quick and easier construction method than a one-off printed circuit, even to using Vero. The illustration (Fig. 6) shows a simple amplifier stage using only three pairs of tags. They are well worth considering for appropriate projects. □

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

...Analogue-to-Digital Converters...

FOLLOWING on from last month's article on digital to analogue conversion we now turn to analogue to digital converters. There are numerous analogue to digital converter chips that are suitable for use with the BBC computer, but many of these would have little advantage over the machine's built-in converter.

In fact most of the converter chips currently available offer higher operating speed than the BBC computer's µDP7002, but in many cases the higher speed is still inadequate for likely applications such as audio digitizing. What probably represents the ideal complement to the built-in analogue port is a converter which offers a conversion rate of around 60000 or more per second with at least 8 bit resolution and a modest asking price.

Converters

The two obvious candidates are the Ferranti ZN427E and the ZN447/8/9E series of chips from the same manufacturer. These are all 8-bit successive approximation converters which cost only a few pounds each.

The main difference between the ZN427E and the other devices is that the ZN427E lacks an integral clock oscillator. It also has a lower maximum usable clock frequency of 600kHz as opposed to 1MHz for the ZN447/8/9E series. In terms of conversions per second, this equates to about 67000 and 110000 respectively.

All these chips are therefore suitable for audio digitizing or any applications which require a comparable conversion rate. Note that these conversion rates are the maximum ones at which the chips are guaranteed to operate, and that most devices will actually operate at rates approaching double the quoted figures.

The ZN447/8/9E series are all essentially the same device, and the difference between them is the guaranteed level of accuracy. This is 1/4 LSB for the ZN447E, 1/2 LSB for the ZN448E, and 1 LSB for the ZN449E. The ZN448E is the most readily available of these chips, and its accuracy is adequate for most purposes.

Actually the ZN449E is often satisfactory, and can be obtained at relatively low prices. The ZN447E is expensive, difficult to obtain, and its increased accuracy is rarely needed. The ZN427E incidentally, has an accuracy of 1/2 LSB.

Interfacing

Interfacing analogue to digital converters to computers is generally a little more involved than interfacing digital to analogue types, and it generally involves a simple form of handshaking. This is certainly the way in which the ZN447E series and the ZN427E are normally used.

These devices do not continuously take readings automatically, and neither do they take an instant reading to provide current data whenever they happen to be accessed. The general scheme of things is for a conversion to be initiated under software control, and then a hold-off has to be provided while the circuit converts the input voltage to a corresponding digital value.

The successive approximation technique has been covered in this magazine on more than one occasion in the past, and we will not consider this process here. However, it is a reasonably fast method of conversion which with the ZN447E series and ZN427E chips takes no more than nine clock cycles.

As the time taken for a conversion to be completed is predictable it is possible to prevent readings being taken prematurely by using a software delay loop to provide the hold-off. When using BASIC there would be no need for any delay loop, since each conversion would be completed well before the converter could be read, even if the start conversion instruction is to be followed immediately by a read command. In fact there is probably no point in adding an external converter if BASIC is to be used, as the built-in analogue port is likely to be at least as effective as the add-on circuit.

The ZN447E series and ZN427E chips both have an "end of conversion" output which goes low when a conversion is initiated, and high again when the conversion has been completed. This output can therefore be monitored via a suitable edge sensitive input, and in conjunction with a suitable software routine used to provide a hold-off.

Analogue to Digital Converters

The user port probably represents the most convenient port when adding an analogue to digital converter to the BBC machine, and Figs. 1 and 2 show how circuits based on the ZN447E series and ZN427E (respectively) can be interfaced to this port. The two circuits are basically the same, and the main difference is in the way the clock signal is obtained.

The ZN447E series have a built-in clock oscillator which requires a single discrete

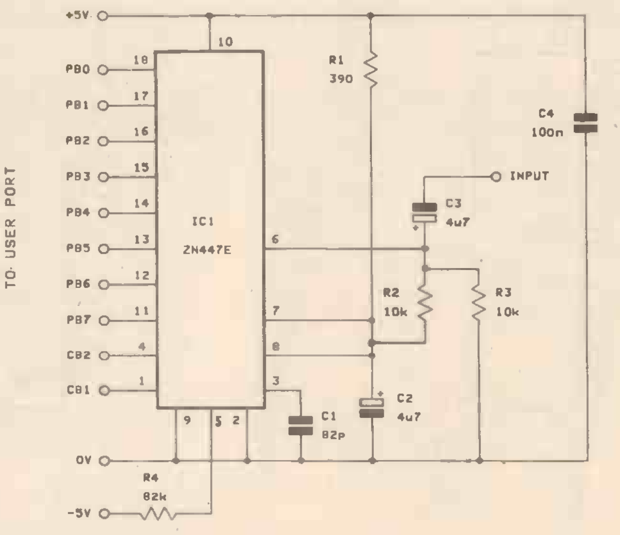


Fig. 1. The circuit of a simple A/D converter based on a ZN447E chip.

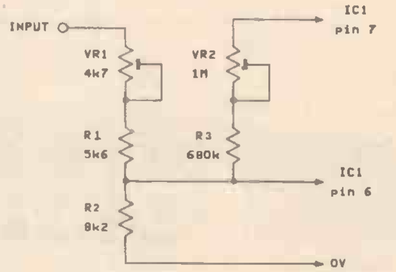


Fig. 3. A zero adjust circuit for a full-scale potential of +5 volts.

component, and this is a capacitor which sets the clock frequency. In this case the capacitor is C1, and it gives a frequency of approximately 1MHz.

With the ZN427E an external clock circuit is required, and in this case the 1MHz clock signal (taken from the 1MHz Bus) is divided by two in IC2 to produce a 500kHz clock signal. If preferred, the circuit could have its own 1MHz crystal oscillator, or even something as basic as a simple 555 astable circuit operating at about 500kHz or so and directly driving pin 3 of the ZN427E would be adequate.

Another minor difference between the two circuits is that the output enable terminal (pin 2) is taken low in the case of the ZN447E series, and high on the ZN427E. In both cases this permanently enables the tristate data outputs of the device, and for some reason the two chips use the opposite method of control in this respect.

The circuits utilize the built-in 2·55V reference generators of the chips, and these require a discrete load resistor (R1) and a decoupling capacitor (C2 of Fig. 1 and C1 of Fig. 2).

It has been assumed that the circuits will be used in audio applications, and accordingly the input is biased to half the full scale input voltage by resistors R1 and R2, and a d.c. blocking capacitor is included at the input. For d.c. applications the alternative input circuit of Fig. 3 should be used. Here the preset potentiometer VR1 is adjusted to give a full scale sensitivity of precisely 5V. Other voltage ranges can be accommodated with VR1, R1, and R2 having values chosen to provide suitable attenuation. They should also give an output resistance of about four kilohms if optimum stability is to be achieved.

Preset VR2 is the zero adjustment control, and this is adjusted by first applying an input voltage equal to 1/2 LSB (9·8mV for 5V full scale), and then adjusting the control so that returned readings more or less alternate between 0 and 1. In most cases more than adequate results will be obtained if VR2 and R3 are simply replaced with a 1M2 resistor.

A negative supply is required for the "tail" resistor in the comparator stage of the converter chip, and this can be obtained from the computer's power port. An alternative method is to derive it from the +5V supply using an oscillator, rectifier, and smoothing circuit, such as the one shown in Fig. 4. This only provides an output of about −3V or so, and resistor R4 in the converter circuit should accordingly be reduced to 47k. Note that the circuit will work with a 74LS14 in place of the 7414, but R1 should be increased to 1k.

Controlling the Unit

Obviously the user port data lines must be set as inputs (?&FE62=0) in order to read the unit, and CB2 must be set as an output in order to provide the start conversion pulse. Probably the best CB2 mode in this case is the one where it provides a brief negative pulse after each write operation to the user port. This enables a brief start conversion pulse to be produced by using a "dummy" write operation to the user port.

If the end of conversion output is to be monitored CB1 must be set to the low to high input mode. These modes are selected using values of 160 and 16 respectively, giving a total of 176 to write to the Peripheral Control Register at address &FE6C.

This simple test routine will set up the user port and read the converter.

```
10 ?&FE62 = 0
20 ?&FE6C = 176
30 ?&FE60 = 0
40 PRINT ?&FE60
```

Note that the start conversion pulse is recorded at line 30 without having to set the user port lines as outputs, and that the value written to the port can be any legal quantity (i.e. any integer from 0 to 255).

The converter circuits can easily be added to the 1MHz Bus, and in its most fundamental form this can be accomplished by connecting the eight data outputs to the data bus, feeding the start conversion input from NPGFD, and driving the output enable pin (pin 2) from the cleaned up NPGFC line (in the case of the ZN427E this line must be inverted). A conversion is then initiated by a "dummy" read or write operation to any address from &FDOO to &FDFF, and the returned value is read at any address from &FCOO to &FCFF.

Address decoding can be used to place the converter at a more restricted address range if desired. This would allow more hardware to be added to the 1MHz Bus, including a simple input port to enable the end of conversion output to be read if necessary.

Next month: We will consider the extra hardware needed for good results in audio digitizing applications, together with some assembly language software for use with the A/D and D/A converters.

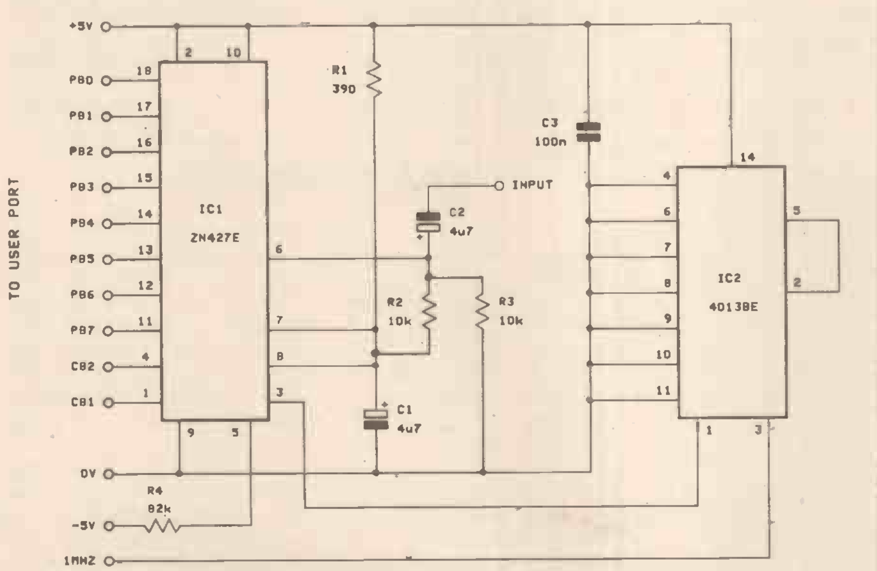


Fig. 2. An A/D converter circuit using a ZN427E.

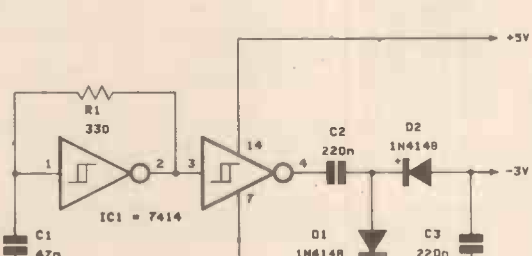


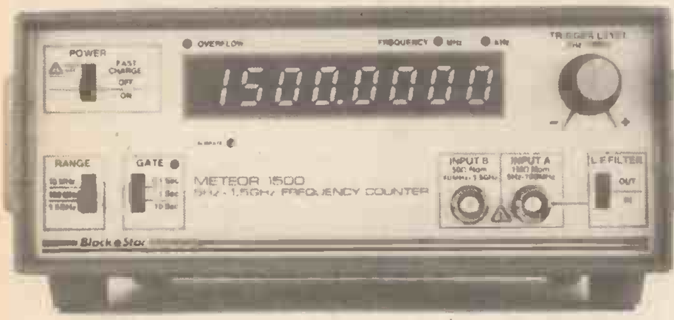
Fig. 4. Generating a negative supply for the tail resistor from the +5 supply.

NEW · NEW · NEW · NEW

PRODUCTS

NEW · NEW · NEW · NEW

FREQUENCY COUNTER



THE latest addition to the **Black Star** range of Frequency Counters is the Meteor 1500, utilising the latest monolithic microwave integrated circuit technology to measure frequency up to 1·5GHz.

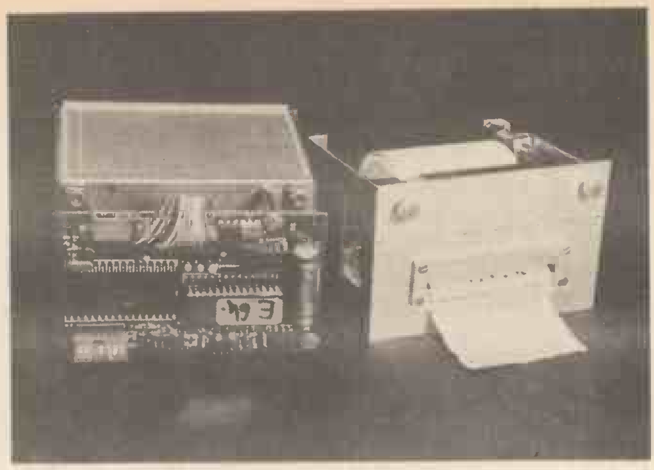
The Frequency Counter is an eight digit battery or mains operated bench instrument with resolution down to 0·1Hz and with sensitivity of <50mV at 1·5GHz. Features include low pass filter, trigger level control, three gate times and battery recharging facility.

The wide frequency range and portability make the instrument suitable for service and test applications in many fields including telecommunications, cellular radio, PMR, etc.

The Meteor 1500 costs £199, plus VAT, and further technical information may be obtained from:

Black Star Ltd.,
Dept EE,
4 Stephenson Road,
St. Ives, Huntingdon,
Cambs, PE17 4WJ.

Tel: 0480 62440



PRINT OUT

A COMPACT plug in unit (measuring 107 × 87 × 85mm) containing a miniature dot matrix printer, and an internal paper supply holder is the latest product from **Crotech**. The complete assembly consists of two parts, a rugged steel case which is mounted on special brackets behind the main instrument panel, and includes a 13-pin D sub-min socket giving connection to the main assembly.

The main assembly contains an MP-250 series printer mechanism, offering either 24, 32 or 40 characters per line, paper roll holder, and polished aluminium front panel. This section is easily mounted in the case by sliding it through the aperture in the main instrument front panel. It is then secured to the case by two retaining screws, one of which incorporates a paper advance switch.

Studs are provided on the rear of the metal case of the Datamega MP-240 for mounting a controller, such as the Datamega MP-181 which includes parallel and serial interface facilities, along with text and data modes, and full graphics capability.

Full information on the Datamega MP-240, and the complete range of printers and ancilliaries, is contained in a Datamega brochure, which is free on request, from:

Crotech Instruments Ltd.,
Dept EE, 2 Stephenson Road,
St Ives, Huntingdon,
Cambs, PE17 4WJ.

Tel: 0480 301818

REMOTE VIEWING

FOR the youngster on-the-move or, more importantly, the hard of hearing, **Kewmode** have just marketed "no wires" infra red headphones for TV and hi fi listening. The phones are claimed to create "spatial sound" and give a simulated stereo effect from the mono signal from TV.

Capable of operating from up to 40ft away, the unit is supplied complete with a small transmitter which simply plugs into the headphone or audio output socket of the TV, video recorder or hi fi. The headphones contain controls for on/off and volume with automatic balance to provide the optimum sound effect.

With no wires to worry about or to restrict viewing distance you can enjoy the entertainment without distracting other members of the family. The system is easy to use and ideal for the hard of hearing who can adjust the volume levels to their personal needs without annoying others.

The Kewmode Infra Red Headphone System is available from electrical and audio stores and sells for around £39.95. For details of nearest stockists contact:

Kewmode Ltd.,
Dept EE, Unit C,
Faircharm Industrial Estate,
Evelyn Drive,
Leicestershire LE3 2BU.

Tel: 0533 893158

A selection of products recently released on to the market.
If you have any items you think should be included here send details, together with photographs, to the Editorial Offices. Please mention **Everyday Electronics** ***when requesting information published in the magazine.***

AUDIO MODULE

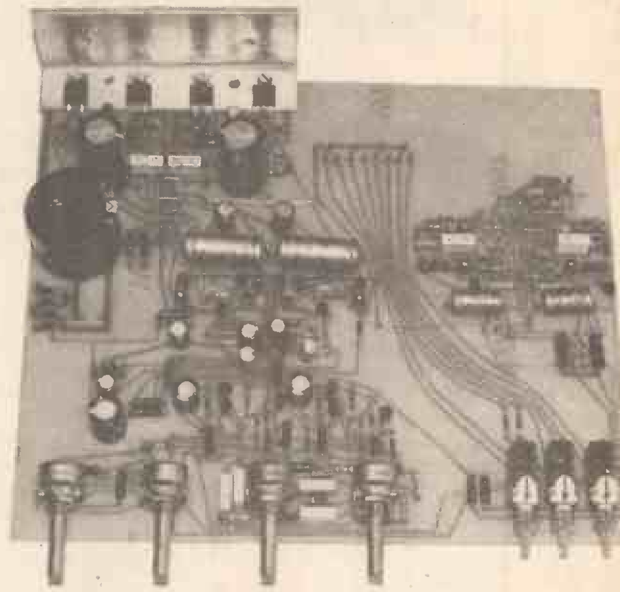
SUITABLE for PA systems, headphone amplifier and low power audio systems, the **Audiokits** Module is a single-board complete hi fi amplifier, less transformer.

The design features a cascode driver stage, claimed to give better linearity and h.f. response, a two transistor constant current source and diode stabilised biasing in the preamp stage, for improved PSRR.

Up to 30W r.m.s. per channel is claimed when driven from a 40V a.c. supply. The module will give a reasonable performance down to supplies of 15V a.c. Additional heatsinking is advisable when used at high powers.

The Audiokit Module is available direct for the sum of £37.50 plus £2 p&p. For details of the complete range of audio products contact:

Audiokits,
Dept EE, 6 Mill Close,
Borrowash, Derby DE7 3GU.
Tel: 0332 674929



CD ON THE RACK

AS THE boom in Compact Disc hardware and recordings continues, so the need for related accessories grows, too.

Racks for storage of discs and cleaning products to ensure that discs maintain their "as new" performance are two obvious areas and **SMC Supplies** have announced, under their Connexions brand, two new products in both these areas.

The Connexions range of eight storage racks offers a variety of differently shaped traditional wood-finish and plastic moulded styles of racks for wall mounting or free standing. The capacity of the racks varies from 10 discs up to 39 discs and retail prices range from around £2.65 incl. VAT, up to £9.25 incl. VAT, ensuring that there is a model to suit most pockets.

The CCC is Connexions CD cleaning kit. It includes a CD spray and is expected to retail at around £9.95 incl. VAT.

For details of local stockists readers should write to:

Connexions, SMC Supplies,
Dept EE, 125 East Barnet Road,
New Barnet, Herts, EN4 8RF.

Tel: 01-441 1282

FAST CHECK

THE Galatrek F.A.S.T. is a 13A socket tester for on the spot checking of the house "power" wiring available from **Galatrek International.** It will automatically test for six possible fault conditions likely to occur on 13A wall mains sockets simply by plugging the unit in to each wall socket.

The tester also has a facility for testing fuses.

The Galatrek F.A.S.T. sells for the sum of £14.95, including VAT and p&p, and is available direct from:

Galatrek International Ltd.,
Dept EE, Scotland Street,
Llanrwst, Gwynedd,
North Wales LL26 0AL.

Tel: 0492 640311

MICRO TRAINING

A NEW 68000 microprocessor training system has just been launched by **Flight Electronics.**

Designed and built in the UK, the FLT 68K operates at 8MHz and links directly to the 16-bit memory allowing high-speed processing. The board has a full-spec 68000, versatile memory system, 68681 dual UART linked to two RS232 ports, 68230 parallel interface timer and a G64 bus connector.

The FLT 68K is prompt-driven and all commands are self explanatory. A set of 53 monitor commands are provided for program generation, debugging and system control. The integral line assembler and de-bugging routines allow the FLT 68K to be used as a stand alone unit, using a terminal as the control consols and a serial printer to provide hard copy output.

A full set of documentation is supplied with the system, including a 256-page user manual, the monitor program source listing and full technical specification/manuals on the Motorola 68000, 68681 (dual UART) and 68230 (peripheral interface/timer).

For full technical details contact:

Flight Electronics Ltd.,
Dept EE, Ascupart Street,
Southampton SO1 1LU.
Tel: 0703 227721

DIGITAL Trouble Shooting

Part Three

MIKE TOOLEY BA

Welcome to our new nine part series on Digital Troubleshooting which aims to provide readers with a practically biased introduction to the diagnosis of faults within digital equipment. The series should also be of interest to anyone wishing to update their knowledge of modern digital devices and circuitry.

THE LAST part of our *Digital Troubleshooting* series dealt with the basic logic gates; AND, OR, NOT (inverter), NAND and NOR. This month we continue the series by looking at monostable and bistable devices.

We also introduce a partner for the Logic Probe described last month in the shape of a Logic Pulser which is also featured in our companion Digital Test Gear project. These two simple instruments will cope quickly and efficiently with a multitude of digital equipment faults.

MONOSTABLES

The logical state of the outputs of the logic gates we met last month remains at logic 0 or logic 1 according to the logical states of their inputs. Provided the input states remain constant, the output state will also remain constant. There are, however, a number of applications in which a momentary pulse (i.e. a 0-1-0 or 1-0-1 transition) is required rather than a permanent change of logical state. A device which fulfils this function is said to have only one stable state and is consequently known as a *Monostable*.

The action of a monostable is quite simple; its ouput is intitially at logic 0 until a level or "edge" arrives at its trigger input. This level change can be from 0 to 1 (*positive edge trigger*) or 1 to 0 (*negative edge trigger*) depending upon the particular monostable device or configuration.

Immediately the trigger is received, the output of the monostable changes state to logic 1. Then, after a time interval determined by external "timing components", the output reverts to logic 0. The monostable then awaits the arrival of the next trigger.

Monostables are available in a variety of forms and, whereas it is possible to make a simple form of monostable from individual logic gates and a few discrete components, the use of purpose-designed integrated circuit monostables is much to be preferred. To illustrate the basic principles of monostable pulse generators we will, however, first consider some simple monostable arrangements based on inverters.

A simple negative-going (1-0-1) pulse generator which is triggered by a positive edge is shown in Fig. 3.1. In order to explain the action of the circuit we need to consider what happens when the trigger pulse arrives. To help us do this we can use the waveform diagram shown in Fig. 3.2.

Since the voltage level at the input is zero before the trigger arrives, the capacitor, *C*, is initially uncharged. The inverter thus receives a logic 0 input and its output will be held high (logic 1). When the trigger does arrive, the input voltage rises rapidly from 0V to approximately 5V.

This voltage change is conveyed, via the capacitor, to the input of the inverting gate. The inverter then recognises a logic 1 input when its input passes through the logic 1 threshold (approximately 1·5V) and its output then rapidly changes state from logic 1 to logic 0.

The capacitor then charges through the resistor, *R*, and the voltage at the input of the inverter falls exponentially back towards 0V. When the inverter's input voltage falls below the logic 0

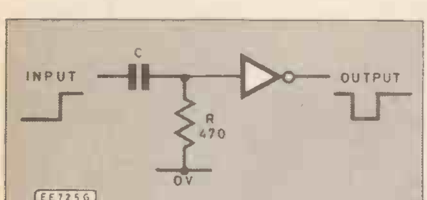


Fig. 3.1. Simple negative-going monostable pulse generator.

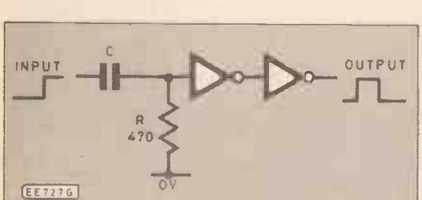


Fig. 3.3. Simple positive-going monostable pulse generator.

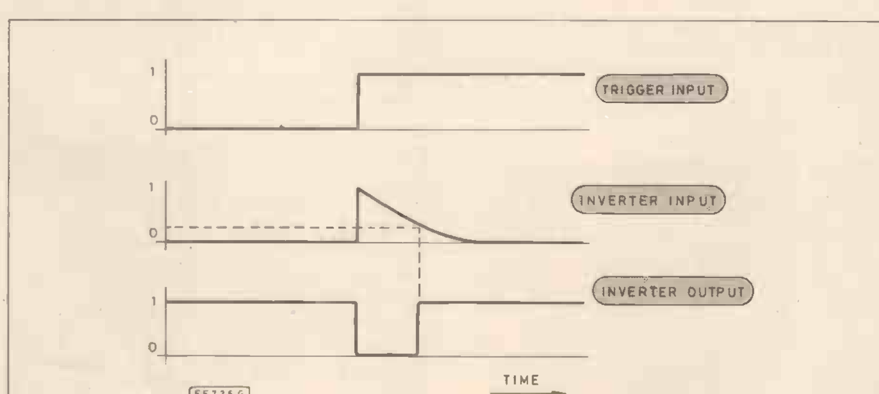


Fig. 3.2. Waveforms for the circuit of Fig. 3.1.

threshold (again at about 1·5V) the gate once more recognises a logic 0 input and its output state reverts to logic 1.

The time taken for the capacitor to charge depends on the time constant of the circuit ($C \times R$). The duration of the output pulse can thus be fixed by a suitable choice of component values. It should, however, be noted that for conventional TTL gates an optimum value of R will be around 470 ohms. Furthermore, it should not be increased much above, nor decreased much below, this value. Hence, to obtain output pulses of different duration, the capacitor rather than the resistor should be varied.

Long duration pulses may require the use of large value capacitors and these will invariably be electrolytic types. It is, therefore, essential that capacitors are low leakage types and, furthermore, close tolerance varieties are necessary if an accurately defined output pulse is required. If we need a positive-going (0-1-0) pulse rather than a negative going pulse (1-0-1) we need only add a second inverter to the output of the circuit, as shown in Fig. 3.3.

How positive and negative output pulses may be derived from a negative edge trigger is shown in Figs. 3.4 and 3.5. These circuits are somewhat similar to those which operate from a positive edge trigger. In this case, however, the input of the inverter is biased into the logic 1 state by means of an additional "pull-up" resistor connected to the positive supply rail. Such an arrangement typically places a quiescent voltage of approximately 2·5V at the input of the logic gate.

POPULAR I.C. MONOSTABLE

Having dealt at some length with simple monostable arrangements it is worth introducing a popular integrated circuit monostable device, the 74121. This can be triggered by either positive or negative edges depending upon the configuration employed. The chip has complementary outputs (labelled Q and $\overline{Q}$) and requires only two timing components (one resistor and one capacitor).

The internal arrangement of the 74121 is depicted in Fig. 3.6. Control inputs A1, A2 and B are used to determine the trigger mode and may be connected in any one of the following three ways:

(a) A1 and A2 connected to logic 0. The monostable will then trigger on a positive edge applied to B.

(b) A1 and B connected to logic 1. The monostable will then trigger on a negative edge applied to A2.

(c) A2 and B connected to logic 1. The monostable will then trigger on a negative edge applied to A1.

It should be noted that, unlike some other astable types, the 74121 is not re-triggerable during its monostable timing period. This simply means that, once a timing period has been started no further trigger pulse will be recognised. Furthermore, in normal use, a recovery time equal in length to the monostable pulse should be allowed before attempting to re-trigger the device.

PULSE STRETCHERS

A typical application for a monostable device is in stretching a pulse of very short duration. A 74121 is an ideal device to perform this function; it can be triggered by a very short duration pulse and will continue with its fixed duration timing period long after the input signal has reverted to its original state. The only requirement is that, to ensure reliable triggering, the input pulse should have a width of at least 50ns.

For a 74121, the values of external timing resistor should normally lie in the range 1·5kilohm to 470kilohm. The minimum recommended value of external capacitor is 10pF whereas the maximum value of capacitor is only limited by the leakage current of the capacitor employed. In practice this means that, if necessary, values of several hundred microfarads can be used. This all leads to a monostable circuit which can provide a very much wider range of monostable periods than the simple circuits based on inverters described earlier. Typical values of 74121 monostable period for various capacitor values can be determined from the nomograph shown in Fig. 3.7.

RS BISTABLES

In any other than the most elementary of logic circuits, one sooner or later realises the need for a device which can remember a logical state (either 0 or 1) for an indefinite period of time (or at least as long as the supply remains connected!). Such devices constitute a very simple form of memory and, since their output can exist in either one of two stable states (0 and 1), they are known as *Bistables*.

Simple bistable devices can be built using nothing more than NAND or NOR gates, as shown in Fig. 3.8(a) and Fig. 3.8(b), respectively. These arrangements have two inputs (labelled SET and RESET) and two complementary outputs (labelled Q and $\overline{Q}$).

A logic 1 applied to the SET input will cause the Q output to become (or remain at) logic 1, whilst a logic 1 applied to the RESET input will cause the Q output to become (or remain at) logic 0. In either case, the bistable will remain in its SET or RESET state until an input is applied in such a sense as to change the state.

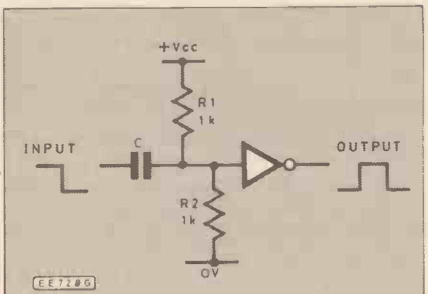


Fig. 3.4. Falling edge triggered positive-going pulse generator.

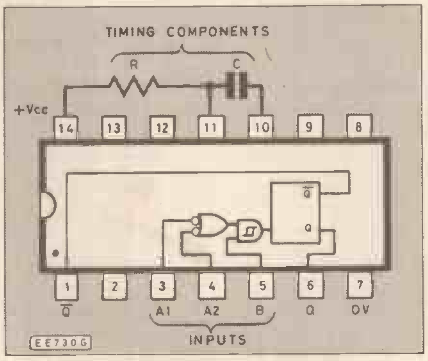


Fig. 3.6. Internal arrangement of 74121 monostable.

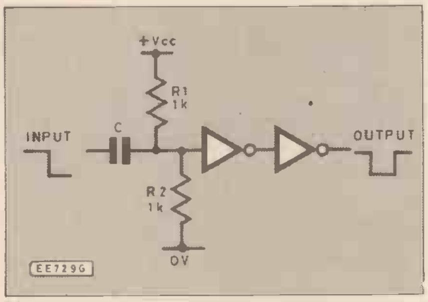


Fig. 3.5. Falling edge triggered negative-going pulse generator.

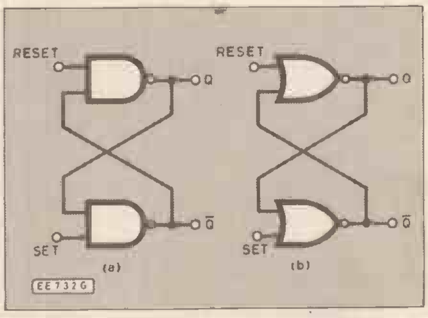


Fig. 3.8. (a) NAND gate RS bistable. (b) NOR gate RS bistable.

Fig. 3.7. Nomograph for predicting 74121 monostable pulse duration. A 100µs pulse is produced when C = 10nF and R = 15k.

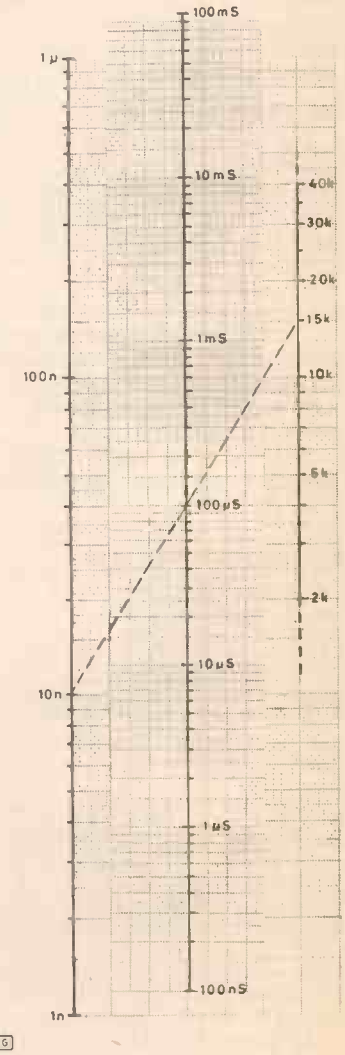


Table 3.1: Truth table for the bistables of Fig. 3.8

SET	RESET	Q	$\overline{Q}$
0	0	NO CHANGE	
0	1	0	1
1	0	1	0
1	1	INDETERMINATE	

Simple NAND and NOR gate bistable arrangements suffer from a problem, as can be seen in the truth table of Table 3.1. It is not possible to predict the output state which results from the simultaneous application of a logic 1 to both the SET and RESET inputs. Hence positive steps are usually taken to ensure that this disallowed state does not arise.

In practice, NAND and NOR gate bistables are rarely encountered since a variety of integrated circuit bistables are available which are both more flexible and predictable in their operation. The commonly used symbols for three common bistable types (RS, D-type and JK) are shown in Fig. 3.9.

The D-type bistable has two principal inputs; D (standing variously for data or delay) and CLOCK. The data input (logic 0 or logic 1) is clocked into the bistable such that the output state only changes when the clock changes state. Operation is thus said to be synchronous. Additional subsidiary inputs (which are invariably "active low") are provided which can be used to directly set or reset the bistable. These are usually called PRESET (PR) and CLEAR (CLR).

A typical application of a D-type bistable as a simple one-bit "data latch" is shown in Fig. 3.10. The operation of the circuit is best explained by considering the timing diagram shown in Fig. 3.11. Here, the state of the D input is transferred to the Q output on each rising clock edge. The Q output remains unaffected by a falling clock edge. It should be noted that, whereas most common D-type bistables (e.g. 7474, 74174, 74175) are all clocked on the rising edge of the clock waveform, this rule does not generally apply to JK bistables which invariably complete their clocking on a falling edge!

JK BISTABLES

JK bistables have two clocked inputs (J and K), two direct inputs (PRESET and CLEAR), a clock input and two outputs (Q and $\overline{Q}$)—see Fig. 3.9. As with the RS bistable, the two outputs are complementary (i.e. when one is 0 the other is 1, and vice versa). Similarly, the PRESET and CLEAR inputs are invariably both active low (i.e. a 0 on the PRESET input will set the Q output to 1 whereas a 0 on the CLEAR input will set the Q output to 0). The truth tables for a JK bistable are shown in Table. 3.2.

Table 3.2: Truth tables for a JK bistable

J	K	Q_{n+1} [Q after clock 1→0 transition]	COMMENT
0	0	Q_n	NO CHANGE [0→0 OR 1→1]
0	1	0	OUTPUT CLEARED
1	0	1	OUTPUT SET
1	1	$\overline{Q}_n$	OUTPUT CHANGES STATE [1→0 OR 0→1]

PRESET	CLEAR	Q
0	0	INDETERMINATE
0	1	1
1	0	0
1	1	ENABLES CLOCKED OPERATION

BINARY COUNTERS/DIVIDERS

A typical four-stage binary counter/divider using JK bistables is shown in Fig. 3.12. Each JK bistable divides by two and thus the frequency of the final output is one sixteenth of the input as shown in the timing diagram, Fig. 3.13.

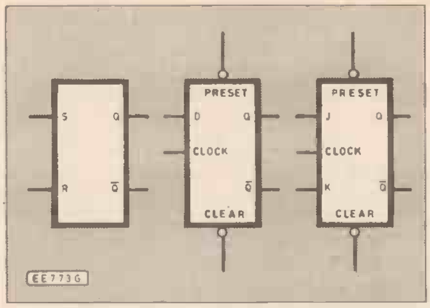


Fig. 3.9. Symbols used for RS, D-type and KJ bistables.

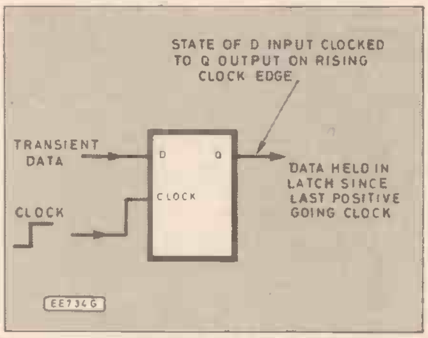


Fig. 3.10. D-type bistable as a data latch.

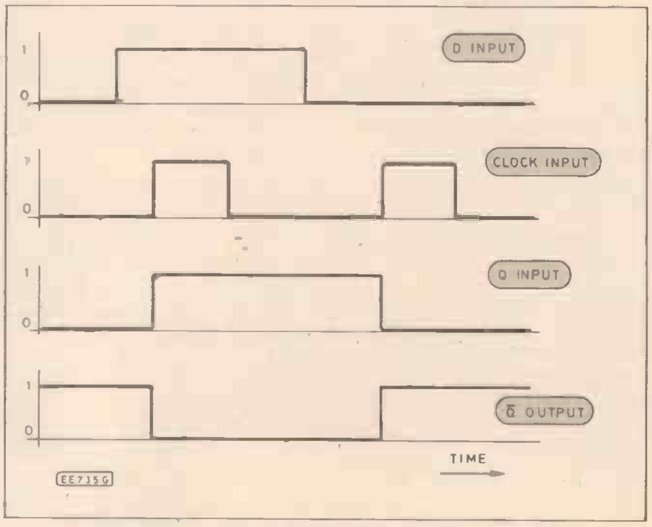


Fig. 3.11. Timing diagram for a D-type bistable.

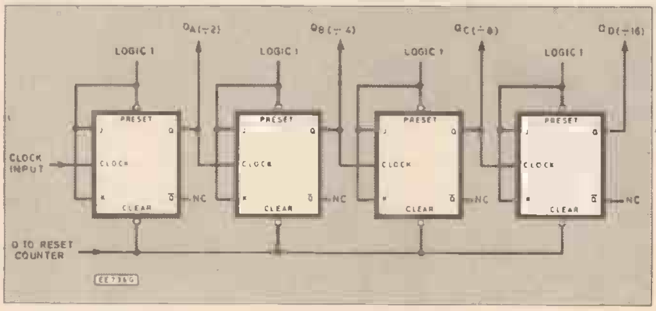


Fig. 3.12. Four stage binary counter using JK bistables.

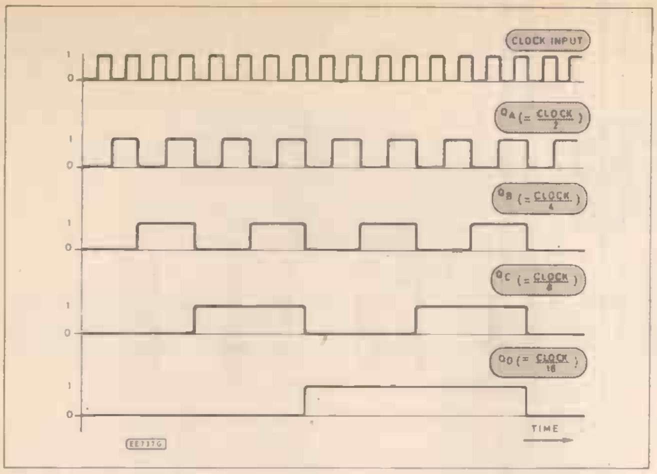


Fig. 3.13. Timing diagram for the circuit of Fig. 3.12.

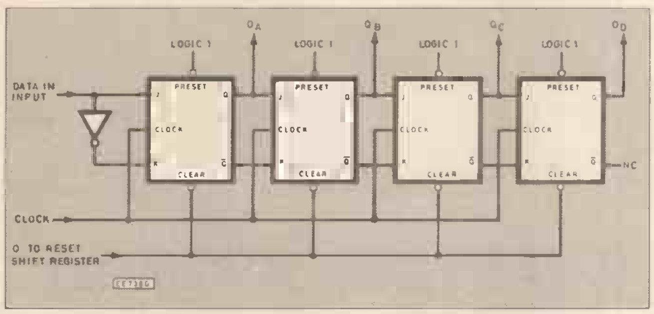


Fig. 3.14. Four stage shift register using JK bistables.

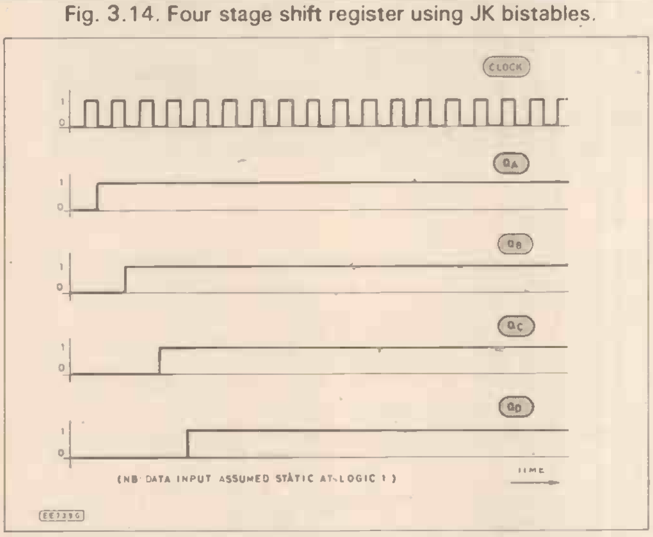


Fig. 3.15. Timing diagram for circuit Fig. 3.14. Data input assumed static at logic 1.

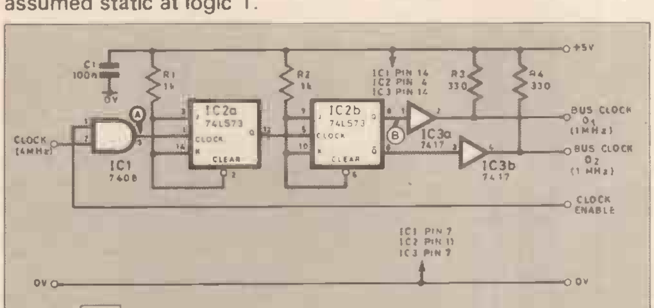


Fig. 3.16 (above). Dual phase microprocessor clock divider. Logic Pulser applied to A, Logic Probe (last month) applied to B.

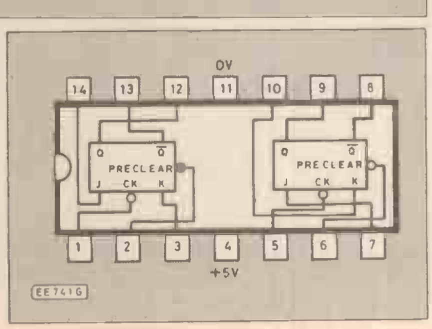


Fig. 3.17. Internal arrangement of the 7473 JK bistable.

Fault-finding on such an arrangement is usually only a matter of following the Q output signals from stage to stage using a logic probe or an oscilloscope. A stage which has a correctly clocked input but has an output which remains static must be considered suspect. It would then be necessary to check the logical state of the J and K, PRESET and CLEAR inputs. These should normally all be high (logic 1) to permit counting.

SHIFT REGISTERS

An example of a four stage shift register using JK bistables is depicted in Fig. 3.14. Data is shifted from stage to stage on each falling edge of the clock. It would thus take four complete clock cycles for a logic 1 present at the input of the first stage to be transferred to the Q output of the final stage. Fig. 3.15 shows a typical timing diagram for the four-stage shift register. This assumes that the register is initially in a cleared state and that the logical state of the input remains unchanged throughout the four clock cycle shifting period.

Fault tracing on a shift register is not quite so easy as a similar exercise performed on a binary counter. The process usually involves checking that the clock is present at each stage and tracing the Q output from stage to stage. Unfortunately, an investigation of this type can be inconclusive if the data input remains static. In some cases it will therefore be necessary to break the circuit at the input and examine the effect first of loading logic 0 into all stages by linking the first J input directly to 0V, and then loading all stages with logic 1 by linking the first J input to +V using a pull-up resistor of 1 kilohm.

LOGIC PULSERS

Having to break into a circuit in order to alter the logical state of a particular point is, to say the least, time consuming and somewhat messy. There is, of course, a much better method which allows one to momentarily to change the state of a point (or "node") in a logic circuit without soldering or desoldering any of the devices and with minimum risk to components and integrated circuits.

A Logic Pulser is a simple hand-held probe which delivers a momentary pulse to the circuit under test. The duration of the pulse is kept short in order to reduce any risk of damage (either to the probe itself or to the circuit under test) and the polarity of the pulse is usually adjustable so that the node under investigation is forced into the opposite logical state.

The pulse is produced at the touch of a button fitted to the probe case. During the period before the button is depressed and for the period after the pulse has finished the probe tip must adopt a tristate (high impedance) condition so that it does not adversely affect the logical state of the node.

Pulsers, like logic probes, normally derive their power supply from the circuit under test and are invariably connected by means of a short length of twin flexible wire fitted with crocodile clips. The leads of an electrolytic decoupling capacitor or the output terminals of a regulator usually make readily identifiable connecting points.

IN USE

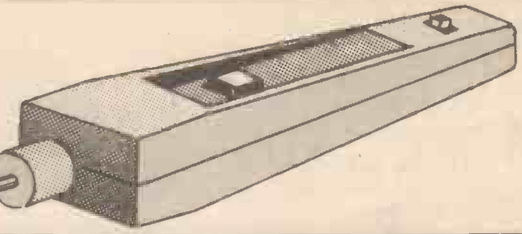
In order to illustrate the use of a logic pulser, consider the two phase 1MHz microprocessor clock divider module shown in Fig. 3.16. The clock divider is based on a TTL dual JK bistable, the internal arrangement of which is shown in Fig. 3.17. Readers may notice that this device is one of the very small minority of TTL devices which do not conform to the usual convention concerning supply pin connections!

Let's assume that both clock signals are missing from the bus and that we have isolated the module from the (presumed functional) system clock. We would simply connect the pulser to the clock input of IC2a (point A, Fig. 3.16) and simultaneously monitor the output of IC2b (point B, Fig. 3.16) using a logic probe. It would then be possible to determine whether or not the divider was operating by repeatedly pulsing the clock input and noting the output change produced. (Note that the pulser over-rides whatever logical output is provided by IC1.)

It should be noted that there would be little point in attempting to identify which particular JK bistable had failed since we would, in any event, have to replace the entire chip! Having verified the operation of IC2 we could then turn our attention to the bus drivers, IC3a and IC3b. In this case we could simply transfer the logic probe to the respective bus lines whilst continuing to pulse the clock input of the first JK bistable.

Next month we shall be introducing some common i.c. timers and our *Digital Test Gear Project* involves the construction of a versatile Pulse Generator which can be used to provide test signals for a wide variety of digital circuits.

LOGIC PULSER



MIKE TOOLEY BA

THIS month's *Digital Test Gear* project deals with the construction of a Versatile Logic Pulser. This instrument is designed for use in conjunction with a logic probe (see last month's *Digital Troubleshooting* project for constructional details) but it can also be used in its own right as a means of changing the logical state of a digital circuit without the need to make any soldered connections. The pulser is fully compatible with both CMOS and TTL devices.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Logic Pulser is shown in Fig. 1. A 555 timer, IC1, is connected as a monostable pulse generator (this circuit configuration will be discussed in Part Four of our series).

The output of IC1 (at pin 3) will go high for a period determined by the time constant, R2 × C2, whenever the pulse button, S2, is depressed. With the values specified, the pulse duration is approximately 5ms.

The polarity of the output pulse is switched by means of S1. Transistor TR1 acts as an inverter whilst TR2 and TR3 operate as saturated switches (providing positive and negative output drive respectively). The output current is limited by resistors R7 and R8. With the component values shown and assuming a standard TTL 5V supply, the peak current sourced or sunk into a short circuit will be limited to several hundred milliamps.

When no output pulse is being produced, TR1 conducts but both TR2 and TR3 are in a non-conducting (switched off) state. The output at the probe tip thus floats in a high-impedance state.

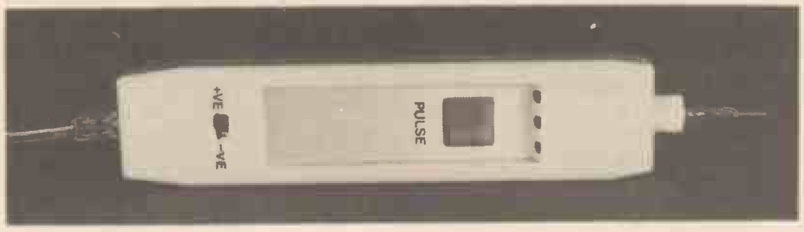
In common with the logic probe described last month, a diode, D1, is incorporated in order to provide protection against inadvertent reversal of the supply leads.

CONSTRUCTION

All components for the logic probe are mounted on a 0·1in matrix board comprising 9 strips of 37 holes. This can be cut from

Specification

Output Pulse Duration:	5.2ms
Pulse Polarity:	Switched positive or negative
Peak Output Current (short circuit):	200mA (approx.)
Quiescent Resistance at Probe Tip:	Greater than 200k
Power Supply Requirements:	4·5V to 15V at less than 15mA quiescent



COMPONENTS

See Shop Talk page 43

Resistors
- R1 10k
- R2 10k
- R3 10k
- R4 4k7
- R5 4k7
- R6 4k7
- R7 10
- R8 10

All resistors are 0·25W 5% carbon

Capacitors
- C1 4n7
- C2 470n tant. 35V
- C3 10μ tant. 16V

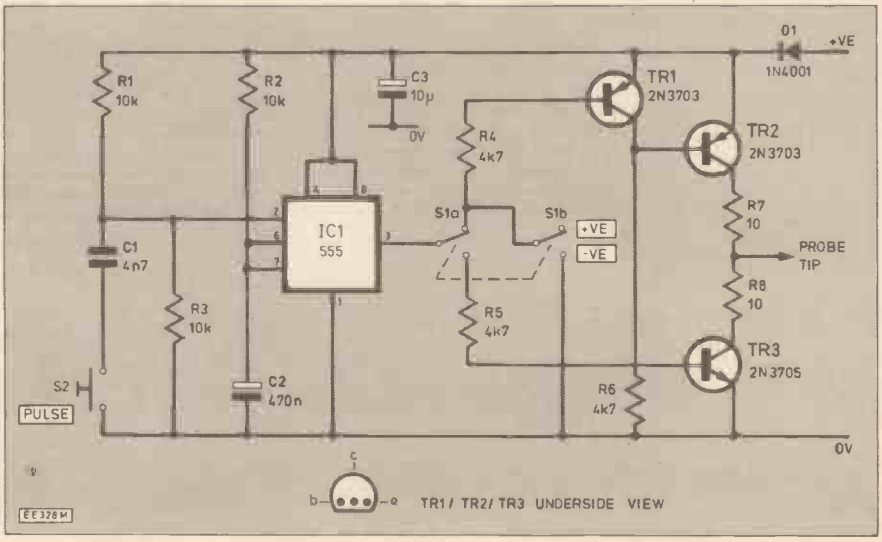
Semiconductors
- D1 1N4001
- TR1,TR2 2N3703 *pnp* silicon (2 off)
- TR3 2N3705 *npn* silicon
- IC1 555 Timer

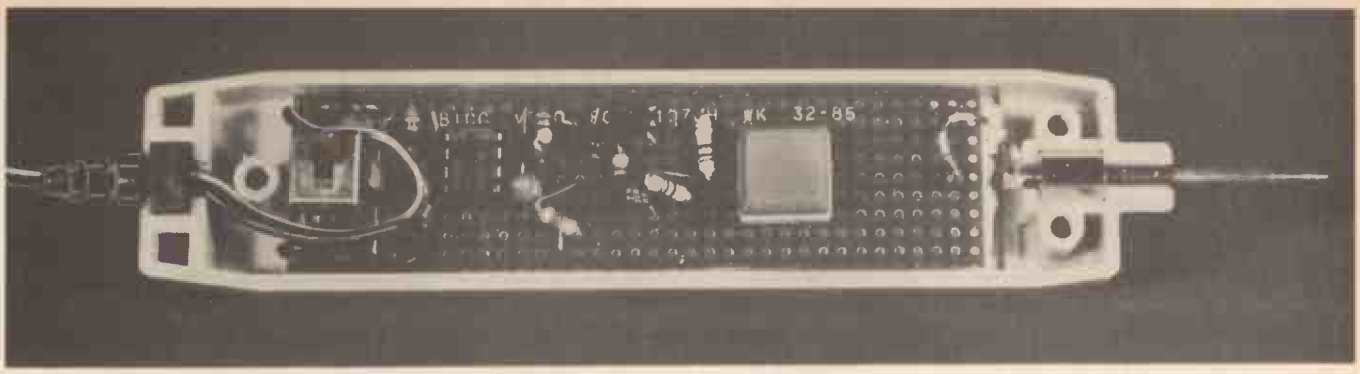
Miscellaneous
- S1 Low profile p.c.b. mounting keyboard switch
- S2 Ultra-miniature DPDT vertical slide switch

8-pin low profile i.c. socket; Probe case, measuring 140mm x 30mm × 20mm approx; Single-sided 1mm terminal pins (3 required); stripboard, 0·1in matrix measuring 95mm × 63mm approx. (see text)

Approx. cost Guidance only £7.25

Fig. 1. Complete circuit diagram for the EE Versatile Logic Pulser.





the standard size stripboard used in this series (24 strips of 37 holes); alternatively the remaining unused board from last month's project may be employed.

The component layout of the Logic Pulser is shown in Fig. 2. The following sequence of component assembly is recommended; button switch, i.c. socket, terminal pins, links, transistors, resistors, diode, and capacitors.

The probe tip boss and supply lead should be connected last. In the latter case, care should be taken to ensure the correct polarity (red crocodile clip/striped lead to positive).

Constructors should note that a total of 18 track breaks are required and these should be made using a spot face cutter. If such a tool is unavailable, a sharp drill bit of appropriate size may be substituted. Three links should also be made under the board, shown dotted on the topside view in Fig. 2.

Before inserting the integrated circuit into its holder and mounting the circuit board in its final position, constructors should very carefully check the components, links, and track breaks. Furthermore, it is worth checking that all of the polarised components (including transistors, diode and electrolytic capacitors) have been correctly oriented. Constructors should also carefully examine the underside of the stripboard for dry joints, solder splashes, and bridges between adjacent tracks.

PROBE CASE

When the board has been thoroughly checked, the integrated circuit should be inserted into its holder (taking care to ensure correct orientation). The circuit board should then be temporarily placed in the base of the probe case (no mounting hardware is required as the board should be held snugly in place when the two probe case halves are mated together).

The upper half of the probe case should then be marked for drilling and cutting the apertures that will be necessary in order to permit access to switches S1 and S2. Switch S1 will require a rectangular hole measuring approximately 8mm × 3mm, whilst S2 will require a square aperture measuring 12mm × 12mm. In both cases it will be necessary to drill several small round holes and then apply a small square or rectangular section file.

When complete, the two case halves should be screwed together (using the countersunk screws supplied with the case) and the probe tip should then be fitted into the mounting boss.

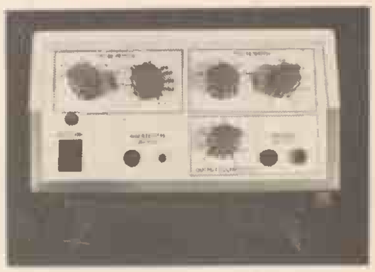
TESTING

The probe should be tested using a current limited 5V supply of the type normally employed with TTL and CMOS circuits (see Part One) together with a logic probe (see Part Two). Connect the pulser and logic probe supply leads together and to the power supply (taking care to observe correct polarity). Then link the two probe tips together using a short length of insulated wire fitted with two crocodile clips.

Switch S1 should first be set to produce a positive pulse. Do not, at this stage, operate the pulse button, S2, but check that the output of the pulser is in a tri-state condition (none of the logic probe's l.e.d.'s should be be illuminated). If this is not the case, disconnect the pulser, dismantle and check the pulser's circuit board again!

Having verified that the pulser operates in the quiescent state, a pulse should be generated by depressing S2. At the same time the state of the logic probe's l.e.d.'s should be examined. Hopefully, these should confirm that a positive pulse is produced. If no pulse is produced or if the logic pulser generates a continuous low or high state output, the pulser should be dismantled and the circuit layout should be carefully checked again. Finally, the foregoing procedure should be repeated with S1 switched to produce a negative going output pulse. □

Next Month: Construction of a Versatile Pulse Generator which can be used to provide test signals for digital circuits.



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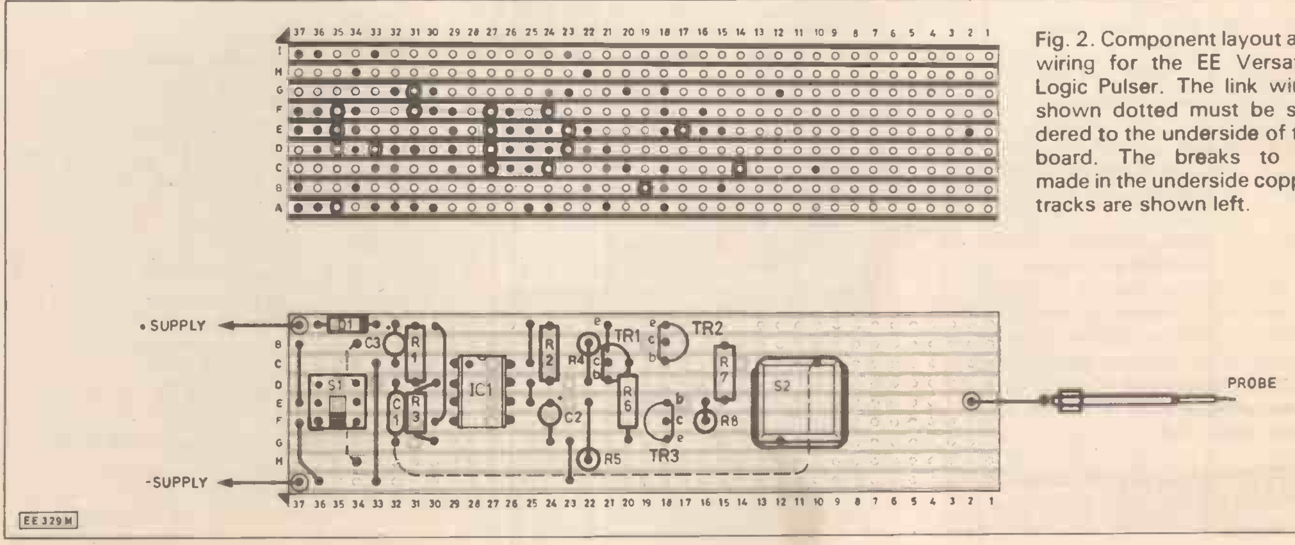

Fig. 2. Component layout and wiring for the EE Versatile Logic Pulser. The link wires shown dotted must be soldered to the underside of the board. The breaks to be made in the underside copper tracks are shown left.

Actually Doing it!!

CONTINUING in the same vein as last month's article, we will consider a mixture of the more unusual and some mundane types of electronic component. We will start with crystals which are perhaps more common in home constructor designs than they once were, but are still not called for very frequently.

Their purpose is to control the frequency of a high frequency oscillator, and their advantage over the alternative forms of frequency control is the excellent stability that they provide. They can also provide very high accuracy without the need for any setting up or adjustment.

In the past crystals were not very popular as they were very expensive and had few applications apart from radio transmitters and calibration oscillators. These days many of the more popular types are available for less than a pound and their primary use is as the frequency determining component in digital and microprocessor circuits.

OVERTONES AND PINS

The main parameter of a crystal is its operating frequency, which is typically a few megahertz, but can be anything from a few kilohertz to more than 100MHz. The types you are most likely to encounter are those which operate on their fundamental frequency, and have operating frequencies of up to about 15MHz.

Crystals intended for use on higher frequencies are often of the "overtone" type, which means that although the fundamental frequency of the crystal might be (say) 9MHz, it could have a marked frequency of 27MHz and would then be a third overtone type. There would be frequency selective components in the circuit to ensure that the crystal produced oscillation at three times its fundamental frequency, and without these the circuit would function at the fundamental frequency.

Even with these additional frequency selective components in the circuit, correct operation is only guaranteed if the crystal is a type cut for third overtone operation. When obtaining high frequency crystals, such as those for use in radio control equipment, it is therefore necessary to take some care to ensure that the right type as well as the right operating frequency is obtained.

There are other crystal parameters worthy of consideration, and one of these is whether the operating frequency is at series or parallel resonance. A crystal has two operating frequencies; one where it provides a very low impedance (series resonance) and another, slightly higher, where it provides a very high impedance (parallel resonance). The difference between these two frequencies is generally only a few hundred Hertz, but this is sufficient to be of importance in some critical applications.

Most components lists and component catalogues do not specify the type of resonance the stated frequency is for, but it can then be safely assumed to be the parallel resonant frequency. The exception is high frequency overtone crystals which are often designed for use at series resonance, and where the marked frequency is often the series resonant one.

It should be realised that there are no series resonant or parallel resonant crystals, and that they are all capable of both modes of operation. Crystals are series or parallel resonant types in that their marked operating frequency is at one or other of these responses. Using a series resonant type instead of a parallel resonant component, or vice versa, will not result in a failure of the circuit to work, but will result in some loss of accuracy.

You will often see references to "load capacitance" in component catalogues, and this is the capacitance which the circuit must provide across the crystal in order to obtain precisely the correct operating frequency, and this is usually 25pF or 30pF. Few applications require such high accuracy that the few parts per million error caused by the wrong load capacitance will be of any consequence.

Where absolute accuracy is important it is normal for the circuit to have a trimmer capacitor that can be adjusted to bring the circuit to precisely the correct operating frequency. Obtaining a crystal with the correct load capacitance is consequently something that you will not normally need to worry about.

Something that it is important to get right is the encapsulation and base type. Most crystals used to be of the plug-in variety as they were used in applications where it might be necessary to change the crystals.

There are still radio applications where the ability to change crystals easily is a decided asset, and plug-in crystals are still in common use. However, they are probably less common now than the wired-ended type which are soldered direct to circuit boards, and are the type normally used in digital and microprocessor circuits.

The most common plug-in styles are the HC-6/U type, and the much smaller HC-25/U type. There are many others though, including the once popular (but now old and obsolete) FT241, FT243, and 10XJ units. Chassis and printed circuit mounting crystal holders of various types are available, and it is obviously essential to have crystals that match the holders if the project requires the use of plug-in crystals.

You are more likely to use wire ended crystals of the HC-33/U or (smaller) HC-18/U varieties. In general, high frequency crystals have the HC-18/U encapsulation while low and medium frequency types have the HC-33/U type (or the "taller" HC-34/U encapsulation), but there is no hard and fast borderline frequency.

Several common frequencies at around 2MHz to 3MHz are readily available in both styles. If a components list specifies an HC-33/U type it is unlikely that there would be any real difficulty in using a HC-18/U crystal, but there would probably be insufficient space to accommodate an HC-33/U crystal where a project has been designed to take an HC-18/U type.

When ordering crystals the main points to watch are that the frequency and encapsulation style are as specified in the components list, plus the component should be for series resonance or for operation on the appropriate overtone if this information is specified in the components list. If these points are correct there should be no difficulty when it comes to using the component.

DIRECT CONNECTION

When fitting wire-ended crystals bear in mind that these components are not amongst the most rugged of electronic devices. Crystals are normally on a mounting that gives plenty of protection from physcial shock and vibration, but excessive heat when soldering them in place would at best impair their accuracy, and at worst would result in the component becoming ruined with the crystal becoming desoldered from its mounting.

Crystals are sometimes mounted horizontally on the circuit board, and this renders them less vulnerable to physical damage. It also means that there is a greater length of leadout wire between each soldered joint and the crystal, giving less risk of heat damage when connecting the device.

Crystals, particularly the smaller types, are often mounted vertically, and there is then very little in the way of leadout wire between the crystal and the joint. It is then a good idea to use short plastic spacers over the leadout wires, as shown in Fig. 1, so as to reduce the risk of damaging the component when fitting it.

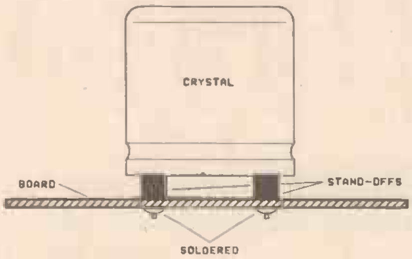

Fig. 1. Using stand-offs to reduce the risk of heat damage when mounting a crystal.

It is worth pointing out that it is not only crystals where this technique can be worthwhile, and that there are other vertical mounting components which can benefit from the same treatment. With something like a radial electrolytic it is probably not worthwhile, as these components are relatively cheap and are not easily damaged anyway. With transistors, and semiconductors which are physically similar to transistors, it is advisable not to mount the components right down on the board, and special spacers or "mounting pads" are available for the popular encapsulations such as the TO-5 and TO-18 types.

Although these pads have the advantage of providing the spacing and giving a mounting of good strength and reliability, it is probably true that few constructors bother to use them (myself included), but instead simply mount the devices slightly proud of the board with no extra physical support for them. This will not give any problems in the majority of cases, but it could result in the pads on the underside of the board being broken away from the board if more than moderate pressure is ever applied to one of the transistors.

LEADOUTS

Continuing on the theme of semiconductors, a frequent cause of confusion are the leadout diagrams for transistors, triacs, etc. Often these days it is not necessary to refer to leadout diagrams as the correct method of connection is obvious from the diagram which shows the component layout for the printed circuit board.

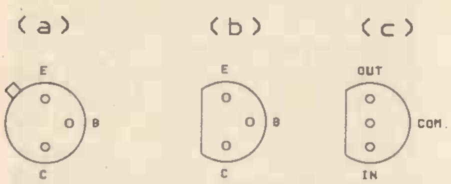

Fig. 2. Typical TO-18 (a) and TO-92 (b) transistor underside views. (c) is for a low power voltage regulator, and is a top view. Compare these with the 3-D views of Figs. 3 and 4.

In some cases though, especially where stripboard is used as the basis of the project, it is essential to refer to the leadout diagrams, and then the convention is that the diagram is a base view (i.e. as seen looking onto the leadout wires).

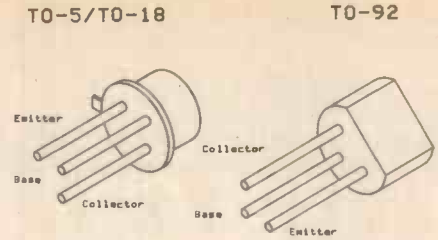

Fig. 3. 3-D equivalents of Fig. 2 (a) and (b).

Thus, the two transistor base views of Fig. 2(a) and Fig. 2(b) are for devices with the leadout configurations shown in the 3-D views of Fig. 3. The 3-D type views for semiconductor leadout diagrams seem to be increasingly popular, and have the advantage of leaving little room for confusion.

Where confusion is most likely to occur is with integrated circuits that have transistor type encapsulations. The convention for integrated circuit pinout diagrams is that they are top views, so should integrated circuits in transistor type cases follow the normal integrated circuit convention, or the transistor base view one?

There is no universally accepted answer to this, but it is more common for these devices to follow the integrated circuit convention, and a pinout diagram such as that in Fig. 2(c) (which is for a low power voltage regulator such as the µA78LO5)

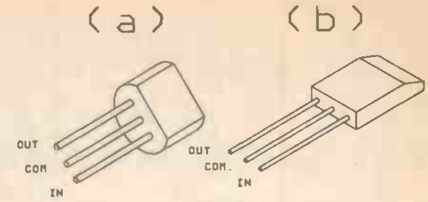

Fig. 4. Pinout details for low power voltage regulators such as the µA78LO5.

would be for a device having the leadout arrangement shown in Fig. 4(a). Usually the leadout diagram will state whether it shows a base or top view, and it is of little value if it does not.

To further confuse matters, some of the voltage regulators I have been supplied with recently have not had the normal TO-92 style case, but have instead have a flat plastic type. These have the leadout arrangement shown in Fig. 4(b).

In next month's article we will have a respite from component matters, and will consider the problem of translating a simple circuit diagram into built-up and working circuit board.

Robert Penfold

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EE MARKET PLACE JANUARY '87

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Laser Submarine Communications

In this country the Ministry of Defence works on the principle of no-need-to-know; only the few people who *need* to know what is going on, are told or can find out. In America it's usually easier to find out what is going on unless there are genuinely good reasons for high security classification.

As an example, the US Government still refuses even to acknowledge that it is working on the Stealth bomber project—that's a 'plane which is invisible to radar. But another project, the use of lasers to communicate with submarines, is nowhere near as secret as the popular press believes. Most of the technical details have already been published and the laser company spear-heading the research will talk with surprising frankness about what it is doing.

Spectra-Physics of California, which sells more lasers than any other company in the world, is working with the Xerox Corporation on the submarine project.

So far the only way to transmit signals through water to a submarine has been to use very low frequency radio waves. Although long radio wavelengths can travel through sea water, they can only carry a very low rate of data. Lasers in the blue-/green spectrum will cut through water and can carry a very high rate of data because the frequency of light radiation is very high. The US military transmits the laser beam down onto the sea from a satellite. Data is conveyed by modulating the beam with radio signals sent up to the satellite from a ground station. A very sensitive light sensor on the submarine picks up the laser radiation and extracts the signal modulation.

The difficult part is to produce a high power laser beam in the blue/green spectrum, from a satellite in orbit where there is only solar energy available. The trick is to use a "yag" laser, made from a crystal of yttrium-aluminium-garnet, which has been grown in a furnace like silicon and doped with neodymium. This will lase and emit coherent light when illuminated with a bright light. Spectra-Physics illuminates the yag with another laser, a solid state diode laser made from gallium arsenide and radiating light at around 0·8 micrometres wavelength. The diode output is precisely tuned at the frequency to which the yag responds, and switched on and off. This "pumps" the yag to produce megawatts of laser light power.

Four years ago Spectra-Physics searched for a suitable high power diode and found that the Xerox Corporation had been working on one to write an optical image on the drum of a xerocopying machine. The joint venture with Xerox, Spectra Diode Labs, has now succeeded in putting 40 separate diodes on a single chip. The diodes are ganged so that they operate in concert to produce 0·5 watt of continuous power, and several watts in pulses. The diode gang is cooled by a Peltier junction to prevent it self destructing (when a current is passed through the junction of dissimilar semiconductors there is a thermoelectric cooling effect).

The 0·8 micrometre light from the diode gang forces the yag to lase at 1·06 micrometres. The light is then halved in wavelength, by passing it through a crystal of potassium titanyl phosphate which has a non-linear optical characteristic and generates a second harmonic of the input frequency. So the beam from the satellite has a wavelength of 0·5 micrometres. Sea water has an optical window at this wavelength, which is why the sea looks blue green when illuminated with white light.

Star Wars

Star Wars is the media's pet name for SDI, the Strategic Defence Initiative. The key component is a very high power laser which can be aimed from a space platform onto incoming missiles. Spectra-Physics has been working on this too. A beam of high energy electrons from a linear accelerator is converted to photons. "Not too many people have a linear accelerator in their back yard" says Herb Dwight, who founded Spectra-Physics 25 years ago and is now company president "but Boeing did, so we are teamed up with them". Early tests suggests that the light output will be far the most powerful ever obtained from a laser, pulses of one million million watts.

I wish I could have more confidence in SDI than I do. It depends on computers to sense attack and control retaliation. The programmes will be the longest codes ever written. My bet is that if anyone ever needs to use the system, nothing will happen. A apologetic programmer will then crawl out of the computer room and say the program has crashed but it should only take a couple of weeks to find the bug.

When is live not live?

The record industry now says concert recordings are "live" when what it really means is that a live concert has been recorded on multitrack tape and later edited, overdubbed and doctored to make it sound as good as the musicians wished they had been able to sound on the night. Wrong notes are excised and replaced by right notes; dull solos erased and replaced by better solos recorded in a studio to the accompaniment of the concert tape used as a backing track; extra instruments, for instance keyboards or percussion, are added to flesh out the sound.

By "live" the TV companies mean recorded on video tape at a concert or a studio and televised after as little or as much editing as time allows and the content dictates. When you see, as I did recently, a preview on breakfast TV of exerpts from "Live from Her Majesty's" to be screened later in the weekend, you can't help wondering what they mean by live . . .

Watch also for the tell-tale jump cuts between sentences in a chat show when the guest got boring, libellous or upstaged the host. Mel Brooks had some hard things to say about his appearance on the Wogan show. The BBC edited the Wogan-Brooks banter to make it look as if Wogan's wit had got the better of Brooks.

On radio stations when there is potentially libellous programming, for instance a phone-in show, the sound is taped and played back into the transmitter around seven seconds later. The tape simply runs a long route from record to playback heads. If anyone is too rude the producer has time to push a "panic button" which mutes playback. The same system will not work with video because the tape has to wrap with precise tension round a rapidly rotating drum. So TV shows must be videotaped, the tapes rewound and played. This means that the delay must be longer than the length of a spool.

Florida company Hubcom has now devised a clever alternative. A series of video recorders are synchronised together by timing pulses. At any time one machine is recording while another replays and a third rewinds what it has just recorded. When the unit playing back comes to the end of its tape, the next machine switches in and starts to play the tape which it has just rewound. A third starts to record while the idle machine rewinds its tape again. This goes on *ad infinitum,* with the broadcast signal always delayed. The control electronics cost $50,000 but this is a small price to pay for security against libel suits. The same system can be used to delay programmes by a full hour and will come into its own when we have a pan-European satellite TV service.

Incidentally in America even live sports tv looks phoney because it is neatly timed to fit round the numerous commercial breaks. Oddly enough, they don't do it by pre-taping. An event like baseball is covered truly live, but the referee or umpire wears a radio headset. He and the TV producer keep in touch to synchronise the commercial and game play breaks.

Free Batteries

Sometimes the answer to a problem is blindingly obvious, once you have thought of it. It is pretty well known now that Polaroid film packs have a built-in six volt battery. It is a flat cell that lies underneath the stack of photographic sheets.

The battery has to drive the film eject motor, control the autofocus and auto exposure circuits and power the flash. So it is a powerful beast with far more capacity than needed for ten shots. Inevitably, when you throw away a spent Polaroid film pack, you are also throwing away an almost perfect six volt battery.

The snag is that the battery doesn't fit any other piece of electrical equipment. The contacts are aluminium pads which won't take solder. Here's the trick.

Break open the spent Polaroid pack to free the battery. Then strip off the paper casing that surrounds it. This leaves a small rectangular cell with one round contact pad (negative) and one free flap (positive). Make the connections to these with a pair of strong crocodile clips—they do the job perfectly. When you screw wires to the clips you have a "free" six volt supply which will run a torch, portable radio or even (and I've tried it with a Tandy 100) a portable computer.

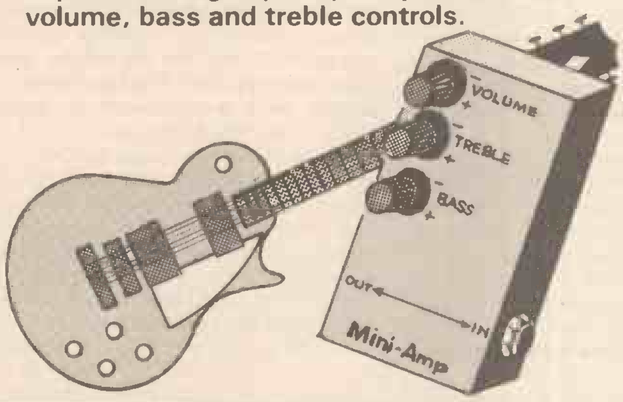
FEBRUARY FEATURES...

FREE GREENWELD KIT CATALOGUE

The first ever Greenweld Kit Catalogue will be given away free inside next month's issue of EE. Within its 24 pages there are over 100 complete kits—some of which are also available ready built and tested.

MINI-AMP

Designed to accept the output from a guitar, mixer or other instrument this amplifier feeds headphones to allow the musician to practice in private. The unit is capable of high quality output and has volume, bass and treble controls.



SPECTRUM I/O PORT

This 8-bit port provides eight input lines and eight separate output lines. The cased unit is powered from the Spectrum and, with a booster board (also described), can control stepper motors.

VERSATILE PULSE GENERATOR

A professional quality pulse generator at a reasonable price. It has five switched ranges for pulse period and pulse width plus variable output voltage and an inverted TTL output.

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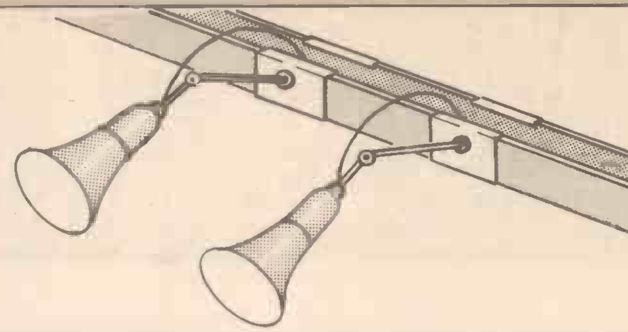
RANDOM LIGHT UNIT



C.J.BOWES

A random switching unit for all types of mains light display

AN INTERESTING lighting effect for discos and parties is achieved by controlling a number of lights so that they are turned on and off in a random fashion. The unit described in this article provides such a control for four mains voltage lighting units each up to a maximum loading of 2A. The unit incorporates an added refinement in that the speed of the changes can be determined either by a panel mounted control or in an "automatic" fashion by the ambient temperature inside the equipment case as it rises with use.

The unit is essentially a binary random number generator, the circuit of which is shown in Fig. 1. The random number, which is used to select the lights which are on, is obtained by sampling the number present in a fast running binary counter circuit at intervals determined by a slow speed clock.

COUNTER CIRCUIT

A series of high speed clock pulses are generated by IC1a which is a half of a CMOS 556 timer, configured as an astable multivibrator circuit. This produces a clock waveform which oscillates at a frequency determined by the values of R1, R2 and C3. Although these values are not critical those given in the circuit diagram produce a clock frequency of approximately 70kHz. These high frequency clock pulses are fed into the CP_0 input of IC2. As long as the CP_1 input of IC2 is held at a logic 1 state these cause the clock circuit to advance producing a rapidly changing binary coded number at the outputs O_0 to O_3.

When the number in the counter reaches 15, which is the maximum number which can be counted in a four bit counter such as the one used, the next clock pulse causes the count to return to zero and the counting process to continue. There are therefore sixteen combinations of on and off values for the four output circuits. Any one of the combinations can be selected by the sample and hold circuit.

SAMPLE AND HOLD CIRCUIT

The selection of the live lighting outputs is achieved by means of a sample and hold circuit which consists of a 4042 quadruple latch (IC3) which is actuated by a strobe pulse applied to the E_1 input of IC3.

The outputs, O_0 to O_3, of the counter circuit are connected to the data inputs D_0 to D_3 of IC3. The connections to the latch

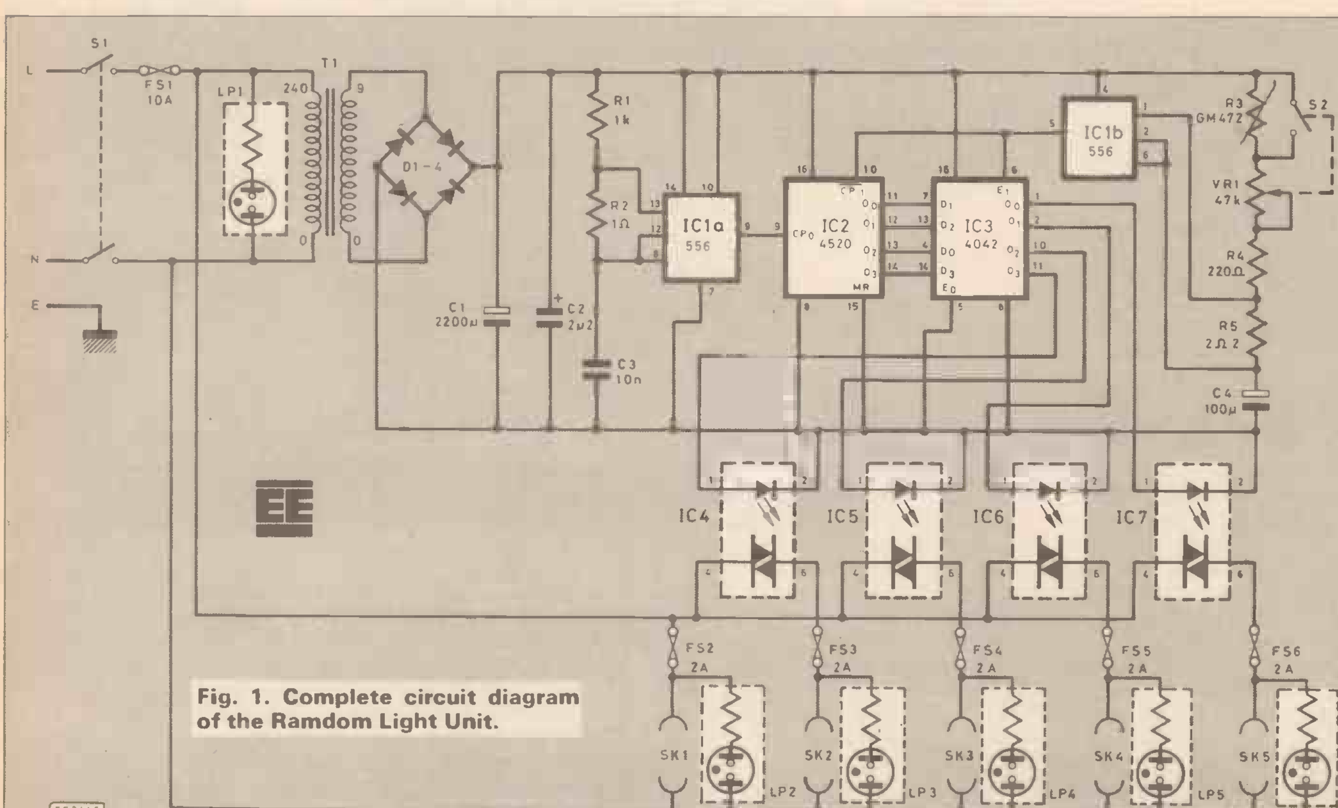
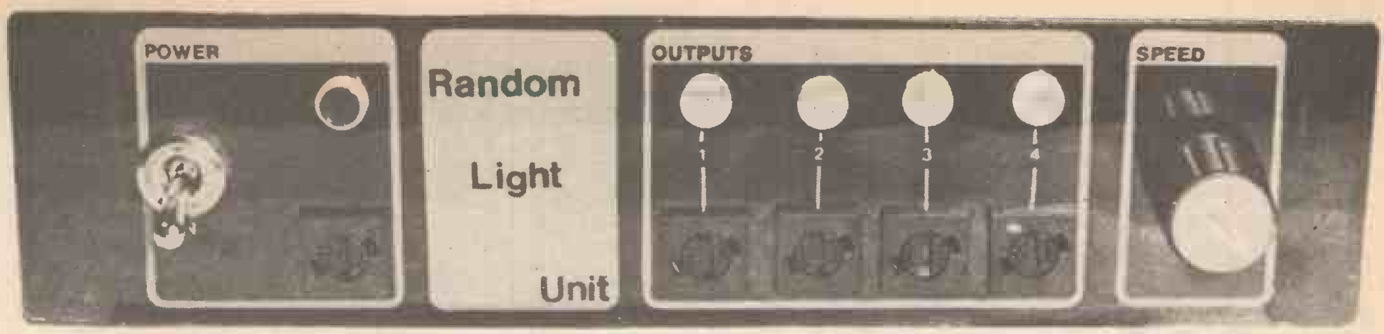


Fig. 1. Complete circuit diagram of the Ramdom Light Unit.



The prototype front panel layout showing the "mimic" neons and speed control.

are made in a random order, chosen to ease the design of the printed circuit board. Although this would not be sound practice for most circuits, in this particular application it is not only acceptable but provides a distinct advantage since it assists in the randomness of the pattern produced by the sampling technique. The inputs to the unit are strobed when both the E_0 and E_1 inputs are at the same logic state. E_0 is connected to the 0 volts power rail anchoring it firmly to a logic 0 state. When the strobe input, produced by IC1b also goes to logic 0 the latch is strobed. This causes the data present at the inputs D_0 to D_3 to be made available at the corresponding outputs O_0 to O_3. When the strobe line returns to the logic 1 state the last data present at D_0 to D_3 immediately prior to the change of logic state is locked into the latch and remains present at the outputs O_0 to O_3. This state persists until the strobe line is brought once more to the logic 0 state at which point the new number in the counter replaces the previous output. The strobe line is also connected to the CP_1 input of the 4520 counter (IC2). When the CP_1 is at logic 0 the counter is inhibited. This prevents the counter changing whilst the strobe line is active and thus avoids the appearance of a high speed flicker on the outputs of the latch.

STROBE PULSE

The strobe pulse which initiates the change in the light pattern is generated by IC1b. This is the other half of the CMOS 556 timer which is also connected as an astable multivibrator. The duration of the strobe pulse is governed by R5 and C4 and the period between the pulses is determined by the values of either R3 or VR1 (depending on the setting of VR1 and its integral switch S2) plus R4, R5 and C4. With the values given the duration of the strobe pulse is approximately 150µs and the time between pulses can be varied between approximately 0·1 sec. and 3·5 seconds, depending on the setting of VR1. A thermistor R3 (a GM472) is wired in series with the resistor chain which sets the period between strobe pulses. When VR1 is set to any resistance greater than zero ohms S2, which is integral with VR1, is in the closed state and shorts out R3. The thermistor therefore takes no part in setting the period between strobe pulses and hence the interval between light changes is governed by the value of VR1 + R4 + R5. When VR1 is set to zero S2 is opened and the period between strobe pulses is set by the value of R3 + R4 + R5. R3 has a negative temperature coefficent and its resistance therefore decreases as the temperature rises. This results in the period between lighting changes shortening as the temperature rises.

POWER CONTROL CIRCUIT

The output from the sample and hold latch (IC3) is a low voltage (12V) low current supply. This is insufficient to drive a lighting output of any significance. It is therefore necessary to use some form of interface device in order to increase the current handling capabilities of the unit. This is achieved by the use of four solid state relays IC4 to IC7 each of which is driven directly by one of the outputs of the latch circuit. These switch the incoming mains voltage off and on as determined by the outputs of IC3. The relays are rated at 2·5A at 240 volts but are protected by 2A HRC fuses (FS3 to FS6) so as to prevent overloading a standard 13A plug circuit in the event of all the outputs being fully loaded and "live" at the same time. An additional output (SK1) which is connected to the incoming mains via S1 is also provided so that a continuous background lighting circuit can be connected to the unit.

POWER SUPPLY

The power supply of the unit is conventional. The incoming mains voltage is stepped down by the transformer T1, rectified by the bridge rectifier D1 to D4 and smoothed by C1. Capacitor C2 is a decoupling capacitor which prevents the appearance of high frequency spikes on the power supply rails, which if not suppressed could cause erroneous operation of the logic circuits.

CONSTRUCTION

All the circuit elements with the exception of the controls, indicator neons and output sockets, which are panel mounted and R3, are accommodated on the printed circuit board as shown in Fig. 2. The p.c.b. track foil pattern is shown in Fig. 2, this p.c.b. is available from the *EE PCB Service*.

The components are assembled onto the p.c.b. as shown. Assembly of the board will be made easier if the smallest components are installed first and the remainder of the components inserted in ascending order of size. Care should be taken when assembling the p.c.b. to make sure that C1, C2, C4, D1 to D4 and the ICs are installed so that the correct polarity of the components is observed. Once the components which are mounted on the p.c.b. have been installed and soldered into place the wired connections to the p.c.b. can then be made. The board should then be very carefully checked for short circuits, solder blobs and broken tracks.

The mains input to the p.c.b. can be expected to carry up to 8A in the event of all the sockets being fully loaded and all the

COMPONENTS

See **Shop Talk** page 43

Resistors

R1	1k
R2	1
R3	GM472 thermistor
R4	220
R5	2·2

All ¼ watt hystab type

Potentiometer

VR1	47k variable resistor with integral s.p.s.t. switch

Capacitors

C1	2200µ elect. axial 16V
C2	2·2µ elect. tantalum 16V
C3	10n disc
C4	100µ elect. p.c.b. 16V

Semiconductors

D1 to D4	1A 50V bridge rectifier
IC1	556 CMOS dual timer
IC2	4520 dual binary counter
IC3	4042 quadruple latch
IC4 to IC7	Solid state 2·5A relays, capable of switching 240V a.c.

Miscellaneous

FS1, FS3 to FS6	20mm 10A fuseholders (5 off)
LP1, LP3 to LP5	Neons (1 × red, 4 × amber) 240V (4 off)
S1	10A d.p.d.t. toggle switch
S2	s.p.s.t. switch, part of VR1
SK1 to SK5	5 way IEC socket block (includes LP2 and FS2)
T1	P.c.b. mounting transformer 240V primary 4·5 + 4·5V, 1·2VA output.

Case; 10A 20mm HRC mains fuse (1 off); 2A 20mm HRC mains fuse (5 off); stand off insulators (4 off); mains cable clamp/gland; case approx 245mm × 220mm × 60mm; connecting wires; knob for VR1.

Approx. cost Guidance only £48

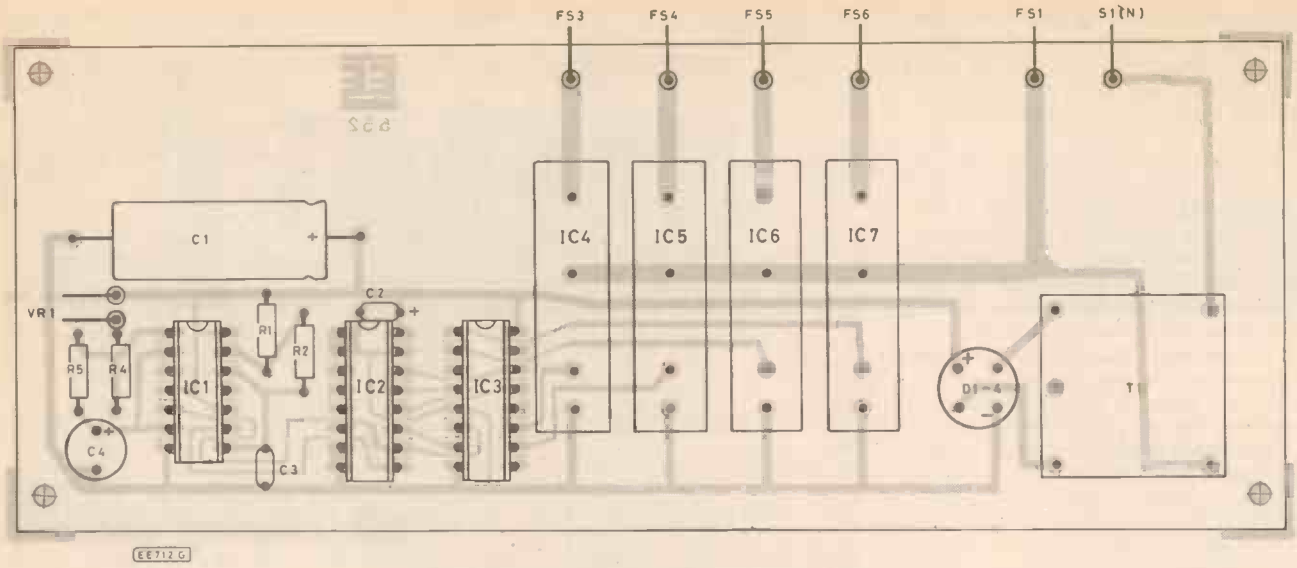
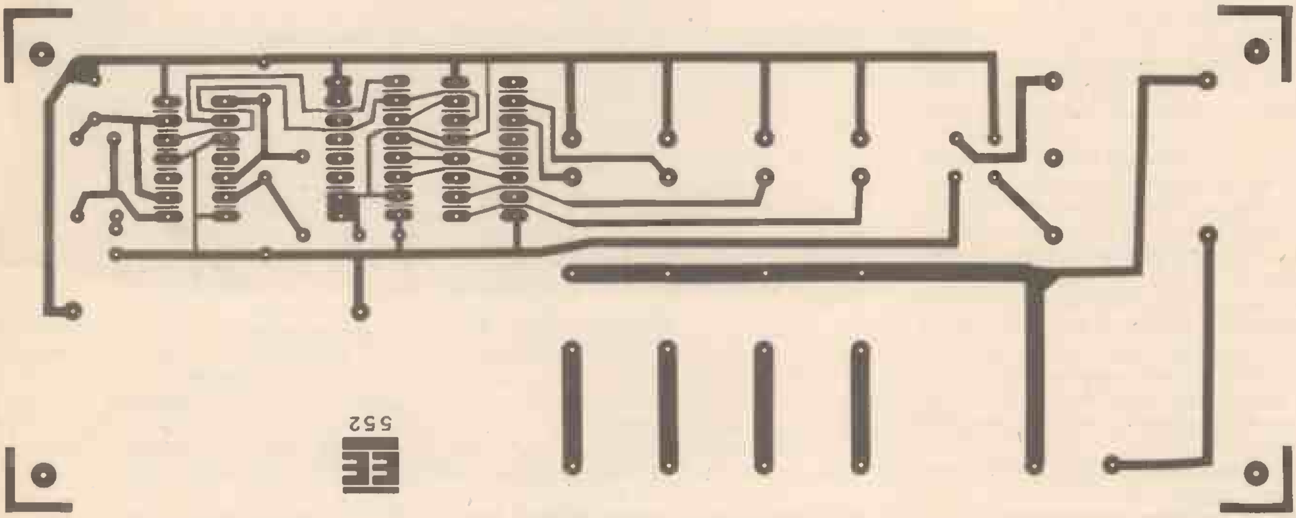


Fig. 2. Printed circuit board layout and wiring.



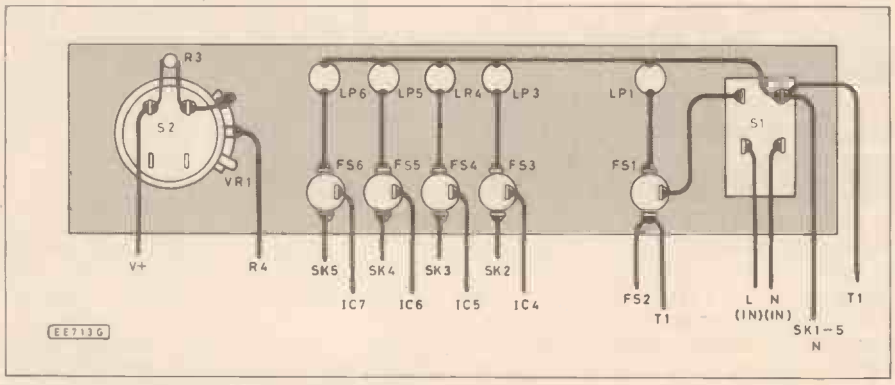


Fig. 3. Wiring of components mounted on the front panel.

outputs selected to be live by the circuit. It is therefore important to ensure that the cable carrying the "live" power connection to the p.c.b. is capable of withstanding this load. The outputs from the relays to the fuseholders should be wired in flexible cable capable of carrying a current of 2A. All the remaining connections are required to carry relatively small currents and can therefore be made with relatively small flexible cables.

CONTROL PANELS

Switch S1, VR1, FS1, FS3 to FS6 and neons LP1 and LP3 to LP6 are all mounted on the front control panel. The holes required to mount these components should be carefully marked and drilled and the panel lettered prior to installation of these components. The front panel is wired up as shown in Fig. 3. You should note that the thermistor is soldered across the switch connections of VR1 by means of its integral leads.

The output sockets (SK1 to SK5), fuseholder FS2 and neon LP2 are supplied as a complete unwired unit. These, together with the input cable clamp are mounted on the back panel of the case. The panel should first be cut to accommodate the socket block and the cable clamp. The socket block can then be mounted on the panel and wired up as shown in Fig. 4. Care should be

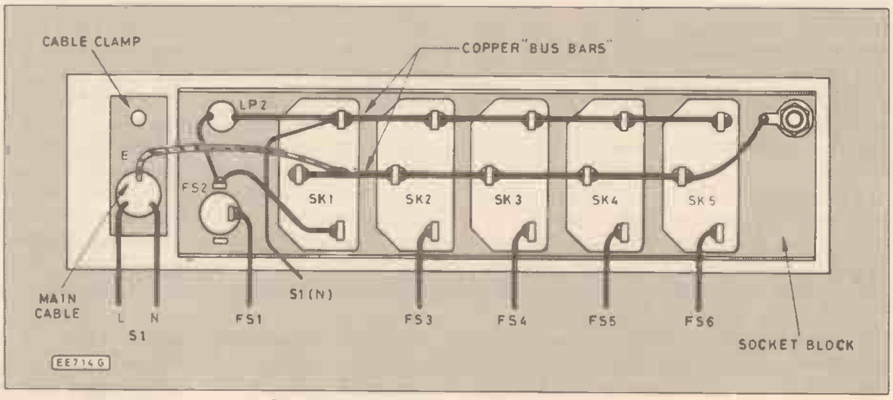
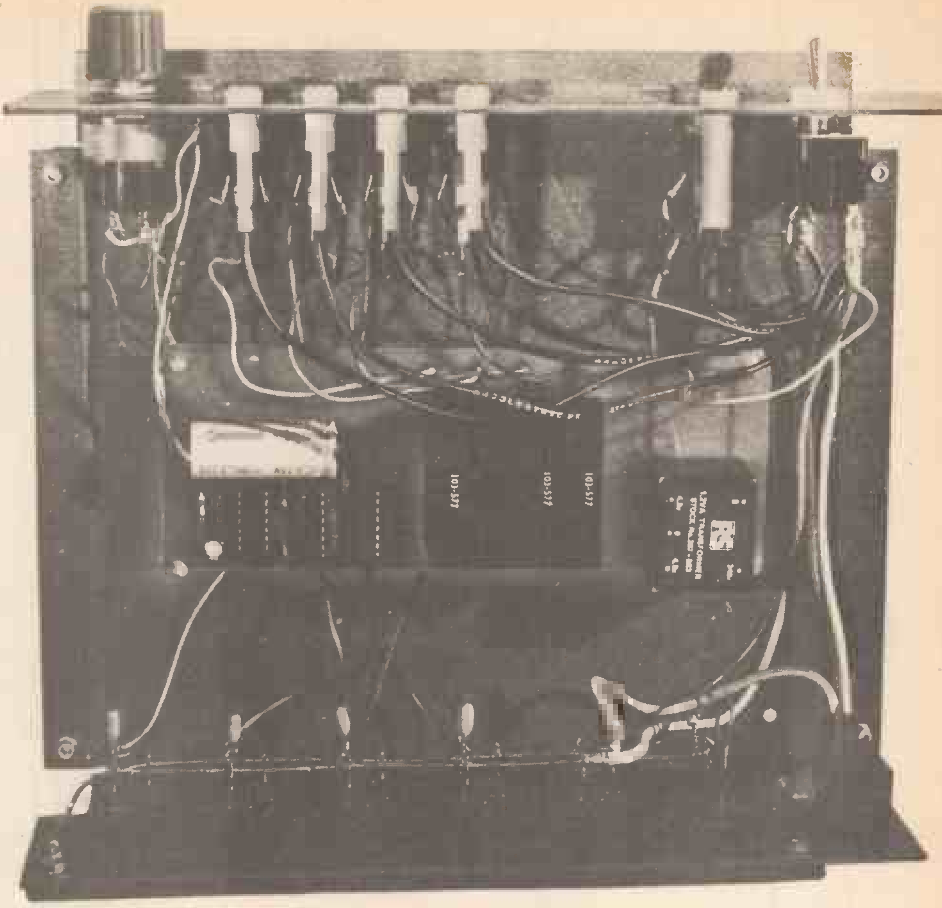


Fig. 4. Back panel interconnections.

taken to make sure that the cables used for the bus-bar earth and neutral connections are suitable for a load of up to 10A. The incoming three core mains cable must be capable of carrying a current of a least 10 amps.

The printed circuit board is mounted on the bottom of the case by means of four insulated stand offs. The position of the mounting holes in the p.c.b. should first be marked on the bottom of the case and suitable holes then drilled through the case to accommodate the self-tapping screws used to retain the insulated stand offs. The stand offs are then secured to the case with self-tapping screws and the p.c.b. simply snapped into position. The panel mounted components can then be connected up to the wires already soldered to the p.c.b. and the unit made ready for testing.



TESTING

Once completed the unit should be carefully checked before connecting it to the mains. Special care should be taken to make sure that the mains wiring is correctly connected and is safely insulated from the case. The case MUST also be correctly and securely earthed through the incoming mains cable.

Once you are certain that all the connections are correct the unit can be connected to the mains and the pattern displayed on the front panel neons observed. The neons should turn off and on in a random sequence, at a speed which can be varied by the setting of VR1. With VR1 turned fully anticlockwise the speed should increase as the thermistor is heated. This is easily tested by holding the thermistor between finger and thumb and noting the effect that this has on the time interval between changes of the pattern.

NOTE that MAINS VOLTAGE IS PRESENT ON THE UNDERSIDE OF THE PRINTED CIRCUIT BOARD. Great care should therefore be taken when investigating the underside of the p.c.b. whilst the unit is connected to mains power.

Whilst testing the prototype unit it was discovered that if a load was not connected to the output socket certain types of neons exhibited a tendency to glow when their control relay was not energised. Should your unit exhibit this tendency the problem can be overcome by connecting a 0·1µF, 250 volt capacitor across each of the output sockets SK2 to SK6. □

BOOK REVIEWS

RADIO AND ELECTRONICS ENGINEER'S POCKET BOOK

Author Keith Brindley
Price £5.50 Hard Cover
Size 170 pages
Publisher Newnes **ISBN 0 408 00720 6**

This is the 16th Edition of this excellent little reference book, and maintains the high standard set by the earlier editions. It would easily be possible to fill a book of this size ten times over, so the author wisely decided in making his choice, to select the information he is always needing himself. In reviewing this book I adopted a similar criteria, and while my requirements do not always coincide exactly with his, he has managed to cover a wide enough range of information to satisfy the majority. I was not surprised to find nearly sixty pages devoted to semiconductors and integrated circuits, and this proportion seems just about right. It contains lists of all the well known types, giving function, comparative types, data, pin layout and encapsulation. All the familiar items are included, such as resistor and capacitor colour codes, laws, formulae, Morse code, "Q" code and the international phonetic alphabet. In addition, it touches on conversions, equivalents, mensuration, trigonometry, calculus and the binary code. It is well indexed, which is essential in a reference book.

Taken altogether Keith Brindley has carried out a difficult and exacting task very commendably and produced a reference book that is a "must" for the professional, the student, and amateur electronic engineer alike. A.S.

ELECTRONICS A PRACTICAL INTRODUCTION

Author P. W. Braby
Price £9.95 Hard Cover.
Size 248 Pages.
Publisher John Wiley & Sons **ISBN 0 471 79844 4**

This is a book for beginners of all ages, a book that in my teens I would have jumped at. It starts with the assumption that the reader has no knowledge of electronics at all and gives compelling reasons why he or she should take it up as a hobby or profession. Sensibly enough it first deals with safety precautions and goes on to explain the correct use of the right tools. It takes the reader through the theory and practice of magnetism and electricity, right up to the construction and use of integrated circuits. It is profusely illustrated and a wealth of useful information has been accommodated into its 248 pages. Although it is aimed at schools and colleges, the author goes into such meticulous detail that it is equally useful to the student working on his own. Every chapter concludes with a summary and a list of questions for the reader to answer. There are nine constructional projects and though most of the parts required are quite standard, being a Canadian publication, they quote "Radio Shack" as the supplier. I checked with "Tandy" our equivalent of "Radio Shack" and found they listed most of the components provided you go to a main dealer. I assume the chapter on Metal Work is included for the benefit of establishments with their own workshops as most constructors today buy ready made chassis.

I have very few criticisms, thermionic valves are not mentioned, though this is of little importance at the present time, and there is no explanation of log or linear potentiometers or variable capacitors. No doubt, the author expects his book to be used as a stepping stone to more advanced electronics. These minor criticisms in no way detract from what is an excellent book and one of the most comprehensive publications on the subject that has come my way. I strongly recommend it. A.S.

exploring electronics

OWEN BISHOP

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

PART 7 Bistables and the like

THE bistable multivibrator circuit has close relatives with useful applications. We discuss the bistable and one of its relatives this month leaving other applications and the other members of the family for the next two parts.

BISTABLE MULTIVIBRATOR

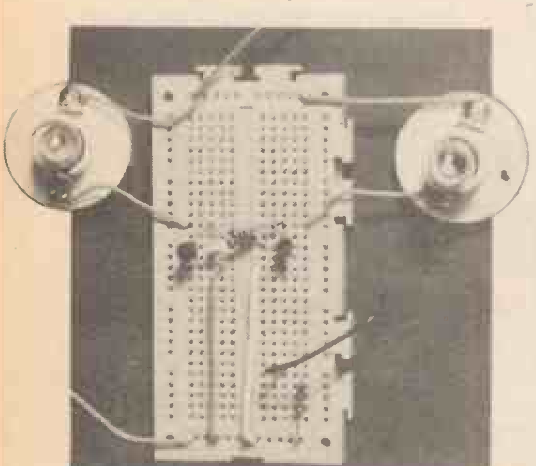
The best way to find out what the bistable multivibrator does is to build it and test it (Figs. 7.1, 7.2). When you connect the power supply one of the lamps lights. It is fully on and the other lamp is fully off. Now touch the flying lead to contacts A or B in turn. Try to work out the "rules of behaviour" of the circuit. After a few trials you will find that:

1) Only one lamp is on at a time, never both.

2) If the flying lead is not touched against either A or B the lamp which is on stays on and the lamp which is off stays off, indefinitely.

3) If LP1 is on, touching the lead to A puts LP1 off and puts LP2 on. Touching the lead to B has no effect.

4) If LP2 is on, touching the lead to A has no effect. Touching the lead to B puts LP1 on and puts LP2 off.



Here we have a circuit that can be in one of two states (point 1 above) and is stable in either state (point 2). This is why it is described as "bi-stable". It can be made to change from one state to another by taking contact A or contact B to a low voltage (points 3 and 4). How it works is explained in Fig. 7.3.

OTHER CIRCUITS

There are several other circuits differently constructed, which behave like this circuit. Some of them are in the form of integrated circuits, which we shall use later in the series.

One of the commonest applications of bistables is in computer circuits. The circuits which behave in the same way as the bistable circuit of Fig. 7.1 can "remember" which of their two inputs (A or B) was last taken to 0V. They store this information indefinitely (or until the circuit is switched off). Such circuits, used in the memory circuits of computers, allow us to store information.

ASTABLE MULTIVIBRATOR

The astable multivibrator circuit (central part of Fig. 7.4) looks very much like the bistable circuit. Like the bistable, it has two distinct states. Unlike the bistable, it changes from one state to the other and back again by triggering *itself.* Let us begin when TR1 is "off" and TR2 has just turned "on". Call this state A. The potential of its collector has suddenly gone "low". This rapid change has brought the potential of both plates of C2 "low". One side of C2 is connected to the positive rail through R2. Current must flow from the high potential of the positive rail to the low potential at C2. One side of C2 gradually becomes charged. Its potential gradually rises. It is connected to the base of TR1, so the potential there rises too. When the potential has risen to about 0·6V, this

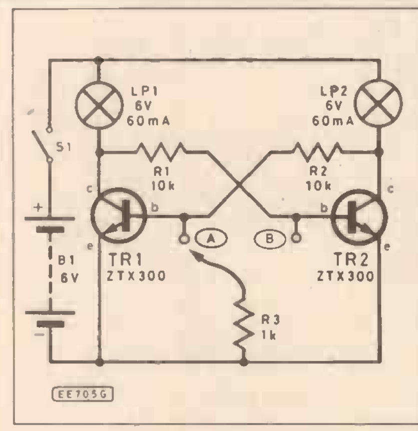
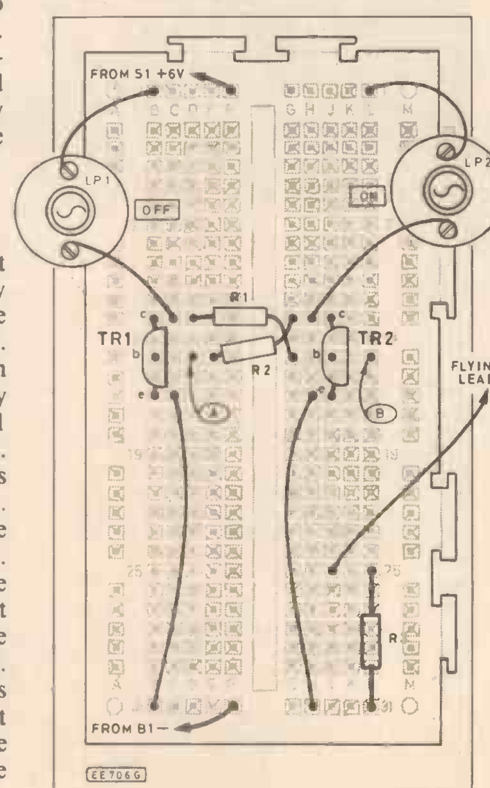
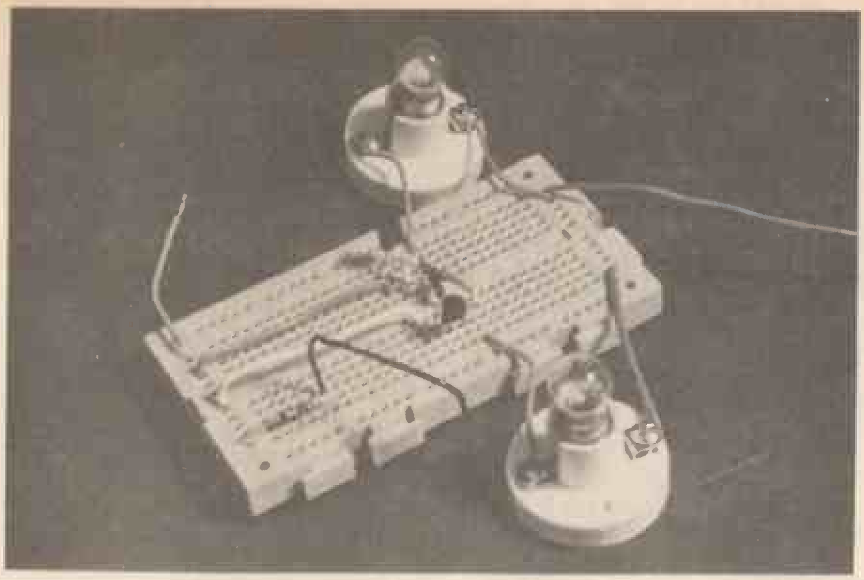


Fig. 7.1. Experimental circuit diagram for a bistable multivibrator.

Fig. 7.2. Demonstration breadboard layout for the bistable multivibrator.





COMPONENTS

BISTABLE MULTIVIBRATOR

Resistors
R1,R2 10k (2 off)
R3 1k
(All 0·25W, 5% carbon)

Semiconductors
TR1,TR2 ZTX300 *npn* transistor (2 off)

Miscellaneous
S1 Push-on push-off switch
B1 6V battery box with cells
LP1,LP2 6V 60mA filament lamps in sockets (2 off)
Breadboard (e.g. Verobloc)

ASTABLE MULTIVIBRATOR

Resistors
R1,R4 560 (2 off)
R2,R3 10k (2 off)
(All 0·25W, 5% carbon)

Capacitors
C1,C2 220n polyester (2 off)

Semiconductors
TR1 to TR3 ZTX300 (3 off)

Miscellaneous
S1 Push-on release-off switch
B1 6V battery box with cells
LS1 loudspeaker (3 to 15 ohm type)
0·1 matrix Veroboard 10 strips by 24 holes: 1mm terminal pins (4 off)

Approx. cost guidance only £5

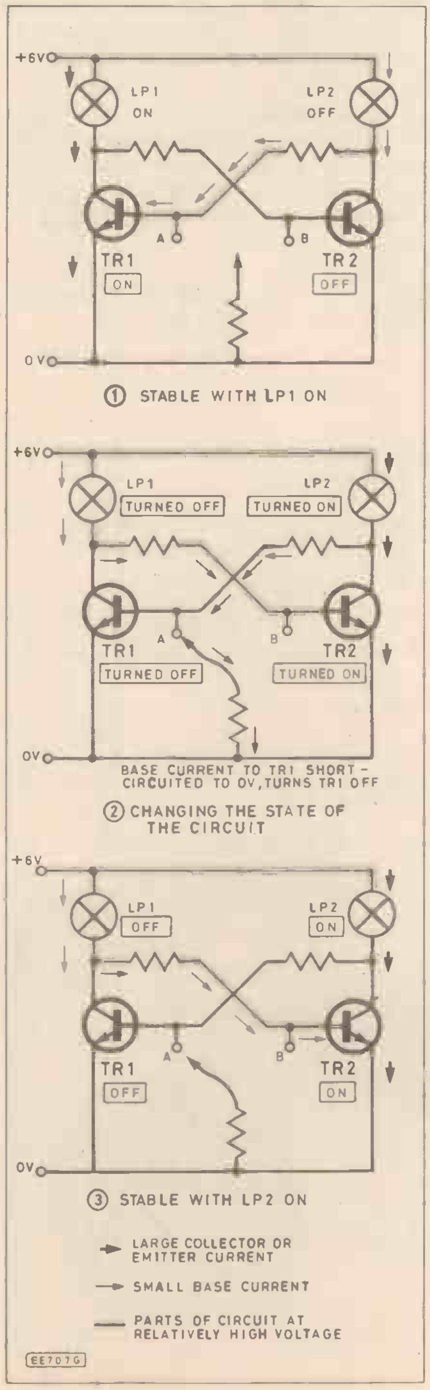
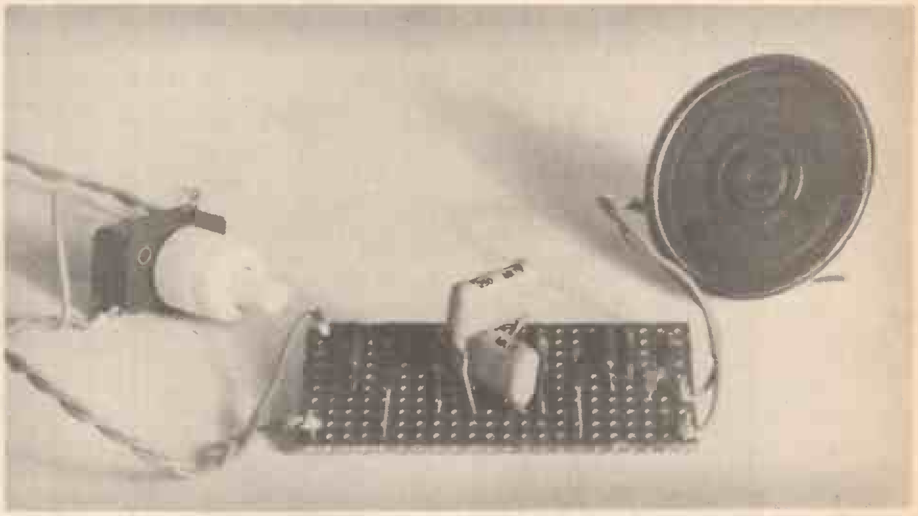


Fig. 7.3 (left). How a bistable multivibrator is made to change state.

is enough to start a base current flowing through TR1. This turns TR1 "on". Immediately the potential of the collector of TR1 begins to fall. This falling potential pulls down the potential of both plates of C1 and the base of TR2. Base current to TR2 is cut off, and TR2 is turned "off". The circuit has now reached state B.

In state B we have the reverse of state A. A current flows through R3 to charge C1 and soon the circuit changes back to state A. The time taken to change from one state to the other and back again depends on how long it takes for the capacitors to charge to 0·6V. This depends upon the values of the resistors R2 and R3 and the values of the capacitors. The higher their resistance and capacitance, the longer it takes for the charging to be completed and the lower the frequency of oscillation.



Turn over for details of how to build a Simple Buzzer using an astable multivibrator circuit

SIMPLE BUZZER

The buzzer circuit shown in Fig. 7.4 produces a tone of constant pitch from a loudspeaker. It can be used as a door-buzzer, a Morse code practice set, or a warning note for alarms of many kinds. Next month we shall see how it can be turned on or off automatically, but in this part we use a switch or Morse key to operate it.

The main part of the circuit is the astable multivibrator. The values of C1 and C2 decide the frequency of oscillation. The values shown in the drawing give a high-pitched note suitable for Morse code practice. For other purposes you may like to have a sound of lower pitch. If so, change C1 or C2 (or both) for capacitors of greater value. If C1 is 1μ and C2 is 220n, the pitch is just right for a door-buzzer. Experiment with several different capacitors until you get just the sound you require.

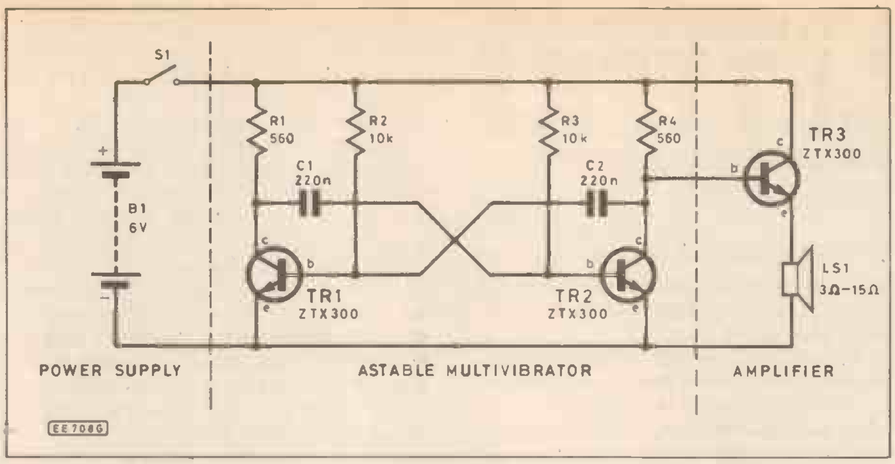


Fig. 7.4. Circuit diagram of an astable multivibrator being used as a Simple Buzzer.

The oscillator cannot drive the loudspeaker directly, for this requires too large a current. If we were to take a large current from the astable, it would not work properly. Instead, we take a small current (about 3mA) from one side of it and use this as the base current of a transistor. The base current flows in regular bursts, in time with the changes in state of the oscillator. The large collector current of TR3 is turned on and off, making the loudspeaker cone vibrate strongly, at the same frequency as the astable.

If the circuit is used as a door-buzzer, S1 is the press-button outside the door. Current is used only when the button is pressed, so the battery lasts for months with normal use. If you are using this circuit as a Morse code practice set, it is better to run it continuously while you are practising, and to connect your Morse key in series with the loudspeaker—between LS1 and the emitter of TR3. This gives a "cleaner" beginning and end to each dot and dash.

CONSTRUCTION

The stripboard layout for building the astable as a permanent unit is shown in Fig. 7.6. Make certain that the transistors are correctly connected. If you follow the layout of the drawing, all transistors have their flat sides towards the right. Try various values for C1 and C2. There is no need for both to have the same value. S1 can be a morse-key, or it can be a bell-push at the front door.

Next Month: Frost Alarm using a thermistor, Schmitt trigger and astable multi circuit.

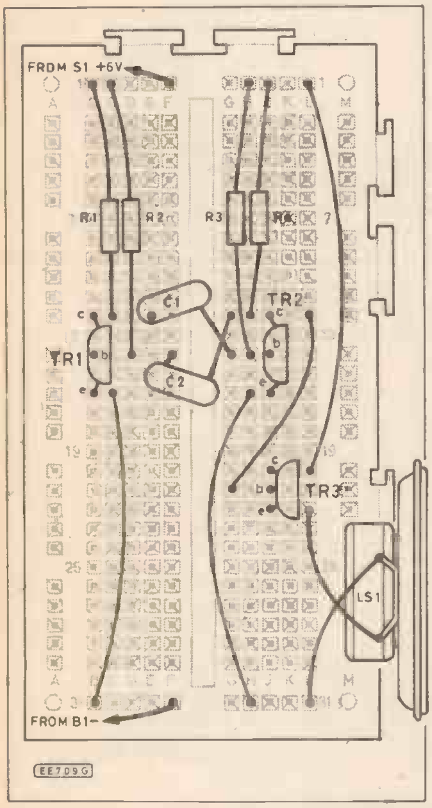


Fig. 7.5. Demonstration breadboard layout for the Simple Buzzer.

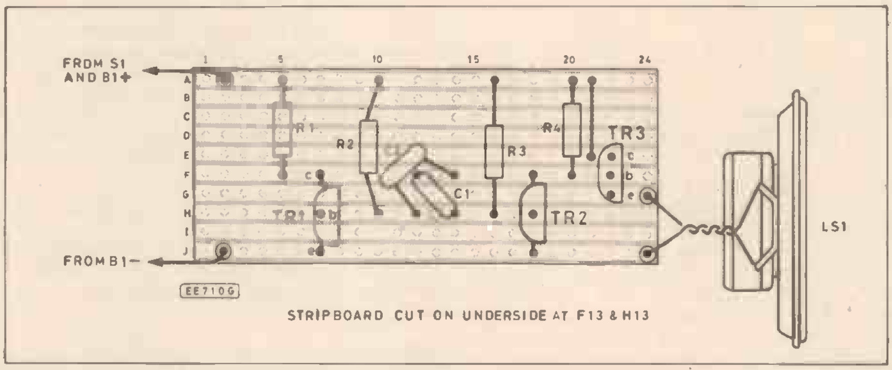
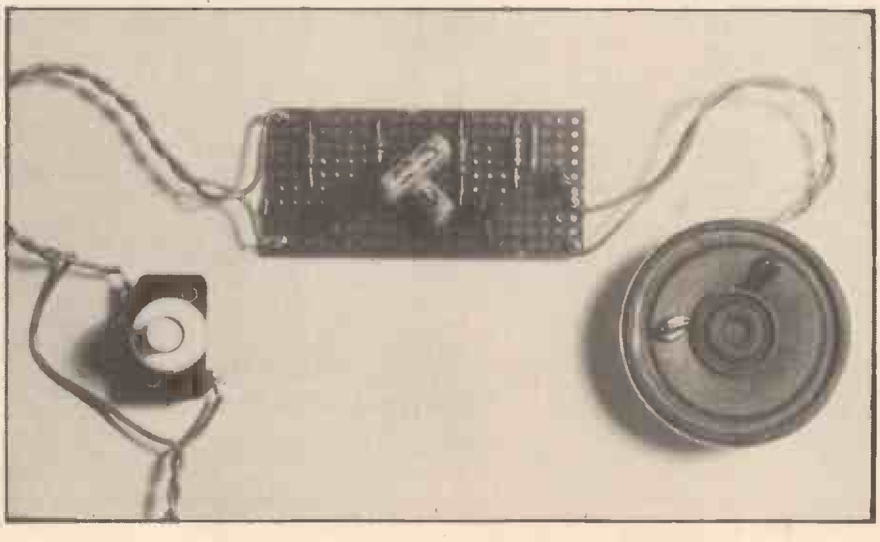


Fig. 7.6. Stripboard component layout for the Simple Buzzer. Remember to make the breaks in the underside copper tracks at points F13 and H13.

The completed buzzer showing wiring to the push switch and loudspeaker.



LETTERS

Well Balanced

Sir—I am writing in response to the letter from G. E. Glover published in the October 1986 issue of the magazine.

The reason why I and many others like *Everyday Electronics* is that there is always something interesting in it. The magazine is well balanced and easy to read. Its paper is better than the reflective gloss paper used by *Practical Electronics* which shines the light into one's eyes and makes reading sometimes difficult. Neither is it extremely technical as *Electronics & Wireless World* is even before their recent change.

Generally, I like the present format and I would be sad to see it substantially changed. The useful price guide for projects is also very handy.

If changes were to be made, I would like to see the introduction of one (and only one) business or semi-business project each month. For example, a device to be plugged (illegally) into the telephone to start a tape recorder whenever the receiver is lifted a computer parallel to series adaptor and perhaps vice versa, a computer printer sharer switch (parallel or series), a break-out box (hopefully substantially cheaper than the ones on the market), a cheap mains powered network, a mains powered intercom, etc.

Perhaps you have already published some of these projects. However, I do feel such projects would open your magazine to a wider readership in addition to retaining the present ones. It would also encourage interested but reluctant readers to take the plunge and to actually build their first real project.

I would like to think G. E. Glover does not represent all your current readers.

Paul Janik,
Slough.

At Risk

Sir—That knotted cable on the EE October front cover is a poor show.

Youngsters doing this are at great risk. I hope you publish the necessary warning in the next issue.

"Mains Cables should go through grommets and holding clips should be used".

Michael Christian
New Maldon,
Surrey.

Quite right too, but we did mention the proper method on page 533 under "Construction".—Ed.

EE READERS DISCOUNT SCHEME

Readers—you can obtain a 5% discount on goods from the advertisers listed using coupons cut from EE, provided you follow the rules below:

CROTECH's complete range of single and dual trace oscilloscopes along with accessories is eligible for the discount scheme. For orders below £250.00 then one voucher is required, on orders above £250.00 only two vouchers are required. This could mean a saving of over £14.00 on our 3132 Dual Trace 20MHz scope.

CPL ELECTRONICS
Kits for *Everyday Electronics and Electronics Monthly* and *Practical Wireless* projects including kits for the *"Teach In"* series. Plus a wide range of competitively priced components, hardware, test equipment and tools. We can also supply, in many cases, "one off" kits for specific projects. Free price lists on request.

GREENWELD ELECTRONICS LTD.
A full range of components at our shop in Southampton; open 9–5.30 Mon–Sat, as well as many surplus lines, all available by mail order. Bargain List free with our Catalogue. Send for your copy today, only £1 inc. post. Now even better value with EE Discount Vouchers!

TK ELECTRONICS stock a wide range of components including triacs, ICs & opto together with other accessories (switches, tools, multimeters, buzzers, crystals, Antex, Velleman and Vero products, etc.). We specialise in kits for timers, disco and home lighting, remote control kits for beginners. Send s.a.e. and 50p (refundable on first order) for catalogue.

OMNI ELECTRONICS are willing to give a 5% discount on all orders over £10.00, excluding VAT, if a valid voucher is enclosed. We stock a wide range of components—ideal for the hobbyist. Goods listed in our catalogue are generally in stock, orders will be sent by return post. Why wait?

E.S.R. ELECTRONIC COMPONENTS supplies the full range of Velleman kits which include amplifiers, light controllers, power supplies, timers and computer interfaces. To complement these kits E.S.R. can offer connectors, switches, control knobs and project cases. A range of small handtools, soldering irons, test equipment and service aids is also available.

BECKER-PHONOSONICS, established 1972. Designers and suppliers of a wide range of kits for projects published in *Everyday Electronics* and other leading periodicals. Range includes musical and audio effects, computer controlled circuits and Geiger counters. EE discount scheme applies to all full kits over £30 goods value, excluding Geiger counters.

D.M.R. ELECTRONICS are prepared to give a 5% discount on orders of their Oscilloscope Component Tester, ideal for testing surplus components and fault finding on p.c.b.s. We also design, manufacture and repair electronic equipment and computers, specialising in the Sinclair Spectrum.

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Amplifiers—(PA, disco, music), audio leads all types, components, capacitors, potentiometers, resistors, disco lighting, sound to light units, disco decks, disco consoles, disco mixers, echo chambers, fuzz lights. Multimeters, mains transformers, microphones, stands, leads, goose necks, speakers with or without cabinets, tweeters, mid range units, 100V line matching audio transformers, etc.

EE BOOK SERVICE, a 5% discount will be given on the total cost—including postage—of all orders that are sent with a valid voucher. Our complete list of books appears in each issue together with ordering details.

RULES

1. Discounts are available from advertisers listed on this page.
2. Unless otherwise stated by the advertiser, discounts are only available on orders over £20 in value.
3. Unless otherwise stated by the advertiser, one voucher is required for each £50 value of the order placed (i.e. for orders between £20 and £50 send one voucher, between £50 and £100 send two vouchers, etc.)
4. Cut out vouchers (not photostats) must be sent when claiming the discount.
5. Each voucher sent must be valid on the day of posting (i.e. it cannot be used after its expiry date).
6. Discount is not available on "sale" or "special offer" items.
7. You must indicate on your order that the 5% EE Readers Discount has been deducted from the payment sent.
8. All advertisers reserve the right to refuse this discount on any item supplied.

Discounts will not be given or coupons returned if these rules are broken.

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ONE COUPON
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Entitles EE readers to discount from listed advertisers when used according to the scheme rules as set out in EVERYDAY ELECTRONICS

LASER SANDWICH

CLAIMING a world first, Mitsubishi have developed a gallium arsenide (GaAs) semiconductor laser with two different wavelengths which are switchable by changing the amperage of the current applied to the semiconductor.

Semiconductor lasers are widely used as the light source in optical communications and compact disc (CD) players. These lasers can emit a beam of only single wavelength. The new semiconductor laser will allow multiplexed wavelengths for optical communications with a single unit, thus expanding the traffic capacity. When used in an optical disc system, which uses a laser beam of different wavelength for writing and reading, the laser will simplify the design of CD machines.

The new laser is made by sandwiching a GaAs layer which emits the light, with 48 alternating layers of aluminium arsenide and gallium arsenide on each side. The structure is called the quantum-well structure.

When the core active GaAs layer is 10 nanometres (one nanometre is a billionth of a metre) thick and 410 nanometres wide, the laser can generate light of different wavelengths when the current applied is adjusted. The wavelengths are 843 nanometres at 150mA and 803 nanometres at 190mA, both infrared rays invisible to the human eye.

The new lasers are expected to be in practical use in about two to three years' time, after further development work to boost luminescence and extend its operational life has been completed.

ELECTRONIC EXAMS

A basic test in electronics will be available to schools this coming spring.

Devised by the Associated Examining Board (AEB), the test is designed to help the teaching of electronics in schools and, it is hoped, be in line with industry's needs.

Boots promotional campaign *"You Can't Buy Cheaper"* has now been extended to include its range of TV and video equipment.

If you can find the same item at a lower price in your town within seven days of purchase, they will happily refund the difference.

DER is to rent out satellite TV receivers through each of its 369 outlets. An agreement has just been concluded whereby DER will distribute NEC Business Systems NESAT satellite TV receivers.

The sets are available to rental customers in London and the South East and they will review progress after six months.

British Weather Wins An Award

The Royal Society "1986 Esso Energy Award" was presented to a team from the Meteorological Office for their development of a world-wide forecasting model for providing accurate information on winds and temperatures to the civil aviation industry, so that flight paths and patterns can be selected to use the minimum amount of fuel.

The gold medal and prize of £2000 went to Dr. P. W. White, Dr. M. J. P. Cullen, Dr. A. J. Gadd, Mr. C. R. Flood, Dr. T. N. Palmer, Mr. K. Pollard and Dr. G. Shutts. The award was presented by Sir George Porter, President of the Royal Society.

DOCKLANDS RAILWAY

In the Spring of 1987, the Dockland Light Railway will take delivery of a microprocessor-based fare collection system from Thorn EMI Computer Systems Division. The system will use magnetically encoded tickets which will be compatible with those of British Rail and those proposed for London Transport.

The Docklands system will comprise 32 ticket vending machines, 32 ticket validators, central office equipment including a computer and fixed communications links between the ticket machines and the central office. The central office computer remotely monitors the ticket machines for low ticket stock, full cash box, power failure and can alert the office of vandalism.

The founder and chairman of Dolby Laboratories, Dr Ray Dolby, is to receive the OBE for his services to the electronics industry. As he is an American citizen, the award is honorary and does not carry a title.

ON THE MAP

The British Overseas Trade Board has published the new edition of its export wall map of the world. The map is designed to provide a ready source of information on world markets and official export services.

The map shows all British diplomatic posts which offer commercial services throughout the world. It also gives details of services offered by the BOTB, its publications and contact points within the United Kingdom, and lists overall figures for British exports to overseas countries in 1985.

This year, the map has been given a completely new look to make it more attractive for display purposes. Measuring 95·3 cm by 67·8 cm, the map now includes some topographic features such as mountains and rivers and is more colourful.

Free copies of the wall map are available to UK exporters from their nearest BOTB regional office, whose telephone numbers are listed in Yellow Pages.

Technology Park

A £2M technology park in Northern Ireland has just been opened by the Duke of Kent.

He visited the 80-acre park near Antrim, owned by the Northern Ireland Industrial Development Board, and met its first tenant, BIS Beecom (International). The Duke said: "The decision by BIS Beecom International to place its investment in this park is a significant gesture of confidence in Northern Ireland as an industrial location."

BIS Beecom (International) is an associate company of the BIS Group based in London. Its chairman, Paul McWilliams, said: "The new international company will concentrate on developing high quality software and will initially employ 40 staff, rising to over 100 within four years." He added: "A major factor in attracting us to this site was the local supply of graduates."

BIS is injecting £5M into the new project, which has the support of Queen's University, Belfast, and the University of Ulster.

Telecom Deals in Kanji

British Telecom have announced the signing of an agreement between Teletrade, BT's International export unit, and the Japanese trading company Mitsui & Co Ltd., to distribute the City Business System in Japan.

The City Business System (CBS), a touch-screen dealing board for the financial community, has been specially developed for the Japanese market, including the use of Kanji characters for the visual display screens. The introduction of Kanji characters was seen as a necessary development to enable CBS to be successfully sold to Japanese financial institutions.

The Japanese version will use 1,800 Kanji characters. Translation from English to Japanese is being undertaken by Mitsui.

One of the UK's leading power supply manufacturers, Coutant Electronics, have just reported that they are on target to export over 50 per cent of their products worldwide in 1986.

YOU'RE NEVER ALONE WITH A PHONE

For octogenarian Cornishman, Irving "Bibs" Rogers, who suffers from chest trouble, the pendant he wears when he is out in the garden could be a life-saver.

The pendant is part of British Telecom's Carephone equipment which can be linked to an Answercall machine. It is a transmitter which, at the press of a button, automatically makes telephone contact with pre-recorded numbers. Mr. Rogers is helping to test the pilot project in the West Country.

It means that 80-year old Bibs, who lives alone, but suffers from a lung complaint which can suddenly leave him fighting for breath, can summon urgent help.

"This Carephone means real peace of mind for me, it's smashing", he says. "I'm not the gardener I used to be, but I like to get out there to do odd jobs. If I'm taken ill I only have to press a button to get in touch with my daughter or my friend across the road."

***"Telephones are cheaper to buy than to rent"*. That's one of the conclusions from "Which" magazine.**

The magazine has found that British Telecom's rental charges add up to the price of a telephone in less than three years.

Following the half-year announcement of a continuing growth in turnover, Circaprint has opened a new 15,000sq.ft. conventional printed circuit board factory alongside its new multilayer and plated through hole facilities at Aylesford.

The Management Services Division (MSD) of W. H. Smith's has agreed a deal worth £12,000 with information systems consultants BIS Applied Systems' MODUS Division.

BIS has provided a management package to MSD at its Swindon HQ which employs over 200 staff.

British Telecom has signed a letter of intent securing an agreement to help develop telecommunications in the Chinese province of Zhejiang and its capital city Ningbo (pop. 500,000) up to the year 2000.

The first phase of the project will concentrate on optical fibre and microwave transmission equipment due for commission by 1988/89. BT will also be involved in the training of Chinese managers and technical staff.

DUMMY

Frazer-Nash Electronics is teaming up with Ogle Design to produce human-surrogate dummies fitted with electronic instrumentation. They will be used to assess the likely bodily discomfort or damage under controlled test conditions.

Fraser's tailor the array of sensors to any specific application, such as accelerations, loads, and pressures, etc. They also design and supply the data collection, storage and analysis systems necessary to evaluate test results.

Their latest project is the design and development of a thorax transducer package for the European Side Impact Dummy (Eurosid) programme.

The Ministry of Defence has awarded a contract worth over £250,000 to the Electro Optics Division of Thorn EMI, for the supply of hand-held thermal imagers for service with the Royal Navy.

Hi-Tech Asia

*A new international high technology exhibition, **Hi-Tech/Asia**, is to be held at South East Asia's premier venue, the Changkat Pavilion in Kuala Lumpur, Malaysia, from 7 to 10 September 1987.*

*The exhibition will be part of Asia's established biennial show, **Powertech '87**.*

The Federation of British Electrotechnical and Allied Manufacturers' Association has approached the British Overseas Trade Board for "joint venture" assistance for British exhibitors.

STARVISION

Greenwich Satellite have clinched a deal to supply more than £1M worth of satellite TV equipment to homes in the North of England.

The initial order, for 1600 NEC domestic receiver systems, has been placed by direct-selling specialist Starvision of Leeds. The placing of this order alone means a 30 per cent boost to sales of satellite receivers in Britain. The current figure for satellite receivers is reckoned to be around 5,000.

HIGH-TECH BOOST FOR TEACHERS

The number of design technology teachers in Richmond, London, area is expected to increase following a joint DTI/Richmond LEA initiative.

In a pilot scheme, starting January '87, eight experienced teachers will attend an intensive introductory course followed by tuition over a six month period. Following completion of the course the teachers will contribute to technology teaching in their schools.

STEREO TV SOUND

The introduction of digital stereo sound with television has moved a step closer following the Government's approval of the joint BBC/IBA specification for a new transmission standard.

The system, developed by BBC engineers, is currently undergoing experimental tests from the BBC-2 transmitter at Crystal Palace in London. The stereo signals are transmitted via a digitally modulated carrier at 6·552MHz above the vision carrier.

Although the BBC has no immediate plans to introduce a full stereo service, the experimental tests at Crystal Palace will be extended during the next few months to include both BBC-1 and BBC-2 transmissions. These tests will enable manufacturers to develop prototype receivers and will allow BBC staff to gain operational experience.

Robot Roundup

NIGEL CLARK

ROBAT

Create a robat machine and see the world. Last year's winner of the British heat of Robat—robot ping pong—went to San Francisco to show the Americans how a little ingenuity can go a long way. This year Venice was the setting for the world championships.

Unfortunately, the distance and cost cut the British representation to one—John Knight—who was able to make it with the help of his £2,000 first prize from the British heat, presented by Nautech of Portsmouth. And the visit was worthwhile because his Charlie took the title against opposition from Belgium and Finland. The Finns were handicapped by not being able to get their machine through the Italian customs but the event organiser, John Billingsley, thought it unlikely that it would have been better than Charlie.

Despite the exotic setting, Venice did create some transport problems because of the lack of road transport. The Belgian machine needed three long journeys on a hand cart to get it from the car park to the venue overlooking the Grand Canal, and a large sum to obtain a boat to take it back. Knight's simpler construction was easily transported and ready to go in a relatively short space of time.

There was a further problem with the specially built table. It was the same dimensions as the table designed by Billingsley to limit the field of operation, thus making a robot game of ping pong more feasible, but the Italian version was more robust than previous tables and the serving mechanism could not be attached without some modification. That required searching for an Italian hardware shop without the necessary Italian words for the items required.

SIMPLIFICATION

Billingsley said the contest was a further lesson in the benefits of simplification and designing equipment that would achieve the task rather than going for elegant but complicated solutions.

To provide vision the Belgians used two independent free-standing cameras, which had to be carefully positioned each time they were used so that the views they received could be co-ordinated. Once positioned on their tripods care was needed to avoid moving them, as that would mean having to position them again.

In contrast, Knight's system was, according to Billingsley, elementary but effective. It consisted of rotating lenses which swept an image of the ball directed onto them by mirrors positioned above and below, across four photocells. The two outer cells provided rough positioning with the fine tuning being achieved by the centre cells.

The Belgian machine experienced further difficulties when put through its paces. The bat was attached to a horizontal bar, along which it moved with vertical movement provided by servos at each end. Tilt was achieved by a second frame behind the first which moved a pole attached to the back of the bat, the degree of tilt depending on the relative positions of the frames.

Unfortunately, the second frame did not work and when the machine was started the servos on the first frame moved in opposite directions, causing it to break. The constructors had warned that it was called OSCAR, standing for 'our system crashes at random'.

Meanwhile, Charlie was displaying perfect horizontal control and while its vertical control was variable, it managed to achieve a perfect return to a slower serve, which was greeted with applause.

Such are the small triumphs which at the moment are sufficient to take the Robat prizes. Although the contest has been running for over two years, Billingsley is not downhearted that more progress has not been made.

LESSONS

He believes that there is great value in merely trying to create something like a robat machine in that it gets away from the theoretical and into the practical and that there are lessons for industry, particularly in high technology. As well as robat he has been involved with Micromouse, in which a buggy has to find the centre of a maze as quickly as possible, for many years. In that time he has seen the machines improve from being able to manage one straight and a corner to being able to get to the centre in a matter of seconds.

He has also seen the technology improve. Although appearing to be a good thing, Billingsley has been persuaded that there are handicaps in always seeking to innovate. In Europe, contestants have tended to turn their backs on things as soon as they have been seen to work.

In the early days of the contest it was dominated by what he called stepper motors—driven wheelchairs, having only two wheels and the steering provided by driving the wheels at different rates. That has since been replaced by servo-driven machine with a third wheel to help with steering.

When the Japanese had the opportunity to show their machines in last year's world championships, Billingsley was surprised to see that but for a few slight embellishments the mice were much the same as the early European versions, but the quickest was almost twice as fast as the best European version.

The winner was not the newest machine with the latest innovations but the oldest because, as Billingsley was told, the makers had had the longest time to develop it.

SPONSORSHIP

Another supporter of robot competitions is Ian Pitkethly, sponsorships manager for BP Oil, which has sponsored two robot building contests for schools and youth organisations in recent years. He also emphasised the practical benefits and added that it gave children who might not be good at games or academic subjects a chance to shine.

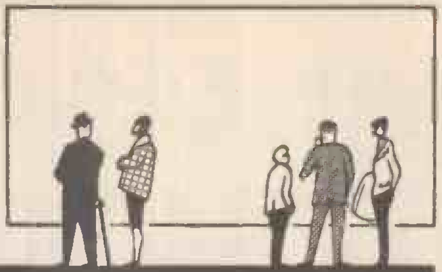
While not being surprised by the efforts of the children, he was encouraged by their ability to tackle often complex problems. Many teachers had reported that they were only needed for guidance rather for leading in any particular direction. And the contestants had been able to confound the experts in the second contest when the set task was to build a robot capable of offering a selection of three drinks, accept the order and bring the required drink.

And there has been no shortage of interest, with more than 300 establishments enquiring about the contests, and on both occasions more than 20 finalists from all parts of the country. While the company is not organising an event this year it is expected that next year will see the launch of a further task. A final decision on the suggestion is still awaited, however.

Next year's final of the Robat contest takes place at Euromicro, being held in Portsmouth in September, and anyone interested in the challenge should contact Billingsley in the Electrical Engineering Department at Portsmouth Polytechnic. He is also looking for backing to help increase the number of competitors.

The team from Campion School, winners of the BP Buildarobot Competition, proudly display their trophy and 'Jeeves' the robot butler.

SHOP TALK



BY DAVID BARRINGTON

Catalogues Received

This month (November '86), with the receipt of two catalogues, it's the turn of the "big boys" to flex their muscles and show that they are still developing.

The catalogues have increased in bulk over previous editions and are the **Cirkit** "Winter 1986 Electronic Constructor's Catalogue" and the **Maplin** "1987 Buyer's Guide To Electronic Components". Both are on sale through leading newsagents, such as W. H. Smiths, or direct from their sales shops and mail order offices.

The 164-page Cirkit catalogue contains over 3,000 product items, with many new to this edition. Among the new items are, low-profile i.c. sockets, cases, Thurlby power supplies and the introduction of the Hameg range of oscilloscopes.

Having built a reputation for the design of good quality add-ons for the Amstrad computer, it's not surprising to see that they are now stocking the Amstrad micros themselves.

Two interesting additions are a simple to enter Competition and a range of "Bargain Packs/Special Offers". The first prize in the competition is a 20MHz oscilloscope. There are a total of 12 prizes to be won. The "bargains" range from a p.c.b. pack to a cassette deck mechanism.

The Cirkit catalogue cost £1.20 and even if you do not win a prize there's still £8 worth of redeemable discount vouchers.

Probably the "big daddie" of them all and the one that the new up-and-coming component suppliers use as their "Starship" to emulate is Maplin. The 1987 edition of the Maplin catalogue is no exception and they have produced a monster 472-page offering that all experimenters and constructors should try to find the time to wrestle with.

New products introduced this time include a range of British Telecom approved telephones and equipment. Also an increased range of connectors, cables and capacitors is being carried.

Of probably more significance is their announcement of the continuing trend towards "own brand" products, this includes extending the Precision Gold label. In particular, the popular range of test gear and musical effects units have been extended.

With the current fears about personal security at this time of year, the increased choice of burglar alarms and home security devices is to be welcomed.

As an incentive to buy, a free Battery Condition Tester is available to all purchasers of the catalogue. This is apart from other free and special offers listed in its pages.

The Maplin catalogue costs £1.50 and the free gift is available direct from Maplin or any of their five stores located in London, Birmingham, Manchester, Southampton or Westcliff, Essex.

CONSTRUCTIONAL PROJECTS

Random Light Unit

There could be problems for readers in locating a local source of supply for some of the components specified for the *Random Light Unit*.

The thermistor specified is a miniature bead type and is claimed to respond to temperatures from −5°C to +70°C. The resistance at 250°C is about 4·7 kilohms. The GM472 (VA3404) is stocked by Electromail: code 151-142.

The IEC 5-way, panel mounting, mains distribution socket block comes complete with a mains neon and fuse and is also available from Electromail: code 489–784. The socket block is not pre-wired, so when wiring up it is most important to use leads that are capable of handling *at least* 10A.

The switch S2 is part of the potentiometer VR1 and is shown as a single-pole single-throw type. This switch arrangement seems fairly scarce and the answer is to use the common double-pole single-throw type. Only one set of contacts need be used.

The 10A toggle switch is most likely to be listed in catalogues under "automobile switch".

We have been unable to locate any source of supply for the Hamlyn solid-state relays specified for this project. However, we have been fortunate in that the solid-state relays currently being stocked by Electromail are pin-for-pin compatible and have identical electrical ratings (could they be made by Hamlyn?). Rated at 2·5A, these single-in-line "relays" cost £6.80 each and should be ordered as: stock no. 348–431.

Hand Lamp Charger

A couple of items could prove troublesome when purchasing parts for the *Hand Lamp Charger*.

The mains rated microswitch and the d.p.d.t. slide switch called for in the mains version is currently listed by Maplin, Marco, Cricklewood, CPL Electronics and Electromail.

Note that the input wire to the mains version should be 3-core mains type, rated at 3A minimum. Also the mains unit should be adequately "earthed" and extreme care should be taken when testing the circuit.

The only source we have been able to locate for the 4-pole 3-position slide switch used in the battery version is from Maplin: code FH38R (4-pole slide). The "cassette recorder" type power plug and socket connector can be obtained from Henry's, Cirkit and Maplin.

Morse Decoder

Most of the components for the *Morse Decoder* appear to be standard devices and should not cause buying problems.

A full kit of parts (£26.98), including the printed circuit board, may be obtained from **Becker-Phonosonics, Dept EE, 8 Finucane Drive, Orpington, Kent BR5 4ED.** The printed circuit may be purchased from them separately for the sum of £4.20 inclusive: quote code 269A.

A fully extended software listing for this project is also available from Becker-Phonosonics for the sum of £7.50 plus a large stamped addressed envelope.

Hands Off Intercom

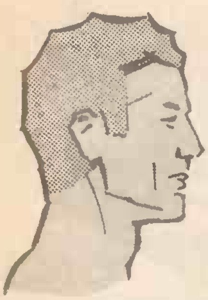
The 1W audio power amp i.c., type ULN2283, called for in the *Hands Off Intercom* project would appear to be stocked only by Cirkit. They are also able to supply the 33μH r.f. choke.

The electret MIC used in the prototype was purchased from a Tandy store. The four-core telephone cable is now stocked by most of our advertisers.

Logic Pulser

If readers wish to use the same probe case shown in the photograph of the *Logic Pulser—Digital Troubleshooting Test Gear* project—this was purchased from Electromail: stock no. 508217.

The rest of the components for this project are all readily available from advertisers.



HANDS OFF INTERCOM

TONY SMITH

Garage to Kitchen— Baby's Room to Lounge— you can keep in touch with this low-cost system

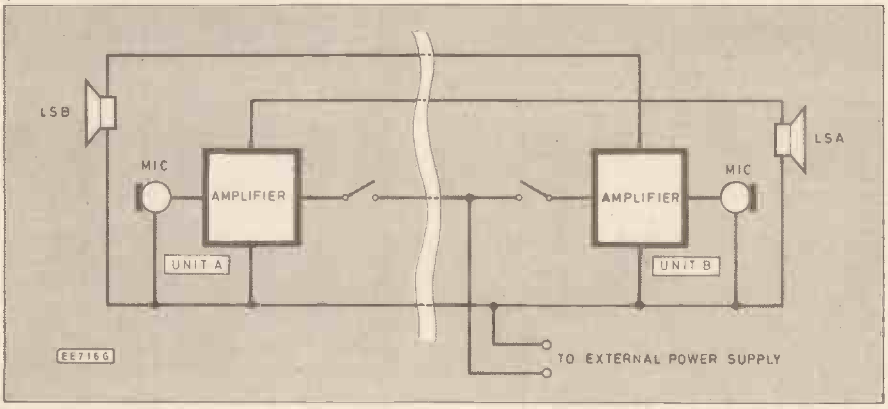


Fig. 1. Block diagram of the operating system for the Hands Off Intercom.

Most published intercom systems use switching to allow a speaker to double up as a microphone, and a single amplifier to serve the entire system. This is certainly an economical way of achieving two-way communication, but it has two main disadvantages. Firstly the speech quality can be distorted, and, secondly, the users need to switch over from "receive" to "speak" continuously throughout the conversation.

Whilst this is quite satisfactory for many applications, there is sometimes a need for a system not requiring switching, and having a better audio quality.

The method suggested here uses two separate amplifiers and separate microphones and speakers. Cost has been borne in mind however, and the microphones used are modestly priced. The integrated circuits used for the amplifiers (ULN2283B) are low voltage devices, operating from 3V to 12V with a minimal quiescent current, making them reasonably economical for battery operation if required.

HOW IT WORKS

Referring to the block diagram Fig. 1, Unit A, a self-contained microphone and amplifier, drives loudspeaker LSA which is located with Unit B in any required separate location. Unit B, a duplicate of A, drives speaker LSB, which is located with unit A.

Both amplifiers are in operation at the same time, allowing normal two-way conversation. A single battery or power-supply serves both units and can be located at any convenient point along the connecting four-way telephone cable.

CIRCUIT DESCRIPTION

The complete circuit diagram (one unit) for the Hands Off Intercom is shown in Fig. 2. Transistor TR1 is a pre-amplifier to enable the microphone to drive the main amplifier, IC1. Potentiometer VR1 controls the gain of the amplifier, and capacitor C3 by-passes to earth any radio-frequency signals picked up by the external wiring.

In the desk model, the microphone is a low-cost dynamic type, the sort sold as replacements for small cassette recorders. In the wall-mounting unit, an electret insert is used, and resistor R4 provides bias for the microphone. R4 is only required when an electret MIC is used.

CONSTRUCTION

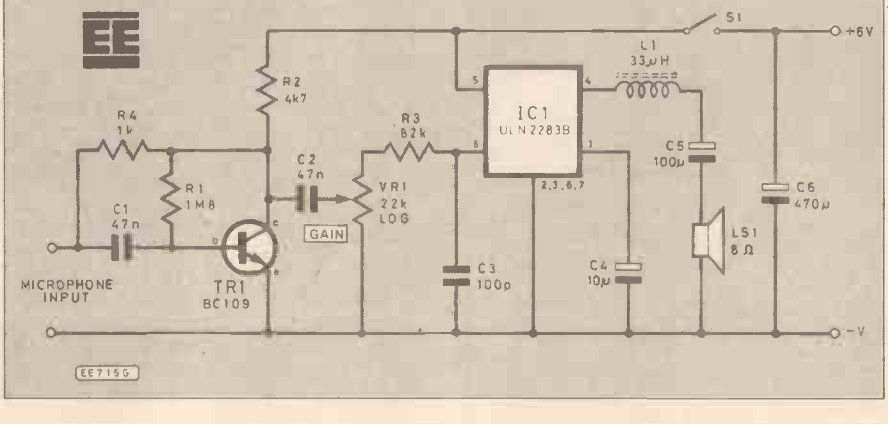
All components are mounted on standard 0·1in matrix stripboard, as illustrated in Fig. 3. i.c. holders are used to avoid soldering the i.c.s directly to the boards.

It should be noted that a slightly different microphone wiring arrangement is required if an electret microphone is used. No detailed constructional information is given, as the shape and size of a terminal unit will depend on its particular location, and the needs of the user.

In the prototype installation two different versions were used. A desk model used a standard car speaker and dynamic microphone, mounted side by side on a polished wood base. A hole was cut in the base under the speaker and the circuit board was mounted there, with the switch and gain control on a small aluminium plate over another recess at the side of the speaker.

The second terminal was a small wall-mounting unit using a miniature 3in speaker with an electret microphone insert. The home-made wooden case had an internal wood divider to minimise acoustic feedback between the speaker and the microphone, see Fig. 4. In both versions the microphone should be located as far away from the speaker as possible, and face away from it.

Fig. 2. Complete circuit diagram of the Hands Off Intercom (two units required). Resistor R4 is only required when an electret microphone is used.



The power supply can be conveniently located anywhere along the route of the connecting cable, where it can be placed out of sight. A 6V lantern battery should be satisfactory for occasional use. In the prototype system the total quiescent current at 6V was about 16mA.

For frequent use, it would be advisable to use a small mains power supply capable of giving 50–100mA at 6V. Suitable designs have previously appeared in this magazine, or can be purchased ready made at modest cost if the constructor is unhappy about working on a mains unit.

Prototype version of the desk model.

WIRING AND SETTING UP

Four-core telephone cable should be used for inter-unit wiring. This can be inconspicuously laid and stapled along a route from one part of the house to another. In the prototype, one end was terminated in a small metal box having a 5-pin DIN socket. The desk model had a flexible lead terminating in a matching DIN plug, which enabled the intercom to be plugged in at this point.

Once the two units are connected up, and power switched on, it will be necessary to adjust the gain controls to ensure there is no acoustic feedback between the microphones and speakers. One person is required at each terminal for this adjustment.

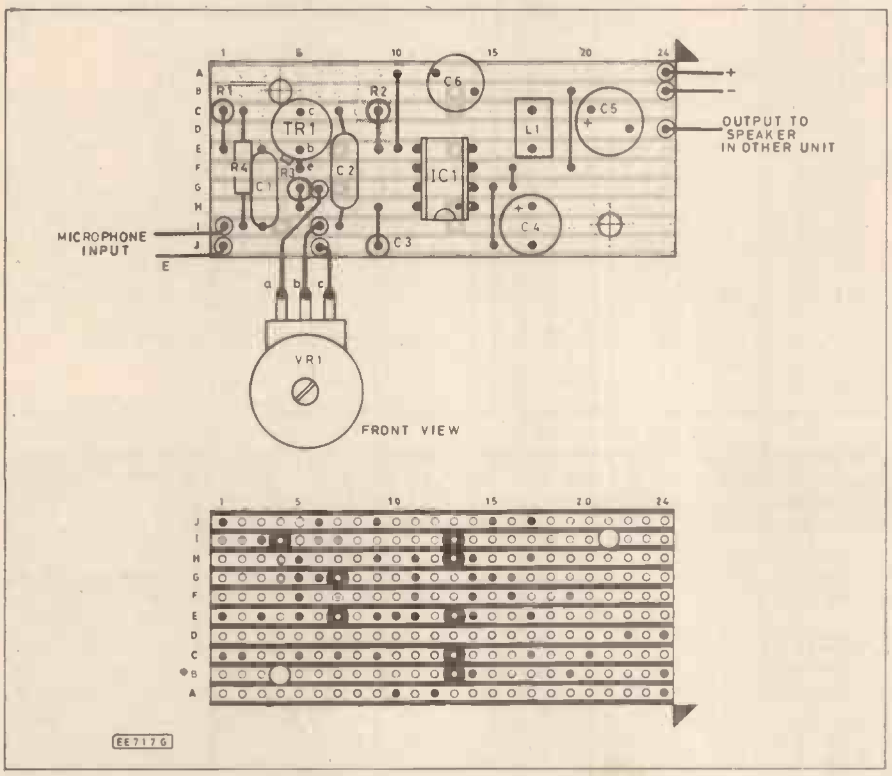


Fig. 3. Component layout, wiring and details of breaks to be made in the underside copper strips of the circuit board. A minimum of two boards are required for this system.

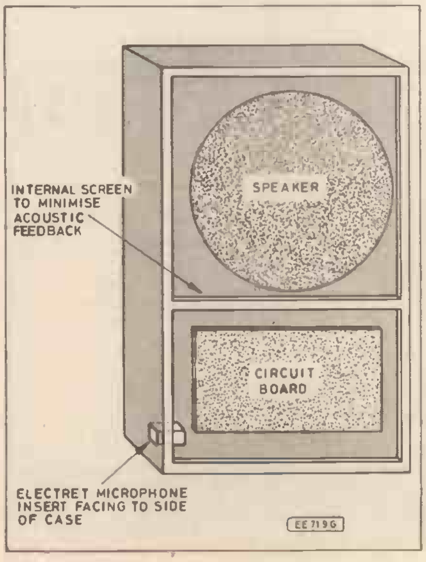
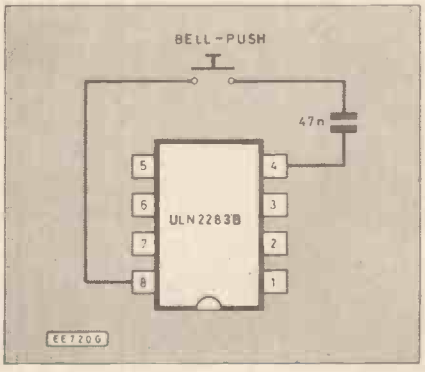


Fig. 4. Suggested arrangement for the wall-mounting unit.

Fig. 5. Simple call-tone to use with street door intercom. The wires to the bell-push must be kept separate to avoid inter-wire capacitance and prevent unwanted oscillation. DO NOT twist wires together.



COMPONENTS

See Shop Talk page 43

Resistors
- R1 1·8M
- R2 4·7k
- R3 82k
- R4 1k (only required if electret mic used)
- All ¼W carbon ± 5%

Potentiometer
- VR1 22k log.

Capacitors
- C1,2 47n polyester (2 off)
- C3 100p polystyrene
- C4 10μ 16V elec.
- C5 100μ 10V elec.
- C6 470μ 10V elec.

Semiconductors
- TR1 BC109 *npn* silicon
- IC1 ULN2283B low power audio amp

Miscellaneous
- L1 Choke, 33μH
- LS1 8 ohm loudspeaker, size to suit case chosen, see text.
- S1 s.p.s.t. miniature toggle
- MIC1 electret microphone element or low cost dynamic microphone, see text.

Stripboard, 0·1in. matrix, 10 strips by 24 holes; 8 pin d.i.l. holder; four-core telephone cable; length to suit installation; control knob; connecting wire; case or mounting to constructor's choice.

Note: The above components are for one unit only and should be repeated for the second unit.

Approx. cost Guidance only £8.20 Each unit

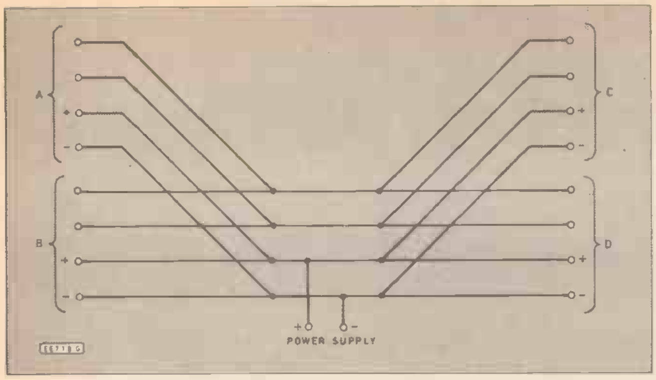


Fig. 6. Wiring to provide socket outlets in different locations. The units will connect between any two outlets.

First prototype model of the wall-mounted version.

The controls should initially be turned completely anti-clockwise. A gradual advancement of each should result in speech being heard from the other terminal. Too much gain will result in oscillation, and the controls should be backed off slightly to provide clear, distortion free amplification in each unit.

USING THE SYSTEM

The switches S1 enable users to activate the system from their end only, i.e. they cannot switch on the microphone at the other end. This feature helps prevent embarrassing eavesdropping, and ensures that speech from one end is transmitted only when those present wish it.

No call-system need be included as all that is necessary is to switch on and call into the microphone for a reply. The person called also switches on and it is then possible to hold a normal two-way conversation, either close to the units or from some few feet away.

OTHER USES

The system offers possibilities as a street door intercom, linked with a push-button call-tone at the door (see Fig. 5), with all switching inside the house. Used as a one-way system it could function as a baby alarm, or serve as a monitor for intruders; telephone ringing; or simply knocks at the door; from one part of the house to another. Provided the microphone at the receiving end is switched off, the gain control of the monitor could be advanced to provide extra sensitivity without the problem of audio feedback.

Units connected by flexible cable could provide an invaluable talk-back facility when adjustments, e.g. to TV antennas, have to be made from remote locations. Additional units cannot be added to the system without complicated additional circuitry, but extra outlets could be wired in at various points along the cable route to enable the two units to be plugged in for use in different locations as required, see Fig. 6. The applications are limited only by the ingenuity of the user. □

SPECIAL OFFER...

THREE CHANNEL Chart Recorder

£49.99

Including VAT and Carriage

THIS fast response three channel chart recorder will provide an ink chart readout of up to three separate inputs. Chart speed is variable from 0·1mm/sec. to 25mm/sec. in eight steps with each channel requiring an input of 8mA for full scale deflection.

The moving coil movements carry lightweight syphon pens fed from a large capacity ink well. Usable frequency range is d.c. to 5Hz and a frequency response of better than 10% at maximum frequency can be achieved. The unit is provided complete with instruction manual, eight bottles of ink, five rolls of paper (approximately 50m length each), scale, pen filler, fuses, connecting cables and spare pens. The recorder is supplied in a strong wooden carrying case and is made in the USSR. Approximate size is 475 × 385 × 165mm; weight 20 kilos.

Delivery is by Securicor. Overseas readers please write for quote on export prices and delivery.

Send your order to EE Offer, Marco Trading, The Maltings, High Street, Wem, Shropshire SY4 5EN. Make cheques payable to Marco Trading. Tel: 0939 32763.

Please complete both parts of the coupon in BLOCK CAPITALS

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ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month we shall be introducing some software for use in conjunction with the 8-Channel Analogue to Digital Converter described last month. We shall also be taking a look at Hisoft's COLT BASIC compiler. Before we get started, however, there is just time to deal with two useful points raised by readers.

Post Bag

G. Everest writes from Burgess Hill, Sussex, enclosing an extremely useful machine code routine that can be used to drive a Centronics printer from Tasword Two via a Z80 PIO (similar to that previously described in this column). Mr. Everest says:

"I have found that Tasword's printer output routine is at address E28D hex. and have modified the code at this point so that I can now print Tasword text files using the Z80 PIO with Port B set to output data to the printer whilst Port A is used for control.

"The port used the following addresses but I see no reason why other addresses should not be used:

Port A Control 64991 decimal, FDDF hex.
Port A Data 64735 decimal, FCDF hex.
Port B Control 65503 decimal, FFDF hex.
Port B Data 65247 decimal, FEDF hex.

"The simplest way to set up the port is to use BASIC and line 10 of Tasword should be modified to the following:

```
10 OUT 64991,255: OUT 64991,240: OUT
65503,15: CLS: LET a = USR 64330:
GOTO 20
```

Listing 1. Assembler source code for the parallel printer port

```
E28D            LD BC,FCDFH
        NTRDY   IN D, (C)
                BIT 7,D
                JR NZ,NTRDY
                LD B,FEH
                OUT (C),A
                LD A,FOH
                LD B,FCH
                OUT (C),A
                INC A
E2A1            OUT (C),A
```

"The first OUT sets port A to control mode and the second sets D0–D3 to output and D4–D7 to input, the last OUT sets port B to output mode."

The Z80 assembler source code is shown in Listing 1 but readers not having access to an assembler can enter this using the following POKEs from address 57997 to 58108:

1,223,252,237,80,203,122,32,
250,6,254,237,121,62,240,6,
252,237,121,60,237,121

Mr. Everest has used the modification with Cannon and Amstrad DMP 2000 printers. He points out that the code was written for the Sinclair version of Tasword Two. It has not been tested with the earlier Tasman version nor (presumably) with the later Tasword Three.

David McInnes has answered my plea for information concerning a method of making use of the extra 32K of RAM present in the 48K Spectrum. He writes:

"I have been using the unused top 32K for over a year, however, I cannot claim to have designed the hardware or software. The 'XK System' has to be soldered into the Spectrum and the software (cassette) is supplied by T.V. Services of Cambridge. The interface is completely compatible with Interface 1 and has the further advantage of pseudo multi-tasking with programs in both pages of memory while sharing a common area of memory between 29000 and 32000 through which data can be passed from one program to another.

"Whether you have a second complete page of memory without any dud bits seems to be the luck of the draw for early issues of the Spectrum as Sinclair Research were buying chips with (theoretically) only one side working. My own Issue Two machine had a second complete 32K.

"The second page of 32K is ideal for using a pseudo RAM disc. By reading an entire microdrive file into internal page 2, page 1 can be used to process incoming data and then, by making available a reference to page 2 through common memory, it is possible using machine code to search the file very rapidly to select the record for updating. An obvious example for using this type of approach is in Stock Control.

"MEGABASIC is not, incidentally, compatible with the 'XK' software in residence. Apart from that, the modification is completely transparent if the computer is used as normal without the 'XK' software."

Compilers and Interpreters

For the vast majority of BASIC programmers, the idea of converting programs to machine code without any fuss or bother is quite irresistible. The resulting code should, at least in theory, be more compact and run very much faster than the original program. This, however, is not always the case!

Having tested several mediocre (and some totally unusable) compilers for the Spectrum, I was prepared to be disappointed yet again when Hisoft's COLT compiler appeared. This, however, was not the case and I am happy to report that I have, at last, found a Spectrum BASIC compiler which I can thoroughly recommend.

Now, for the benefit of anyone out there who does not know what a compiler is, it is worth pointing out that Spectrum BASIC is "interpreted". This simply means that, when your BASIC programs are running, only one line of code (or only one statement if the line involves more than one BASIC statement) is fetched at a time.

The line is then checked and if faulty the RUN is terminated and an error message is printed on the screen. If the line is acceptable it is then executed using appropriate machine code routines within the Spectrum's ROM.

The obvious advantage of this approach is that program development and debugging can be carried out interactively. Furthermore, BASIC statements can be entered directly (without line numbers) and executed virtually immediately.

Spectrum BASIC does, however, have some notable disadvantages. The ROM based BASIC interpreter occupies valuable memory space (in any particular program you would very rarely need to use anything like the full complement of BASIC commands), the BASIC program itself requires not inconsiderable storage space, and execution is painfully slow since each line has to be fetched and checked prior to execution.

A compiler is a utility program which converts a program written in another language (in this case it is BASIC) into executable machine code. The resulting program can be run directly and does not require the services of the interpreter. The end result should be a comparatively short machine code program which will perform exactly the same function as its high-level counterpart but in a fraction of the time.

The COLT

The COLT is a relatively recent BASIC compiler and, whereas it is supplied on cassette tape, it is fully microdrive compatible. A short BASIC loader is used to load the compiler's machine code and executive system. When the loading process is complete the user is presented with an opportunity to make a backup (working) copy of the compiler (Hisoft licenses purchasers to make one backup copy to tape or microdrive).

Assuming that you have backed-up the compiler, the next option allows the user to alter the default starting address (40000 decimal) for the compiled code. Having dealt with this request, the user is then presented with a clear screen containing an interrupt driven clock display in the top right hand corner of the screen. BASIC programs can then be entered or loaded in the usual way.

The compiler is invoked by typing (in direct mode):

RANDOMIZE USR 60000

The COLT then sets about compiling whatever BASIC program is resident at the time and also displays information on the screen during the process. This includes the line number of the line being compiled, the start and end addresses of the compiled code, and the address of the start of RAM area reserved for variables.

Where the compiler encounters a line which does not compile correctly, the compilation process is halted and the dubious line is printed on the screen together with a '?' which indicates the offending part of the line.

The COLT permits full string handling, up to 26 one dimensional arrays and up to 26 one dimensional string arrays, computed GOTOs, and INPUT with full line editing. There are, inevitably, a few situations which the COLT will not cope with (e.g. multi-dimensional arrays and floating point numbers) but these can often be overcome by appropriate modifications to the BASIC program.

The COLT provides an "executive" program which users can make use of. This adds a number of useful facilities to BASIC including sprite graphics, windows, error handling, decimal/binary/hexadecimal conversions, two-byte PEEK and POKE, programmable keys, etc. The executive occupies approximately 7K of memory (from 52470 to 59200) and can be turned 'on' or 'off' or even erased from memory (to provide extra space for compiled code).

In order to put the COLT through its paces I decided to compile the TV/Monitor test program which forms part of our *Update*. As this program is fairly short, I decided to place the compiled code at 50000 (rather than the 40000 default start) so the SAVEd code would not be too long.

Compilation first stopped in line 4 and I discovered that all my "pretty listing" colons had to go! After this, admittedly idiosyncratic problem, was put right I then found that I had to make some changes to the BEEP commands (BEEP 1,20 is acceptable but BEEP 0.2,20 is not!). The program then compiled satisfactorily.

The program was then tested with the compiler still present in memory (using RANDOMIZE USR 40000) and the results proved to be extremely interesting. The vertical linearity display (a circle) showed no discernible increase in speed.

The dot display, on the other hand, appeared to be virtually instantaneous! The colour bar routine showed a speed increase of between five and ten times whereas the cross hatch display was only faster by a factor of about 1.5.

Whereas these widely different results are not all that surprising when one considers what the compiler actually does, they do serve to illustrate difficulty in making an accurate prediction of the scale of increase in speed of execution that can be obtained from a compiled code.

At the end of the session, the machine code program was saved as "tvtest". (One has to remember to disable the executive first otherwise the code will not verify or load correctly as I learned to my cost!) To make the machine code program load and run automatically, a short BASIC loader had to be written. This took the form:

```
10 LOAD "tvtest" CODE,50000
20 RANDOMIZE USR 50000
```

This program was SAVEd to the same tape (BEFORE the machine code program) using a command of the form:

```
SAVE "tvtest" LINE 10
```

The manual supplied with COLT is typical of the thoroughness and high standard of presentation associated with Hisoft's other products. Sensibly, the manual does not assume a great deal of knowledge on the part of the reader and is illustrated with a number of useful examples. It is a great shame that many other software houses seem to be quite unable to produce handbooks and manuals of this standard.

Hisoft's COLT can be very strongly recommended to anyone who requires the services of a BASIC compiler. It is simple and easy to use, is packed full of useful features, and should cope admirably with the majority of BASIC programs. **Hisoft is at 180 High Street North, Dunstable, LU6 1AT.**

Using the Eight-Channel Analogue to Digital Converter

The 7581-based *Eight-Channel Analogue to Digital Converter* described last month is delightfully easy to use. The converter continuously samples each of the eight input channels without the need for any start conversion commands from the host CPU.

Since the outboard clock runs at approximately 2MHz and the 7581 takes 80 clock cycles to convert each channel input, the total time taken to update the 7581's internal RAM is around 320µs. In order to read the state of a particular channel it is only necessary to include a command of the form:

```
100 LET x=IN port
```

where 'port' is the decimal port address (see last month for the port address table).

The value returned in x will be in the range of 0 to 255, i.e. when 0V is applied x takes the value 0 whereas, where a full-scale value (equal, but of opposite polarity, to the reference voltage present at the 'test point') is applied x will take the value 255.

To make this quite clear let's take a simple example. Suppose our reference voltage is 9V (it is unlikely that the reference voltage will be exactly 9.1V as there will invariably be some variation in Zener diode characteristics). If we need to continuously read and display the voltages present on Channels 1 and 2 only, we could use the following few lines of BASIC:

```
10 LET x=IN 31: REM Read channel 1
20 LET y=IN 63: REM Read channel 2
30 LET v1=x*255/9
40 LET v2=y*255/9
50 PRINT AT 0,0; "Channel 1 voltage = ";v1
60 PRINT AT 2,0; "Channel 2 voltage = ";v2
70 PAUSE 20: CLS
80 GOTO 10
```

8-Channel Voltmeter

Whilst this simple program has some obvious limitations it does serve to illustrate how easy it is to write software to operate the analogue to digital converter. Listing 2 is provided for readers requiring a "ready-made" Eight-Channel Voltmeter program. This program can be used to display any one of the eight channels (selected by pressing the appropriate number on the Spectrum keyboard) in both digital and analogue bar form.

The program should be reasonably self explanatory and assumes a 9V reference. Lines 1015 to 1025 are used to strip the digital display voltage string to a sensible length. Calibration may be performed by simply making changes to two lines; 1010 and 1065 for the digital and analogue displays respectively.

Readers should not forget to SAVE the program after entering it and BEFORE attempting to RUN it. When running, the program may be abandoned by pressing the 'q' key (note that this will perform a NEW command which ruthlessly clears the program from memory!).

Finally, the 9V maximum analogue input voltage will be something of a limitation in a number of applications. The value can, however, be very easily increased by including a resistor in series with the appropriate input. A 150k fixed resistor wired in series with a 100k pre-set resistor will, for example, increase the full-scale reading to approximately 90V. The pre-set resistor can then be used to calibrate the particular channel concerned.

If you have any comments or suggestions or would just like a copy of our *'Update'*, please drop me a line at the following address and enclose a large (A4 size) stamped addressed envelope:

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

Next month: We shall be describing a Speech Output Interface.

We shall also be taking a look at Softek's IS compiler.

Listing 2 8-Channel Voltmeter Program

```
   1 REM ******************************************
   2 REM *                                        *
   3 REM *       Eight Channel Voltmeter          *
   4 REM *                                        *
   5 REM *  Everyday Electronics January 1987     *
   6 REM *                                        *
   7 REM ******************************************
   9 REM
  10 REM *** Initialise ***
  11 REM
  20 DIM c(8)
  30 FOR i=1 TO 8
  40 READ c(i)
  50 NEXT i
  60 DATA 31,63,95,127,159,191,223,255
  70 LET ch=1
  80 LET z1=0: LET z2=0
  99 REM
 100 REM *** Print scale ***
 101 REM
 110 BORDER 1: PAPER 1: INK 6: CLS
 120 PRINT AT 11,8; INVERSE 1;"Channel   selected"
 130 PLOT 110,46
 140 DRAW 0,11: DRAW 43,0: DRAW 0,-11: DRAW -43,0
 150 PRINT AT 19,0;"0  1  2  3  4  5  6  7  8  9  10"
 160 PRINT AT 21,14; INVERSE 1;"VOLTS"
 170 FOR i=0 TO 255 STEP 10
 180 PLOT i,32
 190 NEXT i
 499 REM
 500 REM *** Main loop ***
 501 REM
 502 PRINT AT 11,16; INVERSE 1;ch
 505 LET z2=z1
 510 LET r$=INKEY$
 520 IF r$="q" THEN  NEW
 530 LET cs=CODE r$-48
 540 IF cs>=1 AND cs<=8 THEN  LET ch=cs
 550 LET z1=IN c(ch)
 555 PAUSE 2
 560 LET z1=IN c(ch)
 565  PAUSE 2
 570 IF z1<0.95*z2 OR z1>1.05*z2 THEN  GO SUB 1000
 580 GO TO 500
 999 REM
1000 REM *** Print the value ***
1001 REM
1010 LET x=z1/28: REM Calibrate digital display
1015 LET w$=STR$ x
1020 IF LEN w$<=4 THEN  GO TO 1030
1025 LET w$=w$( TO 4)
1030 PRINT AT 15,14; INVERSE 1;"      "
1040 PRINT AT 15,15; INVERSE 1;w$
1050 PRINT AT 18,0;"                                "
1055 FOR y=26 TO 30
1060 PLOT 0,y
1065 DRAW z1*0.88,0: REM Calibrate bar display
1070 NEXT y
1080 RETURN
```

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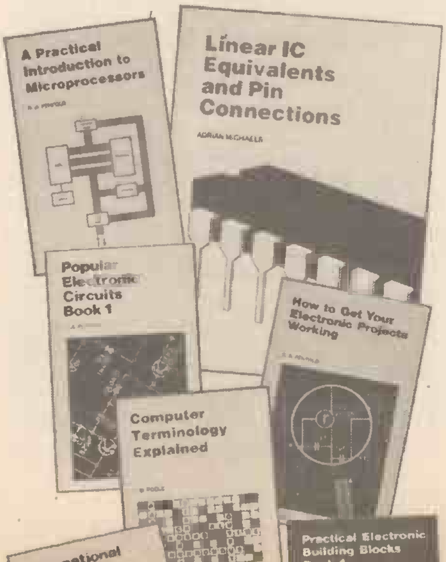

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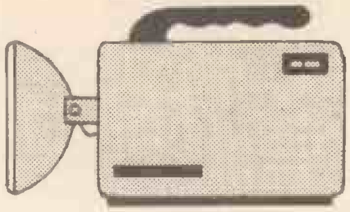
HAND LAMP CHARGER



T.R. de Vaux Balbirnie

Use at home or in the car—a boon for the caravanner!

HAND LAMPS are useful but suffer from the disadvantages of high cost and gradual deterioration of the batteries. This means that the lamp only gives maximum light output when they are fresh.

These drawbacks may be overcome by substituting nickel cadmium batteries for the conventional ones. Although the initial cost is fairly high, savings are soon made since these last almost indefinitely and recharge at practically no cost. Furthermore, the lamp will always operate at peak performance.

The project to be described here will convert an existing hand lamp to nickel-cadmium operation. Two circuits are offered—one for home use where charging is effected from the mains and the other to charge from a 12V car battery.

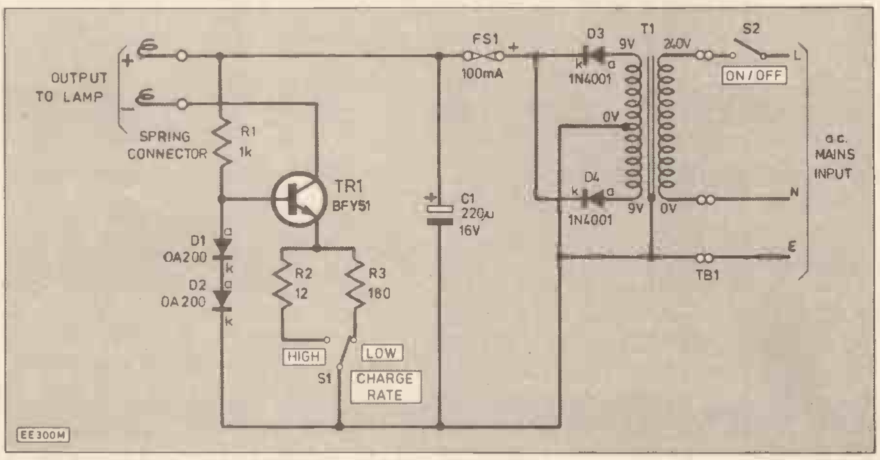


Fig. 1. Complete circuit diagram for the mains-powered version of the Hand Lamp Charger.

The mains-operated circuit is housed in a plastic box on which the lamp is placed when not in use. The weight of the lamp actuates a microswitch which operates the supply. The charging circuit is then connected through contacts on top of the unit and on the base of the lamp.

In the 12V circuit, connections are made by means of a plug and socket and a slide switch operates the supply. An on-off l.e.d. indicator is also provided.

Both mains and battery circuits provide two charging rates—High and Low. In the mains circuit, a separate switch performs this function. In the 12V version, the on-off switch also selects the charging rate.

Batteries may be left charging continuously even on the high setting without harm. Although completely "flat" batteries will take several days of charging to reach full capacity, this is not a disadvantage since they will be capable of use within an hour or so. The charging rates are preset so the use of a meter at the testing stage is not essential.

CIRCUIT—MAINS UNIT

Before commencing construction work, find the operating voltage of the lamp—anything up to 6V is suitable (for example, 4 off 1·5V cells). Check that nickel-cadmium equivalents are available to replace the conventional batteries. With a little planning, perhaps smaller batteries could be used giving some saving in weight and cost. The *minimum* is "AA" size.

Nickel-cadmium batteries must be charged from a *constant current* supply and Fig. 1 shows how this is achieved in the mains-powered circuit. S2 switches on the mains supply to the transformer T1. This provides a low-voltage a.c. output which is rectified by diodes D3 and D4 then smoothed by capacitor C1. Current flows through resistor R1 and the diodes D1 and D2 connected in series.

A silicon diode in forward bias develops 0·7V approximately between its ends so 1·4V will appear between transistor TR1 base and the negative of the supply. This is used as a reference voltage.

Since 0·7V exists between the base and emitter of a silicon transistor, it follows that there will be 0·7V across the emitter resistor—either R2 or R3 according to the position of the Charge Rate switch, S1. The current flowing in the emitter resistor is virtually the same as that in the collector circuit which charges the batteries. Thus, the charge rate may be predetermined by selecting suitable values for R2 and R3. With the resistors specified rates of approximately 4mA and 60mA may be expected.

There will be a maximum of 7·5V to charge the batteries (this takes account of the 0·7V "Drop" across a diode (D6) built into the lamp itself and whose purpose will be explained later). The excess output voltage over that of the batteries appears between TR1 collector and emitter and is self-adjusting.

If the output terminals were short-circuited (as would happen if a heavy metal object were placed on top of the unit) then the whole available 7·5V would appear between collector and emitter of TR1 which would then become hot—this is why a small heatsink is necessary. If diodes D1 or D2 became open-circuit or if a connection here

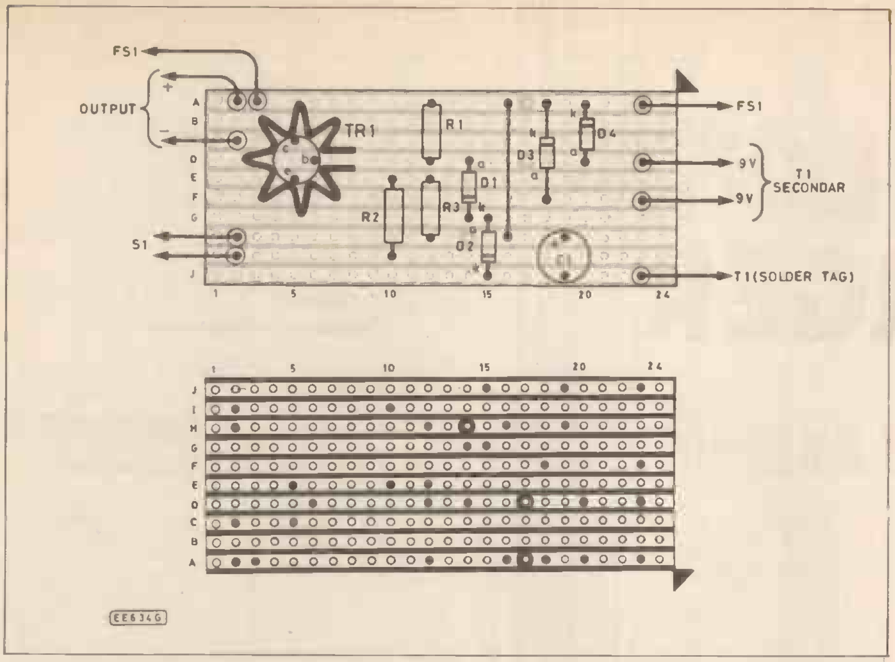


Fig. 2. Component layout and details of breaks to be made in the underside copper strips of the stripboard for the mains hand lamp charging system.

failed, the stabilising effect would be disrupted and the output current would rise —on the "high" charge this would blow FS1.

CONSTRUCTION—MAINS VERSION

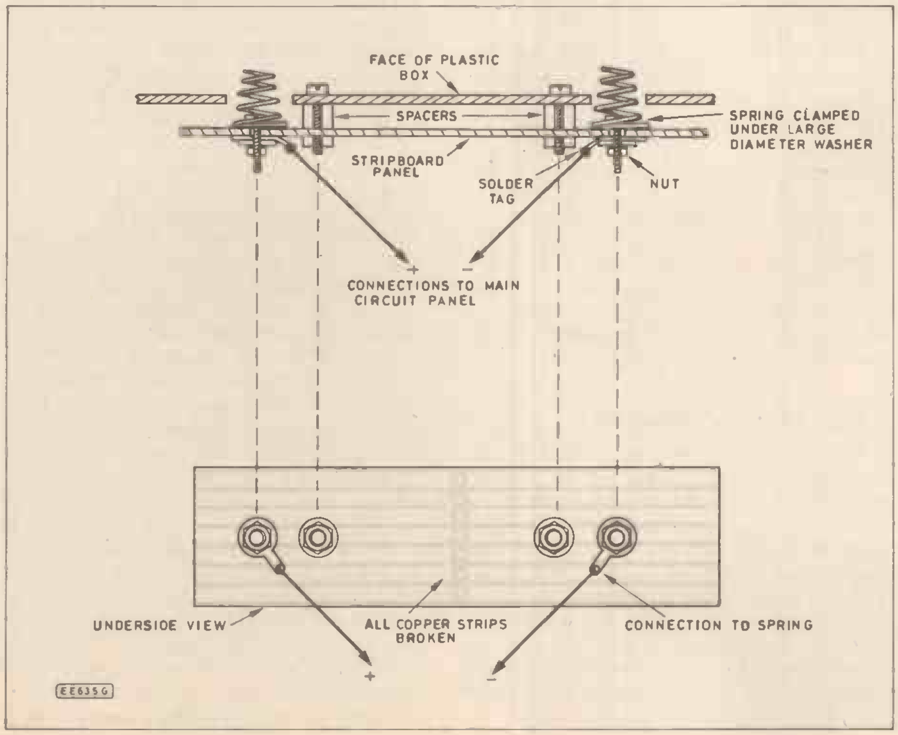
Refer to Fig. 2 and construct the main circuit panel. This uses a piece of 0·1in. matrix stripboard, size 10 strips × 24 holes. Make the breaks in the copper tracks and insert the single link wire.

Solder the on-board components into position noting the polarities of the diodes and C1. Check carefully for solder "bridges" which may have formed accidentally between adjacent copper strips. Drill holes in the box for mains lead entry, for S1 and for mounting T1, TB1 and FS1.

Construct the microswitch support bracket using thin sheet aluminium. Bend the arm of the microswitch very carefully to give an upturned end about 6mm long. Mount the switch on the bracket noting the solder tag at one fixing point. Drill a 5mm hole in the lid of the case for the end of the microswitch arm to pass through and attach the bracket using two small fixings. Check that the switch operates freely.

Make the connecting spring support bracket using a piece of 0·1in. matrix stripboard, size 7 strips × 32 holes (see Fig. 3). Break the strips along the centre line as

Fig. 3. Details of the spring connector support bracket for the mains version.



COMPONENTS

See Shop Talk page 43

Common to Mains & 12V Versions

Resistors
R1 1k
R2 12
R3 180
All 0·4W carbon ± 1%

Semiconductors
TR1 BFY51 *npn* silicon
D1,D2 OA200 (2 off)
D6 1N4001

Miscellaneous
FS1 20mm fuseholder and 100mA fuse to fit; lobed heatsink to fit TR1; nickel cadmium batteries for lamp.

Mains Unit (additional comp)

Capacitor
C1 220μ elec. (p.c.b.) 16V

Diodes
D3,D4 1N4001 (2 off)

Switches
S1 d.p.d.t. slide switch
S2 mains rated microswitch, with lever

Miscellaneous
T1 1·2W miniature mains transformer; 240V primary, 0–9V/0–9V secondaries. Plastic case, size 120mm × 65mm × 50mm, 0·1in. matrix stripboard: circuit board, 10 strips × 24 holes; spring connector, 7 strips × 32 holes; lamp base connector, 9 strips × 33 holes; 3-way 3A terminal block (TB1); aluminium for microswitch support bracket; springs—2 off (see text).

12V Unit (additional comp)

Resistors
R4 1k 0·4W carbon 1%

Diode
D5 5mm red l.e.d.

Miscellaneous
PL1/SK1 cassette recorder type power plug and socket—standard 2·1mm; S3 miniature 4-pole 3-position slide switch; 0·1in. matrix stripboard, 9 strips × 21 holes; plastic case, size 70mm × 50mm × 25mm.

Approx. cost Guidance only
Mains—£10
Bat.—£4.50
Bats. not included

indicated. Mount the springs using large diameter washers and small fixings—include a solder tag at each. Suitable springs may be obtained from a discarded battery connector.

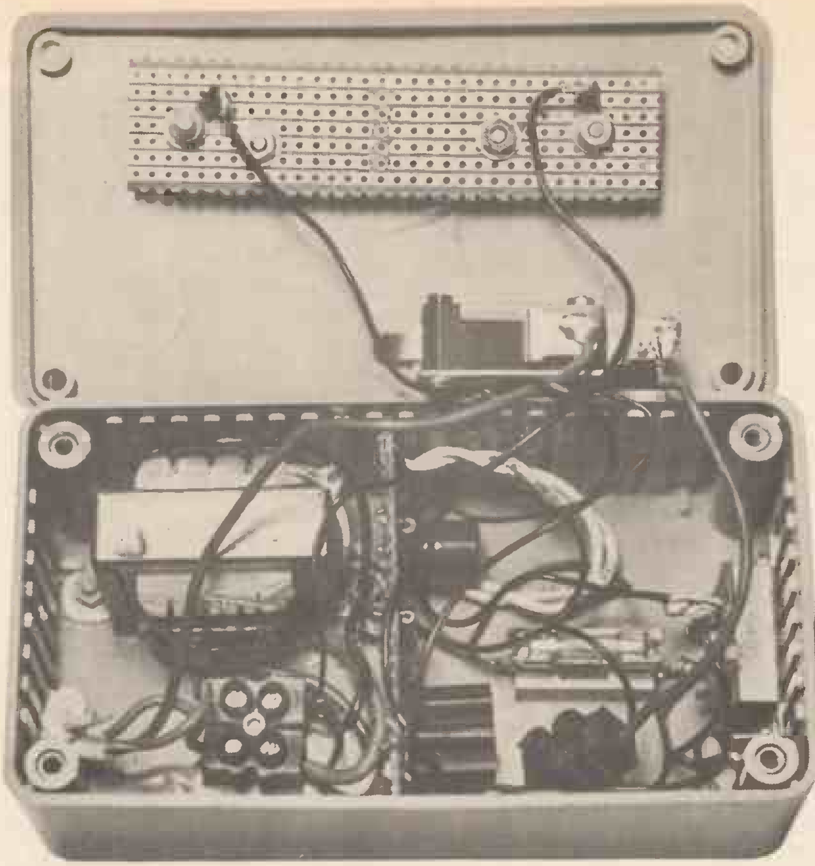
Drill two holes in the lid of the case large enough for the springs to pass through freely when the bracket is in position. Attach the bracket and check that the weight of the lamp—together with the nickel-cadmium batteries—will compress the springs to the level of the face of the lid. Make adjustments as required.

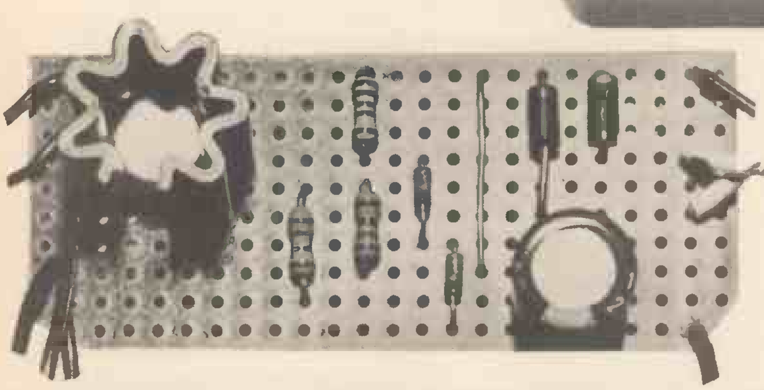
INTERWIRING

Referring to Fig. 4, mount the remaining components and complete all wiring. Note that solder tags are needed at T1 and S2. The input wire should be 3-core mains type of 3A rating minimum. It should have a suitable strain relief provided inside the case to prevent it from being pulled free.

Ensure that the connections to S2 are sound and that no short-circuits are formed between any wire and the metalwork of the support bracket. Make sure the polarity of the output springs are clearly marked.

The mains plug should be fitted with a 3A fuse. Note that this project is designed for plugging into a wall socket—***it should not be permanently connected to the mains supply.***

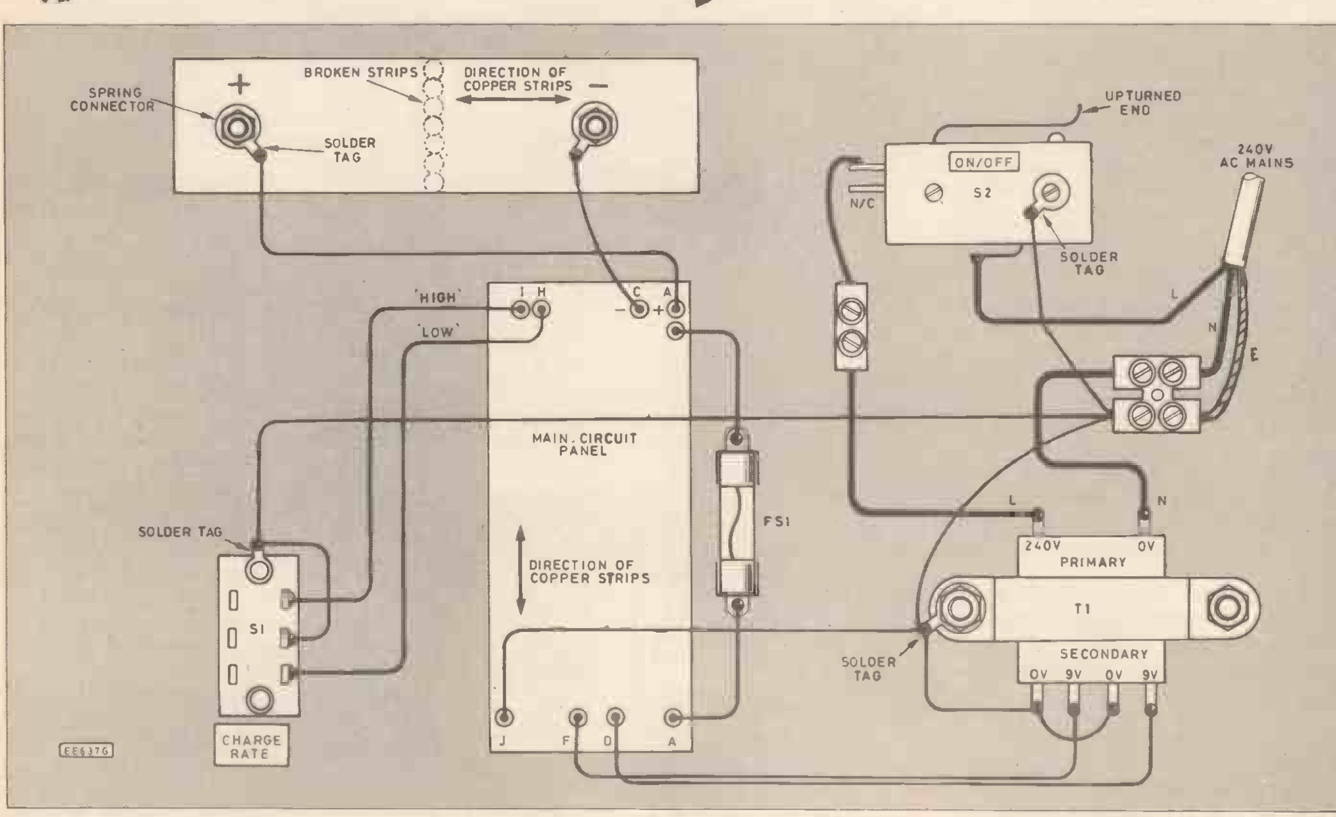




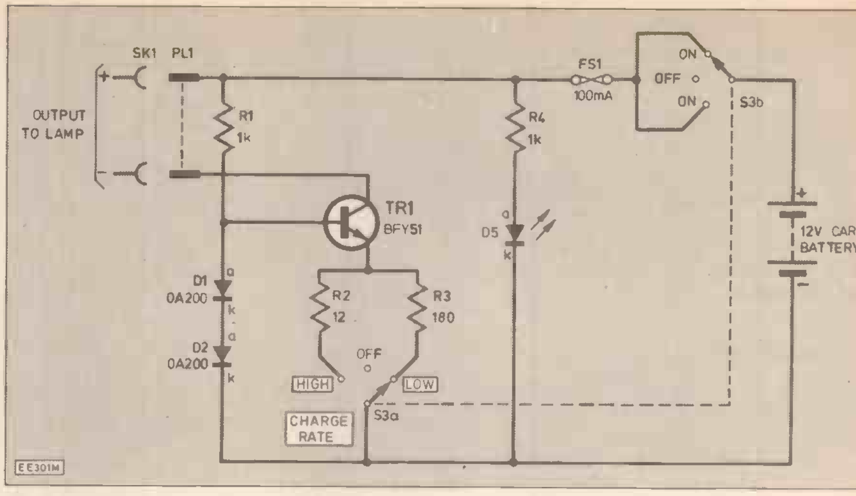
(above) Layout of components inside the plastic case of the prototype mains version. The microswitch is mounted on the lid together with the spring connector bracket.

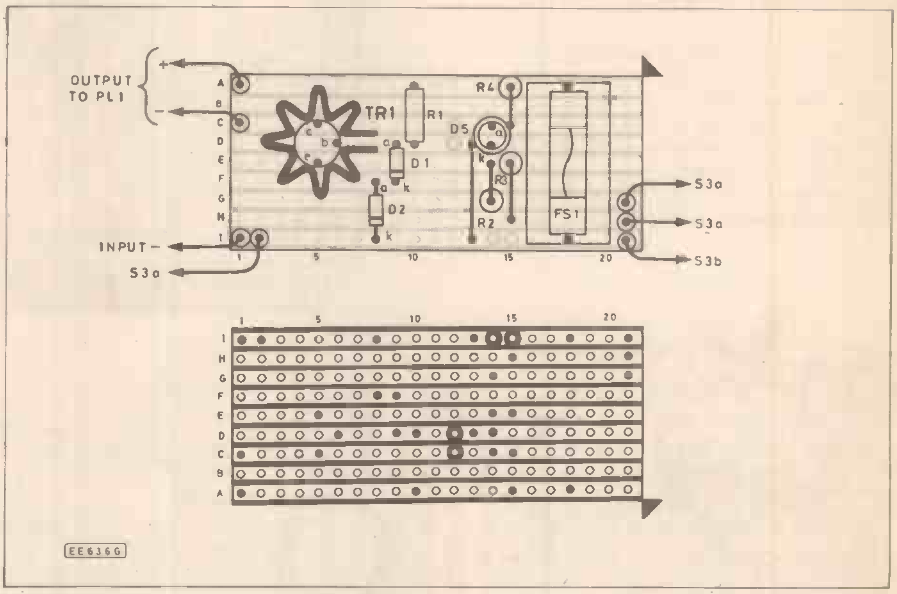
(left) The completed circuit board for the mains version. Note the lobed heatsink on TR1.

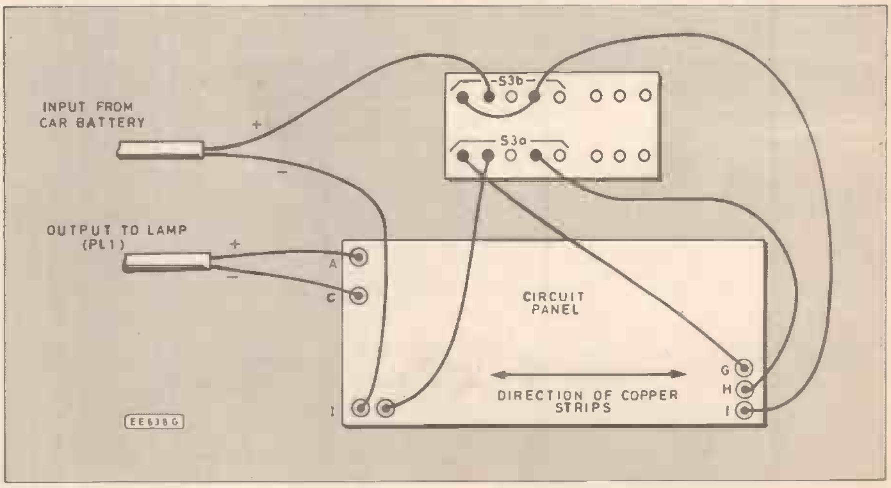
Fig. 4 (below). Interwiring details for the mains-powered Hand Lamp Charger. It is important that a PLASTIC case is used to house these components.



The completed battery version.







CIRCUIT—12V UNIT

The circuit diagram for the battery-operated version is shown in Fig. 5. It is basically the same as the mains one but with certain components omitted. Power is already derived from a low-voltage d.c. supply so T1, D3, D4 and C1 are unnecessary. An l.e.d. indicator D5 shows when the supply is switched on.

Switch S3 is a 3-position slider type, the extreme positions provide the alternative charging rates while the centre position is off. This switch replaces S1 and S2 in the mains version.

CONSTRUCTION—12V UNIT

Details for constructing the battery version are given in Figs. 6 and 7. Construction is based on a piece of 0·1in. matrix stripboard size 9 strips × 21 holes. Make the breaks in the copper strips (underside) and insert the wire link as indicated in Fig. 6.

Referring to Fig. 6, commence mounting components on the circuit board. Note that all components except S3 are mounted on this board.

Next make holes in the case for the input and output leads, for the on/off and charge rate switch S3, and for the l.e.d. indicator D5. Mount S3 in the lid of the case and complete the wiring as shown in Fig. 7.

Suitable strain relief clamps—tightly tied string will do—should be used to secure the input and output leads inside the case. Fit the specified "cassette recorder" type of plug to the output wire. For a negative-earth car, the *sleeve* connection should lead to the *negative* of the unit but for a positive-earth vehicle this should be the *positive*.

Secure the panel to the base of the box with an adhesive fixing pad. Bend the leads of the l.e.d. as necessary so that it protrudes slightly through the hole in the lid.

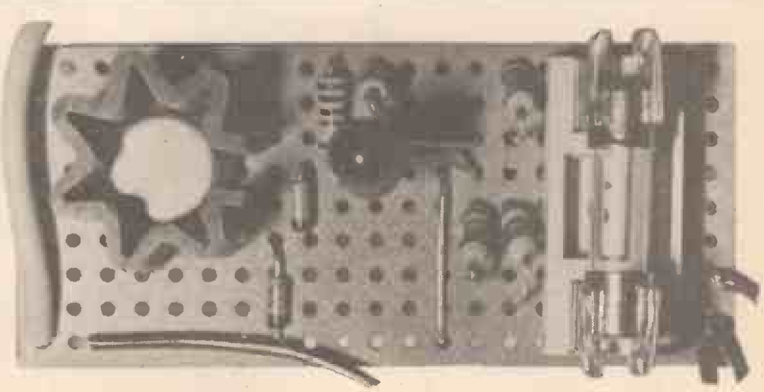
TESTING

The mains unit requires an *earthed* supply. All operations must be carried out with the lid of the case in position.

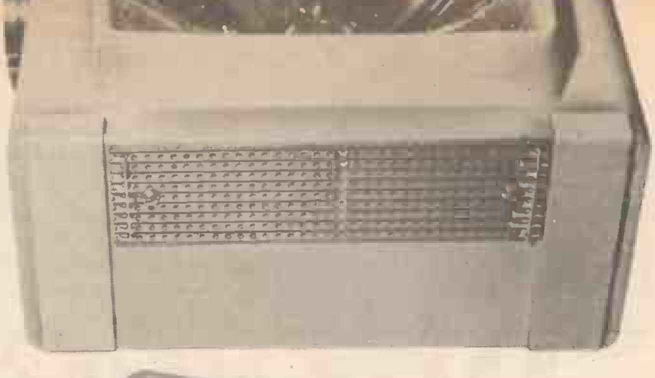
A basic test may be made using a 6V 0·06A (0·36W) bulb and an l.e.d. Connect the 6V bulb direct to the output of the unit whether mains or battery-operated.

With the battery circuit, set S3 to its centre (off) position and connect the input wires to the battery terminals observing the polarity. With the mains-operated circuit,

Fig. 5 (top right). Complete circuit diagram for the battery-powered Hand Lamp Charger.
Fig. 6 (middle right). Component layout and details of breaks to be made in the underside copper strips of the stripboard for the battery version.
Fig. 7 (above right). Interwiring details for the battery-powered Hand Lamp Charger.
The finished circuit board for the battery model. The l.e.d. is mounted proud of the board to allow it to pass through the hole in the lid of the case.



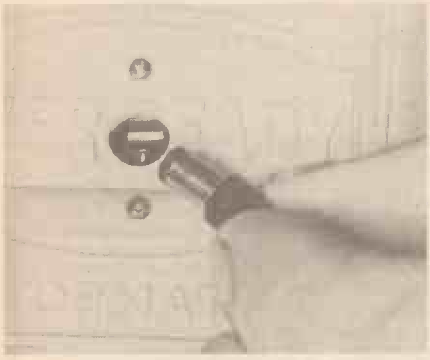
Layout of components inside the plastic case of the battery version.



(top right) Stripboard connector fixed to the underside of the hand lamp.
(above) mains unit showing springs and microswitch lever protruding through case top.

set S1 to High and plug the unit into the mains. Press the microswitch and check for normal operation. With the battery-operated circuit, switch on by moving S3 to its High position. In both cases the bulb should glow at normal brightness. This may be compared with the brightness of the lamp when connected directly to a 6V battery.

With the charge rate now set at Low, the lamp should go off since there is now insufficient current to make the filament glow. Replace the bulb with an l.e.d. observing the polarity (no series resistor is needed). The l.e.d. should glow.



Power socket SK1 mounted in the hand lamp and the charger power plug from the battery version.

If you have access to a multimeter, the output currents may be checked with this instead. Switch it to a current range and apply the probes direct to the output observing the polarity.

PREPARING THE LAMP

Certain modifications need to be made to the hand-lamp to make it compatible with the two chargers. These are set out below and illustrated in Fig. 8.

For the mains unit: Refer to Fig. 8 and construct the stripboard connector to be attached to the base of the lamp. Interconnect all the strips on the left and right-hand sides of the panel and break them all along the centre line as indicated.

Attach the connector to the base of the lamp using two small round-head fixing screws and nuts, with a solder tag under each nut. Check that the head of each fixing makes contact with at least one copper strip and increase the area of contact with a washer if necessary.

Connect the diode D6 in series with the wire leading from the positive connector to the positive battery terminal. Make sure that the polarity of the diode is observed and sleeve it in plastic to ensure that it cannot touch any adjacent metalwork. On some lamps, a small pad needs to be glued to the base of the lamp to operate the microswitch.

For the 12V version: Fit the "cassette power socket" SK1 to the lamp choosing a site with plenty of free space behind. Connect the diode in series with the wire from the positive terminal to the batteries. Connect the negative terminal direct to the negative terminal of the batteries.

If the lamp is to be charged from *either* a mains or a battery unit, then it will be necessary to fit it with both a stripboard connector on the base and a socket. Note, however, that only one diode is needed, see Fig. 8.

The purpose of the diode D6 in the lamp housing is to prevent possible discharge of the batteries in the event of the supply being switched off with the unit connected. In the mains circuit it also prevents a short-circuit if the lamp is placed on a metal surface which would join together both sections of the stripboard connector.

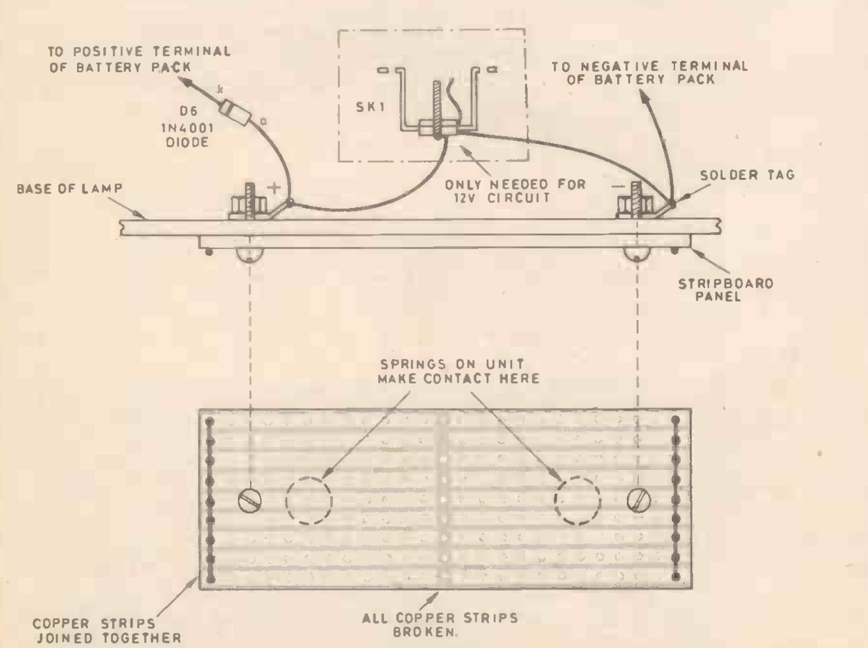


Fig. 8. Hand lamp modification details to make it compatible with both versions of the hand lamp charging systems.

USING THE CHARGER

Note that the mains unit must receive adequate support to the underside so place it on a shelf. It must *not* be free-mounted on a wall—the box is not strong enough for this.

If the batteries are discharged, leave them charging on High for a few days. Experience will soon determine which charge rate is best under particular conditions. Note that it is normal for the case to become warm in prolonged operation.

In the battery circuit, do *not* remove the plug with the unit switched on. This will make certain that no short-circuits can be caused between the plug and nearby metal parts.

You will never be left in the dark with the Hand Lamp Charging System. □

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...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

ROUND THE WORLD/MM

TWO HUNGARIAN radio amateurs are sailing round the world in a 9m long, 2·5m wide boat, the *St. Jupat*. Using the callsign HG4SEA/MM (i.e. Maritime Mobile), Nandor Fa and Jozsef Gal sailed from the Adriatic coast on September 26, 1985, via Gibraltar, the Canary Isles, and Tristan da Cunha, reaching Cape Town in Feb '86.

After leaving South Africa in March, the boat capsized to about 60 degrees during a storm, and it took several days to bail it out, right it, and get the radio equipment working again. Heading for Australia, they lost radio contact with their base station in Hungary, HA4KYN, and Australian amateurs were asked to keep a listening watch for them. On May 10, regular contact was established with Australian stations who relayed advice on the best sea-route to landfall, while New Zealand amateurs supplied the Hungarians with weather reports.

During this part of the journey, amateurs passed on a message to Jozsef that his wife, back home, had given birth to a son. On May 20, the *St. Jupat* arrived at Sydney Harbour, welcomed by yachtsmen, hundreds of members of the Hungarian community, the Australian navy, radio amateurs, and the media.

Round about Christmas, the duo planned to sail again, heading towards South America, round Cape Horn, to Argentina, on to the Caribbean, and across the Atlantic back to Europe. One thing is certain. All along their way, radio amateurs will be monitoring their progress, ready to relay messages and provide assistance whenever it is needed.

OLYMPIC PLANS

The Korean Amateur Radio League will be installing radio facilities at the 1988 Seoul Olympic Games, with KARL volunteers providing a service to competitors, enabling them to send messages home to the 40 plus countries where third party amateur radio traffic is permitted, (alas, not including the UK!).

All visiting competitors and officials who are also amateurs will be granted temporary operating licences to use the facilities provided, including those from countries which do not normally have reciprocal licensing arrangements with Korea. To commemorate the occasion, individual Korean stations, call prefix HL or HM, will use the suffix 88 during the games, and the special station operating from the Olympic site will use the call 6K88SOG.

AMATEUR TV

The holder of an amateur radio licence has a wide range of communications activities open to him or her, including two-way transmission and reception of television signals. In fact, amateur television attracts many non-licensed enthusiasts as well, who derive great enjoyment from receiving long distance amateur and broadcast TV stations either direct, through relay stations, or relay satellites.

Practitioners, licensed and unlicensed, frequently construct the equipment necessary to create TV studios in their own homes, where they design and produce special effects, work with computer graphics, experiment with colour, and produce TV programmes, recording, editing, and animating their own material.

Licensed on-air activities take place on the 70cm amateur band (around 436MHz) and on microwaves on the 1·3GHz band. Because of the limited bandwidth available on 70cm, accompanying sound transmissions are on the 2m band, around 144·75MHz.

This is conventional television with normal "moving pictures", but an interesting alternative to this is slow-scan TV which transmits "still", lower definition, pictures. This hardly sounds like competition with normal TV, but it has the great advantage that it can be transmitted on the international h.f. amateur bands, providing world-wide TV communications. The signal comprises audio tones between 1200 and 2300Hz, permitting operation side-by-side with other radio transmissions. The signal can be recorded on a normal audio tape recorder, or even sent down a telephone wire.

A low-noise 70cm pre-amplifier in the feed line improves performance greatly, but probably the most effective way of receiving ATV is to use an up-converter, which converts the incoming 70cm signal to a frequency within the u.h.f. TV broadcast band. Pre-amps and converters can be home-constructed or bought commercially. Finally, to receive sound, a 2m receiver is required, capable of receiving 144·750MHz, f.m.

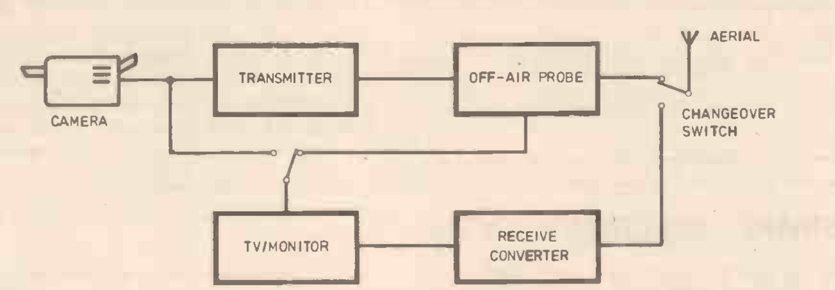
Having done all that, you will now be able to receive amateur TV signals, see what the operator looks like, see his station and equipment, and generally enjoy transmissions over a wide range of subjects. If band conditions improve, to provide a "lift" you may even receive signals from many European countries.

HELP AND ADVICE

The British Amateur Television Club was founded in 1949 to inform, instruct, and co-ordinate, the activities of radio amateurs experimenting with television transmission. It has a quarterly magazine, CQ-TV, which includes circuits, constructional articles, news of activities, and so on.

The club can supply members with special items, such as vidicon camera tubes, scanning and focus coil assemblies, test cards, pcb's, even headed notepaper. There is an annual convention where members display their equipment, exchange ideas, and discuss their problems with each other, and the club exhibits at many of the major amateur radio shows and rallies throughout the year. Contests are held to promote activity on the air.

BATC, which has kindly provided some of the information presented here, has a number of publications specially written for those beginning to take an interest in this absorbing aspect of amateur radio. These include, *Introducing Amateur Television*, a 12 page booklet giving basic information about ATV and the club itself; and *TV for Amateurs*, a practical introduction giving all the information and designs necessary to assemble, and operate successfully, your own licensed amateur TV station. Details of these and other books, are available by sending an s.a.e. to BATC Publications, 14 Lilac Av., Leics, LE5 1FN.



EE330M Fig. 1. Block diagram of basic amateur TV station (courtesy BATC).

GETTING STARTED

It is quite easy to make a start in ATV by setting up a receive-only station to begin with. Experience of receiving has persuaded many to take up amateur TV properly, providing a strong incentive to study for, and pass, the Radio Amateurs' Examination.

Many domestic TV sets, especially portables, will tune 70cm—around channel 17. If there are strong amateur TV signals available it may well be possible to pick these up by simply re-tuning the domestic receiver. However, as amateur signals are much weaker than broadcast signals, and the sensitivity of a receiver is low at the extremes of its tuning range, the results may not be too satisfactory.

If receiving is to be taken seriously, a rotatable antenna designed for the 70cm band is required to optimise reception, connected to the receiver by high quality, low loss, coaxial feeder via "N" type connectors.

CIRCUIT EXCHANGE

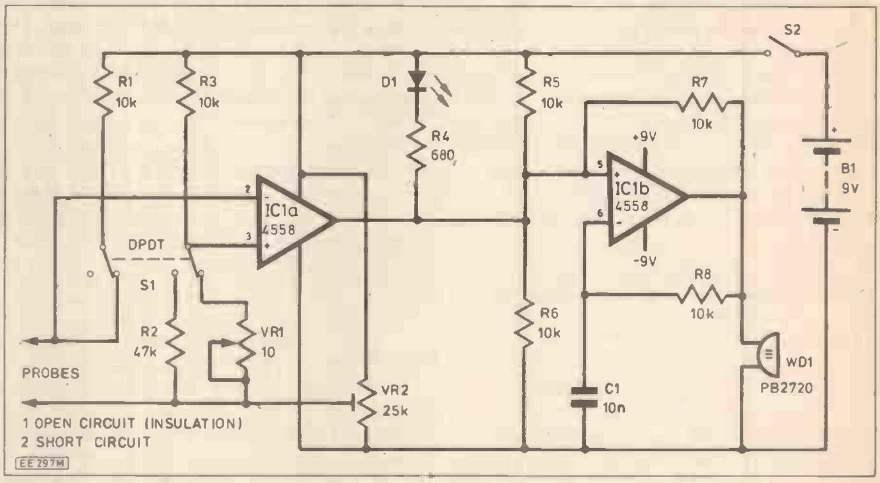
This is the spot where readers pass on to fellow enthusiasts useful and interesting circuits they have themselves devised. Payment is made for all circuits published in this feature. Contributions should be accompanied by a letter stating that the circuit idea offered is wholly or in significant part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

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

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

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

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



DUAL MODE CONTINUITY TESTER

THIS audible tester unlike most continuity testers, has specific extreme parameters to which it will work. Thus giving a more accurate illustration of the true nature of the material between the probes.

To start with potentiometer VR2 has to be set up to give an earth point (which is not necessarily the mid point), this earth point being the crux of the operation. In the short circuit (S/C) mode, it can be used to test dry joints, etc, i.e. will not buzz above one ohm. This value can be calibrated by the variable control VR1 from outside, useful when checking very long wires. Only when the resistance across the probes is less than VR1 does the output of IC1a swing high as the inverting input becomes more negative than the non-inverting input. Probe voltage = 1·6V, current = 0·4mA.

In the open circuit (O/C) mode buzzing will occur at the slightest continuity. Can be used to check insulation, O/C, etc. When tested, it was still buzzing at 30 megohms. This is because the non-inverting input is held high and the inverting input is floating. The slightest continuity to earth will quickly send pin 2 lower than pin 3 and cause the output to swing positive.

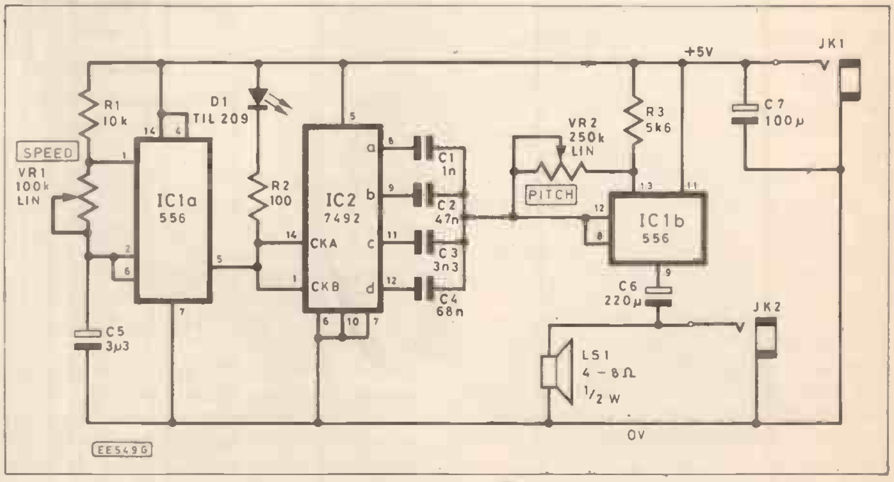
R. R. Goodbourn,
Steyning,
West Sussex.

SIMPLE MELODY SYNTH

THIS circuit is an interesting project for those hobbyists who have an interest in music and melody. It produces sounds containing different notes, in which the speed and frequency (pitch) can be varied.

The circuit is very straight-forward and uses only two i.c.s. One is a dual 556 timer, while the other is a TTL divide-by-twelve binary counter type 7492.

One half of the timer IC1a is used as a clock pulse generator. The duration of clock pulses being established by the values of R1. C5 and VR1, hence we can control the pulse duration of the notes. The output of this clock generator is fed to IC2. The light emitting diode D1 monitors the intervals of clock pulses.



The clock pulses are received at pin 14 (CKA) and pin 1 (CKB) of IC2. This i.c. is used here in pulse divider mode, it converts the pulses into a four-bit output. Capacitors C1 to C4 connect the outputs to the 'threshold', pin 12, of IC1b. This is used as a frequency oscillator, its frequency being determined by R3, VR2 and C1 to C4.

The pulses from IC2 charge and discharge capacitors C1 to C4, with respect of the binary counting. This develops the generation of different notes, the "Pitch" potentiometer VR2 is used to change the frequency of these notes.

Output from the frequency oscillator is filtered by capacitor C6, which then drives speaker LS1. Alternatively, it can be fed to any amplifier by means of jack socket JK2. This unit can be driven from a 5V regulated power supply via JK1. Changing the values of C1 to C4 alters the tone of the unit.

Masroor. H. S. Bukhari,
Hyderabad,
Pakistan.

PCB SERVICE

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

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

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

NOTE: Please allow 28 days for delivery. We can only supply boards listed in the latest issue. Boards can only be supplied by mail order on a payment with order basis.

PROJECT TITLE	Order Code	Cost
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User Port Input/Output *M.I.T. Part 1*	8307-01	£4.82
User Port Control *M.I.T. Part 1*	8307-02	£5.17
— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
Car Intruder Alarm	8308-02	£5.15
High Power Interface *M.I.T. Part 2*	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Pt 2*	8308-04	£3.56
— SEPTEMBER '83 —		
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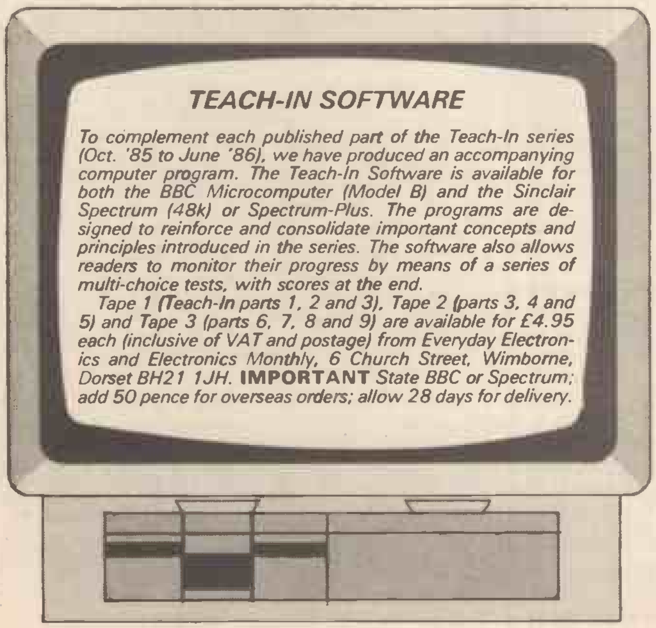

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DOWN TO EARTH

BY GEORGE HYLTON

PITCH AND LOUDNESS

IT IS sometimes said that pitch—in the musical sense—is the frequency of a sound. Pitch and frequency are certainly closely connected. But there's a subtle difference. Pitch is what you, a human being, hear. Frequency is what you measure, with an instrument. Pitch, in other words, is a *subjective* quantity. Frequency is *objective*.

HUMAN FACTOR

There are circumstances in which the distinction is far from academic. If an electronic system of some kind produces an output in the form of a sound whose frequency has to be discriminated by the human ear, then the designer of the system needs to know how the human ear performs as a frequency discriminator. That is, he needs to know how well changes of frequency show up to the listener as changes of pitch.

Music seems to give some pointers. As you go up the musical scale successive tones do not correspond to equal increases of frequency. Instead, the frequency difference increases as you move up from tone to tone. Thus, *G* = 392Hz is followed by *A* = 440Hz, then *B* = 494Hz. The successive intervals are 48Hz and 54Hz, not a constant quantity.

This suggests that the ear, unlike a digital frequency meter, responds not to absolute frequency increases but to proportional increases. The proportion is what is constant.

In fact, to obtain any next-higher semitone from the preceding one this has to be multiplied by the twelfth root of two. This gives twelve notes per octave, spaced out in equal proportion.

On this basis it would seem that if, in some system, the ear must respond to a small change in frequency, then the frequency which changes should be as low as possible, because this makes the proportional change high. For instance, if the starting or reference frequency is 100Hz, and the change is by 10Hz, this is a change of 10 per cent. But a reference frequency of 1000Hz, changing by the same 10Hz, gives a proportional change of only 1 per cent.

On this basis, if the ear responds to percentage changes, as music suggests, using a reference of 100Hz should make discrimination by ear ten times easier than using 1000Hz.

PERCEPTION

In practice, it doesn't work out like that. If you set up an experiment to find out what change of frequency produces a Just-Noticeable Difference (J.N.D.) in pitch, the result looks like Fig. 1. The important thing here is that the ear's sensitivity to pitch itself varies with frequency. At 100Hz, it takes a 3 per cent change to be noticeable to the average ear.

As the frequency rises the sensitivity rises too, until at 1000Hz a change of only 0·3 per cent is just noticeable. After that the ear's performance, pitch-wise, falls off. The result of this variation in sensitivity is that over the 100Hz to 1000Hz range the ear behaves as an absolute frequency discriminator and can detect a change of 3Hz anywhere in the range.

Remember, however, that published figures are for the average person operating in laboratory conditions with minimal background noise. Anyway, the ear doesn't respond to frequency in quite the way music suggests. For once, nature seems to be on the side of the engineer, making his choice of reference frequency comfortably wide—100–1000Hz.

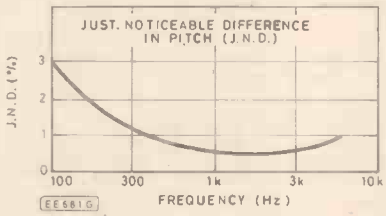


Fig. 1. The ear's ability to perceive small changes of pitch varies with the frequency of sound.

Fig. 2. Equal-loudness curves. To maintain the same subjective volume the real acoustic intensity has to be adjusted as the frequency changes.

THE REAL WORLD

When you come out of the laboratory and into the real world things turn out to be different. If, like me, you play around with metal detectors, you may have discovered that for yourself. One easily-made type of detector, the BFO (beat frequency oscillator) detector does require the user's ear to respond to small changes in pitch.

You soon discover that the best results are obtained by setting the reference frequency somewhere near the low end of the voice band, say 100 to 300Hz. You also find that it helps to adjust the tuning so that, when metal comes into range, the pitch rises rather than falls. And further, it seems easier to notice small changes if you listen with padded earphones (to reduce ambient noise) and set the volume to be just comfortably audible, not loud.

That's the real-world situation, arrived at by trial and error. The question is: why?

PHYSICS and PSYCHOLOGY

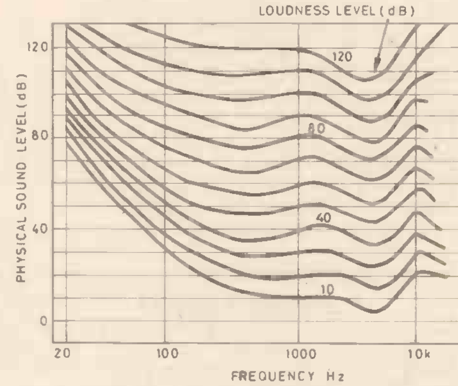
The answers have in fact been sitting in textbooks of physics and psychology (the "experimental" sort of psychology, not the clinical sort) for decades. These give the results of other experiments which add to the information in Fig. 1.

These "experiments" show (Fig. 2) that the response of the ear varies with both frequency and sound level. Fig. 2 shows the loudness of sounds; loudness, like pitch, being a subjective quantity.

To produce these curves, listeners are given half-second bursts of a standard 1000Hz tone at a known level and asked to adjust a volume control which governs a comparison tone on some other frequency. When both tones sound equally loud, the setting of the volume control shows whether the ear is more sensitive or less sensitive to the comparison tone than to 1000Hz.

At 100Hz, for example, the ear is about 15dB less sensitive to weak sounds than at 1000Hz. Maximum sensitivity comes at around 4kHz, but remember this is sensitivity to *sound level*, not to pitch. So 4kHz would be a good bet if you are designing a simple measuring bridge with no output amplification but, as we've seen from Fig. 1, it's not a good bet for a BFO metal detector where pitch-changes, not level-changes, are what matter.

Fig. 2 shows that if the reference frequency is low any rise of frequency produces an accompanying rise of loudness. This is consistent with the trial-and-error finding that it's better to set up for a rise of pitch than a fall. A fall reduces volume and makes the observation more vulnerable to masking by ambient noise.



The "change-in-loudness-with-change-in-pitch" effect is strongest when the volume is low. Again, this is consistent with field experience. But if volume is set too low interference from external sounds becomes troublesome.

The decibel figures on the loudness curves in fact refer to a "0dB" level, not shown, which represents a just-audible sound. This puts a practical working point somewhere about the 40dB curve.

MASKING

Other laboratory experiments have shown that interfering sounds blur or mask sounds which are higher in pitch than the interference but have much less effect on lower frequencies. This favours setting the reference frequency low, because then at least some interfering noises will be far enough above it in pitch not to cause trouble.

From Fig. 2, the rise in loudness with frequency suggests that the reference frequency should be really low, say 30Hz. This would also have the advantage of reducing the risk of masking by keeping interfering noise to the minimum.

In practice, one usually finds that the best reference frequency is much higher, 150–300Hz. The reason is that the cheaper sort of stereo earphones, as used with metal detectors, often have a resonance at 200–400Hz. Setting the frequency a bit lower than the resonant peak puts this to use. In effect the resonance steepens the slope of the Fig. 2 curves as the resonant peak is approached.

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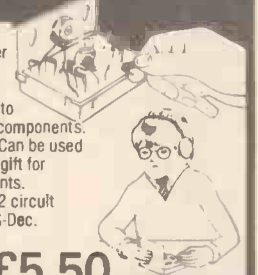

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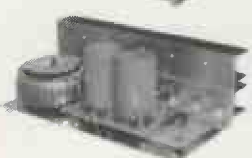
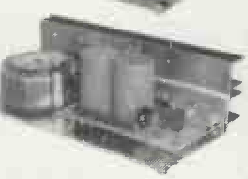
OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE
PRICE £39.99 + £3.00 P&P.



OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. —130dB. Size 300 × 150 × 100mm. PRICE
PRICE £62.99 + £3.50 P&P.



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE
PRICE £79.99 + £4.50 P&P.

NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV). If required, P.A. version (50KHz bandwidth & Input Sensitivity 775mV). Order — Standard or P.A.

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
PRICE £8.50 + 50p P&P.

LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.

Cabinet Fixing in stock. Huge selection of **McKenzie Loudspeakers** available including Cabinet Plans. Large S.A.E. (28p) for free details.

POWER RANGE

8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.
12" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die-cast chassis. White cone. Res. Freq.
25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 + £3.00 P&P ea.

McKENZIE
12" 85 WATT R.M.S. C1285GP Lead Guitar/Keyboard/Disco.
2" ally voice coil. Ally centre dome. Res. Freq. 45Hz. Freq. Resp. to 6·5KHz. Sens. 98dB. PRICE £29.99 + £3.00 P&P ea.
12" 85 WATT R.M.S. C1285TC P.A./Disco 2" ally voice coil. Twin cone.
Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £31.49 + £3.00 P&P ea.
15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £57.87 + £4.00 P&P ea.
10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.
2" voice coil. Res. Freq. 75Hz. Freq. Resp. to 7·5KHz. Sens. 99dB. PRICE £19.99 + £2.00 P&P.
10" 200 WATT R.M.S. C10200GP Guitar/Keyboard/Disco.
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB. PRICE £44.76 + £3.00 P&P.
15" 200 WATT R.M.S. C15200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £62.41 + £4.00 P&P.
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £89.52 + £4.00 P&P.

WEM
5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £22.00 + £1.50 P&P. ea.
8" 150 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £32.00 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £36.00 + £2.00 P&P ea.
12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £47.00 + £3.00 P&P ea.

SOUNDLAB (Full Range Twin Cone)
5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £9.99 + £1.00 P&P ea.
6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.
8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1¼" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

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SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £17.82** Transmitter 80 × 50 × 15mm (9/12 volt). **Price: £11.29** P&P + 75p each. S.A.E. for complete list.

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OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair.
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OMP 19" STEREO RACK AMPS

Professional 19" cased Mos-Fet stereo amps. Used the World over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. Three models (Ratings R.M.S. into 4ohms). Input Sensitivity 775mV

MF200 (100 + 100)W. £169.00
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1 K-WATT SLIDE DIMMER

* Control loads up to 1Kw
* Compact Size 4⅓" × 1" × 2½"
* Easy snap in fixing through panel/cabinet cut out
* Insulated plastic case
* Full wave control using 8 amp triac
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BSR P295 ELECTRONIC TURNTABLE

* Electronic speed control 45 & 33⅓ r.p.m. * Plus/Minus variable pitch control * Belt driven * Aluminium platter with strobed rim * Cue lever * Anti-skate (bias device) * Adjustable counter balance * Manual arm * Standard ½" cartrige fixings * Supplied complete with cut out template * D.C. Operation 9-14v D.C. 65mA
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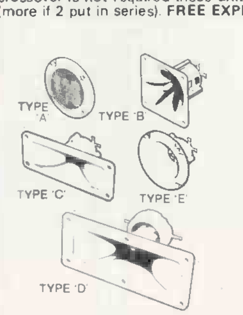
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 40p P&P.**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. Price **£5.99** each + 40p P&P.
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price **£6.99** each + 40p P&P.
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each + 40p P&P.**
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