EVERYDAY ELECTRONICS

FEBRUARY 1987

INCORPORATING ELECTRONICS MONTHLY

£1·10

FREE INSIDE... GREENWELD KIT CATALOGUE

VERSATILE PULSE GENERATOR

MINI-AMP

SPECTRUM I/O PORT

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GETTING THE MOST FROM YOUR 'SCOPE

***Plus* SPECIAL OSCILLOSCOPE OFFER**

The Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

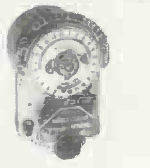
Price per pack is £1.00.* Order 12 you may choose another free. Items marked (sh) are not new but guaranteed ok.

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 ⅓A secondaries
11. 1 – extension speaker cabinet for 6½" 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 ¼ spindle your choice
28. 1 – 6 digit counter mains voltage
30. 2 – Nicad battery chargers
31. 1 – key switch with key
33. 2 – aerosol cans of ICI Dry Lubricant
34. 96 – 1 metre lengths colour-coded connecting wire
39. 1 – long and medium wave tuner kit
41. 8 – rocker switch 10 amp mains SPST
45. 1 – 24 hour time switch mains operated (s.h.)
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 ¾" stack – ½ 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 – 2½ hours delay switch
103. 1 – mains power supply unit – 6V DC
104. 1 – mains power supply unit – 4½V 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 1¾ diameter
127. 4 – pilot bulb lamp metal clip on type
128. 10 – very fine drills for pcbs etc.
129. 4 – extra thin screw drivers for instruments
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 – 6½" 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 ⅜ hole size
182. 1 – short wave tuning condenser 50 pf with ¼" spindle
184. 1 – three gang tuning condenser each section 500 pf with trimmers and good length ¼" spindle
188. 1 – plastic box sloping metal front, 16 × 95mm average depth 45mm
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) 6½" 15 ohm made for Radiomobile
241. 2 – speakers 6" × 4" 4 ohm 5 watt made for Radiomobile
243. 2 – speakers 6" × 4" 16 ohm 5 watt made for Radiomobile
244. 1 – mains motor with gear-box very small, toothed output 1 rpm
245. 4 – standard size pots, ½ meg with dp switch
249. 1 – 13A switched socket on double plate with fused spur
266. 2 – mains transformers 9V ½A secondary
267. 1 – mains transformers 15V 1A secondary p.c.b. mounting
291. 1 ten turns 3 watt pot ¼ 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 – 2¼in. 80ohm loudspeakers
454. 2 – 2¼in. 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.

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 £17.50 post £2.

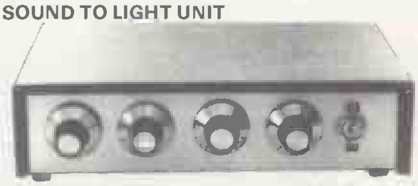


Ex-Electricity Board Guaranteed 12 months.

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 ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form.

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" 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

BENCH ISOLATION TRANSFORMER. Torroidal wound 400 watt but very compact. Has a separate 10V winding which can be added or subtracted to give fine voltage control. Normally £40, our price £10 plus £2 post, ref 10P9.

TANGENTIAL BLOWER HEATERS

We can supply:

1·2KW—quite definitely the smallest tangential blow heater we have ever had, measuring approx. 6 × 6 × 4. This could be just the thing for a small bedroom or to fit under desk or table if you suffer from cold legs. In addition to normal heating functions if put into a simple enclosure this could be a pipe unfreezer (much safer than a blow lamp) possibly even a paint stripper, hair dryer or hand dryer. Price is £5, plus £1 post, ref 5P23

2·5KW—width approx 8" (plus motor), elements made up of two 1·2kw sections, so with switch supplied you can have 2kw, 1kw or cold blow. Over heat cut-out eleminates fire risk should fan stop or air flow be impeded. Fan blades are metal. Price £5 plus £1.50 post, ref 5P62.

3KW—width approx. 13" plus motor, element made up of 1kw and 2kw section, supplied with 4 section rocker switch, allowing 3kw, 2kw, 1kw and cold blow. Price £6.95 plus £2.00 post.

2KW D.I.Y. SPECIAL—if you want a really cheap tangential heater, this is your opportunity, made for 115v mains, to use it on 230v. Simply join elements in series, needs only simple on/off switch, as you will only have one heat level 2kw and no cold blow. Price £2 plus £1 post, ref 2P66.

VERY LOW RUNNING COST—only a 300w element. So would cost only approx. 1½p per hour to run. Should be enough for an airing cupboard or a hot box for seed germination. Might even be enough to keep a damp corner dry. Normal construction approx. 4½" plus motor wide. Price £5 plus £1 post, ref 5P78.

500W–115V TRANSFORMER to isolate you or yours from mains to earth shock dangers. We are able to offer these transformers at less than the price of an auto transformer. Our price for the 500w mains to 115v isolation transformer is £10 plus £5 post, ref 10P6.

RESIN CURED FILLER/BUILDER/STICKER made by the famous Holts company, suitable for repairs, not only to car bodies but also to sinks and wash basins, water tanks, drain pipes and gutters, tiles, roofs, filling holes in walls and concrete, repairing cracks in gates, window frames, etc. etc. It is weather resistant and adheres well to metals, wood, concrete and some plastics. Special bargain price 2 large tubes for £1, ref BD464.

STEPPER MOTOR. By American Phillips corporation. Step angle 7·5°. Coil resistance 27 ohms. Operating volts 10–14. Size approx 2¼" dia by 1¾" deep on a square mounting plate. This is in fact two bi-directional motors with P.M. rotors. Applying correct pulse causes a 7·5° step angle of spindle. Number of steps through which it rotates and a speed at which it rotates is determined by the applied impulses. Properly used this provides an ideal method of speed and position control. Brand new and unused price £5, ref 5P81.

BIG GLASS FIBRE SHEETS. Virtually unbreakable, size 4' × 3' approx. Flat, approx. 1/16" thick. Intended for pcb's but ideal for roof repairs, car port, greenhouse etc. £2 each, Minimum quantity we can despatch is 10. Carriage cost £6.50 per 10. £8.50 for 15.

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 – 4½ 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 1½" stack and good length of spindle
- 2P62 – 1 pair Goodmans 15 ohm speakers for Unilox
- 2P64 – 1 five bladed fan 6½" 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 ½A Mains transformer
- 2P88 – Sangamo 24 hr time switch 20 amp (s.h.)
- 2P89 – 120 min. time switch with knob
- 2P90 – 90 min. time switch with edgewise engraved controller
- 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
- 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.
- 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. 2½" wide) tangential blow heater, 1·2kw
- 5P24 – ⅛hp 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.
- 5P48 – telephone extension bell in black case, ex-GPO
- 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 – 2½kw tangential blow heater, add £1.50 post if not collecting
- 5P73C high pressure mains operated gas or water valve with tube connection suitable soldering
- 5P74 6rpm 60W mains motor and gearbox with instant stop
- 5P79 30rpm 80 watt mains driven motor with gearbox
- 5P82 1 25rpm mains 60w motor with gearbox
- 5P84 1 delay time switch, adjust 0–20 seconds
- 7P1 1 instant heat solder gun—mains with renewable tip and job light
- 10P10. 1 9" extractor fan 115V so supplied with adaptor

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.

EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

VOL 16 No.2 FEBRUARY '87

The Magazine for Electronic & Computer Projects

ISSN 0262-3617

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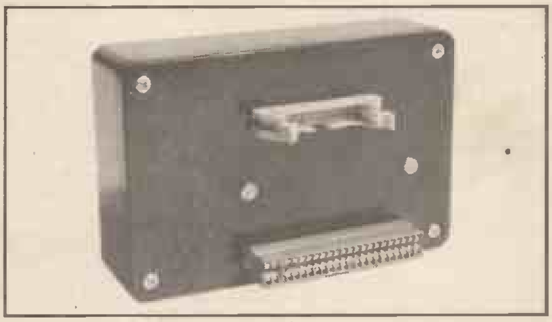
COMMENT . . . POPULAR FEATURES . . .



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For KITS & COMPONENTS - Choose the easy way – with TK

*refundable with first order

Send 50p* & SAE for CATALOGUE

ORDERS: RING (01) 567 8910 – 24 HRS.

NEW POWER STROBE KIT

Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator. Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75 × 50 × 45.

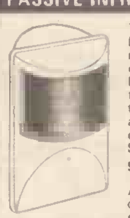
XK124 STROBOSCOPE KIT £12.50

REMOTE CONTROL SWITCH KIT

Comprises a compact 9V (PP3) powered single channel uncoded infra-red transmitter and a mains powered receiver, this kit is ideal for switching table lamps, radios, etc. on and off remotely. Range 20ft. Max. load 500W (240V a.c. only). Size—Transmitter: 7 × 5 × 3cm (including box). Receiver: 7 × 3·5 × 3cm.

MK6 TRANSMITTER	£4.95
MK7 RECEIVER	£11.50

PASSIVE INFRA-RED DETECTORS



The INVADER is a Passive Infra Red Detector with 12 metre range and 110 angle of detection and a memory. Its 9–16V operation and attractive styling make it easy to install and use with virtually any control panel in a domestic alarm system. Size: 105 × 65 × 50mm.

950 136 £33.00

AUTOLITE—replaces a standard wall switch and saves energy by switching lights when movement is detected within its 4m range. Includes a dimmer and daylight sensor. 250W max.

950 137 £34.50

ELECTRONIC SIREN KIT

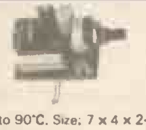
Produces an extremely loud piercing swept frequency tone from a 9-15V supply. Enable input for easy connection to alarm circuits. Includes 5in. Horn Speaker.

XK116 £8.65

Mini Siren
As above, but with a small speaker (instead of horn speaker) for internal use. Complete with box.

XK117 £4.70

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0·5°C. Ideal for photography, incubators wine-making, etc. Max. load 3kW (240V a.c.). Temp. range up to 90°C. Size: 7 × 4 × 2·5cms.

MK4 £7.10

NEW HIGH SECURITY LOCK KIT

Designed for use with our lock mechanism (701 150) this kit will operate from a 9V to 15V supply drawing a standby current of only 50μA. There are over 5000 possible 4-digit combinations and the sequence can be easily changed. To make things even more difficult for an unauthorised user an alarm can be sounded after 3 to 9 incorrect entries—selectable by means of a link. The alarm can sound for a few seconds to over 3 minutes during which time the keyboard is disabled preventing further entries. A latched or momentary output is available making the unit ideal for door locks, burglar alarms, car imobilisers, etc. A membrane keyboard or pushbutton switches may be used and a beep sounds when a key is depressed. Kit includes high quality PCB, all components, connectors, high power piezo buzzer and full assembly and user instructions.

XK121	LOCK KIT	£15.95
350 118	Set of Keyboard Switches	£4.00
701 150	Electric Lock Mechanism 12 volt	£16.50

TEN EXCITING PROJECTS FOR BEGINNERS

This Kit has been specially designed for the beginner and contains a SOLDERLESS BREADBOARD, COMPONENTS, and a BOOKLET with instructions to enable the absolute novice to build TEN fascinating projects including a light operated switch, intercom, burglar alarm, and electronic lock. Each project includes a circuit diagram, description of operation and an easy to follow layout diagram. A section on component identification and function is included, enabling the beginner to build the circuits with confidence.

ORDER NO XK118 £13.75

XK102 3-NOTE DOOR CHIME

Based on the SAB0600 1C the kit is supplied with all components, including loudspeaker, printed circuit board, a predrilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete.

AN IDEAL PROJECT FOR BEGINNERS **£6.00**

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300W of lighting.

TDR300K	Remote Control Dimmer	£16.45
MK6	Transmitter for above	£4.95
TD300K	Touchdimmer	£8.50
TS300K	Touchswitch	£8.50
TDE/K	Extension kit for 2-way switching for TD300K	£2.70
LD 300K	Light Dimmer	£4.35

TK ELECTRONICS
13 BOSTON RD
LONDON W7 3SJ
Tel: 01-567 8910

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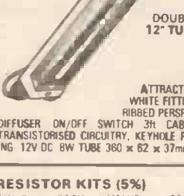

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EVERYDAY ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

The Magazine for Electronic & Computer Projects

VOL 16 Nº2 **FEBRUARY '87**

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BURNT FINGERS

THE electronics industry has suffered from two years of "difficult" trading and while technological developments have proceeded at an ever increasing pace during '85 and '86, the industry has been hard pushed to sell the end results to consumers. Perhaps many people have had their fingers burnt with the purchase of a high technology product which quickly became a white elephant—remember the Oric and Dragon Computers, or the Phillips 2000 video and (increasingly) Betamax.

I wonder how many "consumers" are waiting for the finite "flatter, squarer, tube" on TVs or for the standard on stereo TV transmissions or even for direct broadcast transmissions. It seems to me that we are still going through a period when developments are pushing ahead but the realisation of innovative, value for money, domestic product is still some way off. Perhaps the next boom product will be satellite TV and I for one will wait until a direct broadcast satellite (DBS) system is available and prices of equipment steady off after the initial inevitable fall.

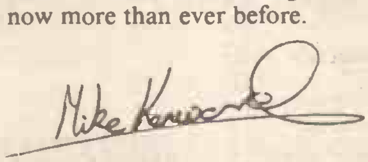
We know that most of the household hi-tech names have pre-production prototypes just waiting for the day the market opens up, so presumably competition will be hot and therefore prices competitive. Perhaps the electronics industry has been its own worst enemy in the past!

STANDARD

If only there had been a standard for video recorder systems in the early days—or compact disc—or a hobby computer operating system, how much easier it would have been for the man in the street. We have learnt from our mistakes and the next time we will wait for the market leader in various systems to evolve and for the price to fall. The problem is, who will buy the early systems to set the standard?

MARKETING

It all adds up to marketing and no doubt the big names in high technology will now be spending more money convincing us to buy their product than they do developing ideas. There will still be the systems that fail—and possibly they will not be the worst systems, simply those that are not pushed hard enough. Witness the supremacy of VHS over Betamax and Phillips 2000, the former with HQ, is only now able to rival the quality of Beta and possibly of the Phillips system but that has not stopped it becoming the "standard" through product and software availability and good marketing. In short it is not necessarily the best product that produces the best sales and the high tech boffins need the marketing and sales teams now more than ever before.



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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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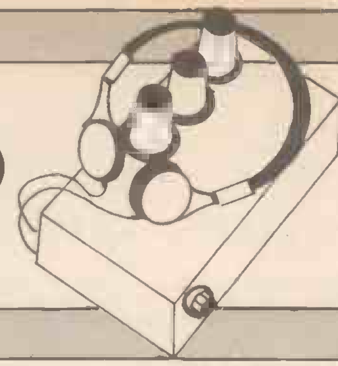
MINI-AMP



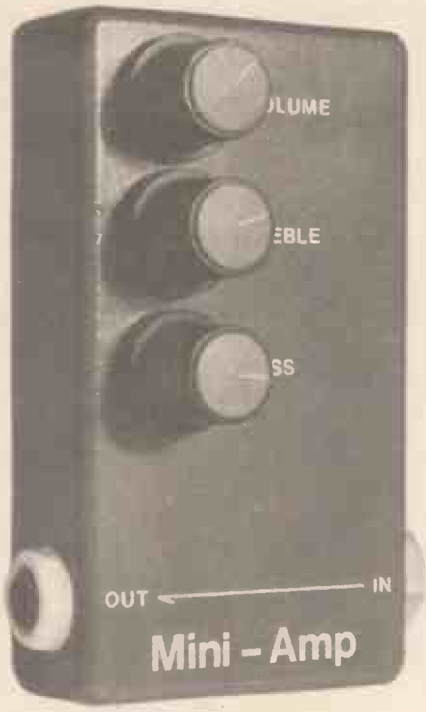
IAN COUGHLAN

Practice at any volume without the "turn it down" accompaniment. A project for aspiring musicians

MANY, many musicians who practice at home probably have the words "turn it down" etched deeply in their minds. Other members of the household, and neighbours, would much rather be able to hear the TV than listen to the strains of a guitar solo, or the latest synthesised creation, regardless of how wonderful it may sound to the ears of the musician. This project ought to go some way to ensure that the aspiring musician stays on good terms with his family and neighbours.

The Mini-Amp is, not surprisingly, a miniature amplifier, designed to accept the output from a guitar or other instrument, and to amplify the signal to a level sufficient to drive a pair of headphones. Controls are provided for adjusting the volume, bass response, and treble response. A clip on the rear allows the user to wear the Mini-Amp on his belt, giving freedom of movement, while keeping the controls close at hand. Power is supplied by an internal nine volt battery, sufficient to deliver some 1·5 watts into the headphones.

The Mini-Amp will accept the output from a mixer, so other musicians may join in, each having his own Mini-Amp; or the solo musician can play along with recorded music.



CIRCUIT DESCRIPTION

Integrated circuit IC1 is a dual low-noise operational amplifier (Fig. 1), the first half of this device is configured as a variable-gain amplifier block, whose gain is set by the volume control, VR1. With the volume control fully counterclockwise, and therefore at minimum resistance, the gain of the stage is unity, or 0dB. Turning the volume control clockwise increases its resistance, thus increasing the gain of the stage, up to a maximum of about 47, or 33dB. This allows the Mini-Amp to handle input signals in the range 130mV peak-to-peak (45mV r.m.s., −25dBu) to 6·5 peak-to-peak (2·3V r.m.s. +9dBu).

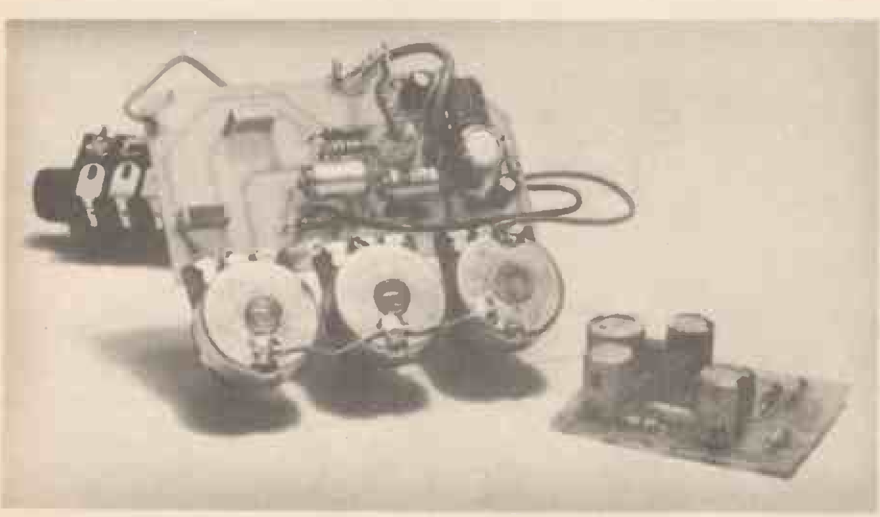
Note that these are the input levels required to produce maximum power, just before the amplifier is driven into overload: to allow for peaks in the input signal, about 10dB of headroom will be necessary, so these levels ought to be conservatively rated at 10dB below the figures above. The input impedance of this stage is 47kilohms.

TONE CONTROLS

The other half of the dual op-amp forms the heart of the tone control circuitry. The components around the Bass and Treble controls form what is known as a Baxandall network.

With the bass and treble controls midway, the gain of this stage is practically unity, right across the audio spectrum: the frequency response is said to be "flat". Rotating, say, the treble control clockwise will reduce the amount of negative feedback at frequencies much above 1000 Hertz, thereby increasing the gain of the stage at these high frequencies: the treble response has been "boosted". Conversely, rotating the treble control counterclockwise will *increase* the amount of negative feedback at frequencies above 1kHz, thereby *decreasing* the gain at high frequencies; the treble response has been "cut".

The bass control works in a similar way, increasing or decreasing the gain at frequencies below 1kHz. Bass and/or treble response can be cut or boosted by up to 9dB. The output from the tone control stage is some 2·3V r.m.s., while that required by the next stage—the power amplifier—is only 60mV r.m.s. R11 and R12 form an attenuator, reducing the signal level by the required amount.



POWER AMPLIFIER

The power amplifier is a simple integrated device, providing a good output, with low quiescent current drain (that is, the current drawn by the device when no audio signal is present). This amplifier will provide 1·5 watts into 4 ohms with a good 9 volt battery, falling to about half that at 6 volts. This should be enough to keep most folk happy!

A natural consequence of delivering high powers into low impedances is the demand put on the supply line, and the resulting surges. These surges must be prevented from reaching the sensitive pre-amplifier and tone controls, which would otherwise become unstable, distorting at best, and oscillating at worst. R3 and C2 effectively decouple IC1 from any surges present on the supply line.

Note the wiring of the output socket, SK2: tip and ring contacts are wired to-

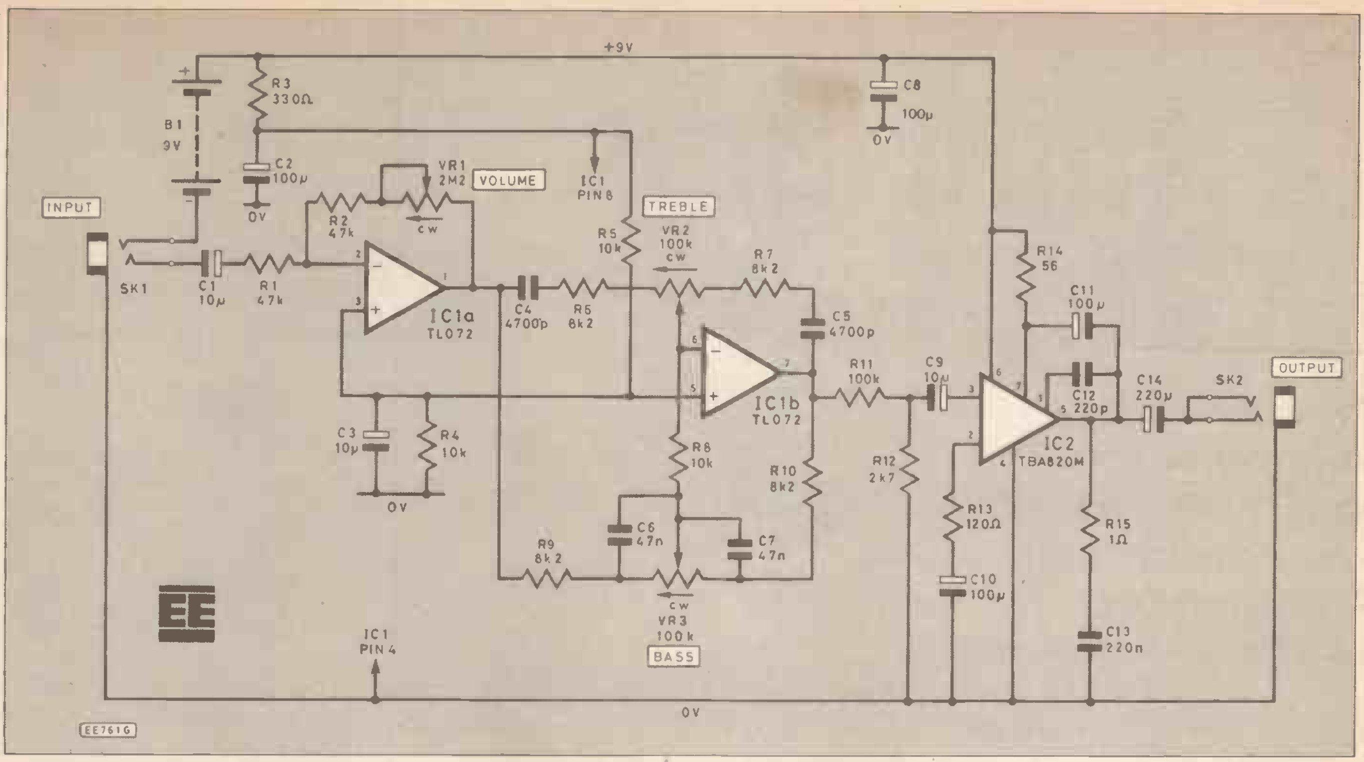
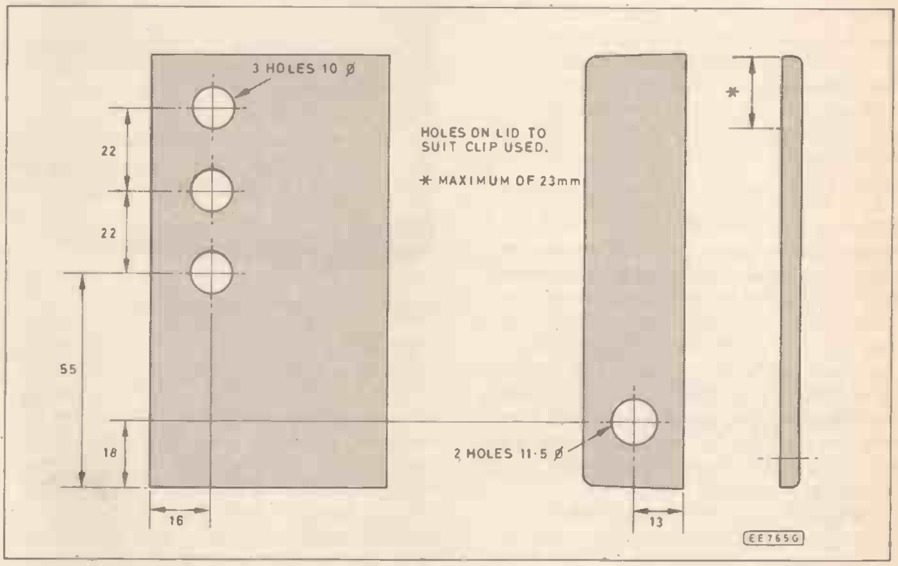


Fig. 1. (above) Complete circuit of the Mini-Amp.

Fig. 2. (right) Case drilling details.



COMPONENTS

Resistors

R1,R2	47k (2 off)
R3	330
R4,R5,R8	10k (3 off)
R6,R7,R9,R10	8k2 (4 off)
R11	100k
R12	2k7
R13	120
R14	56
R15	1

All $\frac{1}{4}$W carbon ±5%

Potentiometer

VR1	2M2 log. carbon
VR2	100k lin. carbon
VR3	100k lin. carbon

All type P20

Capacitors

C1,C3,C9	10μ miniature elect. 16V radial (3 off)
C2,C8,C10,C11	100μ miniature elect. 16V radial (4 off)
C4,C5	4700p 160V polystyrene (2 off)
C6,C7	47n 250V miniature layer (2 off)
C12	220p 160V polystyrene
C13	220n 100V miniature layer
C14	220μ miniature elect. 16V radial

See **Shop Talk** page 75

Semiconductors

IC1	TL072, dual low-noise op-amp
IC2	TBA820M, audio amplifier

Miscellaneous

SK1,SK2 stereo jack socket (2 off)

Die-cast box 114 × 64 × 30mm; spring-clip for rear of box (made from aluminium); two printed circuit boards (available from *EE PCB Service*, order code EE554 and EE555); control knobs (3 off); PP3 battery connector; 8-pin d.i.l. sockets (2 off); plastic spacers 16mm long; 7/0.2 wire; 22s.w.g. link wire; miniature screened wire; thin foam-rubber; primer and paint; dry-transfer lettering; clear varnish.

Approx. cost Guidance only £17

gether, so any attempt to connect a mono jack-plug to this socket will short the output of the power amplifier to 0V, almost certainly causing damage. The reason the socket is wired in this way is so that stereo headphones can be used without rewiring the plug. A pair of 'phones with an impedance of 8 ohms will have a combined impedance of 4 ohms when plugged into the output socket of the Mini-Amp. If you must connect a mono jack-plug, then re-wire the socket. For best performance, it is recommended that an alkaline battery is used.

CONSTRUCTION

The Mini-Amp is constructed in a die-cast box measuring 114 × 64 × 30mm. Two printed circuit boards are used, one containing the pre-amplifier and tone control components, including the potentiometers, the other containing the power amplifier components. These p.c.b.s mount one on top of the other, with wire links carrying signals between the two. These link wires

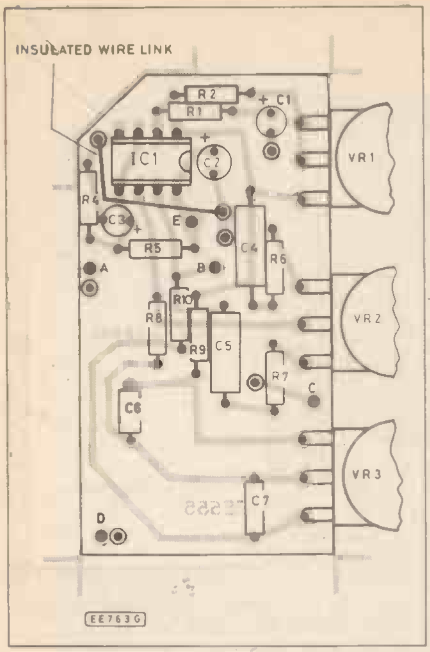
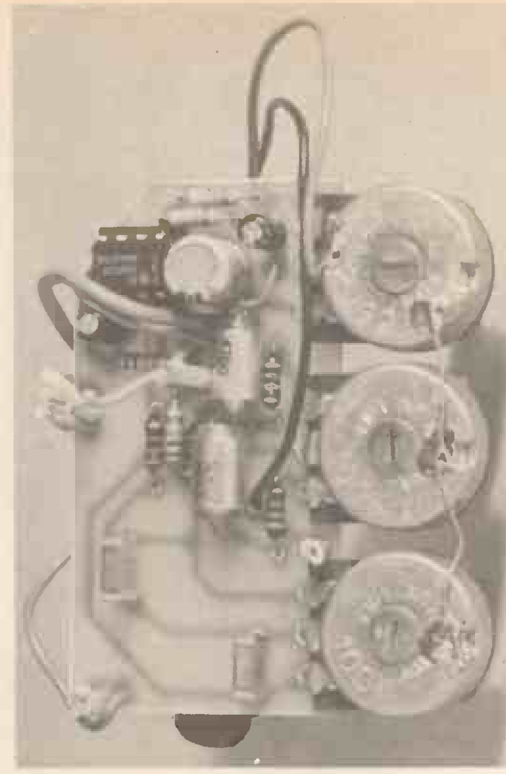


Fig. 3. Main p.c.b. layout and wiring. These boards (EE554/5) are available from the EE PCB Service.



also serve to locate the smaller of the p.c.b.s (the power amplifier) on the larger p.c.b. (pre-amp and tone controls). The larger p.c.b. is attached to the potentiometers, and these in turn are fixed to the box, thus all the electronics are secured. Foam rubber improves location still further, resulting in a robust assembly.

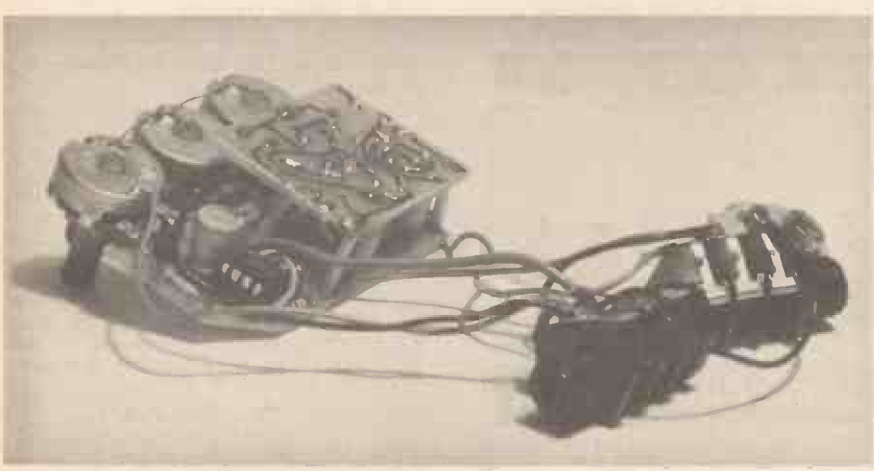
Begin construction by drilling the box as shown in Fig. 2. Rub the box down with wet'n'dry paper, clean it, prime it, and then paint it, preferably by spraying. When the paint is dry, lettering can be applied by dry-transfer such as Letraset or Mecanorma. This should then be protected by a coat of clear varnish such as Letracote.

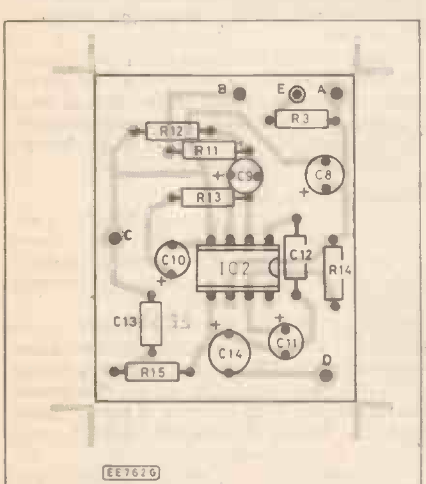
Fix the three potentiometers to the large p.c.b., bending the solder tags close to the surface to minimise the possibility of shorts to the inside of the metal box. In fact, do this with all component leads; and when soldering, try not to leave "peaks" that rise much above the surface of the p.c.b. The assembly is compact and similar components to those used in the prototype will ensure a neat unit.

Resistors should be soldered first, followed by the capacitors, and then the integrated circuits. Note that i.c. sockets can be used, if desired. The insulated wire links should be soldered before the p.c.b.s are joined, as should the screened cable and other connections to the large p.c.b. (no such connections are made to the small p.c.b.). Also, connect the red lead from the battery clip to the large p.c.b.

The boards are held together by short lengths of 22s.w.g. tinned copper wire (the offcuts of components just fitted can be used). Remember to slip these wires through plastic spacers 16mm in length (on the prototype, the plastic stem of cotton-buds was used).

Bend all the contacts on the jack sockets inwards, to reduce their height, and mount them to the box. Cut a piece of thin foam rubber to the same dimensions as the large





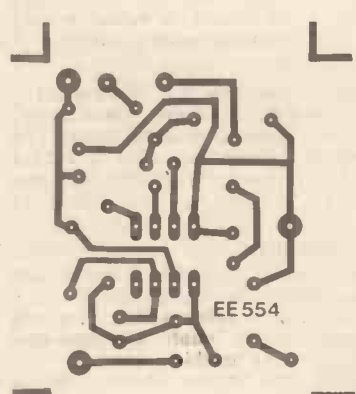
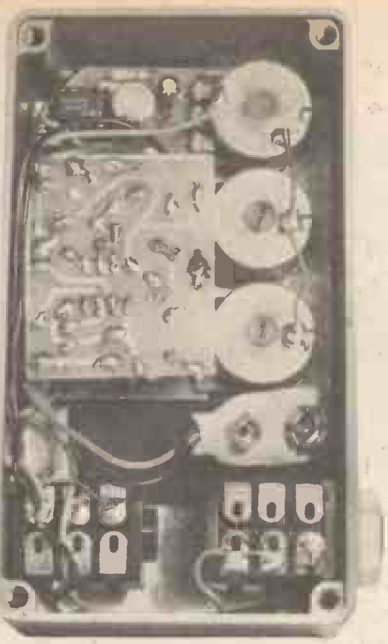


Fig. 4. Amp p.c.b and wiring.



p.c.b., and glue it to the inside of the box. With a nut and a shakeproof washer on each of the potentiometers, offer the p.c.b. assembly up to the box, gently guiding the controls through the holes in the box. Fix a nut to each potentiometer, and tighten them, taking care not to scratch the paint! Attach three control knobs. The wires from the p.c.b. assembly should now be connected to the jack sockets, as shown in Fig. 3. Don't forget to run a length of link wire along the backs of the potentiometers. Cut another piece of thin foam rubber to the same dimensions as the small p.c.b., and glue it to the inside of the box lid. A third piece should be cut, 45 × 17mm, and glued inside the box where the battery will sit.

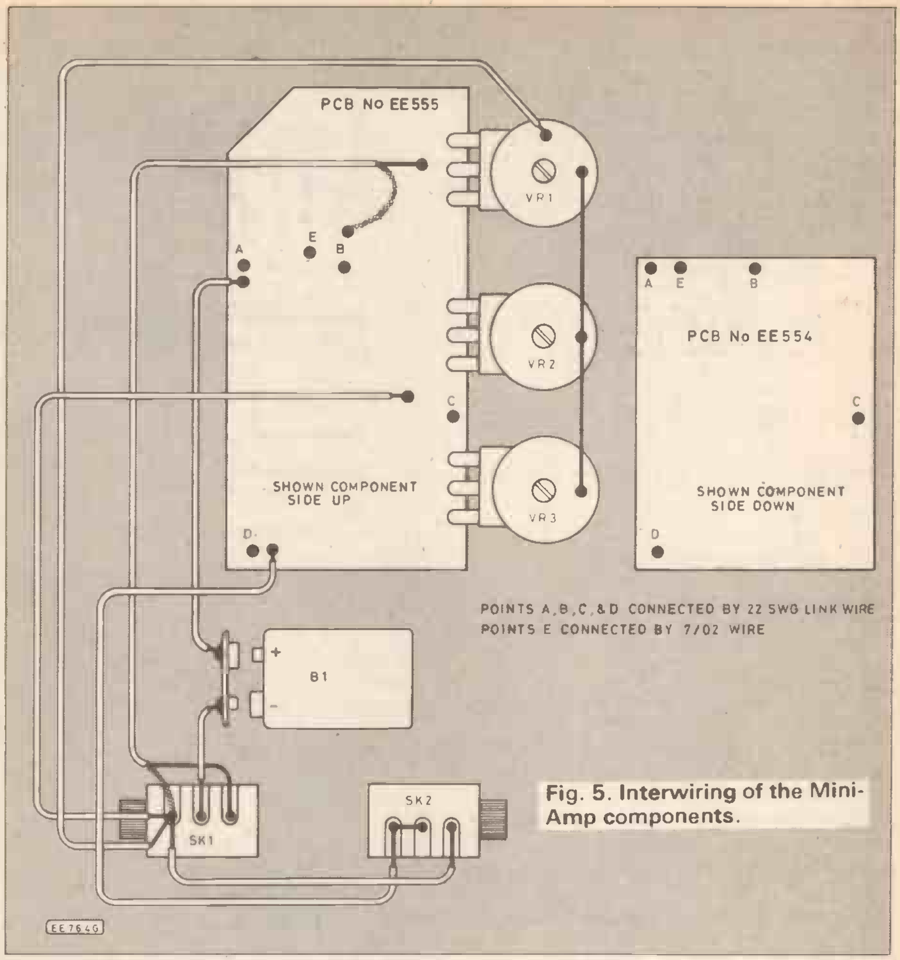


Fig. 5. Interwiring of the Mini-Amp components.

After checking all connections and connecting the battery, the Mini-Amp can be tested. Connecting a jack plug to the input socket switches the Mini-Amp on. Plug in the headphones and make sure all the controls operate correctly. □

SHOP TALK

BY DAVID BARRINGTON

Car Voltage Monitor

The bargraph module used in the *Car Voltage Monitor* is available from Electromail, code 304-611, and comes complete with its own small printed circuit board. This board is simply wired to the main "mother" board.

The 10-element red l.e.d. display module provides a linear analogue display. The driver i.c. mounted on the p.c.b. module is the LM3814.

The 20-turn cermet trimmer is now quite a common item and stocked as an "off-the-shelf" component. The main p.c.b. for this project is available from the EE PCB Service, code EE553 (see page 116).

Spectrum Speech Synthesiser

The only item that could cause purchasing problems for the *Spectrum Speech Synthesiser* is the 3·2768MHz crystal X1. These are usually listed under "special frequency" types for timers and counters, currently stocked by Maplin and Cirkit.

The interface controller, voice synthesiser and amplifier chips should be readily available, but in case of difficulty they are stocked by Omega, Happy Memories, Magenta and Omni. The i.c. sockets and edge connector should be available from any good local components stockists.

Frost Alarm

The thermistor type VA 1040 used in the *Frost Alarm*, "Exploring Electronics" project, may prove difficult to locate. The only source we have been able to find for this device is Greenweld Electronic Components. This device has a resistance of 130 ohms at 25°C.

Video Guard

As most contructors who wish to build the *Video Guard* will also be owners of a video machine, it follows that they will most likely have a "gash" cassette carcase they can use for this project.

The only other items which could be troublesome are the mercury tilt switch and position sensor. If readers do have difficulty in obtaining these they are currently listed by Electromail: code 339 881 and 337 289 respectively.

Expanding The Simple Printer Buffer

Readers who purchase a ready programmed EPROM for the original *Printer Buffer* circuit and wish to expand the buffer, Tayside Microsystems will reprogram the chip for a nominal fee. Send the original EPROM (in working order) with 54p in stamps, and your name and address.

New constructors may still purchase the p.c.b. (without amendments) £9.75 and the EPROM (new program) £8.25 from **Tayside Microsystems, 55 Causewayend, Coupar Angus, Perthshire PH13 9DX.**

Versatile Pulse Generator

Looking through the components list for the *Versatile Pulse Generator* they all appear to be standard "off-the-shelf" items, except the rotary range selection switches S2 and S3.

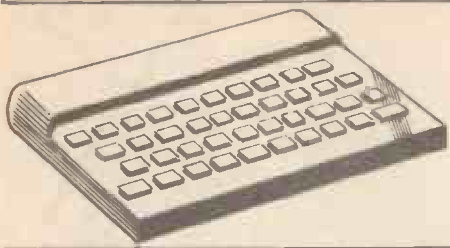
These can be made up from the "makaswitch" assemblies which have an adjustable stop. The switch wafer should be a 2-pole 6-way type and only one pole used. These switches are stocked by Marco Trading, Bi Pak, Maplin and Omni.

Spectrum I/O

Most of the parts required for the *Spectrum I/O* should be available from most of our advertisers. The semiconductors and connectors are stocked by Omega, Magenta, and TK Electronics.

A complete kit, including a printed circuit board (£14.75), the stepping motor driver extension (£5.19) and the stepping motor (£16.80) are available from **Magenta Electronics, 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST.** Add £1 for p&p per order.

We cannot foresee any component buying problems for the *Mini-Amp* project.



SPECTRUM I/O

MARK STUART

Put your Spectrum into overdrive with this low-cost add-on

THIS interface allows the Sinclair Spectrum computer to be connected to a wide variety of external circuits which require an 8-bit input or output port. Circuits such as motor drivers A-D and D-A convertors, keypads, light pens, speech synthesisers and sound generators can all be interfaced in this way. It should also be possible to use many of the peripherals designed to connect to the BBC computer user port.

Computer input output ports are usually designed in one of two ways. One way is to use a single i.c. known as PIO (Programmable Input/Output). A number of these specialised i.c.s are available, many of them incorporate a range of functions which make them extremely versatile. The snag is that they require a number of programming steps to set them up. The other type of computer port uses standard "simple" single function i.c.s which are directly accessible from a program with just one command.

The circuit described here uses the second approach and provides a simple means for the computer to read the state of 8 input lines and to control 8 output lines. The inputs and outputs are entirely separate, they are provided by two separate i.c.s (Fig. 1a and Fig. 1b) and operate independently.

CIRCUIT

The circuit diagram of the Spectrum I/O Port is shown in Fig. 2; IC1 provides the 8 outputs, it contains eight "flip-flop" sections. Each flip-flop has an input—which is connected to the computer data bus—and an output. A third input to the flip-flop is the "clock" terminal. When a pulse is applied to the clock terminal the signal on the flip-flop input is transferred and latched into the flip-flop output. The flip-flop output then remains in its latched state regardless of the state of the inputs.

The 8 inputs are provided by IC2 which contains eight input buffer circuits with "tri-state" outputs. The outputs are connected to the computer data bus. A further input to the i.c. is the "gate" input. During a pulse on the gate input a signal on the input of IC2 is transferred to its output. Unlike IC1 this circuit does not have a latching function, the input is transferred to the output only during the gate input pulse. Before and after the pulse the output is effectively disconnected and does not load or have any effect on the computer data bus.

The clock pulse for IC1 and the gate pulse for IC2 have to occur at the correct time so that only the right data is latched into the output port and read from the input port. These pulses are obtained from the computer via IC3 which decodes the computer signals. IC3 contains four two-input OR

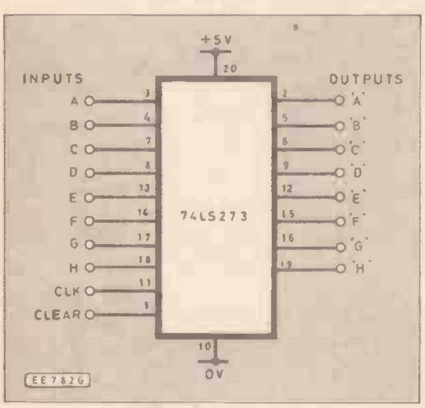


Fig. 1a. Pin functions for the 74LS273.

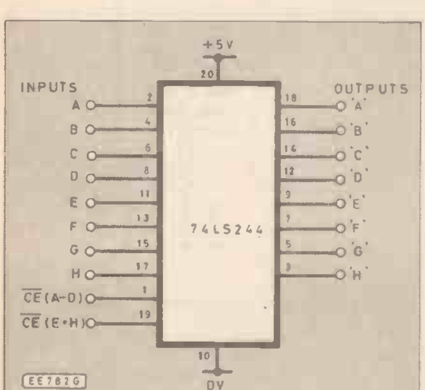
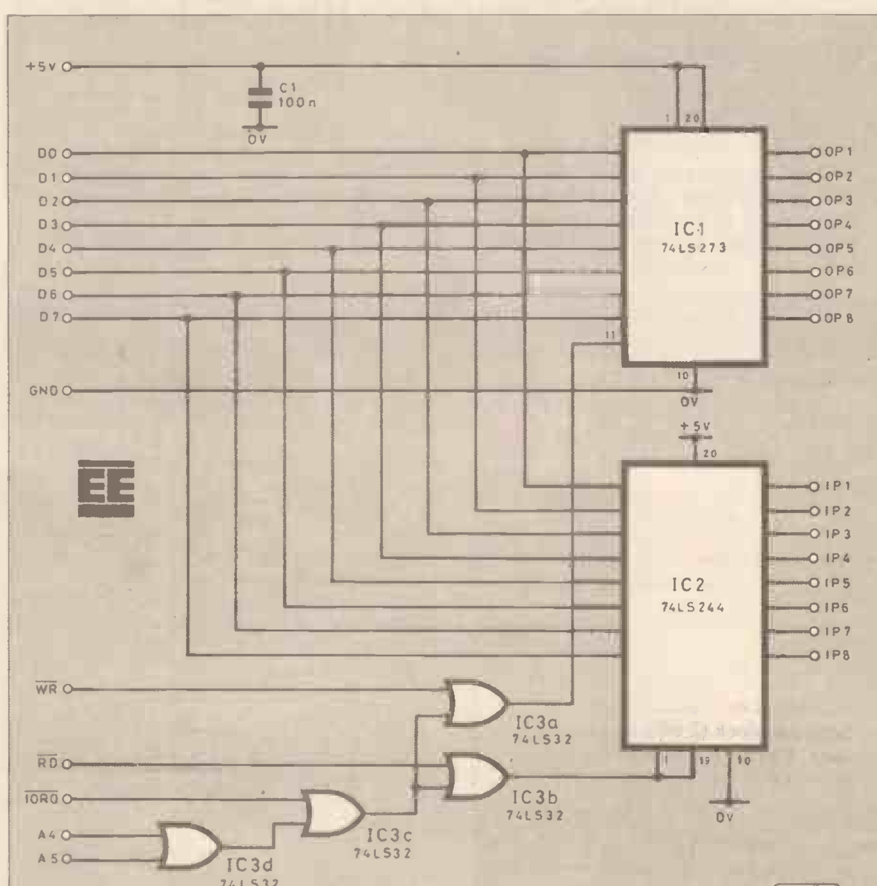


Fig. 1b. Pin functions for the 74LS244.

Fig. 2. Complete circuit diagram for the Spectrum Input/Output Port.



gates. The truth-table for these gates is shown below.

INPUTS		
1	2	OUTPUTS
0	0	0
1	0	1
0	1	1
1	1	1

The significant feature of the truth table is that the gate output will only be at a logic 0 state when both inputs are also at logic 0. Any other combination of inputs produces a logic 1 output.

These are two aspects of decoding the computer signals to provide the clock and gate pulses. The first is to get the correct address from the computer. This is achieved in this circuit by using A4 and A5 from the address bus and the IORQ (input-output request). In this way the port is located in a special area reserved for input and output (I/O) devices. The exact detail of the memory and I/O mapping of the Spectrum computer is too involved to cover here, but has been covered well in various computer books and magazines.

When A4 and A5 are at logic 0 the output of IC3d is 0. This and the IORQ line are then applied to IC3c. The output of IC3c is therefore only low when A4, A5 and IORQ are low. This is the decoded address signal which is then combined with the RD (read) and WR (write) signals from the computer by IC3a and IC3b. These two gates provide the second part of the computer signal decoding.

When the correct address is present the output of IC3c drives to logic 0 one input each of IC3a and IC3b. When it is required to produce an output from the port the computer sets up the appropriate address and data and then produces a carefully timed pulse on the WR line. This pulse is a logic 0 and so is passed by IC3a to the clock terminal of IC1. The end of the WR pulse is timed so that the correct data is present on the data bus and is latched into the outputs of IC1 at the correct moment.

A similar procedure occurs with the RD line which carries a logic 0 pulse when an input from the port is to be read by the computer. This pulse is passed by IC3b and applied to the gate input of IC2. During the RD pulse the computer reads the inputs to IC2 which are transferred to its data bus.

CONSTRUCTION

As can be seen from the circuit diagram there are just three i.c.s and a capacitor in the circuit along with the input and output connectors. Unfortunately a large number

of connections are required and so a double-sided printed circuit board and a number of wire links are necessary. Fig. 3 shows the printed circuit board track patterns and Fig. 4 the component layout.

A number of connections between the top and bottom of the board ("pin throughs") are required. Some of these are made using i.c. pins and others use extra pins or short pieces of tinned wire which are passed through the board and soldered top and bottom. It is not possible to use sockets for the i.c.s as some pins must be soldered both sides of the board. As the i.c.s are not CMOS and are nowadays relatively inexpensive, this should not be a problem.

COMPONENTS

Capacitors
C1 100n ceramic disc

Semiconductors
IC1 74LS273 octal D-type flip-flop
IC2 74LS244 octal tri-state buffer
IC3 74LS32 quad 2 input or gate

Miscellaneous
PL1 20 way IDC board plug (straight type)
SK1 23 or 28 way DS 0.1inch edge connector
PCB (available from the *EE PCB Service*, Order Code 557); ribbon cable (4-way); case—(optional) size approx 120 × 80 × 35mm.

See Shop Talk page 75

STEPPING MOTOR BOOSTER

Resistors
470 ¼W (4 off)

Semiconductors
TIP121 Darlington transistors (4 off)

Miscellaneous
20-way IDC connector; 20-way ribbon cable (0·5m); 12-way terminal block (2 off); Connecting wire; Stepping motor (Magenta MD200)

Approx. cost Guidance only **£15**
Motor & Ext Kit extra

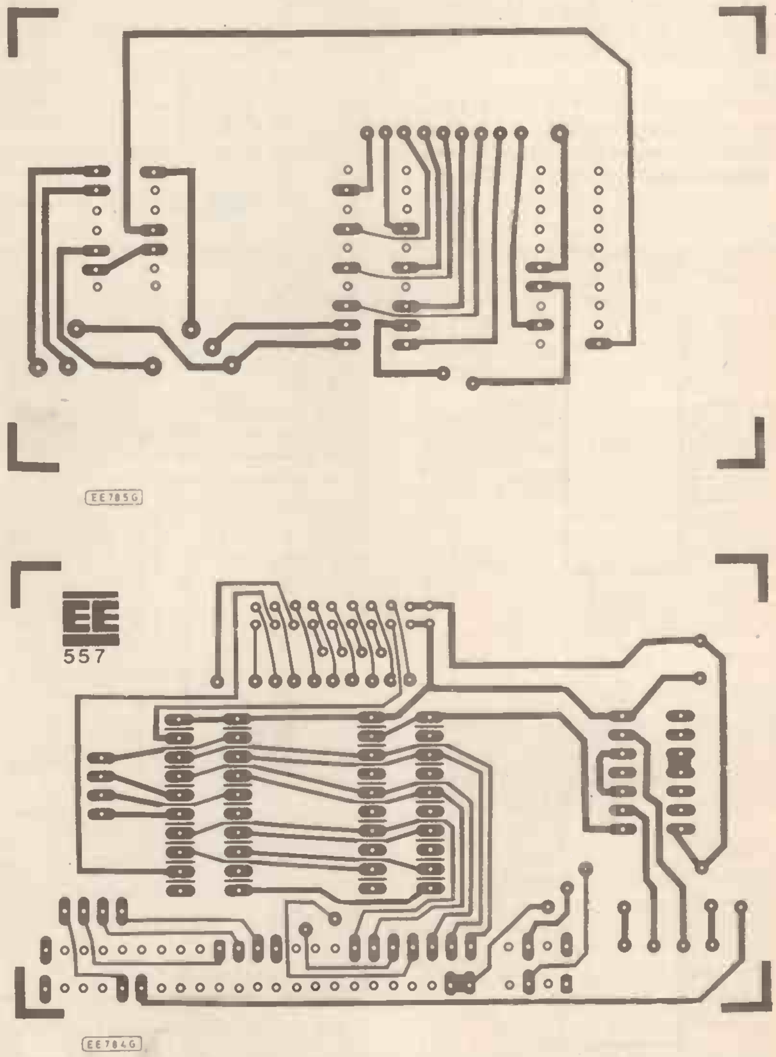


Fig. 3. Full size printed circuit master patterns for the top and underside of the circuit board.

CONNECTORS

The connector for the computer is a 23-way double-sided 0·1 inch edge connector. These types are readily available and cheaper than the full 28-way Spectrum version. The board will accept the 28-way connector, but the extra pins are unused. A 20-way IDC header plug is used for the input/output connections, Fig. 6 shows the pin designations. Two links on the board are made from lengths of four-way ribbon cable. The links are made from letter to letter as shown, and can be routed as required.

Begin construction by making the pin through connections from short spills of wire soldered both sides. Next fit the i.c.s and solder the bottom of the board first and then carefully solder the top side connections. Be particularly careful where there are tracks passing between pins to avoid making solder bridges. If necessary check for short-circuits with a multimeter on the low ohms range. Excess solder can be removed easily using desolder braid.

The computer connector should be fitted so that it is as far above the board as possible, Fig. 5. Finally fit the ribbon cable link leads, C1, and the IDC output plug.

The circuit can be used without a case but can be fitted into a suitable plastic box if required by making cut-outs for the two connectors. It is also possible to eliminate the IDC connector, solder ribbon cable directly to the board and wire the remote end of the ribbon cable to a set of terminal blocks. These options are left to the constructor.

TESTING

Before connecting the unit to a computer it should be thoroughly inspected for dry joints, solder bridges and incorrect connections. When everything looks correct switch off the computer and plug in the interface. Switch on the computer and check that the normal copyright message appears. The interface is located in the I/O area of the computer at 65487. To read inputs type PRINT IN 65487, to send out data type OUT 65487, n (where n is a number from 1 to 255).

A very useful command with the Spectrum computer is the BIN command, which makes it easier to set up 1's and 0's in the output port. For example, OUT 65487, BIN 01000101 set output lines to 1's or 0's exactly as the number suggests.

A simple program to check the input port is as follows:

```
10 PRINT IN 65487
20 PAUSE 10
30 CLS
40 GO TO 10
```

This prints the value of the input port in the top left hand corner of the screen. Take each pin of the input to zero (via a 470 ohm resistor) one by one and the reading will change to follow the table below.

DATA LINE	VALUE	READING
0	1	254
1	2	253
2	4	251
3	8	247
4	16	239
5	32	223
6	64	191
7	128	127

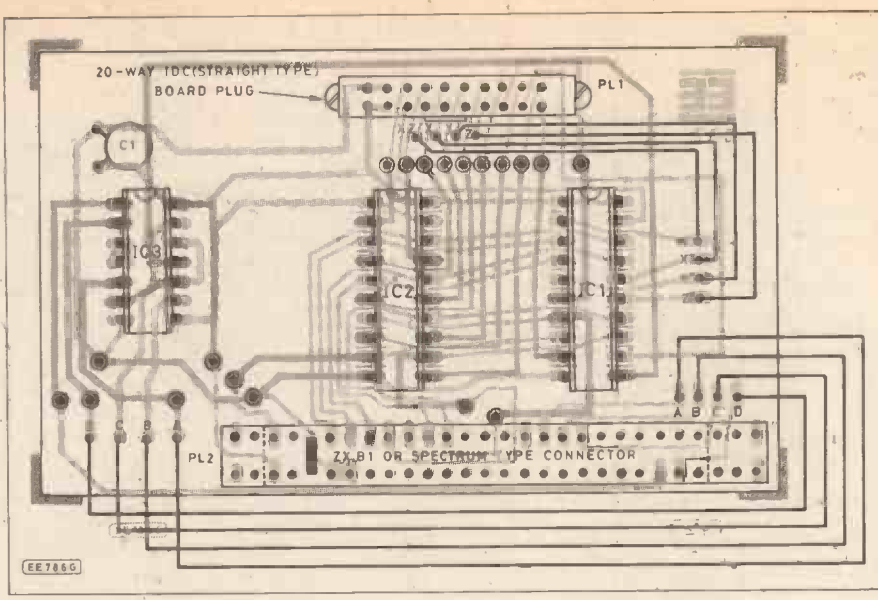
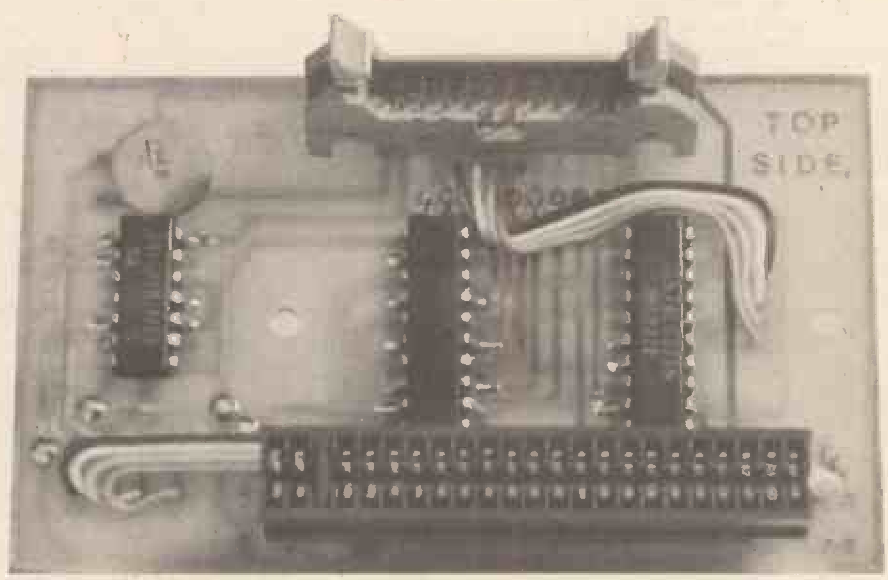


Fig. 4. Component layout on the printed circuit board. The "pin through" connections are indicated by the circles with dots in the centre. Also be sure to solder the i.c. pins top and bottom. This p.c.b. is available from the *EE PCB Service*, code EE557.



Completed circuit board showing the ribbon cable connections and mounting of the connectors.

Fig. 5 (right). Mounting the computer connector proud of the circuit board.

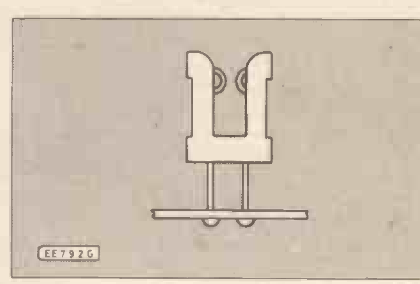
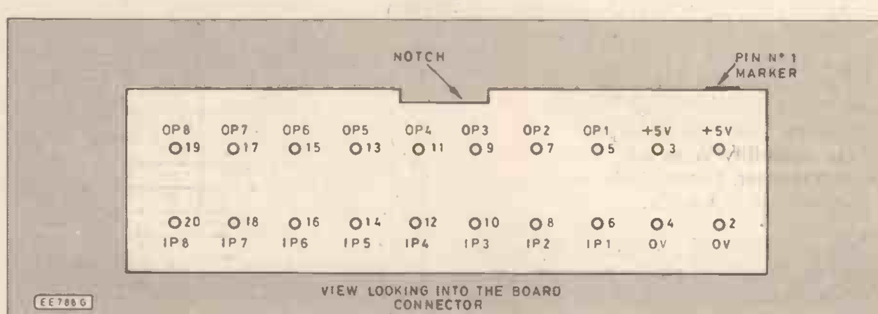
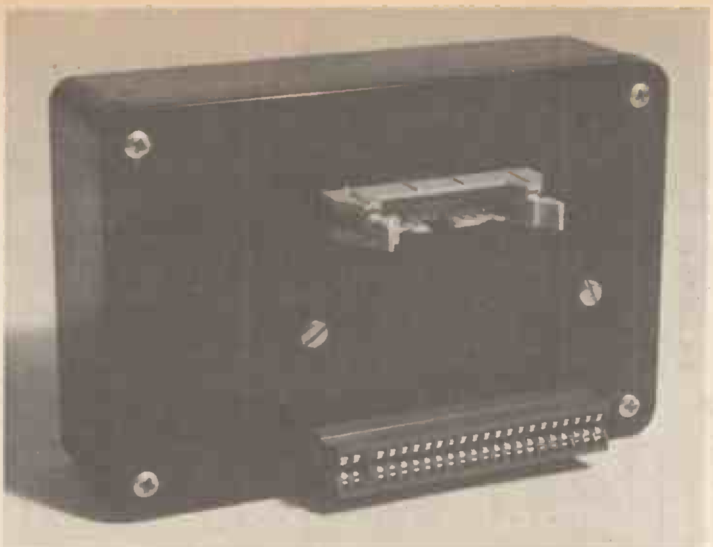


Fig. 6 (below). Pin connection details for the IDC output plug.





The completed unit mounted in a plastic case.

If none of these work there is probably a fault in the address decoding section. If just some of the lines give wrong readings trace the individual pins.

Next check the output functions. The state of the lines can be checked either by means of a multimeter or by an l.e.d., in series with a 470 ohm resistor from +5V to the pin being tested. The l.e.d. will light when a logic 0 state is present.

A suitable test program is:

```
10 INPUT S
20 OUT 65487, S
30 GO TO 10
```

At switch-on the output port will be loaded with a random number. When the program is entered and run it requests a number input. Enter the numbers one by one as listed below and check the state of the pin in each case.

NUMBER	HIGH OUTPUTS
0	NONE
1	D 0 ONLY
2	D 1 ONLY
4	D 2 ONLY
8	D 3 ONLY
16	D 4 ONLY
32	D 5 ONLY
64	D 6 ONLY
128	D 7 ONLY
255	ALL

As with the input section any general errors are probably caused by faulty decoding circuitry whilst individual errors should be found by tracing the appropriate pins. If all these tests are passed the interface is ready to run.

OUTPUT POWER

The output lines from the port are standard LS TTL types. From the manufacturer's specification each line will supply a guaranteed 400 microamps to logic 1 level and 20mA minimum into a short circuit. These figures are fine for driving other electronic components but no use at all where higher power loads are concerned.

A simple way to increase the power output capability is to add a Darlington power transistor. These devices are actually two transistors connected together to produce a single device of very high gain. A commonly used device is the TIP121 which is shown in Fig. 7. The manufacturer's data for this device shows that it has a typical current gain of 4000 and will handle up to 5 amps at up to 80 volts. It is also able to absorb the sort of voltage spikes generated by switching inductive loads such as motors and relays.

With at least 400µA available from the port a current gain of 4000 means that the transistor will be able to switch at least 1·6 amps. In practice this should easily be 5 amps or more because the port output current of 400µA is a guaranteed minimum value and most ICs will comfortably exceed this.

Fig. 7 shows one output port line connected to the base of the power transistor via a 470 ohm resistor. The resistor is not strictly necessary but it does help to protect the output port from power surges and accidental short circuits.

STEPPING MOTORS

The power capability of these transistors can be applied to a variety of jobs. A typical one is the control of a stepping motor.

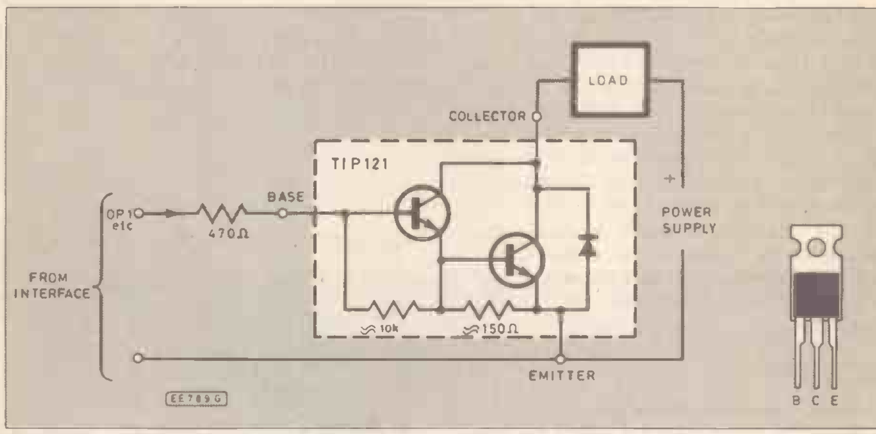


Fig. 7. Circuit diagram for the Darlington power transistor interface and pin details for the TIP121.

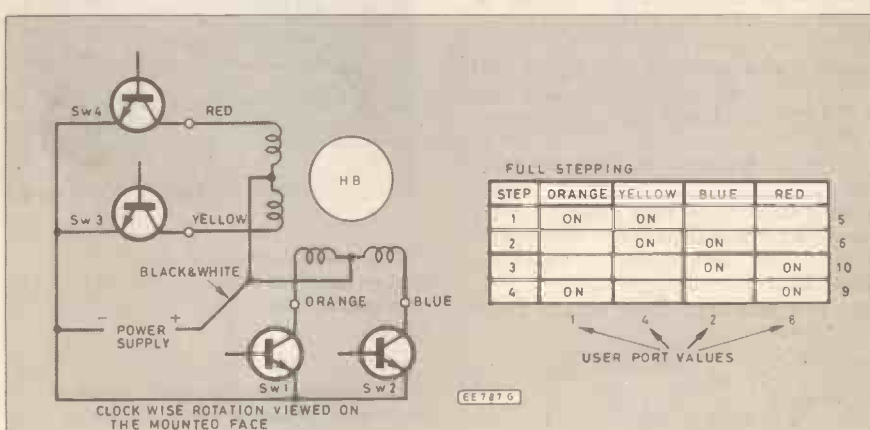
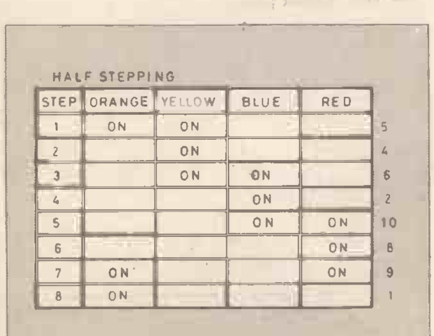
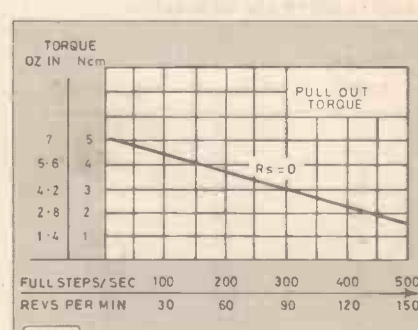


Fig. 8. The MD200 stepping motor drive sequences and torque/speed graph.





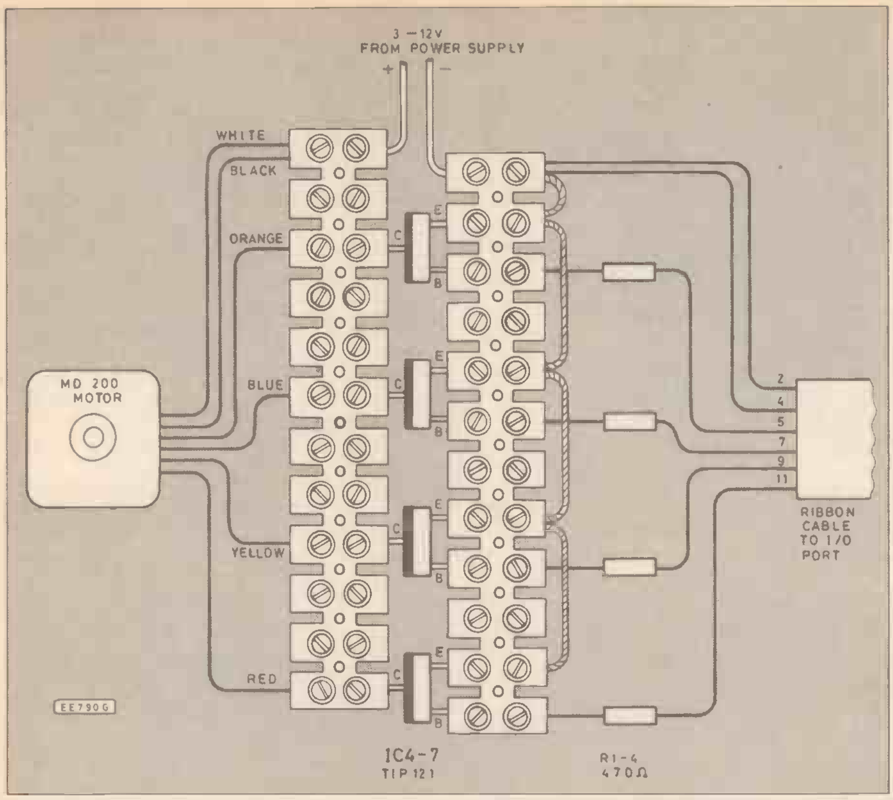
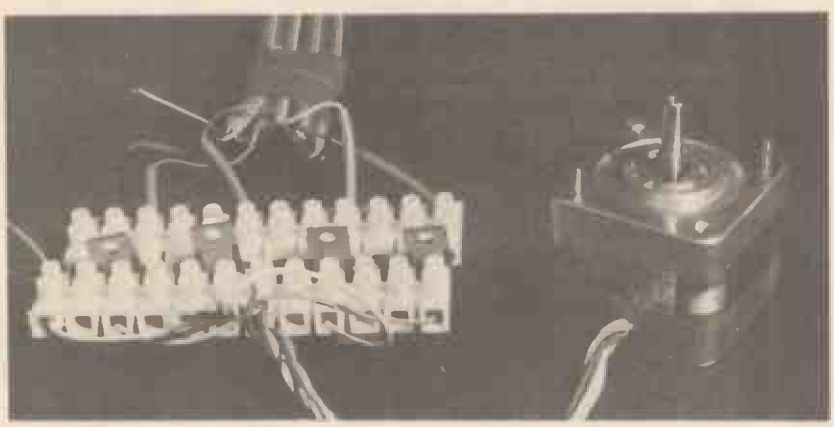


Fig. 9. Wiring details for the stepper motor driver connections using power Darlingtons.



```
  5 REM stepping motor driving program
        for half step operation of
        MD200 stepping motor
 10 LET f=0
 20 LET p=0
 30 INPUT x
 70 IF p=-1 THEN LET p=7
 75 IF p=8 THEN LET p=0
 80 IF p=0 THEN LET s=5
 85 IF p=1 THEN LET s=4
 90 IF p=2 THEN LET s=6
 95 IF p=3 THEN LET s=2
100 IF p=4 THEN LET s=10
105 IF p=5 THEN LET s=8
110 IF p=6 THEN LET s=9
115 IF p=7 THEN LET s=1
120 OUT 65487,s
122 IF f=x THEN GO TO 200
124 IF f>x THEN LET p=p-1
128 IF f<x THEN LET p=p+1
140 IF f>x THEN LET f=f-1
150 IF f<x THEN LET f=f+1
160 GO TO 70
200 PRINT "in position "; f
310 GO TO 30
```

```
  5 REM stepping motor driving program
        for full step operation of MD200
        stepping motor
 10 LET f=0
 20 LET p=0
 30 INPUT x
 70 IF p=-1 THEN LET p=3
 75 IF p=4 THEN LET p=0
 80 IF p=0 THEN LET s=5
 90 IF p=1 THEN LET s=6
100 IF p=2 THEN LET s=10
105 IF p=3 THEN LET s=9
120 OUT 65487,s
122 IF f=x THEN GO TO 200
124 IF f>x THEN LET p=p-1
128 IF f<x THEN LET p=p+1
140 IF f>x THEN LET f=f-1
150 IF f<x THEN LET f=f+1
160 GO TO 70
200 PRINT "in position "; f
310 GO TO 30
```

Fig. 10. Spectrum program listings for half- and full-step MD200 motor driver.

Standard four phase unipolar stepping motors require four transistors to drive them. Fig. 8 shows the circuit and the connections required. The two tables in Fig. 8 show which transistors need to be turned on to produce full-step rotation and half-step rotation.

A simple practical connection arrangement of the port is shown in Fig. 9. Two 12-way terminal blocks are used to connect between the power transistors and the input and output leads. The computer port output lines D0, D1, D2 and D3 are used in this arrangement each one driving a winding of the stepping motor via a TIP121 power transistor. The order of the connections is made so that the sequence numbers 5, 6, 10, 9 are required on the output port to give full step clockwise rotation. Reversing the sequence gives anticlockwise rotation.

For half-step rotation the additional values of 4, 2, 8 and 1 are added to the sequence. The MD200 motor supplied by Magenta gives 200 steps per revolution when full stepping and 400 steps per revolution when half stepping. A separate power supply is required for the stepping motor. This should be 12V at 500mA for full power but the motor will run very well at voltages as low as 3 volts and 50mA current.

PROGRAMS

Two simple programs are given in Fig. 10 for full and half step operation. These are only intended for demonstration but can be modified and incorporated into more elaborate software for computer control systems. As they run in BASIC they are also rather slow—the motor can be run at very much higher speeds. Other languages or possibly even machine code routines could be written which will result in much faster rotation of the motor. The programs are accurate however, and demonstrate very well the ideal use of stepping motors in open loop positioning systems.

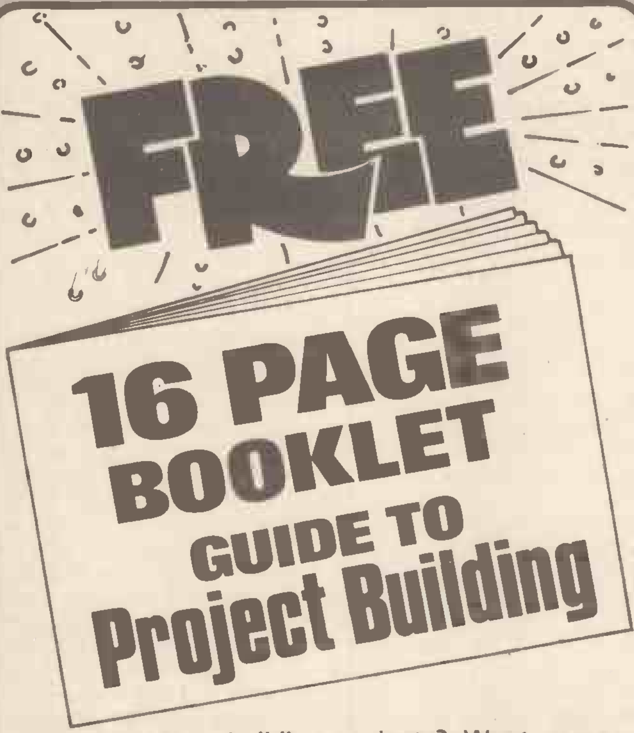
Each program sets the motor to the step 1 position and then prompts for a position. Entering the number 200 will result in 1 full rotation in full-step mode and one-half rotation in half-step mode. Any positive integer can be entered and the motor will move to that position. Enter 0 and the motor will return to the starting position. The program cannot handle negative or fractional numbers but these are not usually required in stepping motor systems.

AERIAL ROTATOR

A good application for a system of this type would be an aerial rotator. Note though that should the computer be turned off it will lose track of the position of the motor and will just lock it into the nearest "step 1" position when switched on again. This problem can be solved fairly easily by the use of a "homing" sensor which could be connected to the input side of the user port. Such a sensor would normally be a slotted photosensor or a microswitch arranged to detect when the motor or load is in a specific "home" position. A simple initialising program is run after switch-on to rotate the motor slowly until the homing sensor indicates that the starting position has been reached.

Note that the stepping motor driver section of the circuit is also usable with any other computer output port, such as that on the BBC computer. □

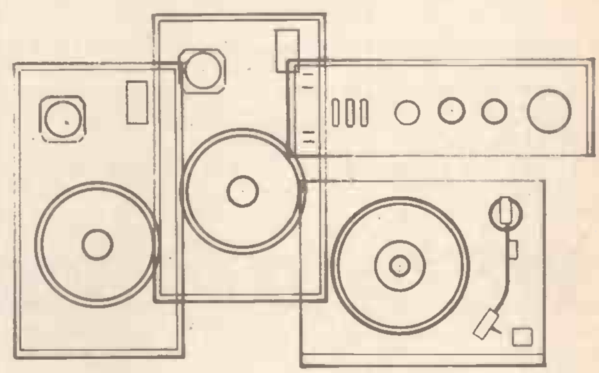
MARCH FEATURES...



Worried about building projects? Want some more details on construction, component identification, wiring, etc? Then this special booklet is just for you.

HI-FI AMPLIFIER

A 50 watt per channel true hi-fi amplifier which will arguably be one of the best ever published. Designed by Graham Naulty especially for EE, the Apex amplifier will certainly be the most up market project we have ever published. If you like your music this amp. is for you.



DIGITAL IC TESTER

A very useful piece of test gear that can be used for testing the majority of common CMOS and TTL logic gates and devices.

Computer BUFFER/INTERFACE

Provides buffered outputs with increased output current. Suitable for experimentation, for educational equipment and as a line driver. The unit protects the computer, is rugged, reliable, easy to build and inexpensive.

EVERYDAY ELECTRONICS

MARCH ISSUE ON SALE FRIDAY, FEBRUARY 20, 1987

Actually Doing it!!

FOR the complete beginner it is definitely advisable to choose a first project that is very simple and is accompanied by thorough and explicit building instructions. In fact it is advisable for beginners to limit themselves to projects of this type until they have successfully put a few projects together, and then to be a little more ambitious. This does not just mean building bigger and better projects, but also embraces tackling some of the design work yourself.

Designing the electronics for projects yourself is something that is well beyond the scope of the average beginner, and is an ability that is only likely to develop after a fair amount of experience has been gained. On the other hand, designing your own circuit boards is a relatively simple task, and something most constructors try their hand at before too long. There are plenty of circuits published in magazines and books (*Circuit Exchange* in this magazine, for example, provides a source of useful circuits), and before too long you will probably wish to build one of these. With only a circuit to work from there is little choice but to design your own circuit layout.

STRIPBOARD

There are several methods of construction to choose from, but really stripboard and a custom printed circuit board are the only practical choices for most circuits. Designing and building printed circuit boards is quite an interesting and challenging hobby in its own right, but it is something that is perhaps best left until a fair amount of experience has been gained. For the beginner stripboard represents a much easier starting point and it is the constructional method we will consider here.

Stripboard is something that anyone who has constructed a few projects is likely to have encountered already, but I suppose that the popularity of buying custom printed circuit boards is such that this is not a foregone conclusion. It is a form of proprietary printed circuit board having continous rows of copper strips spaced 0·1 inches (2·54 millimetres) apart and a matrix of holes on a 0·1 inch pitch, as shown in Fig. 1.

As with an ordinary printed circuit board, the components are mounted on the plain side and soldered into place on the underside. However, with a custom printed circuit board the copper tracks are designed to join up the components in the appropriate manner, whereas with stripboard it is necessary to design the component layout so that the rows of copper strips provide the required interconnections. In fact this is generally too simplistic to be workable in practice, and with all but the most simple of circuits some link wires on the top side of the board will be needed, together with some breaks in the copper strips on the underside.

As an example of how to translate a circuit diagram into a stripboard layout we will use the circuit of Fig. 2 as our basis. This is for a simple signal tracer which is basically just a high input impedance, high gain amplifier feeding into a crystal earphone. The circuit is simple enough, but a point that has to be kept in mind is that simply providing a board layout that connects everything together in the right way will not necessarily result in a working project.

Signals in one part of the circuit can be coupled to other parts of the circuit via stray capacitances and (or) inductances, and with stripboard the main route for this stray coupling is via the capacitance between adjacent copper strips. With many circuits this is something that is of no consequence, but with a sensitive amplifier of this type it can easily result in the unit turning into an oscillator. This is something we will consider in more detail shortly, but the first task is to make a start on the component layout.

With experience you may well be able to make up stripboard layouts as you go, but initially, even with quite simple projects, it is a good idea to draw them up and perfect them on paper first. In fact these days you may have one of the increasingly popular computer drawing packages, and some of these are excellent for this type of thing as they enable changes to be made very easily. If the design is drawn up on paper it is a good idea to use graph paper and to use a soft pencil at moderate pressure so that bits of the drawing can easily be erased and redrawn if necessary.

Drawing the design at double life size is likely to give a less cluttered and easily followed result, but you need to be careful that adequate space is allowed for each component. It is remarkably easy to produce a very plausible looking 2:1 layout that is totally unbuildable in practice due to over-crowding of the components. A good way of avoiding this is to fit the components onto the board (without actually soldering them in place or trimming the leadout wires) as you draw up the design, making sure that everything fits into place properly.

When designing anything the most difficult part is deciding where to start. It is probably best not to go in for too much prevarication, but to jump in and make a start. Use the lowest strip on the board as the earth rail, one an inch or so higher as the positive supply rail, and have some spare board above this for the mounting holes for the board. The input part of the Fig. 2 circuit around TR1 is the logical place to start, and it is usually easier if the physical layout is along the same general lines as the layout of the circuit diagram. In other words, C1 should be towards the extreme left hand side of the board, working across to C5 which should be on the extreme right hand side.

Potentiometer VR1 and jack socket JK1 are off-board components, and there are two basic approaches to dealing with these. The first is to have these connected to the board just like the other components, but via solder pins and hard wiring rather than actually mounting them on the board. The alternative approach is to only have these components connected to the board where this is unavoidable, with any connections purely between off-board components being taken direct from one to the other and not by way of the board.

With a custom printed circuit design the former is often the neater and better solution, but with stripboard the latter is perhaps the better method. This is especially the case with a design of this type where in the interests of stability and low pick up of electrical noise there should be a minimum of wiring at the input, and what wiring there is should be screened. In this case then, it is probably best if the board is wired to VR1 using a screened lead, with a second screened lead being used to connect VR1 to JK1.

THE LAYOUT

The standard technique is to position the active components first and then to fit the passive components in around them.

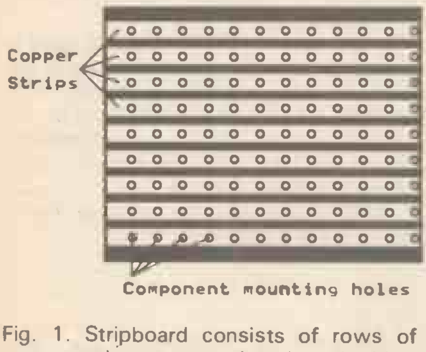


Fig. 1. Stripboard consists of rows of copper strips on an s.r.b.p. board with a matrix of component mounting holes.

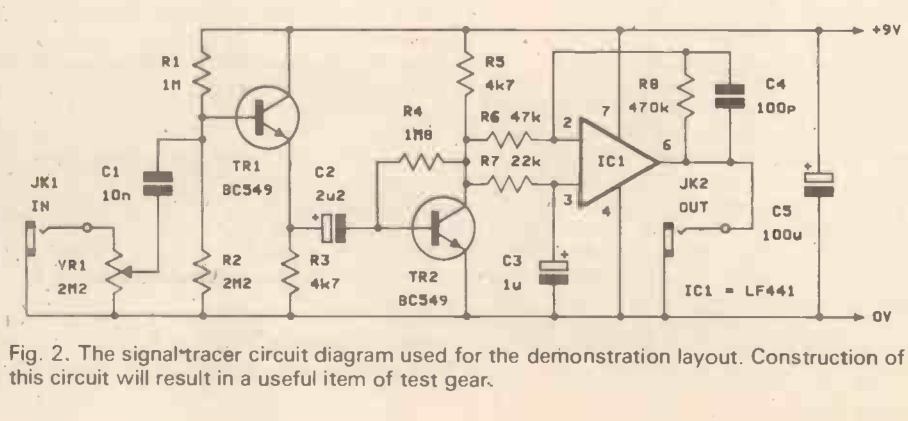


Fig. 2. The signal tracer circuit diagram used for the demonstration layout. Construction of this circuit will result in a useful item of test gear.

Where there are a fair number of passive components per active device, as in this case, it is usually easier if the active components are taken one at a time. In this case TR1 is the one to start with, and the obvious place to position it is towards the top left hand corner of the board with its collector terminal on the positive supply strip, and the base and emitter terminals on the two strips immediately below this one. R1 to R3 can then be drawn in across the appropriate copper strips, you will normally find that once a main component has been positioned on the layout that the other components more or less fall into place around them.

There is a slight problem with R1 in that it has to connect between adjacent copper strips, and it can only be mounted horizontally if it is positioned diagonally on the layout. Having one or two components mounted diagonally across the board is all right, but it is something that is probably best avoided as far as possible. This is simply because the general scheme of things is to have the copper strips running across the board with the components running perpendicular to them. Components mounted diagonally across the board can tend to get in the way, resulting in a lot of wasted board area.

Normally vertical mounting of resistors is something that is avoided as it is relatively weak mechanically. With stripboard a few compromises have to be accepted, and mounting resistors in this way is one I accede to. With custom printed circuit boards it is normal for resistors (and many other components) to have their mounting holes a standard distance apart which makes construction of the board much easier. This approach does not lend itself well to stripboard layouts though, where it would necessitate the use of large numbers of link wires. This would probably increase the time needed to build the board and would also increase the risk of errors. It is something I would definitely not recommend.

In some instances the components will force you to use a specific pitch for the mounting holes, and many printed circuit mounting capacitors (with their minimal leadout wires) fall into this category. Ideally C1 would be mounted from the strip that connects to TR1's base, down to a copper strip near the earth rail. The two pins to carry the connections to VR1 would then be close together, making it easy to connect the screened cable to them. If the component used for C1 is an uncooperative type this would only be possible with the aid of a link wire. Due to the sensitivity of the circuit it is probably best to have as few strips as possible carrying the input wiring, and it would therefore be better to simply settle for the two pins being some way apart.

The next component to fit into place is TR2, which logically has its emitter terminal connected to the earth rail with the base and collector terminals connected to the strips immediately above this one. Once again, the passive components (R4, R5 and C2) then naturally fall into place between the appropriate pairs of strips. This gives us a layout of the type shown in Fig. 3. Obviously there is no definitive layout, and numerous practical layouts are possible. In Fig. 3 physical representations of the components have been used, and these are generally easier to follow when building the board, and they also reduce the risk of designing an impossible layout. However, many people find it easier to use circuit symbols, and this is really just a matter of using whichever system you find it easier to work with.

FINAL STAGES

The final stages of development are to place IC1 on the layout, leaving sufficient space to its left for R6, R7 and C3. In fact it might be better to fit these three passive components into the layout first, but they would have to be positioned in such a way that they could tie in correctly with IC1 when it is added to the layout, and some forethought can save a lot of redrawing or adding of unnecessary link wires.

With IC1 added, some link wires become inevitable, as these are needed to connect the device to the supply rail strips. Another link wire is needed to connect R8 and C4 across the appropriate pins of IC1 (which are on opposite sides of the device). As these components are wired in parallel it is possible to use a single link wire for them both, and it is only sensible to do so. It is possible to simply wire in components over the top of an integrated circuit, but this is a very untidy and unreliable way of doing things which should be avoided.

Breaks in the copper strips must be introduced at this stage, with four being needed between IC1's two rows of pins. These can conveniently be marked using "X" signs at the appropriate points on the drawings. Always be on your guard against unwanted connections between newly added and existing components. In this case two further breaks in the strips are needed in order to eliminate a couple of these.

FINAL LAYOUT

The finished layout appears in Fig. 4. Capacitor C5 could have been an axial type wired straight across the supply rails, but a radial type plus a link wire enables an otherwise vacant area of the board to be occupied and gives a more compact layout. I have actually left the components well spread out in general, and it would obviously be easy to draw up a condensed version of the layout. Where compactness is important this is often the most satisfactory way of doing things, rather than trying to jump straight in with a miniature layout.

Always check the finished design very carefully a couple of times, preferably going away and leaving it for a while before making the final check. It is much easier to correct mistakes on the drawing than on the finished board. Also, mistakes on the drawing will not damage any components, but those that are carried through to the finished board might. Can you spot the deliberate mistake in Fig. 4?

STABILITY

As explained previously, any significant stray feedback from the output to the input of the amplifier is likely to result in oscillation which would render the unit useless. This layout looks to be quite good as far as stability is concerned, with a break in the copper strip close to the non-earthy input terminal so that there is little opportunity for stray pick up here. The base terminal of TR1 is equally sensitive to stray pick up, and it might be worthwhile moving the break on this copper strip along to the left, close to R2. Alternatively, an extra break in the strip could be placed here, and extra cuts are a good way of minimising the length of strip carrying signals so that stray feedback is discouraged. In an extreme case unused bits of copper strip can be removed so as to reduce stray coupling. A less extreme but effective system is to have an earthed copper strip running between two strips which could potentially give feedback problems. This usually screens them from each other well enough to avoid problems.

On the output side of the circuit there is only a short length of strip carrying the output signal. Note that the link wire from R8 and C4 to IC1 has been placed on the input side of IC1. Placing the link wire on the output side would start to introduce possible feedback routes from the output to the input and would be a dubious way of doing things.

Robert Penfold

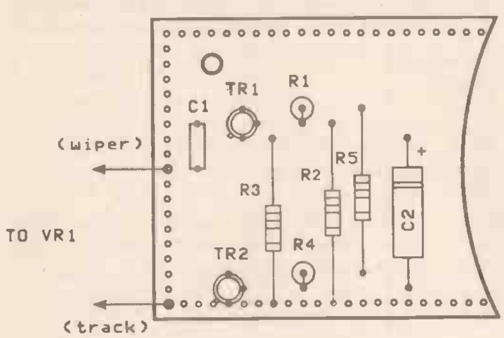


Fig. 3. The component layout in its early stages.

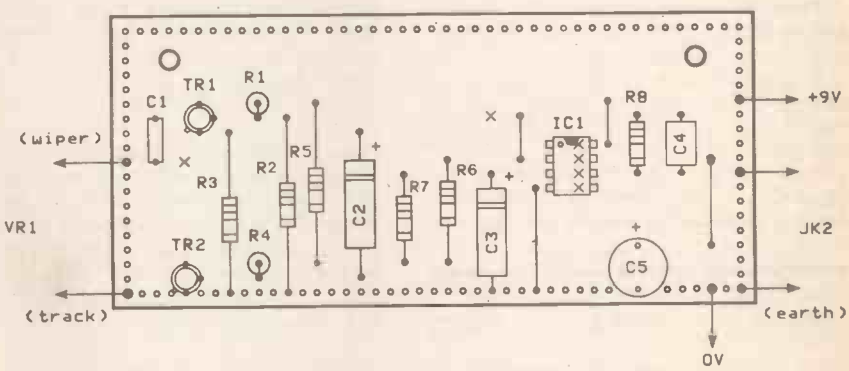


Fig. 4. The final (unchecked) component layout.

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 8 Using a Thermistor as a Frost Alarm

THIS month we use the properties of a device first introduced in Part Four of this series to develop a circuit which will react to changes of temperature and to build up a Simple Frost Alarm. The device is a thermistor which, as we have seen, has a high resistance when very cold and its resistance drops as the thermistor gradually warms up, i.e. recovers to a preselected level.

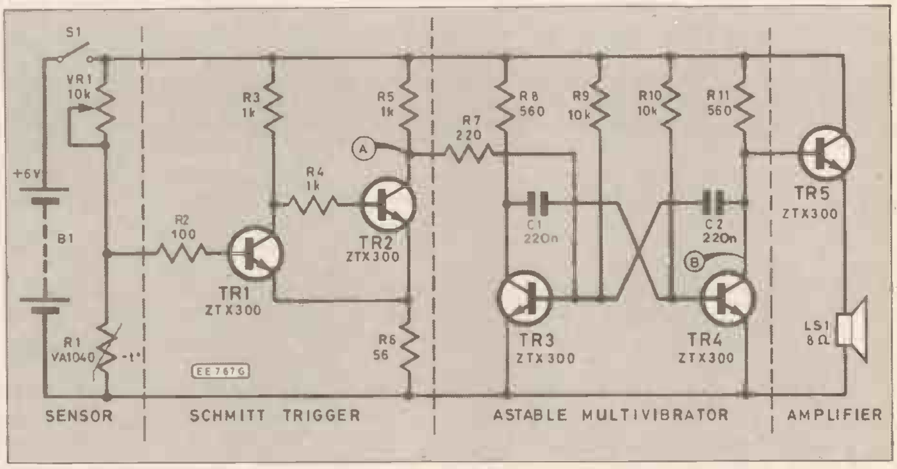


Fig. 8.2. Complete circuit diagram of a Simple Frost Alarm. This circuit is made up of various circuits already described in this series.

THERMISTORS

Just to recap, a thermistor is made by mixing nickel, cobalt, manganese and other oxides. The mixture is heated to fuse it into a bar, disc, or bead.

As the temperature increases, the resistance of the material decreases. We say it has a negative temperature coefficient. The "–t" in the symbol used for this device indicates this fact, see Fig. 8.1. Positive temperature coefficient thermistors are also available.

SIMPLE FROST ALARM

The complete circuit diagram for the Simple Frost Alarm is shown in Fig. 8.2. This circuit consists of three circuits previously described in the series, namely the Schmitt trigger, astable multivibrator and a single transistor amplifier.

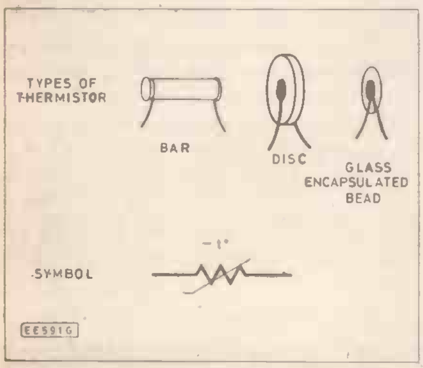


Fig. 8.1. Various types of thermistors.

The circuit can be set to switch on an audible alarm whenever the temperature falls close to freezing, or to any other level. It can also be set to sound when the temperature has risen to a given value, so it is useful as a warning indicator when the greenhouse is too hot and needs ventilating.

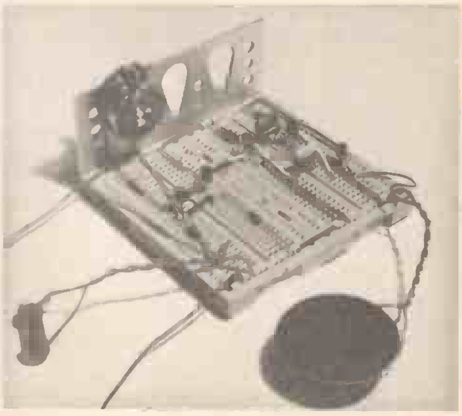
HOW IT WORKS

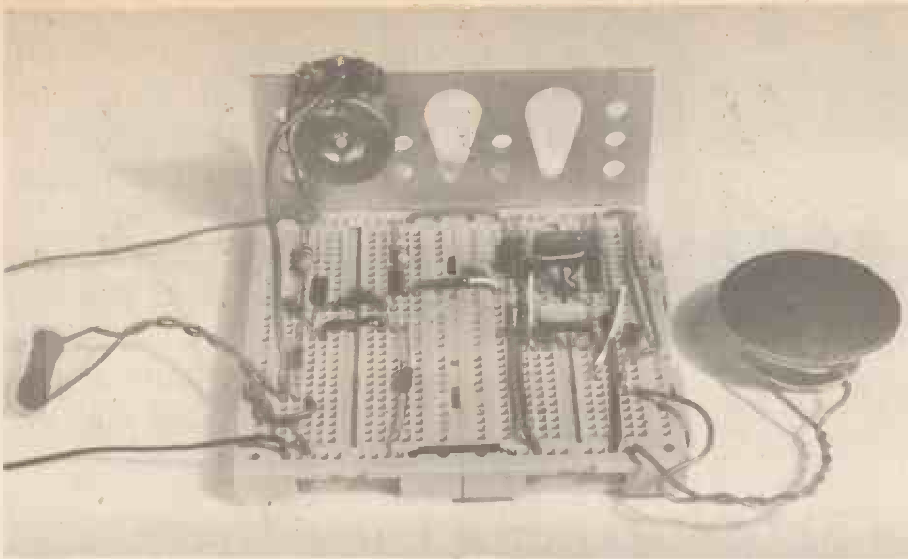
The temperature sensor (Fig. 8.2) is a negative coefficient thermistor, R1. It can be situated in a remote place (for example, the greenhouse) if required.

The thermistor operates a Schmitt trigger circuit, similar to that described in Part Five (November '86 issue), but with a reduced gain. When the temperature of the thermistor is above a chosen value, set by adjusting potentiometer VR1, the voltage at the collector of TR2 (point A) is low. As the temperature falls below this value, the voltage goes high.

The trigger section of the circuit is connected to an astable multivibrator (TR3, TR4) through resistor R7. When the circuit is not in the triggered state, the voltage of the base of TR3 is held low, so TR3 is permanently off and the multivibrator can not oscillate. No sound comes from the loudspeaker LS1

When the temperature falls to below the chosen level, the voltage at the collector of TR2 suddenly goes high. This change allows TR3 to be turned on and off as the multivibrator oscillates. The changing voltage at the collector of TR4 (point B) is fed to the amplifier section. A sound is now heard from the loudspeaker.





COMPONENTS

Resistors

R1	VA1040 thermistor
R2	100
R3–R5	1k (3 off)
R6	56
R7	220
R8,R11	560 (2 off)
R9,R10	10k (2 off)

All 0·25W, 5% carbon except where stated

See Shop Talk page 75

Potentiometer

VR1	10k carbon, lin.

Capacitors

C1,C2	220n polyester (2 off)

Semiconductors

TR1–TR5	ZTX300 *npn* transistor (5 off)

Miscellaneous

B1	6V battery box with cells
S1	switch
LS1	8 ohm loudspeaker

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

Approx. cost Guidance only £10

CONSTRUCTION

The demonstration breadboard layout is shown in Fig. 8.3. Commence construction by building the multivibrator and amplifier sections first and make sure they operate correctly. Then build the trigger section, and join it to the multivibrator by resistor R7.

When you switch on, you will be able to make the alarm emit sound or stay silent by altering the setting of VR1. Adjust VR1 to the position in which the alarm *just* ceases to sound. Then put the thermistor R1 in water containing ice. After a few seconds, the alarm should sound loudly.

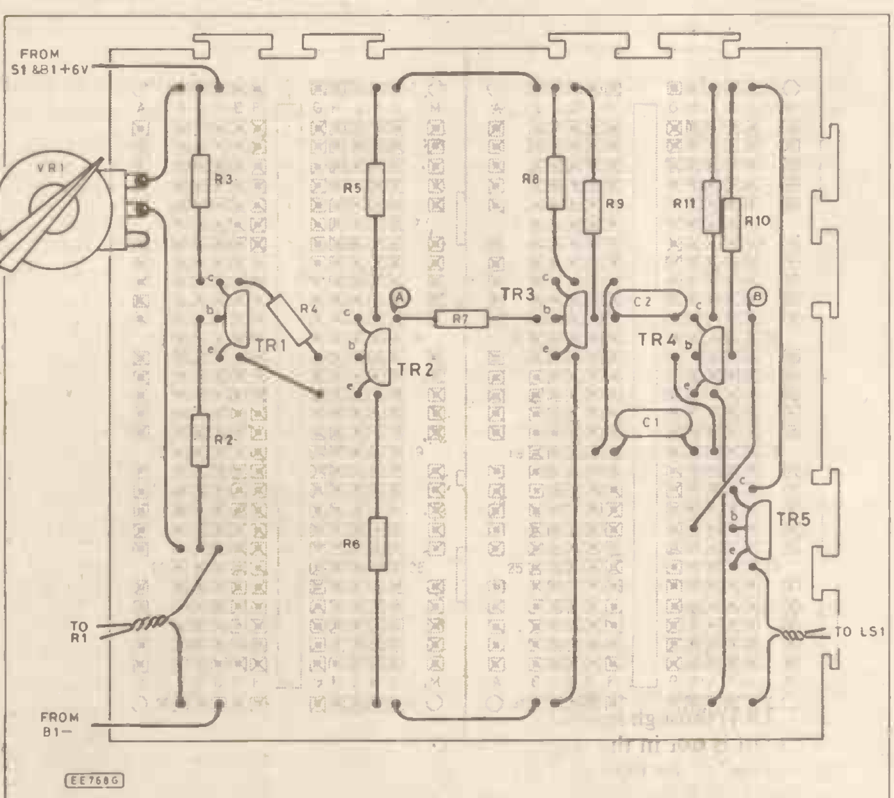
You will probably notice that, when the alarm is connected to the trigger circuit, it has a higher-pitched sound. This is because extra current flows through resistor R7 to capacitor C2, when the alarm is being activated. This means that C2 charges more quickly than before, so the action of the multivibrator is speeded up—it works at higher frequency and gives a higher-pitched sound. If the pitch is too high, try increasing the value of C2.

VARIATIONS

This circuit can be adapted so that it can be triggered when the temperature rises *above* a certain level. Simply exchange resistor R1 and potentiometer VR1, Fig. 8.4. You may find it better to use a one kilohm variable resistor (potentiometer) instead of one of ten kilohms. This circuit could become the basis of a fire alarm system.

Another variation is to use a light-dependent resistor, l.d.r. in place of thermistor R1. The alarm can then be triggered by the breaking of a beam of light, or by the sudden increase in the amount of light falling on the l.d.r. This has obvious applications as a security device.

Fig. 8.3. Demonstration layout on two breadboards for the Simple Frost Alarm.



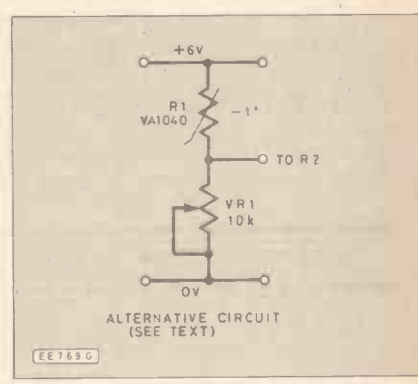


Fig. 8.4. Alternative arrrangement to trigger the circuit when the temperature rises above a preset level.

Next Month: Light triggered circuits, including a Slave Flash project and a Model Railway or Robot Control

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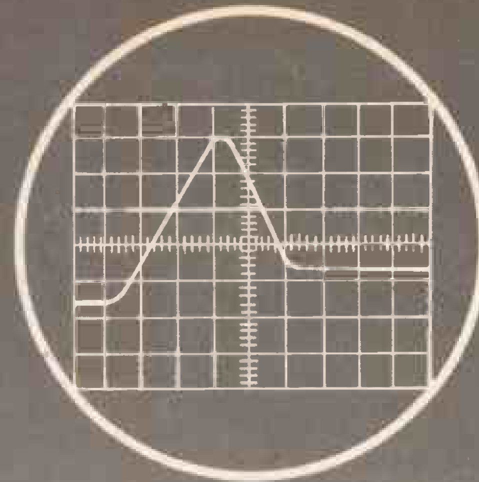

BRIAN HOLLINGSWORTH

Though an oscilloscope is undoubtedly the most common piece of test equipment that the engineer will purchase, and probably the most expensive. Essential, because it enables the user not only to measure the voltage and frequency of his signal but also displays any irregularities in the signal, irrespective of whether the signal is a digital or analogue output. As yet the oscilloscope has no real parallel for checking the dynamic performance of an electronic, or indeed electrical, circuit.

However, all too often the instrument is not used to its full capability or, worse, is expected to perform well beyond its specification limits. These shortfalls are often caused by uncertainty on the user's part regarding the terms used to describe the instrument's performance parameters and, therefore, more importantly how to apply these parameters to a specific technical requirement.

Initially it should be understood that an oscilloscope is an analogue measuring instrument which displays rapidly changing, or high frequency, voltages against time in the form of a graph on a cathode ray tube (c.r.t.). Two main circuit elements achieve this, the vertical deflection system (Y), and the time base or horizontal deflection system (X). The main circuit elements of a particular oscilloscope are shown in the block diagram Fig. 1. The constraints of both these systems dictate the main specification parameters of the instrument.

So let us look at the vertical system and terms used to define its performance.

DEFLECTION COEFFICIENT

The vertical amplifier is a fixed gain system comprising a high sensitivity pre-amplifier section feeding an output amplifier which in turn connects to the vertical plates (Y) of the c.r.t. However, as the oscilloscope will undoubtedly be required to investigate signals over a wide range of voltages, the test signal is initially connected to an attenuator, or sensitivity control, which reduces the signal applied to the amplifier.

The attenuator is typically calibrated with deflection coefficients of 2mV/division to 10V/div. So the combination of the vertical amplifier and attenuator set the first parameter of the oscilloscope, the sensitivity range or deflection coefficient.

BANDWIDTH

The next parameter that we should look at is the bandwidth of the vertical amplifier; normally this is given for the −3dB point. So what is bandwidth? All amplifiers have what is called a response curve, in other words, deflection amplitude at various frequencies for a constant input amplitude. Due to the amplifier's response at high frequencies the amplitude of the displayed trace will decrease and the frequency at which the amplitude is decreased to 0·707 (−3dB) of the original low frequency amplitude (say 50kHz) is denoted as the bandwidth.

It should also be noted that the response of an amplifier rolls off more rapidly once the −3dB point has been passed, typically in a 20MHz bandwidth instrument the response has fallen to 0·35 (−9dB) at 40MHz. A typical response curve for an oscilloscope is shown in Fig. 2.

In practice the bandwidth of an oscilloscope is the most important parameter that should be seriously considered when selecting an oscilloscope for any application, as there are certain traps which should be avoided. For example, if the highest frequency waveform to be investigated is a 2MHz sine wave; is a scope with a 2MHz bandwidth all that is needed? Certainly this would be the minimum requirement; it should be noted that if the sine wave contained harmonics, or aberrations, then only the second harmonic (i.e. 4MHz) would be seen, and as this would be at the −9dB point could not be measured with any degree of accuracy. Also if the signal contained high frequency parasitics then these undoubtedly would not be seen. Therefore, the bandwidth of the oscilloscope needs to be greater than the fundamental frequency of the test signal, for instance in this

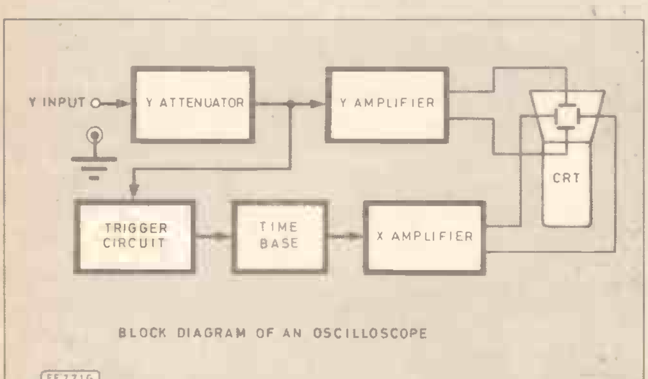

Fig. 1. Main circuit elements of an oscilloscope.

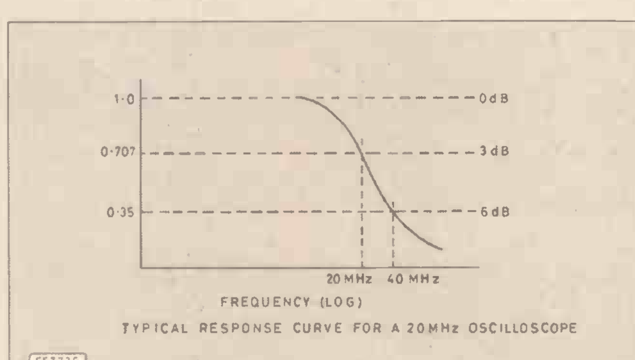

Fig. 2. The response of the Y amplifier.

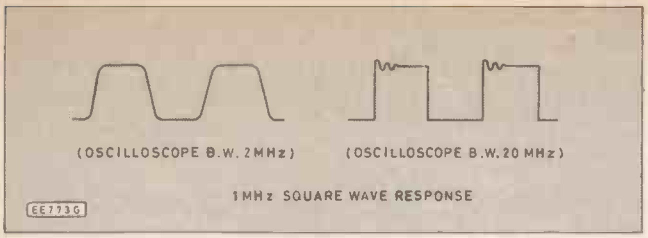

Fig. 3. Effect of limited bandwidth on the signal display.

example a 20MHz oscilloscope will display and enable the 9th harmonic of a 2MHz sine wave to be measured with a high degree of accuracy.

If we now look at an application where we need to display and measure a 2MHz square wave signal then the bandwidth of the instrument becomes even more important. For if the scope bandwidth is the same as the fundamental frequency then the displayed trace would look more like a sine wave, as shown in Fig. 3. This is because in theory a square wave contains an infinite number of harmonics. So in this application an oscilloscope with a 15MHz or 20MHz bandwidth is essential. While these examples have dealt with 2MHz signals the comments are equally valid for any test frequency, and therefore the bandwidth of the oscilloscope chosen to meet a particular application should be high relative to the test frequency.

RISETIME

In applications which involve the analysis of square waves or pulses then the risetime of the vertical amplifier is a far better guide to the suitability of the instrument for the particular application. The risetime of an oscilloscope is defined as the time taken for the leading edge of the signal to rise from 10 per cent to 90 per cent of its maximum amplitude, see Fig. 4, and is normally specified in nano seconds (ns).

A trap to be avoided in this type of application is to select an oscilloscope with the same risetime as the test signal, as the displayed risetime on the scope will be approximately 40 per cent larger than it is in practice. To prevent falling into this trap the risetime of the oscilloscope should be faster than the test signal, ideally around five times faster as then the displayed error will be less than two per cent, and for most practical purposes can therefore be ignored. However, if this puts the required oscilloscope beyond your budget then an instrument with a risetime of the same order as the test signal can be selected and the actual risetime calculated using the following formula:

$T_{RA} = \sqrt{T_{RM}^2 - T_{RO}^2}$

where T_{RA} = actual risetime, T_{RM} = measured risetime and T_{RO} = scope risetime.

It should be noted that the oscilloscope may well be better than the quoted risetime and therefore errors could result because of this.

HORIZONTAL DEFLECTION SYSTEM

The main circuit element in the horizontal deflection system is the time base which provides an accurate signal varying directly with time which is applied to the horizontal deflection plates of the c.r.t. The ramp generator incorporated in the circuit is invariably designed to be compatible with the bandwidth of the vertical amplifier, so that at the fastest sweep speed several cycles of the bandwidth frequency can be displayed.

The sweep speed is selected on the time base control which is marked in second/div; the majority of instruments currently available use a 1, 2, 5 sequence on this control. This sequence has been selected as it gives a very good degree of overlap between ranges so that a test signal may be displayed on more than one time base range. An ×5 expansion control which enables the complete trace to be expanded, on any sweep speed, is also often incorporated and this facilitates more detailed investigation of the displayed wave form.

MEASUREMENTS

As mentioned earlier the oscilloscope is an analogue instrument but unlike other instruments of this type it displays the peak to peak voltage value of a test signal, as opposed to the r.m.s. value which is more normal for, say, a volt meter. However, it is possible to calculate the r.m.s. value of a displayed sine wave. Fig. 5 shows a typical sine wave display. The first measurement that can be made is the voltage level of the signal. For this example let us assume that the vertical amplifier control is set at 20mV/div. and a display of 4 div. is obtained then the peak to peak voltage of this signal is: 4div. × 20mV = 80mV.

The r.m.s. value of this signal can be calculated by dividing the peak to peak value by $2 \times \sqrt{2} = 2{\cdot}83$, i.e. $80/2{\cdot}83 = 28{\cdot}2$mV (r.m.s.)

The peak voltage of the signal can also be calculated which in this case is 2 div. × 20mV = 40mV. In the case of square and pulse waveforms the peak to peak value is normally quoted and measured.

As both the vertical and horizontal deflection systems are calibrated in either volts/division or seconds/division both the voltage and time, and therefore frequency, of a displayed signal can easily be interpreted from the display on the face of the c.r.t.

FREQUENCY MEASUREMENTS

In Fig. 5 we have assumed a time base sweep speed of 5μs/div. If we now measure the time taken for the duration of one cycle we can calculate the frequency of the signal by using the following formula:

f = 1/time

The time for one cycle is therefore 4 div. × 5μs = 20 μs. Therefore the frequency is 1/20μs = 50kHz.

For a pulse waveform the measurement techniques are

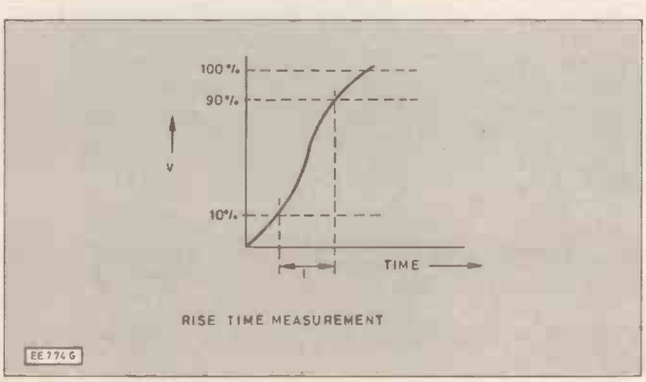

Fig. 4. Measuring the rise time of a 'scope.

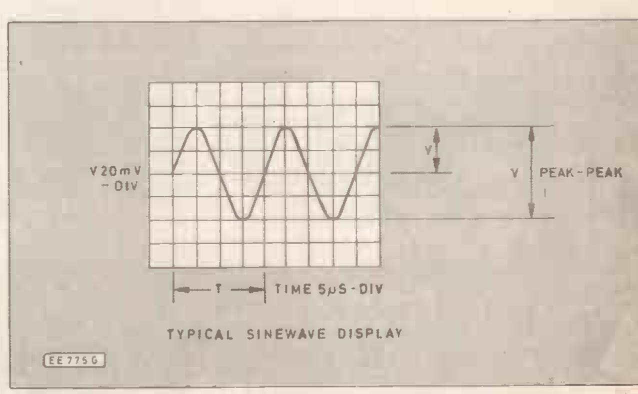

Fig. 5. Measuring a sinewave display.

exactly the same, though this type of waveform is normally specified in terms of pulse width and repetition rate, as opposed to frequency.

D.C. MEASUREMENTS

The oscilloscope can easily be used to monitor and measure d.c. voltages applied to the vertical input. In this mode of operation a reference point must first be fixed. This is achieved by selecting the auto trigger mode, so that a bright base line is displayed. Then the input to the vertical amplifier must be grounded by selecting the GND position on the input coupling switch. It should be stressed that in this position, only the amplifier is grounded, the test signal is left floating so that no damage can occur to the circuit under test. In the grounded position the vertical position of the trace should be adjusted to a convenient reference point on the display area (see Fig. 6). Then the d.c. coupling should be selected, the trace will shift vertically. If we assume that the sensitivity setting on the amplifier is 1V/div. and the shift is 4·5 div. then the d.c. voltage is 1V × 4·5 div. = 4·5V.

The shift in this particular example is upward which indicates that the applied d.c. voltage is positive. The same technique can also be used for measuring negative voltages.

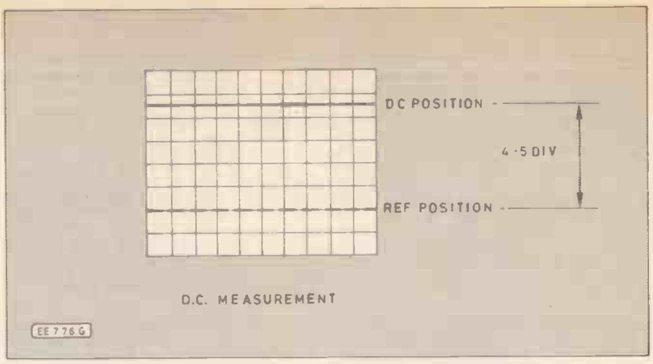

Fig. 6. The distance between the reference and the display gives the voltage.

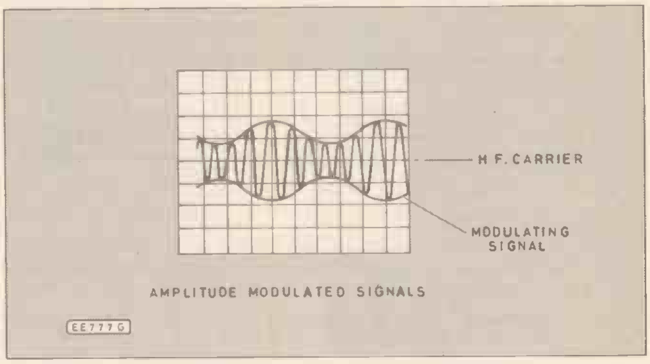

Fig. 7. External triggering is very useful on an amplitude modulated signal.

EXTERNAL TRIGGERING

The external triggering facility offers advantages over internal triggering under certain conditions. For example a master signal, such as the clock frequency in a digital circuit, can be applied to the external trigger. Then this leaves the vertical trace, or traces in a dual trace instrument, free to be placed at various parts of the test circuit without the need to re-adjust the trigger.

External triggering has also a distinct advantage when a signal contains both high and low frequency components. This is so in an amplitude modulated signal (Fig. 7). On internal triggering, difficulty will be experienced as the trigger circuit will try to lock on both the h.f. carrier and the l.f. modulating signal at the same time. Under low modulation depth conditions, the 'scope will trigger on the h.f. signal and the display will be free running. Therefore, the amplitude modulating low frequency signal should be applied to the external trigger socket. It will be found that reliable triggering can then be achieved under wide variations in both the carrier and modulating signal.

EXTRA FACILITIES

Some oscilloscopes offer extra facilities as part of the package. Those forming the special offer in this issue for instance (see page 86). The Crotech 3132 has a component comparator, which incorporates two well-proven component testers, each of which can be used to check both active and passive components. When used together they act as a comparator for checking a suspect device against a known standard, enabling faulty devices to be very quickly detected.

Circuit boards can also be compared by employing a circuit signature technique. Protection of the device under test is assured as the output of the comparators is limited to 28mA.

The 3132 also includes a triple output d.c. source with all outputs available on the front panel through 2mm sockets. The outputs are +5V at 1A; ± 12V at 200mA, with a floating common allowing ± 24V operation by grounding the appropriate terminal. These outputs are compatible with modern TTL and CMOS circuits, also all three outputs are protected by thermal shutdown in case of overload or short circuit conditions. The benefit to the user is that he now has three units in one instrument, a 20MHz scope, a means of checking components, and a power supply for driving development circuits or p.c.b.s under service. □

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For everyone out there with ZX81s gathering dust in a cubboard because they cannot play games like the Spectrum and you cannot think of anything else to do with them, Feedback Instruments has come up with the answer. The company's latest arm, the Armatrol MkII Model ESA 1010 can be controlled by the old Sinclair trailblazer as well as the BBC B, Commodore 64, Apple IIe and IBM PC.

To say that it is the company's latest arm is a little misleading as the list of, now ageing, machines with which it works indicates. It is an upgrade of the Micrograsp, one of the machines which Feedback took over when it merged its output with that of Powertrain Cybernetics at the end of 1985. At that time Feedback said it was not happy with a number of features, including the gripper, and improvements would be made.

The job was given to the US branch, Feedback Inc, and the machine has now gone back on sale as the Armatrol with a large number of small refinements to improve the quality and reliability and a more robust gripper and more user-friendly software.

However, the basic design remains the same. It is a mechanical articulated arm with four axes plus a gripper. It is driven directly by d.c. servos with potentiometers providing feedback and the gripper is also motor driven.

The waist can move through ±85 degrees, shoulder +90 degrees to −10 degrees, elbow and wrist pitch both ±80 degrees and the gripper can open to a maximum width of 38mm. It has a reach of 290mm and at full extension can carry nearly 0·5kg. Repeatability is claimed to be ±6mm.

For each computer there is what the company calls a personality pack which includes an interface, software and the necessary cables as well as a teaching manual. The software has been simplified in that feedback control is provided by the interface board and not through the host computer, however it is limited in that although the keyboard can be used to control the arm it cannot remember the movements. If any sequence is being created for playing later it has to be entered as part of a program, giving instructions to each axis, using the Armatrol's own movements scale.

As with most of Feedback's output it is intended for the education market and with all the necessary additions will cost about £1,100 with VAT on top.

WORKSHOP

Gordon Ashbee is considering reviving his Robotics Workshop concept which he first launched in South London two years ago. The original idea was for a shop selling all forms of robotics equipment where the assistants would also be able to provide advice to the customers.

There was no shortage of interested visitors but the sales did not match the effort the staff was putting in and the shop was closed. Now Ashbee says the time appears to be better and he is considering reopening with the same basic concept. He modelled the Robotics Workshop on the earlier Computer Workshops, which he also started, where enthusiasts could go to meet enthusiasts without being harrassed by over-eager, ill-informed salespeople.

One of the most common problems which Ashbee found was the lack of a universal interface. He contacted Peter Mellor of Micro-Robotics of Cambridge who has since come up with a solution in the form of a micro-controller which can accept up to eight analogue inputs and can control up to four digital outputs as well as 16 servos, an eight-stepper motor driver card and a 32-character l.c.d. and be programmed from a host computer.

GIRLS

The Inner London Education Authority is looking at ways in which it can encourage young women to taken an interest in what many see as the male preserves of robotics, cybernetics and electronics. It is looking for women who work in the sector, are within easy reach of the ILEA area and are prepared to speak to girls about how to set out on a career in these areas of engineering.

Anyone interested should contact Dave Doyle, deputy director, ILEA Design and Technology Centre, which is also the London SATRO, at 39 Black Prince Road, London SE11 6JJ, tel. 01-582 7588.

REDUCED MOVITS

In 1984 when interest in robots in the home suddenly took off in the UK, Prism Microproducts introduced a range of small toy robots from Japan called Movits. They were moderately successful and when Prism went into liquidation (for other unassociated reasons) the stock was taken over by Commotion.

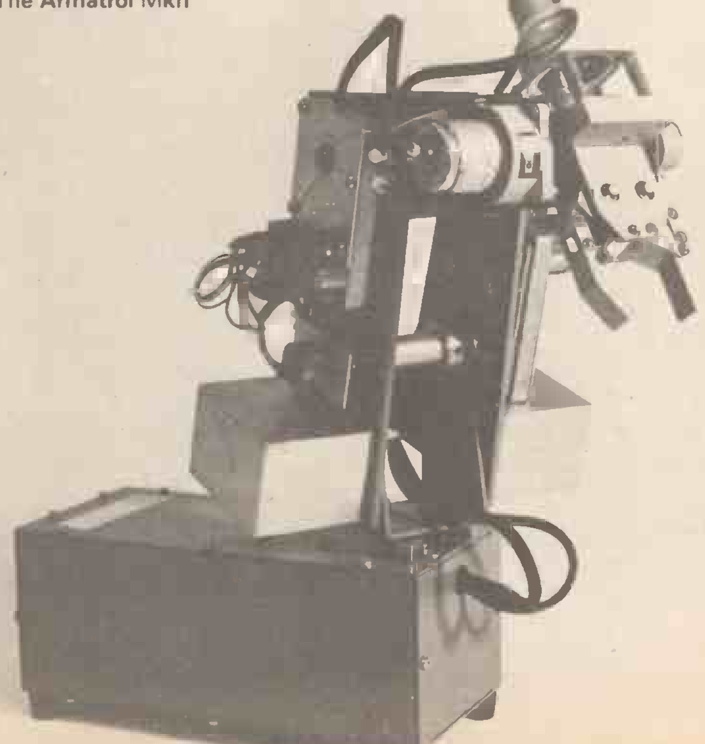
Five other models were added to the original five but after problems with delivery Commotion decided to pull out and is now offering two of the more complex machines at a reduced price to clear them. Both come in kit form and can provide some simple insights into the principles of robotics.

Line Tracer, as the name suggests, follows a line and, says Commotion, can be adapted into a simple buggy which can be run from any relay switching interface. Details of the conversion are included, all for £12.

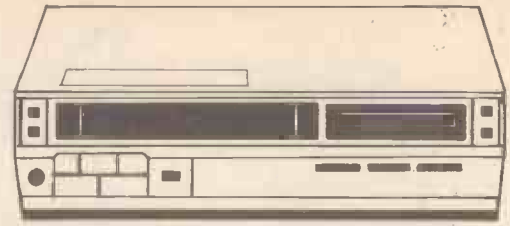
For £15 you can buy the Circular, a radio-controlled mobile where movement is provided by two vertical rotating rings, powered from within the machine, the relative speeds of which govern its direction.

Note: Readers of the December column will have been informed that the RTX from Universal Machine Intelligence could be obtained for £3,000. Unfortunately I was working from an out-of-date pricing and have since discovered the price to be about £5,000.

The Armatrol MkII



VIDEO GUARD



MICHAEL PERROW

Protect your video recorder from theft with this easy to use device

IT IS an unpleasant fact that home burglaries are on the increase and high on a thief's hit list are video recorders. The Video Guard described here is a simple alarm which is housed inside a standard video cassette. It is hoped that the device will help prevent the theft of a VCR.

The unit is inserted into the video recorder whenever it is not in use and is activated by any movement of the recorder. The majority of modern recorders will not eject the cassette without the mains power being connected to the unit and if someone intends removing the VCR, presumably one of the first things done would be to remove the mains cord. Once tilted the alarm will sound and continue until reset, which entails removing the cassette from the VCR.

CIRCUIT DESCRIPTION

The circuit can be split neatly into two distinct sections; the triggering section (Fig. 1) consisting of IC1, TR1 and associated components and the siren, comprising of IC2, IC3 and the passive components round the i.c.s. Integrated circuit IC1 is four separate two input NOR gates, in this application only three are used.

In the quiescent state IC1a has its inputs taken to the positive rail either via the link LK1 or the sensor unit. Its output is therefore low. IC1b and c form a bistable. In the untriggered state the output from IC1c is low resulting in TR1 base being held low and hence cutting off the transistor. With TR1 not conducting there is no negative return path for the siren section and this is therefore silent.

When the circuit is triggered by the position sensor going open circuit IC1a input is taken low via R1, this causes the output to go high which in turn takes IC1b high. The same results if the tilt switch is operated instead—IC1b input is taken high via R2 and the tilt switch.

This causes IC1b and IC1c to flip over onto their other stable state and IC1c output goes high resulting in TR1 turning on and allowing the siren to function. Capacitor C1 ensures the bistable always assumes the correct state on switch on.

SIREN

Integrated circuits IC2 and IC3 form a simple siren. IC2 operating at a high frequency and driving the loudspeaker via C6 whilst IC3 runs at about 4Hz and is used to modulate IC2 and give the siren effect.

Capacitors C3 and C4 along with R4,R5 and R6,R7 are the main components which decide the frequency of the oscillators and may be varied within reason to provide different sounds.

CONSTRUCTION

The prototype was built into a Betamax cassette which is physically smaller than its VHS counterpart so, providing that the printed circuit board is cut to the exact size and shape shown there should be no problems in building the video guard into either cassette system. In fact it should be a lot easier to fit into the VHS cassette.

The p.c.b. has been designed so that a choice of two different types of triggering device may be used. Either a position sensor or a tilt switch. When the latter is used a wire link must be fitted into the p.c.b. where the position sensor would have been fitted. No link is required when a position sensor is used.

Proceed with assembly in the normal pattern i.e. resistors and capacitors first followed by the transistor and i.c.'s the last component to be fitted should be the trigger unit. If a position sensor is used mount this vertically to the board. If your choice is a tilt switch mount this parallel to the p.c.b. In both cases leave a little spare length on the legs of the device to enable adjustment of the triggering angle.

With the board completed it is a good idea to give it a dry run to make sure it works correctly. Connect a loudspeaker and a 9V to 12V supply. On tilting, the alarm should sound and continue even when the p.c.b. is returned to its original position.

CASSETTE HOUSING

If all is well lay the p.c.b. to one side for a while and prepare the housing. You can use an old tape or buy the cheapest new tape

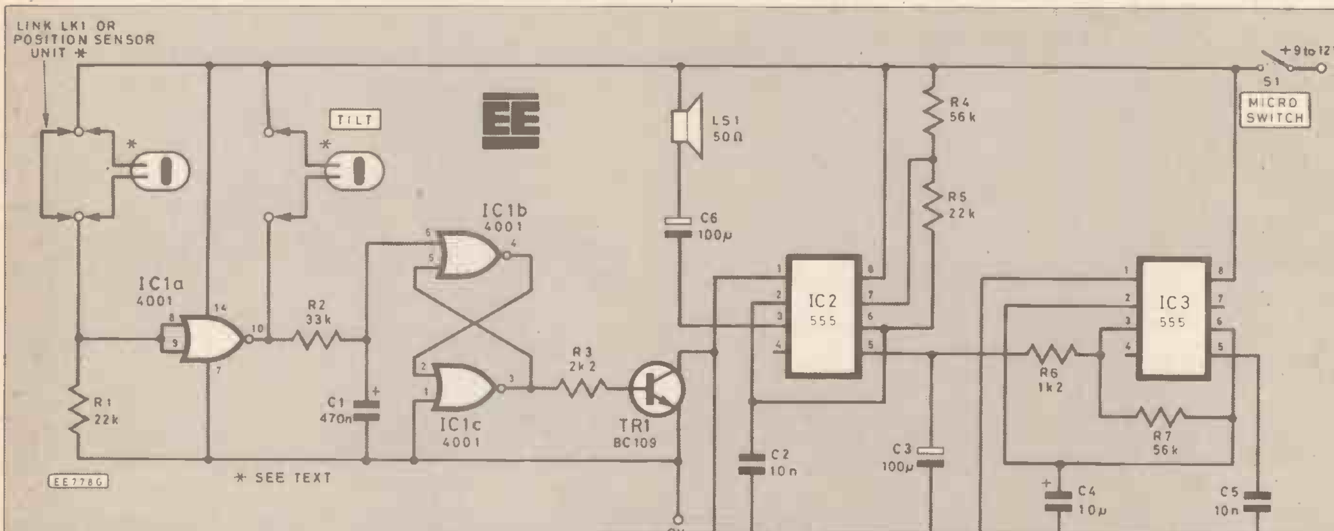
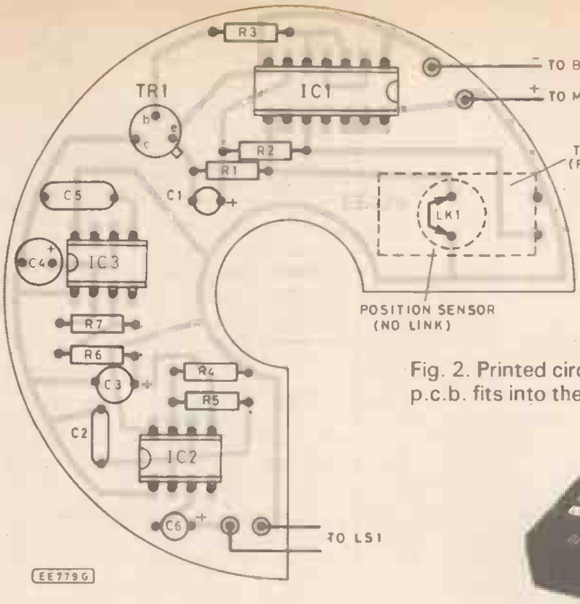


Fig. 1. Complete circuit of the Video Guard.



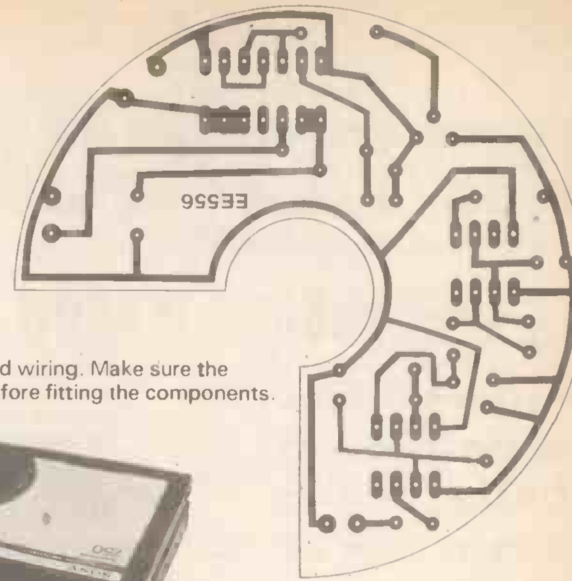
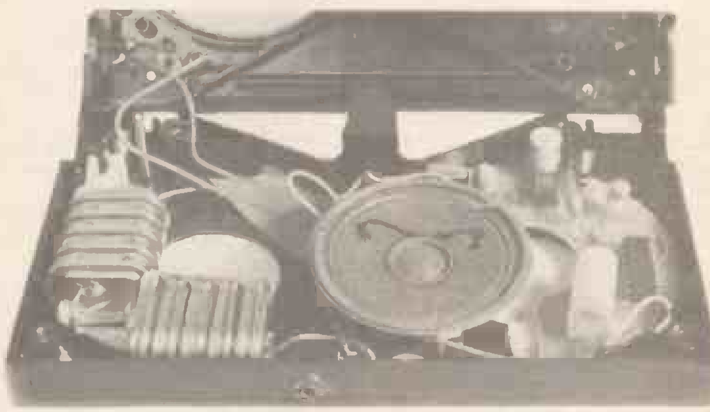


Fig. 2. Printed circuit board layout and wiring. Make sure the p.c.b. fits into the empty cassette before fitting the components.



you can find. The quality doesn't matter as you are only interested in the carcase. Remove the securing screws and carefully separate the two halves of the cassette—watch out for springs and things! Remove the spools and the tape but leave the flap system intact as this is required. It may also be necessary to remove plastic mouldings within the cassette to enable the fitting of necessary parts required for the Video Guard.

Carefully study Fig. 3 to see where to mount the various parts. The micro switch is Araldited to the top half of the cassette so that it operates when the flap is opened. The p.c.b. and the loudspeaker are held in place by double sided sticky tape and holes should be drilled into the top of the cassette to match up with the position of the loudspeaker.

The wiring to the battery and the micro switch are shown in Fig. 3. The prototype used two 6V rechargeable batteries but a 9V PP3 or equivalent should suffice and have a long life.

Retest the unit before finally securing the two halves together. If all is o.k. stick on the labels supplied with the cassette—just to give it that authentic look and slot it into your video recorder. This will lift the front flap and activate the Video Guard. If the alarm sounds the trigger is too sensitive and will require physical adjustment. □

COMPONENTS

See **Shop Talk** page 75

Resistors

R1	22k
R2	33k
R3	2k2
R4	56k
R5	22k
R6	1k2
R7	56k

All ¼W carbon

Capacitors

C1	47µ tant. 16V
C2	470n tant. 16V (10n)
C3	100µ elec. 16V
C4	10µ tant. 16V
C5	10n
C6	100µ elect. 16V

Semiconductors

IC1	4001
IC2	555
IC3	555
TR1	BC109 silicon *npn*

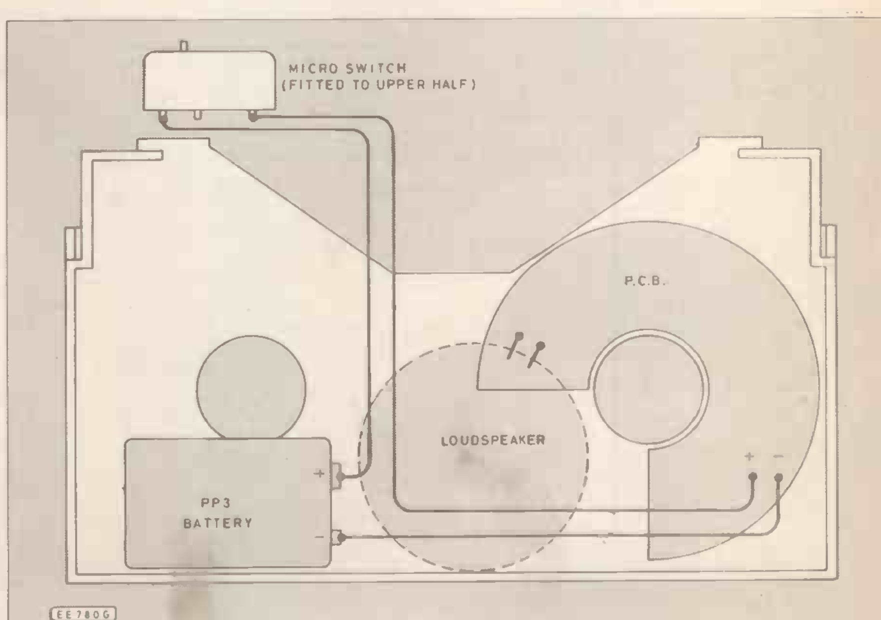
Miscellaneous

LS1	50ohm miniature loudspeaker
S1	micro switch

Tilt switch or position sensor (see text); video cassette carcase; wire, etc.

Approx. cost Guidance only. £8.50

Fig. 3. Layout and wiring of the unit in the cassette.



ON SPEC

a regular feature for the Spectrum Owner...

by Mike Tooley BA

THIS month's instalment of *On Spec* will, hopefully, contain something of interest to all Spectrum users. For the software enthusiast, we shall be continuing our survey of Spectrum BASIC compilers by taking a look at Softek's IS compiler. For hardware types, our contructional project is devoted to a simple speech synthesiser.

We begin, however, with some important information for constructors of the *Escape Interface* described in the October and November 1986 issues of Everyday Electronics.

Escape Interface

Judging by the huge quantity of correspondence from readers, the *Escape Interface* seems to have attracted more interest than any other project described in this column. Unfortunately, the "gremlins" must have been at work when I put the material together as the information supplied for testing the interface (page 616 November *EE*) contains an error. (Those who have sent for a recent *Update* will already be aware of this.)

To put the record straight, the information given under "Testing the Interface" should read: "PRINT PEEK 109 will return a value of 32 (not 40) whilst, with a functional interface, this value should be changed to 40 (not 32)". Furthermore, the disassembled code should refer to the fact that: "JR NZ has been changed to JR Z at address 6DH" (and not the other way round!).

All other information is correct and, provided the circuit diagram has been correctly followed, readers should be rewarded with a functional interface. Apologies go to anyone who may have been perplexed by this blunder!

IS Compiler

Last month I described Hisoft's COLT compiler; this month we examine its chief rival in the form of Softek's IS compiler. Softek offers two forms of Spectrum BASIC compiler; IS (a compiler which can only cope with signed 16-bit integer numbers) and FP (which can handle the full range of floating point numbers permissible in ZX-BASIC). The IS compiler (like Hisoft's COLT compiler) can therefore handle whole numbers in the range −32767 to +32767.

The compiler is nicely packaged (it is boxed, unlike the COLT which comes in a transparent plastic wallet) and, whilst the software is supplied on cassette, no instructions are provided concerning transfer to microdrive.

The COLT and IS are very similar in use. They both provide a default address for the start of the user's machine code of 40000 (in both cases this can be changed, if desired). However, IS is not capable of handling the extensive range of commands that the COLT can deal with.

In many cases this may not present a severe restriction. However, most notable amongst the omissions are that there is no provision for dealing with arrays (of any dimension). Thus, if your BASIC program has to use any arrays it will NOT compile with IS. (This restriction does not apply to the FP version.)

Softek claim a typical speed increase of ten times when using the compiler but less when using the FP version. This was borne out in practice, though I could not achieve anything like the 500 times speed increase hinted at in the instructions!

The instructions supplied with the compiler consist of only one large sheet of paper. After a few sessions' use this became extremely "tatty" and rather lets the product down. In other respects the software was easy to use and worked well.

Finally, for those interested in producing software for distribution or sale to others, it is heartening to note that Softek impose only minor restrictions on the use of the IS and FP compilers when used to create commercial software. Hisoft's COLT is less favourable in this respect and it does not appear to be possible to create and distribute commercial software with the COLT without infringing copyright.

SPECTRUM SPEECH SYNTHESISER

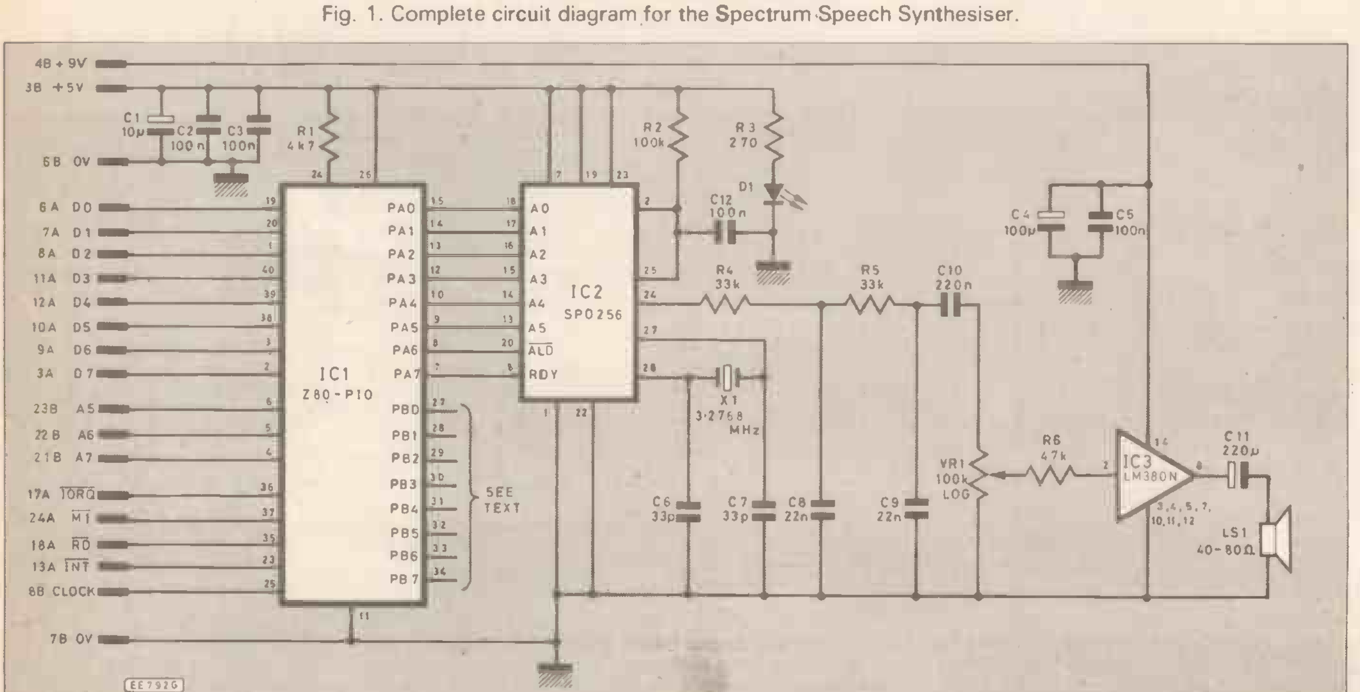
A. J. Harper of Hitchin has sent in details of a speech synthesiser based on the popular General Instrument SP0256 allophone generator chip. Mr Harper writes:

"The speech synthesiser works much like a D to A converter; the input is a six-bit word and the output is one of 64 (2^6) different sounds which, when combined together, form words. The circuit is simple to construct and costs are small (around £20)."

The complete circuit of the Spectrum Speech Synthesiser is shown in Fig. 1. The parallel interface controller IC1 is a Z80-PIO in which all eight of the port-A lines are dedicated for use with the synthesiser chip. The other eight lines may be used for other purposes, if desired (see *On Spec* February/March 1986 for details).

The allophone generator chip, IC2, is housed in a 28-pin DIL package and has its own internal clock oscillator which operates at a frequency determined by crystal X1. The output of the speech synthesiser passes through a simple two-section low-pass C–R

Fig. 1. Complete circuit diagram for the Spectrum Speech Synthesiser.



filter before it is applied to a 1W audio amplifier, IC3, based on the ubiquitous LM380N.

The speech synthesiser obtains its supply rails, +5V and +9V, from the Spectrum and these are decoupled at various points by C1, C2, C3, C4 and C5. An l.e.d., D1, is incorporated in order to indicate that power is applied to the unit.

Construction

Like most of our previous projects, the Speech Synthesiser can be assembled on a piece of Veroboard measuring approximately 80mm × 100mm. The precise dimensions of the board are unimportant provided that it has a minimum of 28 tracks aligned in the vertical plane sufficient to allow the mounting of a 28-way double-sided edge connector. Readers requiring further information on the connector should refer to March 1985 *On Spec* or send for the *Update*.

However, we have designed a printed circuit board and the component layout and p.c.b. master pattern is shown in Fig. 2. This board is available from the *EE PCB Service*; code EE558 (see page 117).

COMPONENTS

See **Shop Talk** page 75

Resistors

R1	4k7
R2	100k
R3	270
R4	33k
R5	33k
R6	47k

All 0·25W 5% carbon

Potentiometer

VR1	100k log.

Capacitors

C1	10µ p.c. elec. 16V
C2	100n polyester
C3	100n polyester
C4	100µ p.c. elec. 16V
C5	100n polyester
C6	33p ceramic
C7	33p ceramic
C8	22n polyester
C9	22n polyester
C10	220n polyester
C11	220µ p.c. elec. 16V
C12	100n polyester

Semiconductors

D1	Red l.e.d.
IC1	Z80-PIO parallel interface controller
IC2	SP0256 voice synthesiser
IC3	LM380N audio amp
X1	3·2768MHz crystal.

Miscellaneous

Low-profile d.i.l. sockets; 1 × 40-pin, 1 × 28-pin, and 1 × 14-pin. 28-way open end double-sided 2·54mm (0·1in.) pitch edge connector.
Printed circuit board available from the EE PCB Service: order code EE558

Approx. cost Guidance only £20

When the printed circuit board wiring has been completed, the integrated circuits should be inserted into their respective sockets, taking care to ensure correct orientation of each device, and the entire board should be very carefully checked before attempting to connect it to the Spectrum. **Note that the Spectrum should always be disconnected from its supply before either connecting or disconnecting ANY interface module.**

If all is well, when power is re-applied, the normal copyright message should appear. If not, disconnect the power, remove the interface and carefully check again!

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 describe the setting-up and testing of the Speech Synthesiser and include some novel LOGO routines which can be used as an alternative to BASIC or machine code for programming the interface. We shall also be taking a look at Hisoft's new BASIC compiler ('Hisoft BASIC') and rounding off with some hints and tips sent in by readers!

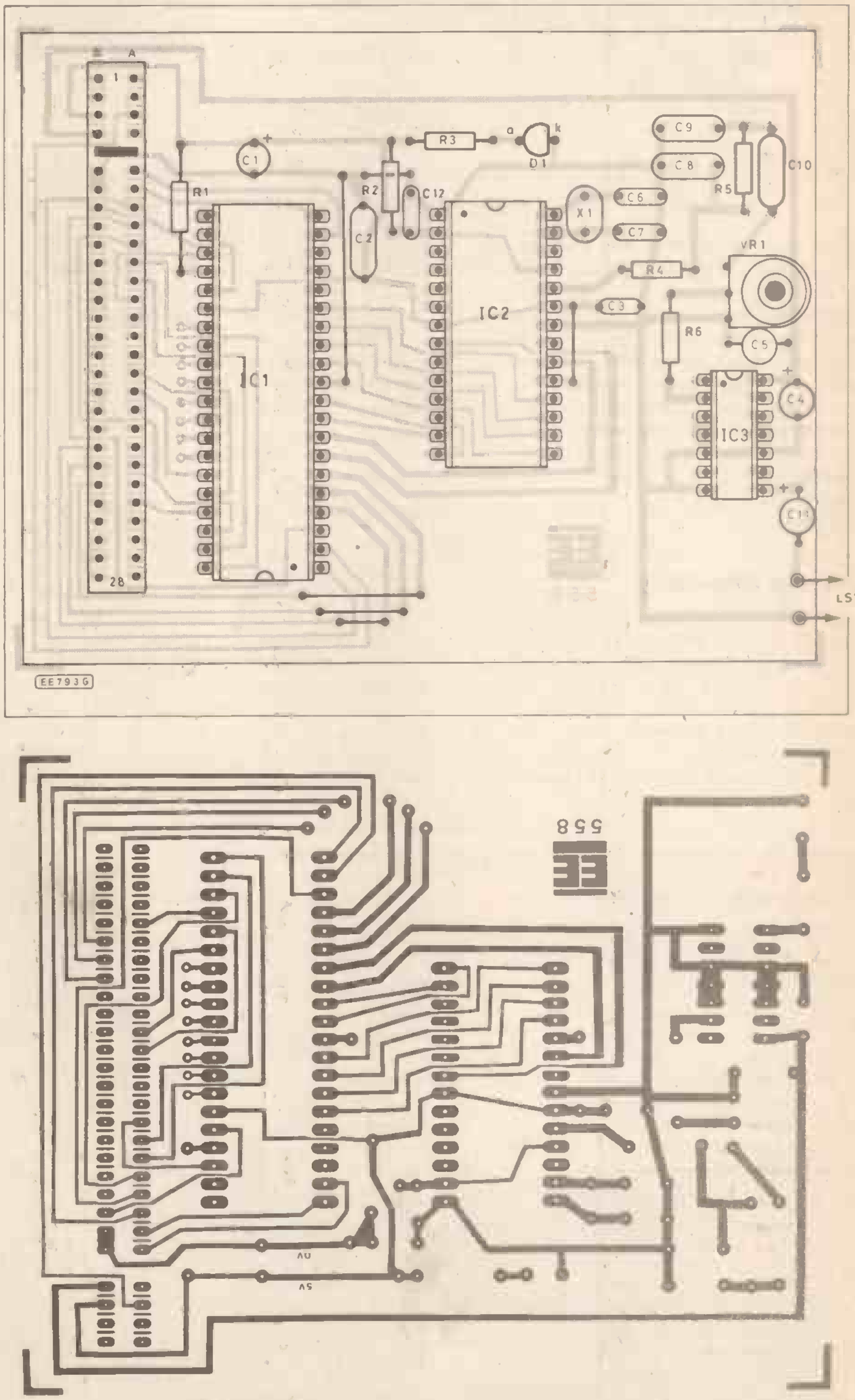


Fig. 2. Printed circuit board component layout and p.c.b. master pattern. The 28-way double-sided edge connector should be mounted proud of the board on the "tips" of the pins. This is to enable the unit to be mounted flush to the Spectrum.

DIGITAL Trouble Shooting
Part Four

MIKE TOOLEY BA

Our nine part series on Digital Troubleshooting 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 monostable and bistable devices. We also introduced some basic counters and shift register configurations. This month we shall be exploring the world of i.c. timers and our companion constructional project, which features a pulse generator, provides an example of the versatility of these devices.

TIMERS

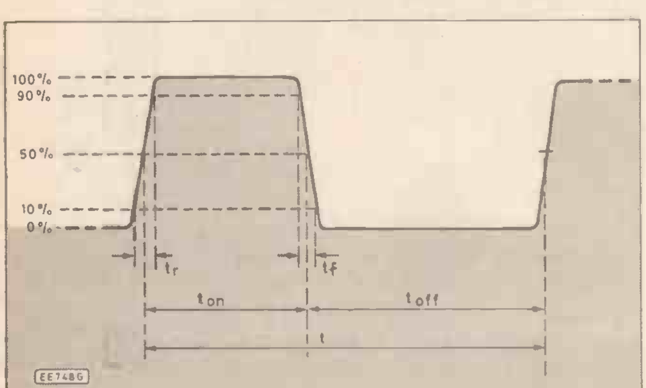
Digital circuits often require a source of accurately defined pulses. The requirement is generally for a single pulse of given duration (i.e. a "one-shot") or for a continuous train of pulses of given frequency and duty cycle. The former requirement can be met by a monostable circuit (see last month) whilst the latter requires an "astable" configuration. (The word "astable" simply refers to the fact that the output does not remain in a stable state; i.e. the output continuously alternates between the "low" and "high" states and thus the circuit can be considered to be a form of free-running oscillator).

Rather than attempt to produce an arrangement of standard logic gates to meet these requirements, it is usually simpler and more cost-effective to make use of one of the range of currently available i.c. timers. These devices can usually be configured for either astable or monostable operation and require only a few external components in order to determine their operational parameters.

TIMER GLOSSARY

Before we describe some typical monostable and astable timer circuits it is worth summarising a few of the terms commonly applied to such devices:

Fig. 4.1. Typical parameters of a pulse waveform.



Pulse Repetition Frequency (p.r.f.)

The pulse repetition frequency (p.r.f.) of a pulse waveform is simply the number of pulses which occur in a given interval of time (invariably one second). A waveform with a p.r.f. of 1kHz will thus comprise 1000 pulses every second.

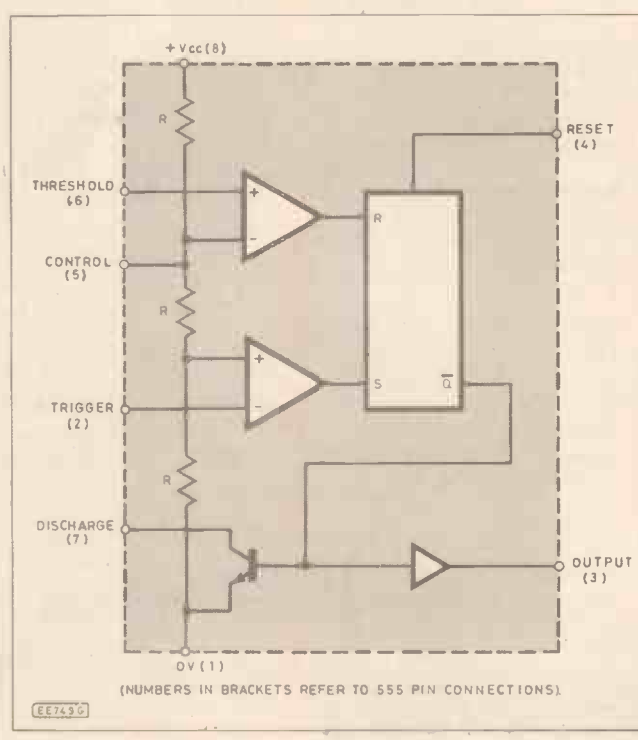
Pulse Period

The period of a pulse waveform is the time taken for one complete cycle of the pulse. It is thus equal to the reciprocal of the pulse repetition frequency, i.e.:

$$\text{Pulse period, } t = \frac{1}{\text{p.r.f.}}$$

The pulse period of the example quoted earlier will thus be 1/1000s or 1ms.

Fig. 4.2. Simplified internal circuitry of a 555 timer.



Duty Cycle

The duty cycle of a pulse waveform is the ratio of "on" (or "high") time to "on" (or "high") plus "off" (or "low") times. Duty cycle is often expressed as a percentage, i.e.:

$$\text{Duty cycle} = \frac{t_{on}}{t_{on} + t_{off}} \times 100 \text{ per cent}$$

A waveform which is high for 1ms and low for 1ms thus has a duty cycle of 50 per cent (i.e. the pulse is present for half of the period).

Mark to Space Ratio

The mark to space ratio of a pulse waveform is the ratio of on (or high) time to off (or low) time. Thus:

$$\text{Mark to space ratio} = \frac{t_{on}}{t_{off}}$$

Pulse Width

The pulse width of a rectangular waveform is the time interval (measured at the 50 per cent amplitude points) for which the pulse is on or high.

Rise Time

The rise time of a pulse is the time interval between the 10 per cent and 90 per cent amplitude points of the pulse. The rise time of an "ideal" pulse would be zero.

Fall Time

The fall time of a pulse is the time interval between the 90 per cent and 10 per cent amplitude points of the pulse. The fall time of an "ideal" pulse would also be zero.

A typical pulse waveform on which the various parameters discussed have been marked is shown in Fig. 4.1.

THE 555 TIMER

The 555 timer is without doubt one of the most versatile chips ever produced. Not only is it a neat mixture of analogue and digital circuitry but its applications are virtually limitless in the world of digital pulse generation. In order to understand how such timer circuits operate, it is worth spending a few moments studying the internal circuitry of the 555.

The simplified internal arrangement of the 555 timer is shown in Fig. 4.2. Essentially, the device comprises two operational amplifiers (used as comparators) together with an RS bistable element. In addition, an inverting output buffer is incorporated so that a considerable current can be sourced or sunk to/from a load. A single transistor switch, TR1, is also provided as a means of rapidly discharging the external timing capacitor.

How the standard 555 can be used as an astable pulse generator is shown in Fig. 4.3. In order to understand how the astable pulse generator works, assume that the "output", pin-3, is initially "high" and that TR1 is non-conducting. The capacitor, *C*, will begin to charge with current supplied by means of the series resistors, R1 and R2.

When the voltage at the "threshold" input, pin-6, exceeds two-thirds of the supply voltage, the output of the comparator A will change state and the bistable will be reset, making the Q̄ output go low and turning TR1 "on" in the process. Due to the inverting action of the buffer, the final "output", pin-3, will then go "high".

The capacitor, *C*, will now discharge, with current flowing through resister R2 into the collector of transistor TR1. At a certain point, the voltage appearing at the "trigger" input, pin-6, will have fallen back to one-third of the supply voltage at which point comparator B will change state and return the bistable to its original set condition.

The Q̄ output of the bistable then goes low, TR1 switches off, and the final "output", pin-3, goes high. Thereafter the entire cycle is repeated indefinitely.

The output waveform produced by the circuit of Fig. 4.3 will be similar in form to that previously depicted in Fig. 4.1. The essential characteristics of this waveform are:

Time for which output is "high": $t_{on} = 0{\cdot}693\,(R1 + R2)\,C$
Time for which output is "low": $t_{off} = 0{\cdot}693\,R2\,C$

Period of output: $t = t_{on} + t_{off} = 0{\cdot}693\,(R1 + 2R2)\,C$

P.r.f. of output: $\text{P.r.f.} = \frac{1{\cdot}44}{(R1 + 2R2)\,C}$

Mark to space ratio of output: $\frac{t_{on}}{t_{off}} = \frac{R1 + R2}{R2}$

Duty cycle of output: $\frac{t_{on}}{t_{on} + t_{off}} = \frac{R1 + R2}{R1 + 2R2} \times 100\%$

It should be noted that the mark to space ratio produced by a 555 timer can never be less than unity, i.e. 1:1. However, by making resistor R2 very much larger than resistor R1 the timer can be made to produce a reasonably symmetrical square wave.

A standard 555 timer operating in monostable mode is shown in Fig. 4.4. The monostable timing period is initiated by a falling edge (i.e. a "high" to "low" transition) applied to the "trigger input".

Fig. 4.3. The 555 astable configuration.

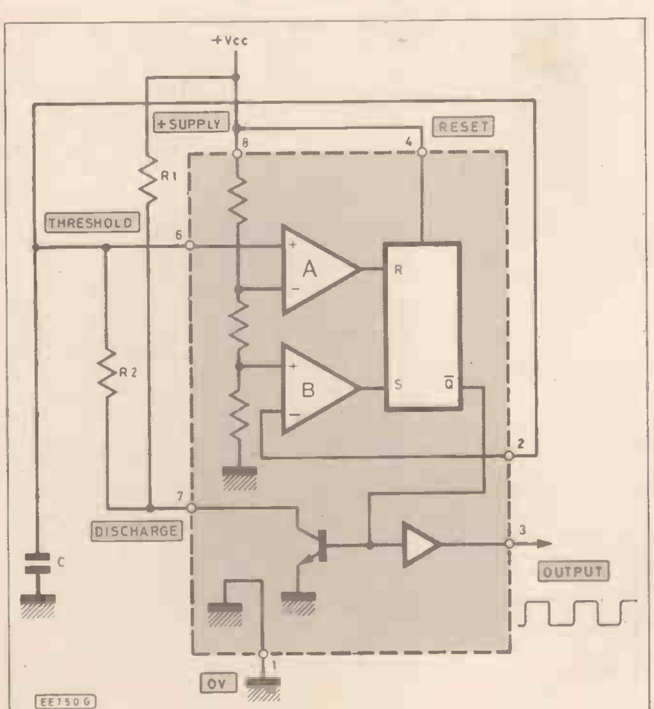
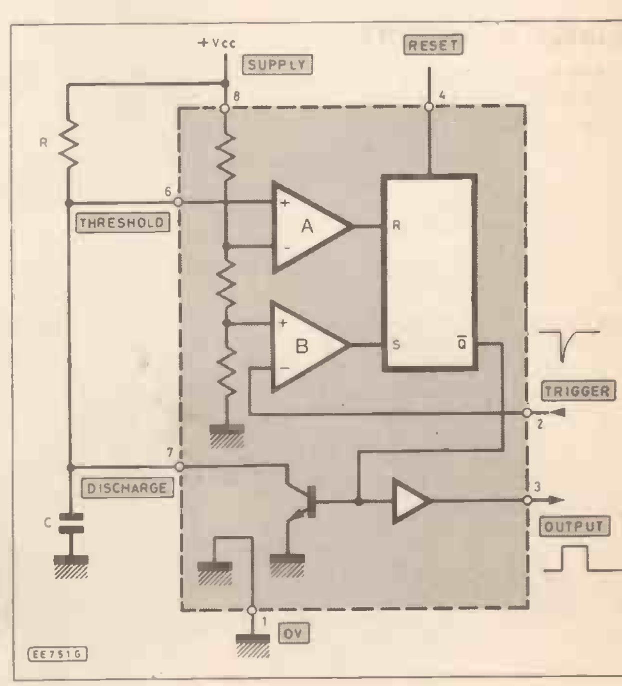


Fig. 4.4. The 555 monostable configuration.



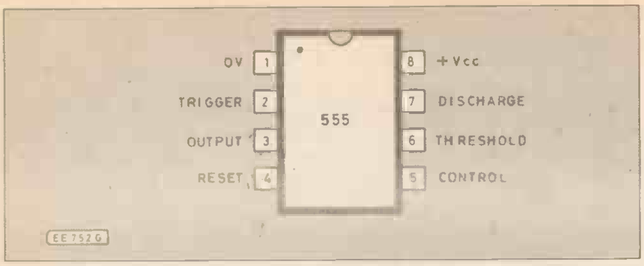


Fig. 4.5. Single 555 timer pin connections.

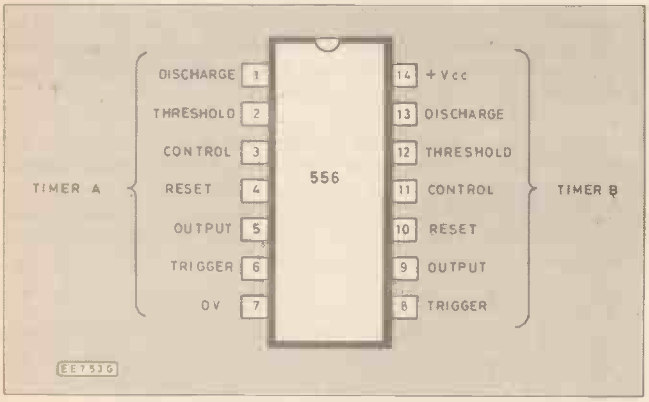


Fig. 4.6. Dual 555 timer pin connections.

When such an edge is received and the trigger input voltage falls below one-third of the supply voltage, the output of comparator B goes "high" and the bistable is placed in the set state. The Q output of the bistable then goes low, transistor TR1 is placed in the "off" (non-conducting) state and the final output, pin-3, goes high.

The capacitor, *C*, then charges through the series resistor, ***R***, until the voltage at the threshold reaches two-thirds of the supply voltage. At this point the output of comparator A changes state and the bistable is reset. The Q output then goes high, TR1 is driven into conduction and the final output, pin-3, goes low. The device then remains in the inactive state until another trigger pulse is received.

The following data refers to monostable operation:

Period for which the output is "high": $t_{on} = 1{\cdot}1RC$

Recommended "trigger" pulse width: $t_{tr} < \frac{t_{on}}{4}$

THE 555 FAMILY

The standard 555 timer is housed in an 8-pin DIL package, the pin connections for which are depicted in Fig. 4.5. The device operates from supply rail voltages of between 4.5V and 15V. This encompasses the normal range for TTL devices and thus the device can be used in conjunction with TTL circuitry.

The following variants of the standard 555 timer are commonly available:

Low-power (CMOS) 555

The ICM7555IPA device is a CMOS version of the 555 timer which is both pin and function compatible with its standard counterpart. By virtue of its CMOS technology, the device operates over a somewhat wider range of supply voltages (2V to 18V) and consumes minimal operating current—120μA typical for an 18V supply.

Fig. 4.7. Nomograph for predicting 555 astable p.r.f. The example shows how a p.r.f. of approximately 400Hz results from C=220n and R=R1=R2=10k.

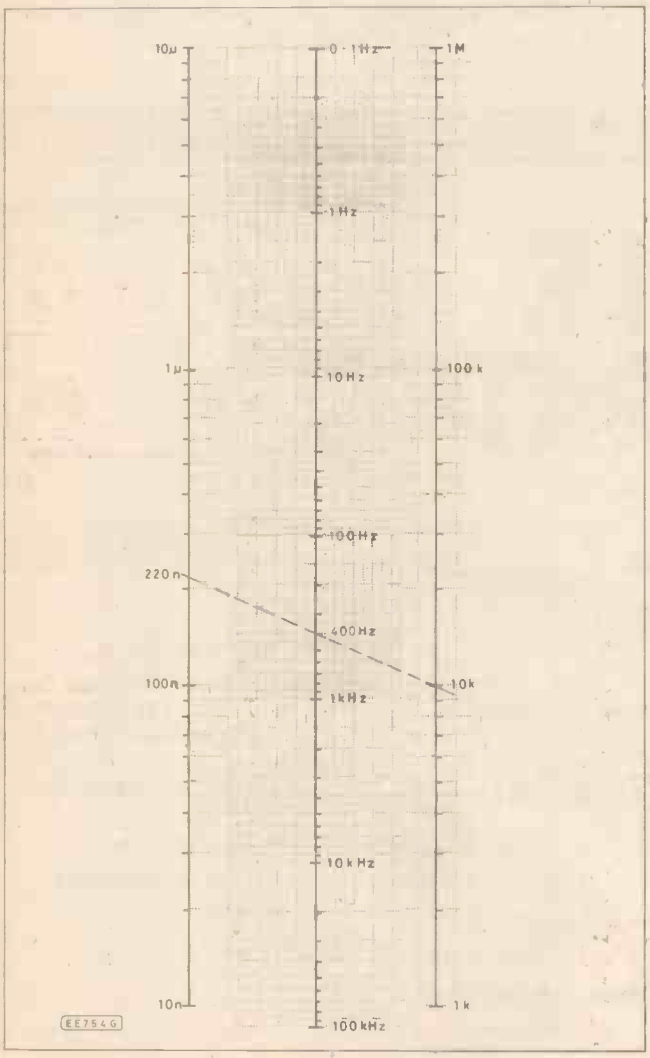
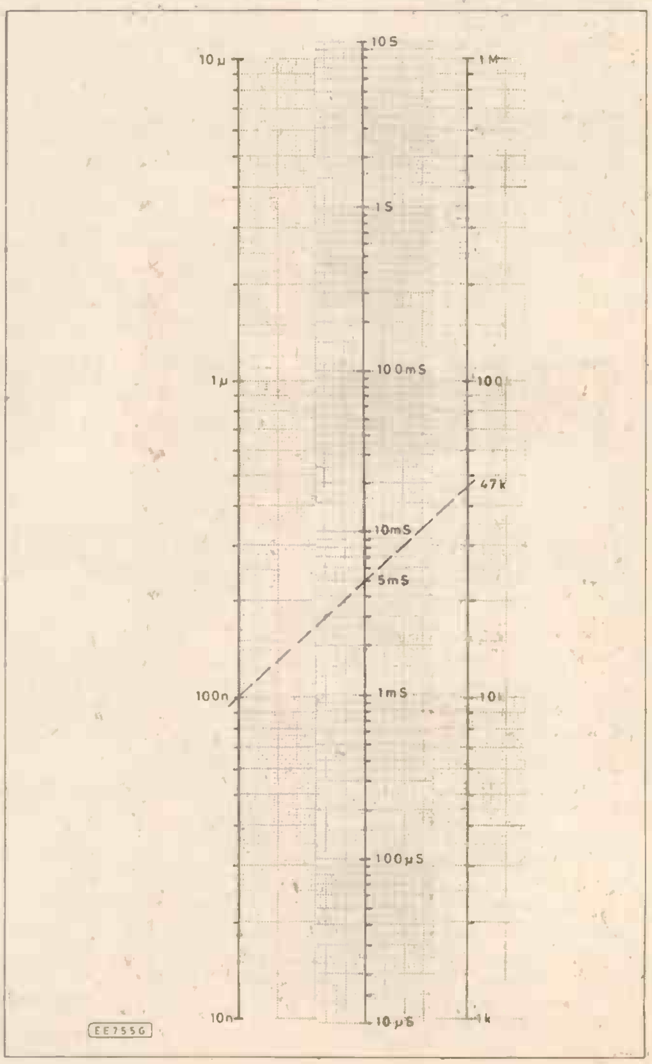


Fig. 4.8. Nonograph for predicting 555 monostable pulse width. The example shows how a pulse width of approximately 5ms results from C=100n and R=47k.



Note that, by virtue of the low-power CMOS technology employed, the device does not have the same output current drive possessed by its standard counterpart. It can, however, supply up to two standard TTL loads.

Dual 555 timer

The NE556A device is a dual version of the standard 555 device, housed in a 14-pin DIL package (see Fig. 4.6). The two devices may be used entirely independently and share the same electrical characteristics as the standard 555.

Low-power (CMOS) dual 555

The ICM7556IPA chip is a dual version of the low-power CMOS 555 device contained in a 14-pin DIL package (see Fig. 4.6). The two devices may again be used entirely independently and also possess the same electrical characteristics as the low-power CMOS 555.

FAULT FINDING

Fault finding on timer circuits is a relatively straightforward process. It is first necessary to determine whether the timer is operating in the astable or monostable mode. Next it is necessary to have some idea of the period of the pulse produced at the output. If necessary, this can be determined by reference to the formulae stated earlier or use can be made of the nomographs presented in Fig. 4.7 and Fig. 4.8.

The output state of the timer, at pin-3, can be determined using a logic probe (*a suitable design appeared in the* Dec '86 issue) or using an oscilloscope (if one is lucky enough to have one available!—*see next month's issue*). In astable mode, a logic probe placed with its tip on pin-3 (assuming a standard timer) should indicate the presence of a continuous pulse train (with the logic 0 and logic 1 l.e.d. indicators producing appropriate indications). It is even possible to make a rough estimate of the duty cycle of this waveform by referring to the relative brightness of the logic 0 and logic 1 l.e.d.s.

It should be noted that the "reset" input, pin-4, has to be held "high" to enable astable operation. In some circuits this input is used to gate the bistable "on" or "off". It is, therefore, worth checking the logical state of this input whenever an astable is failing to produce an output.

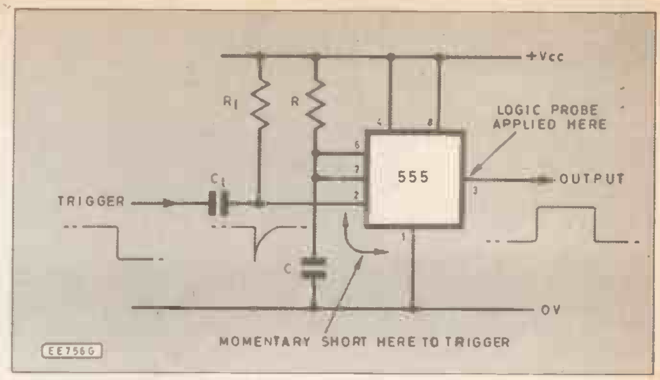


Fig. 4.9. Typical triggering arrangement of a 555 monostable.

Monostable operation can also be checked using nothing more than a logic probe. However, where the monostable period is very short (e.g. less than about 100ms) it will be essential for the probe to incorporate a pulse stretching facility.

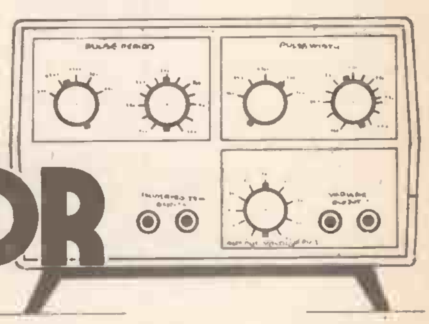
The probe tip should again be applied to the output (pin-3 of a standard 555) and then the "trigger" should be applied. In some circuits this will be a fairly straightforward process, particularly where the trigger is applied from some form of push-button.

In other cases, a falling edge trigger may be simulated by simply shorting out pin-2 momentarily to 0V, as shown in Fig. 4.9. It is also important to note that, where the trigger input is a.c. coupled, the falling edge pulse *MUST* have sufficient amplitude for the voltage at pin-2 to fall below one-third of the supply voltage.

In a situation where the output pulse duration is not as expected (particularly in circuits which employ electrolytic timing capacitors) it may sometimes be necessary to investigate the d.c. voltages appearing at the "threshold" and "discharge" inputs of the timer. This will ONLY be a meaningful exercise when a d.c. voltmeter having VERY high internal resistance is employed. Standard bench multimeters (of 20kohm/V, or thereabouts) are generally unsuitable for making this measurement as they may significantly alter the charge and discharge time constants.

Next month: We shall be dealing with fault finding on microprocessor systems. Our companion *Digital Test Gear Project* will describe the construction of a Digital I.C. Tester.

VERSATILE PULSE GENERATOR



MIKE TOOLEY BA

Our fourth Digital Test Gear Project deals with the construction of a versatile pulse generator. This unit provides a means of generating a wide range of pulse waveforms which can be used with all types of digital circuitry.

The pulse period is adjustable from 1·4s to approximately 14µs in five decade ranges, whilst the pulse width is adjustable from 0·7s to approximately 7µs in five decade ranges. Two independent outputs are provided: one is TTL compatible (5V peak output) whilst the other is variable in amplitude over the range 0V to 8V peak.

The unit is operated from a 240V a.c. mains supply and, in common with our other Digital Test Gear Projects, the pulse generator uses low-cost readily available components and is based on a standard Verobox and Veroboard.

Specification

Pulse Period:	Adjustable from 1·4s to 14µs in five decade ranges.
Pulse Width:	Adjustable from 0·7s to 7µs in five decade ranges.
Pulse Amplitude:	Adjustable from 0V to 8V peak.
	Fixed inverted TTL output 5V peak.
Rise and Fall Times:	Better than 0·5µs on all ranges.

CIRCUIT DESCRIPTION

The complete circuit of the Pulse Generator is shown in Fig. 1. The mains transformer, T1, provides 9V a.c. input to the

COMPONENTS

See Shop Talk page 75

Resistors

R1	220
R2	220
R3	680
R4	1k
R5	10k
R6	2k7
R7	3k9
R8	100
R9	150
R10	10
R11	10k

All 0·25W ± 5% carbon

Potentiometers

VR1	100k lin.
VR2	100k lin.
VR3	1k lin. wirewound

Capacitors

C1	2200µ axial elec. 25V
C2	100µ p.c. elec. 16V
C3	10µ p.c. elec. 16V
C4	10µ axial lead elec. 25V
C5	1µ polyester
C6	100n polyester
C7	10n polyester
C8	1n polystyrene
C9	100n polystyrene
C10	4µ7 axial elec. 25V
C11	470n polyester
C12	47n polyester
C13	4n7 polystyrene
C14	470p polystyrene
C15	10n polystyrene
C16	100n polystyrene
C17	820p polystyrene
C18	10µ p.c. elec. 16V
C19	100µ p.c. elec. 16V

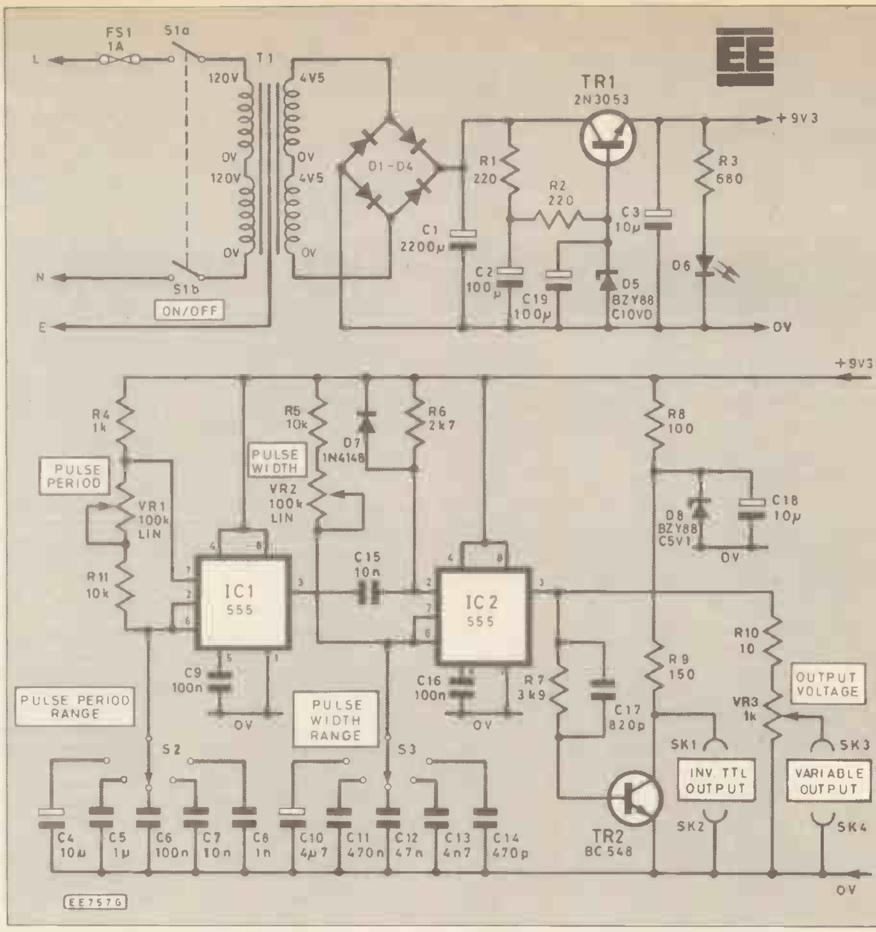
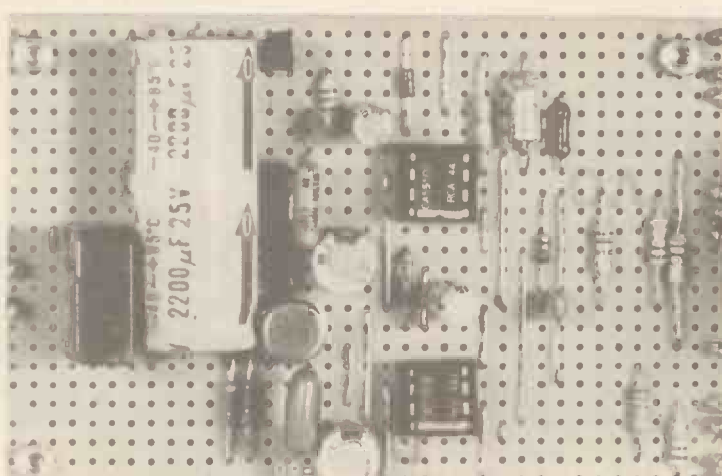


Fig. 1. Complete circuit diagram for the Versatile Pulse Generator.



Semiconductors

D1–D4	200V 1·6A In-line bridge rectifier
D5	BZY88C10 10V Zener
D6	Red l.e.d. (fitted with bezel)
D7	1N4148 general purpose signal diode
D8	BZY88C5V1 5·1V Zener
IC1	555 Timer
IC2	555 Timer
TR1	2N3053 *npn* medium power silicon
TR2	BC548 *npn* small signal silicon

Miscellaneous

T1	Mains transformer rated at 12VA and having a 240V primary (or 2 × 120V primaries connected in series) and a 9V secondary (or 2 × 4·5V secondaries connected in series).
FS1	20mm 1A quick-blow fuse and panel mounting fuseholder.
S1	DPDT min. rocker switch rated for 240V a.c. operation.
S2	1-pole 5-way rotary switch
S3	1-pole 5-way rotary switch
SK1 to SK4	4mm sockets (2 black, 1 red, 1 yellow).

Case, Verobox measuring 205mm × 140mm × 110mm. approx. (Vero part number 202-210368); optional tilt-leg assembly; Veroboard 0·1in. matrix, measuring 95mm × 63mm; single-sided 1mm terminal pins (13 required); low profile 8-pin DIL i.c. sockets (2 off); insulated spacers or mounting pillars (3 off); mounting nuts and bolts (5 sets required).

COMPONENTS approximate cost £13.50 (case extra)

encapsulated bridge rectifier, D1 to D4. The d.c. output of the bridge rectifier (approximately 13V) is developed across the reservoir capacitor, C1. Transistor TR1 acts as a simple series regulator in which Zener diode D5 provides a voltage reference of approximately 10V. The l.e.d. provides an indication that the supply is present.

A standard 555 timer, IC1, is connected in astable mode. Potentiometer VR1 is used to provide adjustment of the pulse repetition frequency (p.r.f.), whilst switch S2 provides selection of one of five decade timing capacitors. The output of IC1 (a reasonably symmetrical square wave) is applied to the trigger input of IC2 by means of the pulse forming network, C15, R6 and D7.

A second 555 timer, IC2, operates in monostable mode with the output period made adjustable by means of potentiometer VR2. Rotary switch S3 also provides five decade switched ranges of timing capacitance.

The output of IC2, comprising a pulse train of adjustable duty cycle, is fed to potentiometer VR3 which provides adjustment of the output level present at socket SK3. Transistor TR2 is an inverter and "inverts" the output signal to provide the inverted TTL compatible signal at SK1.

CONSTRUCTION

With the exception of the mains transformer, fuseholder and front panel controls, all components are mounted on a standard size matrix board comprising 24 strips of 37 holes. The stripboard component layout is shown in Fig. 2.

Readers should note that fifteen 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 used.

The following sequence of component assembly is recommended; i.e. sockets, links, capacitors, resistors, bridge rectifier and terminal pins. Before mounting the stripboard in its final position, however, constructors are advised to carefully check that components, links and the 15 track breaks have been correctly placed.

Furthermore, it is also worth checking that the polarised components (including electrolytic capacitors and bridge rectifier) have been correctly orientated. Constructors should also examine the underside of the stripboard for dry joints, solder splashes and bridges between tracks. It should go without saying that a few minutes spent checking the board at this stage can save many hours of agony later on!

When the board has been thoroughly checked, it should be mounted horizontally in the base of the case using three short insulated stand-off pillars. The i.c. devices should then be inserted into their sockets, again taking care to ensure correct orientation.

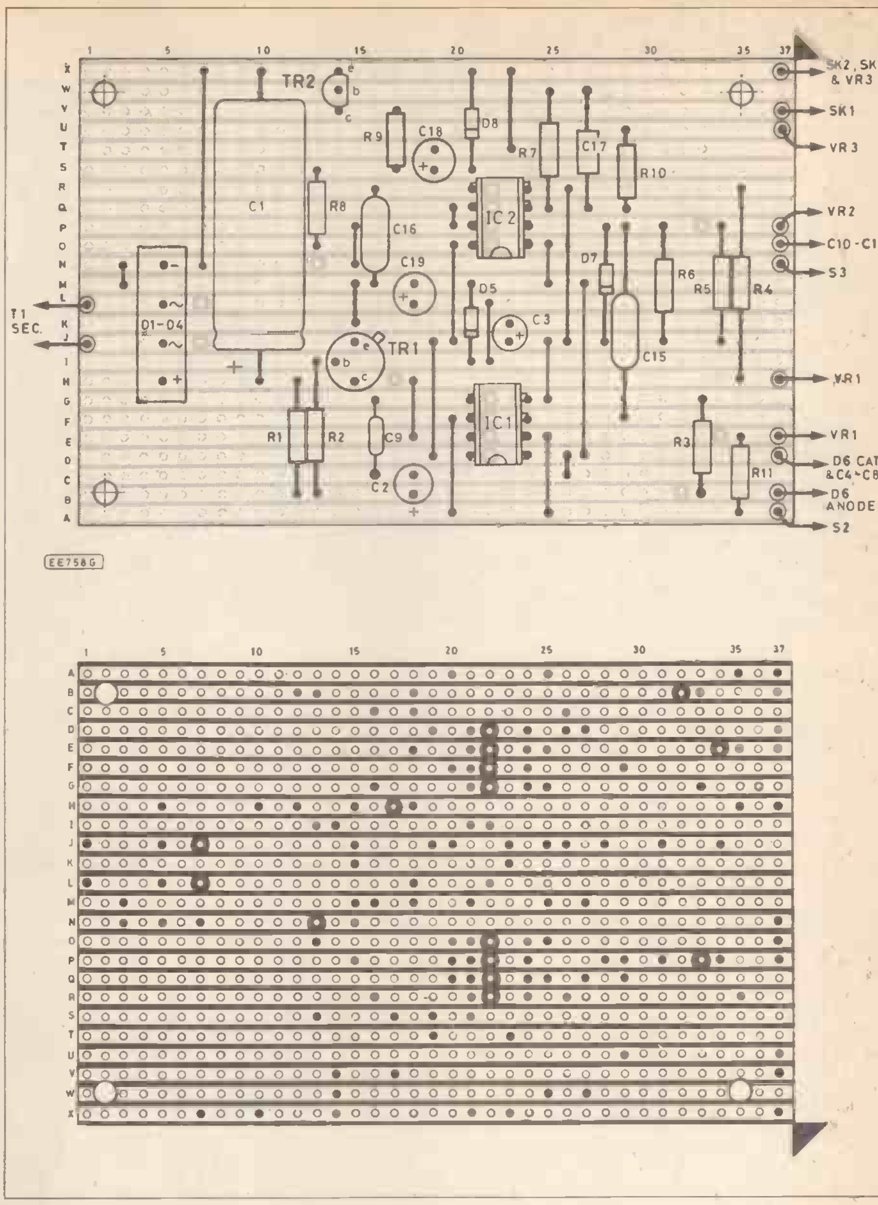


Fig. 2. Circuit board component layout and details of breaks to be made in the underside copper tracks.

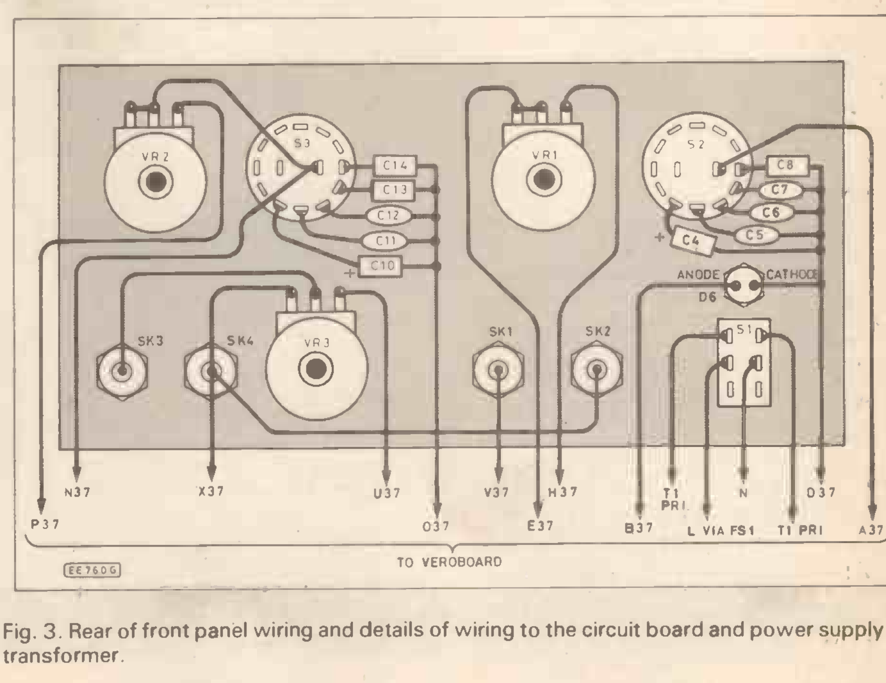


Fig. 3. Rear of front panel wiring and details of wiring to the circuit board and power supply transformer.

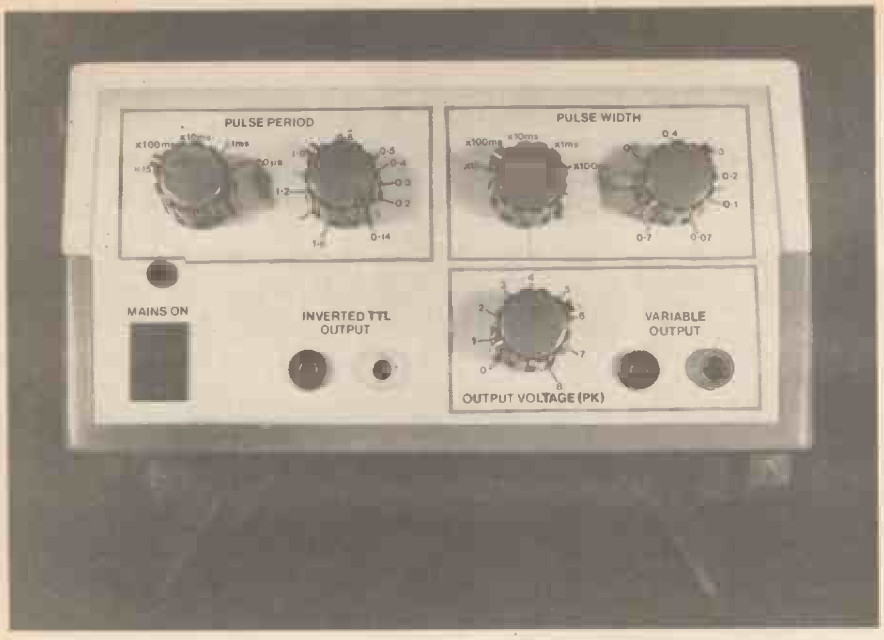
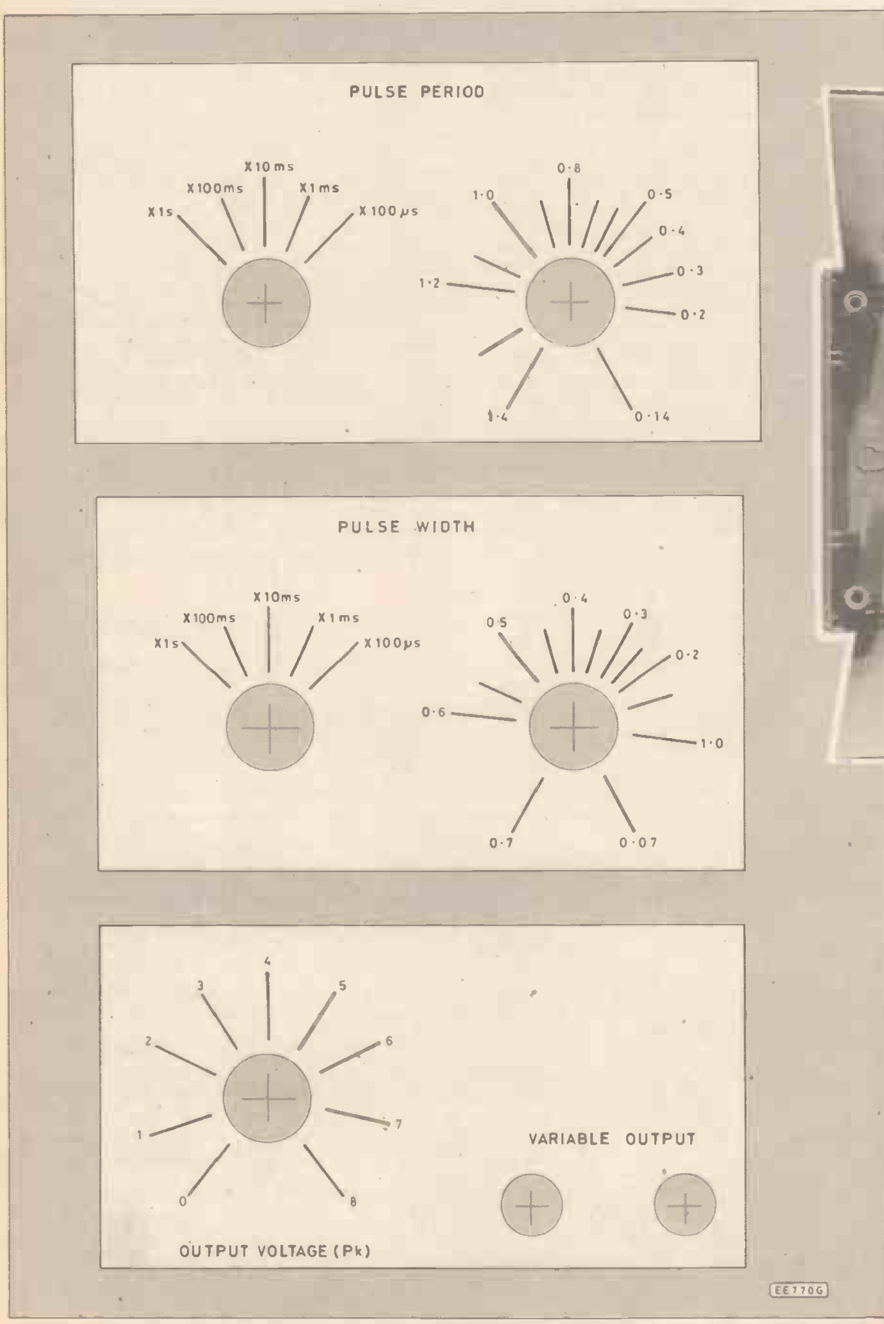


Fig. 4. Full size front panel overlays for the Pulse Period, Pulse Width and Variable Output sections. The photograph above shows their relevant positions on the front panel.

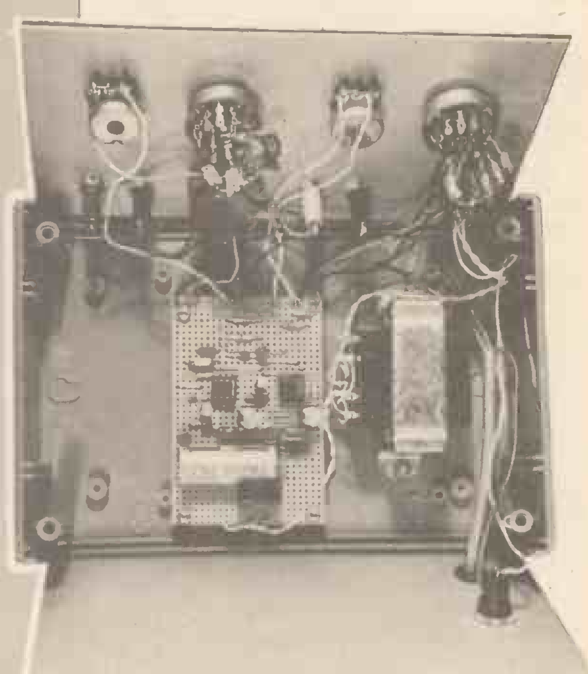
Controls, switches, indicators and output connectors are mounted on the front panel according to the photographs. Suggested overlays are shown actual size in Fig. 4. These overlays may be cut out and fixed to the front panel using an appropriate adhesive. Links to the front panel mounted components should be made using short lengths of insulated wire, following the wiring diagram shown in Fig. 3.

TESTING

When complete, constructors should carefully check the internal wiring – taking particular care to check the fuseholder, mains transformer and mains switch. The mains supply should now be connected and a multimeter (switched to the d.c. voltage ranges) should be used to check that the voltage developed across C1 is in the range 11V to 13·5V. Having confirmed that this voltage is correct, the meter should be transferred to the positive supply rail (pin-8 of IC1 or IC2) and this should be within the range 8·5V to 9·5V. The output of the pulse generator can then be checked using a logic probe or oscilloscope. □



Internal layout and wiring of the completed unit.



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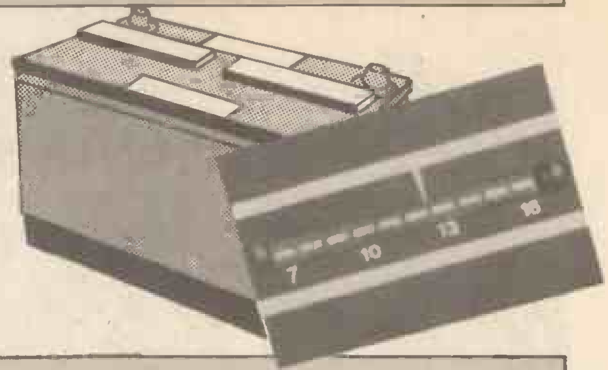
CAR VOLTAGE MONITOR



D.E.COX

A simple and versatile voltmeter with a bargraph readout

IT IS always desirable to keep a check on the car's electrical system to avoid the embarrassment of flat batteries and give warning of fault conditions. A voltage in the range 13–15V, with the engine running, is about right. Although designed with the motorist in mind the *Car Voltage Monitor* has wide applications as an add-on unit for boats, solar power cells, mobile radio and auxiliary power supplies to name but a few.

The circuit provides continuous voltage monitoring of the electrical system and conveniently derives its power requirements from this source. The display is presented in the form of a bargraph, being more robust than a moving coil meter and easily read with side vision when main concentration needs to be directed elsewhere.

BARGRAPH DISPLAY

The circuit makes use of the 3914 bargraph module and some remarks on its operation are appropriate here. The 3914 comes in two forms; a conventional d.i.l. packaged i.c. and a module, Fig. 1, on which both the chip in die form and a 10 element red l.e.d. display are mounted and interconnected. It is this convenient module version that is used in the *Car Voltage Monitor* and will be described here. Connections to the module are via twelve 0·1 inch pitch solder pads.

Referring to Fig. 2 it can be seen that the internal circuitry of the module (IC1) contains a string of ten comparators each with its own threshold voltage set by a resistor network. The input signal and comparator divider voltages may be 15mV to within 1·5V below V+ (12V max.) The RLO of the divider chain can be set as negative as V- if necessary. The voltage set between RHI and RLO is divided into ten equal increments and the l.e.d.s will light as the signal input voltage matches that of the appropriate comparator.

The 3914, both module and d.i.l. forms, have an internal voltage reference for setting the divider chain voltages. The reference voltage is nominally 1·25V and is available between the REF OUT and REF ADJ connections. A further feature of this reference voltage source is that it also controls the l.e.d. brightness. The current of each l.e.d. is approximately ten times that drawn from REF OUT and is adjusted by the programming resistor formed by R1 and R2.

The module is very versatile and can be operated as a dot display or bargraph. For our purposes the bargraph is used, selected by linking the MODE connection to V+. Leaving the MODE connection open circuit would give the dot display.

CIRCUIT

The circuit diagram as shown in Fig. 2 uses the 3914 module with only eight additional components. As voltages below 7V in the car are of little interest, the meter is arranged to indicate from 7V to 16V in 1V intervals. To do this the reference voltage and a divided value of it, from the R1 and R2 resistor combination, are applied accross the module resistor divider network (RLO, RHI). Thus, even at the lowest end of the working range there will still be sufficient voltage to drive the inter-

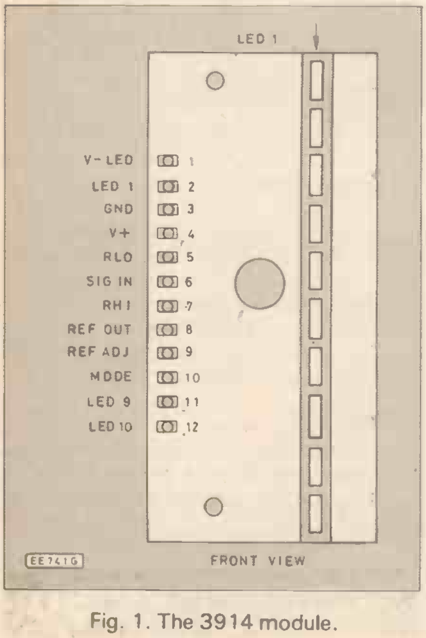


Fig. 1. The 3914 module.

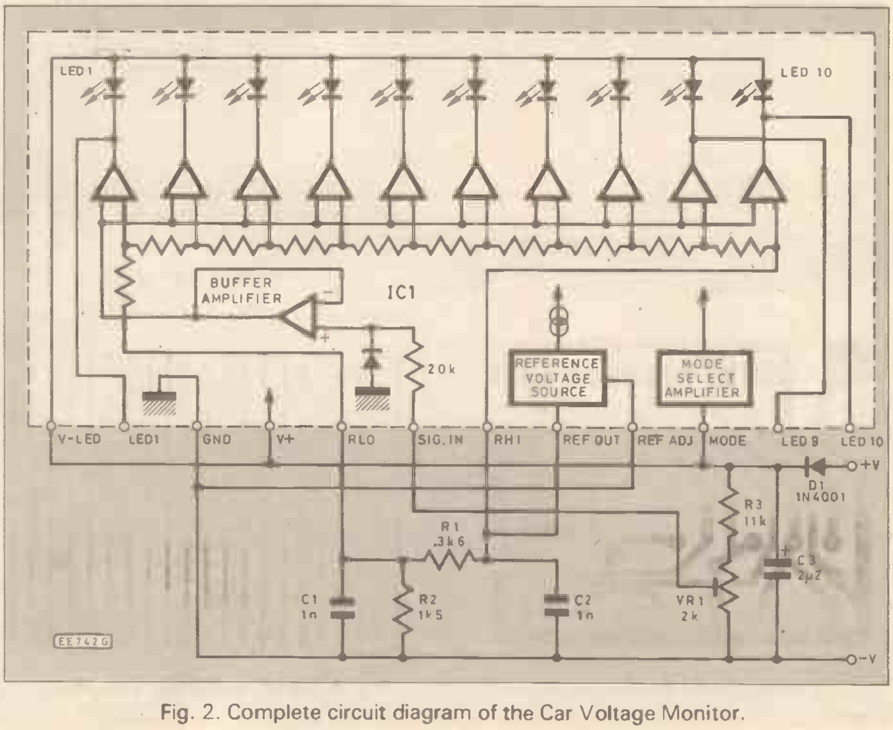
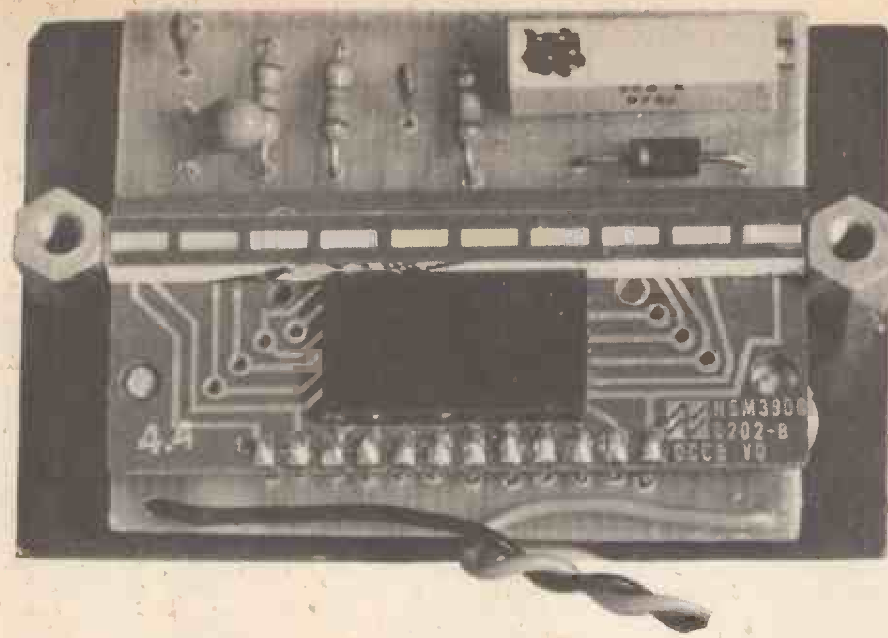
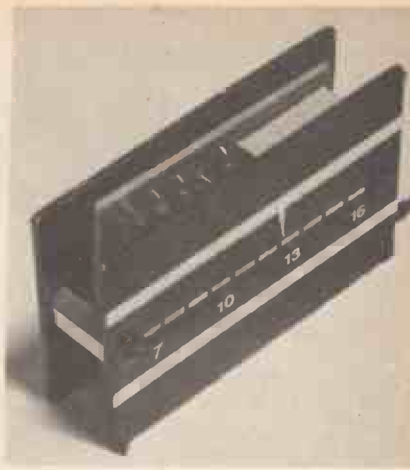


Fig. 2. Complete circuit diagram of the Car Voltage Monitor.



Photograph of the printed circuit board version of the Car Voltage monitor.



Construction of the unit.

nal voltage reference (requires 3V minimum). The ratio of R1 and R2 determines the potential at which the first l.e.d. lights. If other voltage ranges are needed it must be remembered that the module resistor divider chain is in parallel with R1 when calculating these resistor values. The l.e.d. currents are set to approximately 3mA each by the combined value of resistors R1 and R2. This keeps the highest power drain, with all l.e.d.s lit, within the maximum rating (500mW) of the module.

The supply voltage, to be monitored, is then divided by R3 and VR1, with VR1 adjusted such that the maximum of 16V would just light the last l.e.d. of the display. Deriving the signal input in this way ensures that this input voltage is well below the manufacturer's recommended limit of 1·5V less than the module V+ supply. The potentiometer VR1 is necessary, rather than a fixed resistor, as the reference voltage varies slightly from one module to another. Diode D1 provides protection from reverse transients, e.g. from operation of solenoids, while capacitors C1, C2 and C3 provide decoupling of the noise common in car electrical systems.

CONSTRUCTION

The printed circuit diagram is shown in Fig. 3; this p.c.b. is available from the *EE PCB Service*. An alternative layout for a Veroboard of 20 track and 15 holes is shown in Fig. 4.

In either form care should be taken to ensure correct polarity of the diode and electrolytic capacitor. Solder runs between p.c.b. conductors and between Vero strips must be checked for and corrected as necessary. Make sure all track cuts (three of them) and all the wire links (there are seven of them) are correct on the Veroboard, there are no such requirements for the p.c.b. version.

To connect the module it is placed on the component side of the circuit board, l.e.d. side up, and separated from the p.c.b. by a spacer such that, when the unit is finally assembled, the l.e.d.s can protrude through the front panel without it fouling the other components. The wire links are then soldered through from the module to the

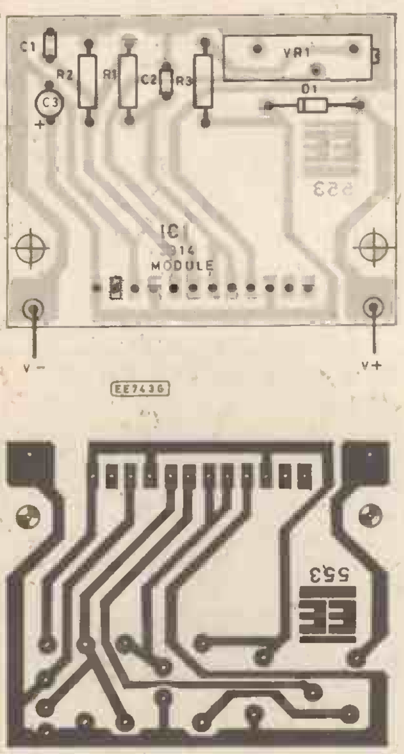


Fig. 3. Printed circuit board layout and wiring.

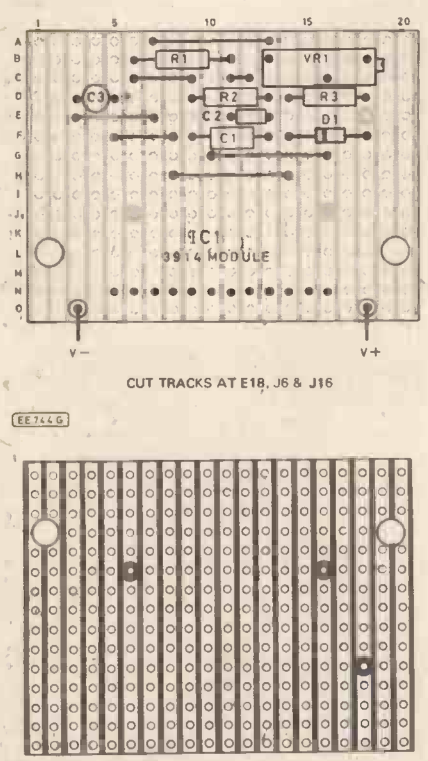


Fig. 4. Veroboard layout and wiring.

COMPONENTS

See **Shop Talk** page 75

Resistors

R1	3k6
R2	1k5
R3	11k
All 0·25W 5%	

Potentiometers

VR1 — 2k 3/4 inch 20 turn Cermet trimmer

Capacitors

C1,C2	1n min. disc ceramic
C3	2μ2 35V tantalum bead

Semiconductors

IC1	3914 Bargraph module
D1	1N4001

Miscellaneous

Veroboard or p.c.b. (available from the *EE PCB Service*, order code 553); nuts; bolts; spacers; wire, etc.

Approx. cost Guidance only **£8.50**

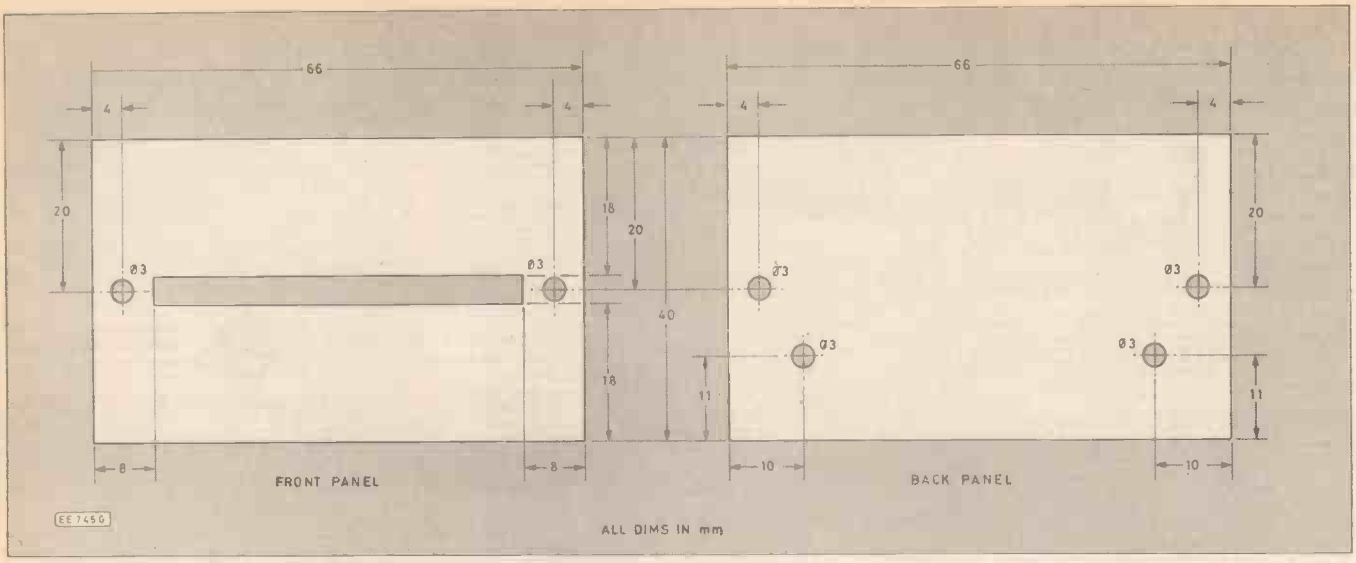


Fig. 5. Mounting panel details.

circuit board conductors. Note that the module solder pads 2, 11 and 12 are not used in this application.

The front and back mounting panels can be cut from thin plastic sheet. An old p.c.b. with all the copper removed would be suitable. Holes and dimensions are shown in Fig. 5. The circuit board and module are bolted to the back plate. It is most important that either plastic bolts or insulating washers are used to ensure that no accidental electrical connection is made to the conductors on the module which run close to the fixing holes.

Then, with the use of spacers, the front panel is fixed over the front of the unit. The assembly drawing, Fig. 6, will make these latter details clear. Finally the front panel is suitably marked with voltages and possibly a reference mark to indicate at a glance the expected normal working voltage, see photographs.

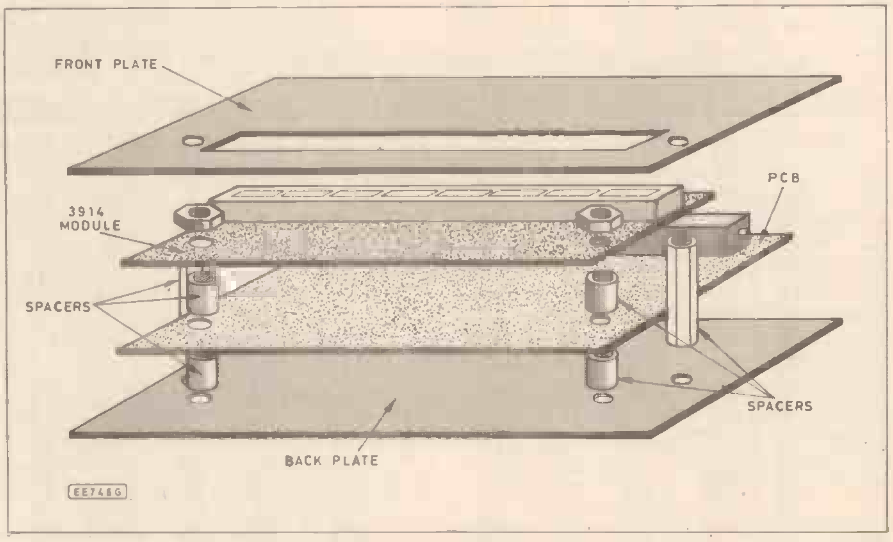


Fig. 6. Final construction details.

SETTING UP

Calibration can be performed very conveniently if a variable voltage power supply, adjustable to 16V, and a voltmeter are available. With 16V applied across the V+ and V– connections of the unit. VR1 is adjusted until the last l.e.d. just lights. If 16V is not available then the highest voltage available in the working range should be set up with batteries and VR1 adjusted until the appropriate l.e.d. just lights, e.g. l.e.d. No. 6 for a 12V supply. A fully charged car battery which has been disconnected from its charging circuit for a while can be taken as being just over 12V output.

The unit may then be wired into a suitable outlet of the car's electrical system. The unit is equally suited to positive or negative earth wiring. For safety reasons it is essential for there to be a 1A fuse somewhere in the supply line in case the unit is damaged in an accident or has a component failure.

Once fitted the unit will be found to be very helpful for reliable and worry free motoring. □

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

MOONBOUNCE

One particularly fascinating amateur radio activity is e.m.e. (earth-moon-earth) communication, popularly known as moonbounce. Radio signals are aimed at the moon and bounced back, sometimes to their point of origin, and sometimes to a point on the earth's surface thousands of miles away.

It is not for the raw beginner but, as in any other specialist amateur activity, its practitioners are always ready and willing to help newcomers in their first attempts to transmit through space. The first step is to get a signal to hit the moon and return to where it came from, as a confirmation that everything is working properly. It is quite feasible to do this as the radio signal takes just over two seconds to reach the moon and return to earth, thus permitting a brief signal from the transmitter to be heard as a sort of echo in the station receiver moments later.

Before this can be achieved, however, there is quite a lot to be done, and several problems to be overcome. Firstly, the antenna must be accurately aimed in the right direction.

Many moonbouncers have steerable antennas to follow the path of the moon. Some of these are computer controlled and are programmed to track it automatically throughout the year. There are others who have fixed antennas directed so that the moon will pass through their radio beams at a time when it can be seen by the operators at both the sending and receiving ends of an intended contact.

SPECIALISED ANTENNAS

The antennas themselves must have a very high gain, that is they must be capable of directing most of the radio energy from the transmitter in one particular direction in the narrowest beam possible. This requirement has resulted in the creation of some very specialised antennas by amateurs. These usually consist of an array of up to sixteen, or more, conventional antennas wired together to obtain the high performance required.

Of course, such large arrays require a lot of ground space. Not every amateur has this facility, and smaller antennas can be used, especially if the other station has an extra high gain antenna. Theoretically, the requirement is for a total antenna gain between the sending and receiving station of at least 40dB. If both antennas have 20dB gain, all is well. If one has 25dB and the other 15dB, they will be able to make contact also, but the station with the smaller antenna will not always be able to contact further stations unless they, too, have larger antennas.

Another factor, which is typical of amateur radio generally, is that sometimes propagation conditions improve unexpectedly. Conventional theories are contradicted, and contacts can then be achieved with smaller antennas and lower powers than usual.

HIGH POWER

Conventionally, quite high power is required for moonbounce operations. A minimum of about 600 watts is needed for reasonably consistent results and some stations, in countries where higher power is permitted, use more. In Britain, where there is a maximum permitted power of 400 watts, ideal conditions cannot be achieved but that does not stop UK amateurs setting up moonbounce stations and working round the world with them.

It is not just the distance involved which makes it necessary to have such high power and sensitive aerials. The round journey is about half a million miles, and that is demanding enough for any radio signal. Add to that the fact that the beam has spread out to a width much greater than the diameter of the moon by the time it gets there, so only part of the signal has any chance of being reflected back. Then, over 90 per cent of what does arrive there is absorbed by the moon's surface. The irregular surface of the moon reflects what's left of the signal in many directions, so only a portion of that actually returns to earth. Finally, the returning signal is spread all over the earth's surface which is facing the moon, and it is a very tiny part indeed of the origianl signal which finally reaches the receiver.

Despite all these difficulties and uncertainties, hundreds of amateurs around the world operate with moonbounce on a scientific experimental basis. Not all amateurs want to do it. Not all have the facilities for it. But it does demonstrate just how wide is the range of activities within the hobby of amateur radio, and just how exciting and satisfying success can be for those wishing to operate an e.m.e. station.

WOODPECKERS

Tuning the shortwave bands today, one often comes across a broad-band form of interference sounding very much like a woodpecker in full peck, making reception of other signals very difficult and sometimes impossible. Inevitably nicknamed "the woodpecker", this worldwide pest is to be found on all h.f. bands, changing frequency suddenly and often.

It is, in fact, a low-frequency radar system, known as Over-the-Horizon-Radar, OTHR, which is an early-warning defence system utilising high power pulses. Most of the signal is concentrated in a bandwidth of about 15kHz, with a weaker pulse filling the adjacent spectrum to a total bandwidth of about 100kHz. The frequency changing represents a chasing of the maximum usable frequency at the point of origin, with a "dwell-time" on any given frequency ranging from a few seconds to a few minutes.

Originally it was thought the woodpecker originated only from within the Soviet Union. It is now known, however, that while stations do exist at a number of locations from Minsk to Vladivostok, other countries also have OTHR including Australia and the USA—which has stations in Maine and Crete.

It is expected that Britain may have it, and Japan was reported in early 1986 to be in process of setting up a 200kW transmitter with a frequency range spread over 24 channels between 5 and 28MHz.

OTHER SERVICES AFFECTED

Amateur radio is not the only service affected of course, and as long ago as 1978 the World Administrative Radio Conference for aeronautical services issued an anti-woodpecker statement which resulted in some lessening of the interference, for a time at least.

The Association of North American Radio Clubs set up an OTHR Committee in 1985 to monitor the amateur bands to obtain factual information on woodpecker activity. Many national radio societies have "Intruder Watch" organisations, which include the woodpecker in their watching brief.

All efforts are worthy of support, and many amateurs send in reports when they experience such interference. Just what can be done to eliminate it is another matter. There is obviously concern among all h.f. radio users, but it seems unlikely that much will be done until the national administrations concerned find that the disadvantages to them of OTHR interference outweigh the perceived advantages of maintaining such a system.

HERE IS THE NEWS

The RSGB has a number of services providing the latest news and information on amateur radio activities. *Headline News*—a three minute pre-recorded tape giving a summary of the main news of the week can be heard by telephoning Potters Bar (0707) 59312. *Databox*—If you have a Prestel compatible system you can gain access to several hundred pages of amateur radio related information by dialing 0707 52242. *Prestel*—Hundreds of pages of RSGB news and information are available to Micronet subscribers, RSGB page 8107.

GB2RS News Service—Apart from the BBC and ITA, the RSGB is the only organisation in the UK licensed to broadcast news bulletins. These are transmitted every Sunday on the 80, 40, and 2 metre bands at 30 minute intervals, starting at 0900 hours local time, from many parts of the British Isles. Details of time/location schedules are obtainable by sending an s.a.e. to the Radio Society of Great Britain, Lambda House, Cranborne Road, Potters Bar, Herts, EN6 3JW.

NEWS
...from the world of electronics

INDUSTRY PROVIDES FINANCIAL BACKING FOR SCHOOLS

TWO BRITISH companies are to fund technology awards for students to the tune of £100,000. Aimed at encouraging innovation and the development of technological skills at educational establishments around the country, Texas Instruments Ltd and Cirkit Holdings Plc (specialist component supplier well known to EE readers) have come together to help set up the YEDA Trust.

The Young Electronic Designer Awards have now achieved Trust status with the Board of Trustees formally adopting the YEDA Trust Charter. The Charter lists as its principal objective the development of world-beating products in pursuit of future (British) success in international markets, together with the creation of more jobs.

By providing funding and by helping to create the Trust, they have responded in a practical way to the Government's call for greater co-operation between industry and the educational establishment as one means of bringing about recovery. At a time when industry frequently complains about the lack of properly trained school leavers and graduates available for recruitment, they have taken positive steps to help solve this national problem.

They have set up the new trust to secure the scheme's future development with the support of a top-level multi-vocational Board of Trustees. The Board includes Professor Eggleston of Warwick University; Sir John Egan, Chairman, Jaguar Cars; Air Marshall Sir Alec Morris, British Aerospace plc; The Rt. Rev. Ashley Mann, Dean of Windsor; The Rt. Hon. Lord Peyton of Yeovil, Chairman, Texas Instruments Ltd; Alistair McDonald CBE, Chairman, Cirkit Holding plc.

Announcing the establishment of the new charitable foundation Peter van Cuylenburg, MD Texas Instruments, and Chris Sawyer, Chief Executive Cirkit, said, "*there must be a greater emphasis on the development of practical skills and commercial awareness in our young people from an early age if a national recovery is to be brought about.*"

"*It is inevitable,*" they continued, "*that in a technological age society will depend increasingly upon electronics, so teachers and their students have to be provided with the incentive to include the practical subject on the curriculum, rather than regard it as merely a hobby or leisure activity. And Business has to be more prepared to provide the necessary resources to bring ideas to the market.*"

Last year's "Young Electronic Designer Awards", Senior Category, winners from Essex University receiving their awards from Dr. Robb Wilmot CBE and the Rt. Rev. Michael Ashley Mann, Dean of Windsor.

Joint Venture

Texas and Cirkit are contributing jointly some £100,000 in resources to the YEDA Scheme in the current year, providing students and participating institutions with the opportunity to win a scholarship, cash awards and equipment as well as career prospects.

To enter, applicants in full-time education have to complete an electronic design project, which has a useful and viable application in everyday life, for assessment by a panel of experts. The judges assess not only innovative and technical merit but the commercial potential of the projects. Preliminary judging will take place in May and the finals in June/July.

In addition to the awards to be won, there is the potential for successful applicants to have their designs taken up for commercial manufacture through the help of the sponsoring organisations.

How To Enter

For further information and how to enter *The Young Electronic Designer Awards* readers should write to: The YEDA Trust, Dept EE, 3rd Floor, Standard House, 16–22 Epworth Street, London EC2A 4SX. Tel. 01-628 7651.

MICRO NAVY

British Telecom has been awarded a £2M contract to supply the Royal Navy with more than 300 specially adapted micro computers. The M4000 systems will be used mainly for catering administration and accounting, both on ships and shore establishments.

Software written by the Royal Navy has been converted to work on the new system.

A. F. Bulgin and Co., have appointed Rifa Electronics of Stockholm to market their electronic and electro-mechanical components in Sweden.

POWERFUL EXHIBITION

The latest developments in battery technology will be featured at a forthcoming conference and exhibition devoted to power sources and supplies.

The annual Power Sources & Supplies event is now to be held as part of the 1987 British Electronics Week at London's Olympia Exhibition Centre. The conference and exhibition will run from 28 to 30 April, 1987 and is being coordinated by the Evan Steadman Services.

Subjects being covered include batteries for uninterruptible power supplies, batteries for p.c.b. mounting, electric vehicle power systems, microprocessor controlled charging and batteries for photovoltaic power systems.

For the second year in succession Beckman Industrial has been awarded the contract for the supply of handheld digital multimeters to BT. Worth over £300,000, it is one of the largest orders placed in Europe for digital multimeters.

The Business Intelligence Services Group has just completed the acquisition of JBA, the computing software and information systems company based in Sydney, Australia. BIS first agreed terms with JBA in November, 1983.

COBRA

THORN EMI Electronics has joined forces with companies from Germany, France and America to form the EURO-ART Organisation, in order to bid for the proposed three-nation requirement of the new European weapon-locating radar—COBRA. As the UK member of the consortium they are being funded by the UK Ministry of Defence in the project definition study.

The all weather COBRA (counter battery radar) will provide accurate location and identification of the firing position of enemy artillery and projectiles. To improve its effectiveness and survivability in battlefield environments, the radar will employ sophisticated techniques to escape disruption from countermeasures.

eb...Beeb...Beeb...Beeb...Bee

. . . versatile sound digitising . . .

WITH the analogue to digital and digital to analogue converter designs described in the last two *Beeb Micro* articles you have the basis of a versatile sound digitising set-up which can be used in a variety of ways. These boil down to use as a sound sampling system, a digital delay line, and an audio storage oscilloscope. With the first two options there are numerous sub-options, such as the range of effects (echo, reverb, chorus, etc.), that can be achieved with the system set to operate as a delay line.

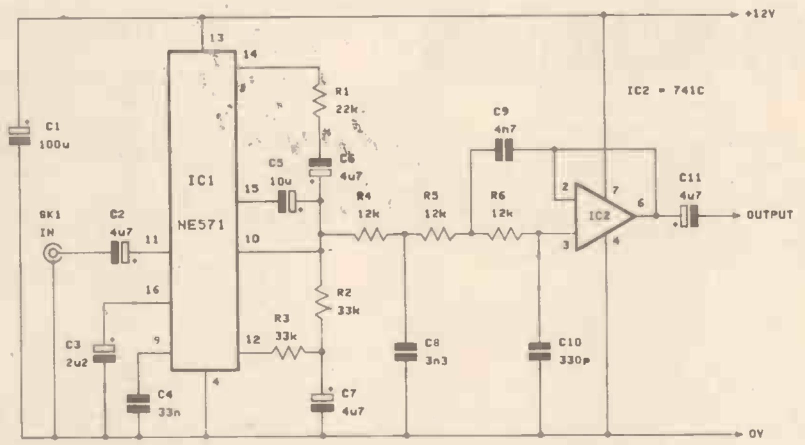


Fig. 1. The compressor and input filter circuit diagram.

Enhanced Quality

I will not make any great claims about the quality that can be obtained from a simple set-up of this type, and it is important to realise that 8-bit resolution places severe limitations on the audio quality. For oscilloscope applications the 8-bit resolution is actually perfectly adequate, and with a maximum vertical resolution of 256 pixels this is all that the graphics' capability of the BBC machines justify anyway. A storage oscilloscope add-on and supporting software was described in the November 1984 issue of this magazine, and it is not a topic that will be pursued further here.

Commercial digital music equipment often uses 12-bit resolution, and high quality digital recording normally has 14- or 16-bit resolution. The difference in terms of bits might not seem to be that great, but remember that the quality (in terms of noise and distortion) doubles each time an extra bit is added, or perhaps of more relevance in this case, halves each time the resolution is reduced by one bit. A 16-bit system does not offer double the quality of an 8-bit type, but 256 times the quality.

In absolute terms the quality of an 8-bit system does not seem to be too bad at first sight, with a signal to noise ratio approaching 50dB and distortion of under 0·5% being achievable. For sound sampling applications this will often be adequate, but for delay line use the signal to noise ratio is rather high, especially taking into account the fact that many delay line effects use recycling of the signal which degrades the signal to noise ratio quite substantially. Another problem is that the distortion may be quite low at maximum input, but in percentage terms the distortion figure doubles for each halving of the input level. This gives distortion in the region of 5% at −20dB and 50% at −40dB, which is inadequate for most delay line applications.

Compander

Both the signal to noise ratio and distortion performance can be greatly improved by the use of a compander. This gives audio compression at the input of the system and expansion at the output. The most popular compression/expansion characteristic is a 2:1 type, and with this, reductions in the input level produce a fall in the output from the expander of only half as much. In other words, reducing the input by 40dB results in the signal fed to the analogue to digital converter falling by only 20dB. This gives about 5% of distortion at the −40dB point instead of 50%, which is obviously quite an improvement. The expander restores the original dynamic levels at the output so that there is no overall change in the dynamic levels through the system.

Another effect of the compander is to reduce the noise level on low level signals, effectively boosting the signal to noise ratio to around 90–100dB. Well, in theory anyway, as in practice noise generated by the compander or in any circuits following it will tend to degrade the signal to noise ratio slightly, but a figure of better than 80dB will normally be achieved.

The NE571 compander chip is the obvious choice for this application, and it seems to perform very well in practice. This chip has two identical sets of circuit blocks fed from common supply pins, and in normal use one set of blocks is configured as the compressor while the other set are connected to operate as the complementary expander. Fig. 1 shows the circuit diagram of the compressor circuit.

There is insufficient space available here for a detailed description of the NE571, but in this mode some of the input signal is fed to a precision rectifier circuit which generates the control voltage for a variable gain block circuit. The latter is connected in the negative feedback loop of an operational amplifier, and as the input signal level is raised the gain block provides increased negative feedback that reduces the gain of the amplifier and introduces the required compression.

Integrated circuit IC2 operates as a buffer amplifier in a third order (18dB per octave) lowpass filter. With any audio sampling system, in order to avoid "aliasing" distortion the sampling rate must be at least double the maximum input frequency, and preferably three or more times the maximum input frequency. This gives conflicting interests, with a high sampling rate being desirable as it gives a wide bandwidth, but a low sampling rate being needed in order to provide a long delay from a given amount of memory.

In this case a compromise has been adopted with a bandwidth of about 8kHz being used. While this is less than the full audio bandwidth, it is sufficient to give good results, and enables quite long delays to be achieved. Note that the output of this circuit connects direct to the input of the converter, with C11 effectively replacing the coupling capacitor at the input of the converter. The two input bias resistors must be retained though.

The expander circuit appears in Fig. 2, and with this configuration the voltage controlled gain block is placed directly in the signal path with the operational amplifier merely acting as an output buffer stage. Thus, as the input level is raised so is the gain of the circuit, giving the required expansion effect. The expander is preceded by a fourth order (24dB per octave) lowpass filter, and this smoothes out the steps on the output from the digital to analogue converter. These occur due to the output jumping straight from one sample voltage to the next.

Software

The system is designed for use with input signals of up to about two volts peak to peak. Due to the compander, reasonably good results will still be obtained if a somewhat lower input level is used, but the system can not be operated successfully if it is fed directly from a low level source such as a microphone or low output guitar pick-up.

In order to operate fast enough the software must have assembly language routines to handle the sampling process. The basic technique is to have a block of memory with samples being stored at successive addresses until the block is full. This process is

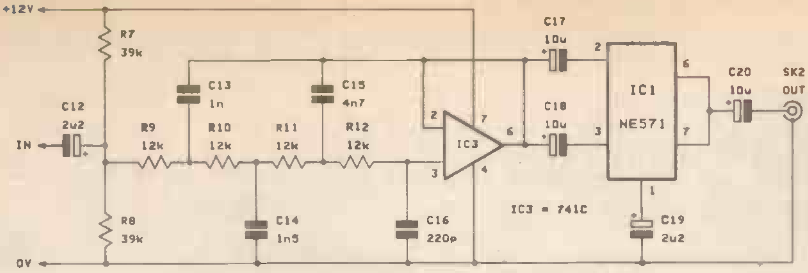


Fig. 2. The expander and output filter circuit diagram.

repeated indefinitely with new samples overwriting those of the previous pass. The delay is provided by outputting each sample just before it is overwritten, so that a complete cycle of the memory block occurs between a value being stored and sent to the digital to analogue converter. The delay time can be varied by altering the size of the memory block, or by outputting values other than just before they are overwritten so that the effective block size is reduced.

The accompanying listing should get you started, and this uses a 20K chunk of memory. The delay time seems to be not far short of one second, which would suggest a sampling rate of about 25kHz (which is more than three times the maximum signal frequency). The software is written for an analogue to digital converter connected to the user port, and a digital to analogue converter connected to the printer port. Note that the software monitors the "end of conversion" output of the analogue to digital converter using line CB1, with CB2 providing the "start conversion" pulses. Therefore the system can only function if both these handshake lines are connected to the converter.

In theory, using the Master 128 computer much longer delays could be obtained due to its larger memory size. In practice things could be less straightforward, as there is a lot to be said for a continuous block of memory for applications of this type, rather than having small blocks of memory liberally scattered around the memory map. It would be an interesting line of experiment for anyone with a Master 128 though.

User-port interface

Anyone who is interested in hard-wired applications for the BBC micro, but is put off using the user port by the thought of making connections to one of the major chips (not to mention having to work out the connections to the 20-way IDC connector) will be interested in the model 441B interface unit from Charter Systems Technologies.

This unit plugs into the user port and provides four inputs and four outputs. This slightly restricts the flexibility of this port, the eight lines of which can be programmed as any required combination of inputs and outputs, but many practical projects could be used with this arrangement.

The unit can either be used on its own for demonstration and simulation purposes, or connected to external "real" applications.

For use on its own, each input has a switch and a l.e.d. indicator. Each output has an indicator light to indicate whether the line is high or low. For connection to external devices, there are 3mm sockets. External voltages must not be applied to the inputs, these are for switches only, but the outputs have relays which are rated at 1A/28V d.c. or 0·5A/100V. a.c., so are capable of handling real loads.

The manual provided with the unit has instructions for getting started, a brief description of the user port and how to address it (using the "illegal" indirection operator method, which won't work with a second processor), and an example program which simulates the operation of a washing machine.

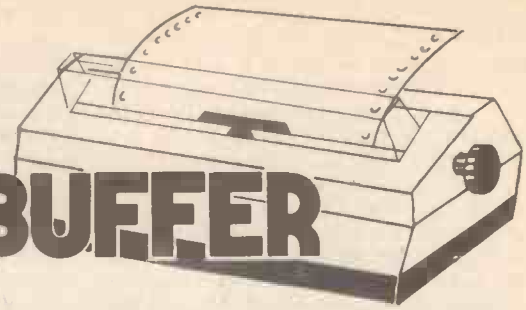
This unit is likely to be of most interest to schools, especially science departments where it could greatly simplify the connecting of experiments to the computer. It will also help solve the problem of the inaccessibility of the user port underneath the computer (micros in schools usually have to be screwed down to prevent them going home with the pupils).

The Model 441B Interface Unit is made by Charter Systems Technologies of 12 Hadleigh Road, Finham, Coventry CV3 6FF, telephone Coventry (0203) 410181.

ECHO PROGRAM

```
10 REM Echo Program
20 DIM CODE 100,STORE 20480
30 ?&70=0:?&71=STORE DIV 256+1
40 ?&72=?&70:?&73=?&71+96
50 ?&74=?&70:?&75=?&71
60 ?&76=?&70:?&77=?&71
70 ?&FE6C=176
80 FOR I%=0 TO 2 STEP 2
90   P%=CODE
100  [OPT I%
110  CLD
120  SEI
130  LDX #80
140  LDY #0
150  .INLOOP
160  STA &FE60
170  .WAIT
180  LDA #16
190  AND &FE6D
200  BEQ WAIT
210  LDA &FE60
220  STA (&74),Y
230  INY
240  BNE INLOOP
250   INC &75
260  DEX
270  BNE INLOOP
280  .BOTHLOOP
290  LDA (&76),Y
300  STA &FE61
310  STA &FE60
320  .WAIT2
330  LDA #16
340  AND &FE6D
350  BEQ WAIT2
360  LDA &FE60
370  STA (&74),Y
380  INY
390  BNE BOTHLOOP
400  INC &75
410  LDA &75
420  CMP &73
430  BNE CHECKPLAY
440  LDA &71
450  STA &75
460  .CHECKPLAY
470  INC &77
480  LDA &77
490  CMP &73
500  BNE BOTHLOOP
510  LDA &71
520  STA &77
530  JMP BOTHLOOP
540  ]
550  NEXT I%
560 *K.10 OLD|M |L PRINT "RUN to restart"|L|M
570 CLS
580 PRINT "Press BREAK to reset."
590 CALLCODE
```

EXPANDING THE SIMPLE PRINTER BUFFER



W. HUNTER

Expand the Printer Buffer (EE Sept 86) to provide 32K of memory

The *Simple Printer Buffer* project in the September edition of *Everyday Electronics* has proved extremely popular. One or two readers have written to ask if it is possible to incorporate additional memory to increase the buffer's storage capacity. The original design only provided for memory up to 16K bytes, utilising two 6264 RAM chips, and no provision was made for expansion beyond this.

At the time of design, these RAM chips cost over £30 each and the design was intended to produce an inexpensive construction project. Since then the volume production of the 6264 memories has reduced the price by a factor of ten. With current prices so low, constructors will be pleased to learn that with simple modifications to both the printed circuit board and the program in ROM, the capacity of the buffer can readily be doubled to 32K bytes.

PIGGYBACK

Two more RAM chips must be mounted on the circuit board, but there is no space for them. The technique to get round this problem is called "piggyback mounting". The additional memory chips are soldered on to the backs of the existing memory chips—each pin soldered to the corresponding pin of the chip underneath (apart from the pin used for chip selection). This requires a little delicacy with the soldering iron, but is not difficult.

The pins of the upper memory chip are bent inwards slightly so they wedge onto the lower chip leaving a gap between the bodies of the two chips. Soldering should be performed fairly quickly, two or three seconds maximum on any one pin. If you are a bit slow, allow the chips to cool down before doing the next joint. Be sure to leave enough length of lower pin to fully engage in the socket on the printed circuit board.

RAM chip selection is made using pin 20 (CS1) on each chip. It is necessary to send a different signal to pin 20 on the upper chip, from the signal sent to pin 20 on the lower chip. When preparing the upper chip for soldering, bend pin 20 outwards slightly, so a flying lead can be soldered on later, and so that there is no danger of it touching pin 20 on the chip beneath.

Decoding the additional memory requires the use of an inverting gate. There are spare NAND and NOR gates available in IC6 and IC7—any of these would serve by joining the two inputs together. The chosen gate has inputs 15 and 14, and output 13 on IC6. The inverter acts on address line A14 (Fig. 1) producing a signal which is low in address space 16K to 32K. This inverted signal will select the two new memory chips, distinguishing them from the original memory which is selected in address space 0K to 16K. The original chips are selected by a non-inverted version of address line A14.

The R/W line from the CPU pin 34 is now connected to IC7d pin 2 instead of going straight to the RAM chips. In IC7d it is NOR'd with VMA.E from IC6a pin 3 before being inverted by IC6d and then going to the WE on pin 27 of the RAMs. This is required because the R/W line changes to the write state at the same time in the CPU cycle that the address lines change and this can cause data to be written to the wrong addresses. This was not a problem in the original design because the

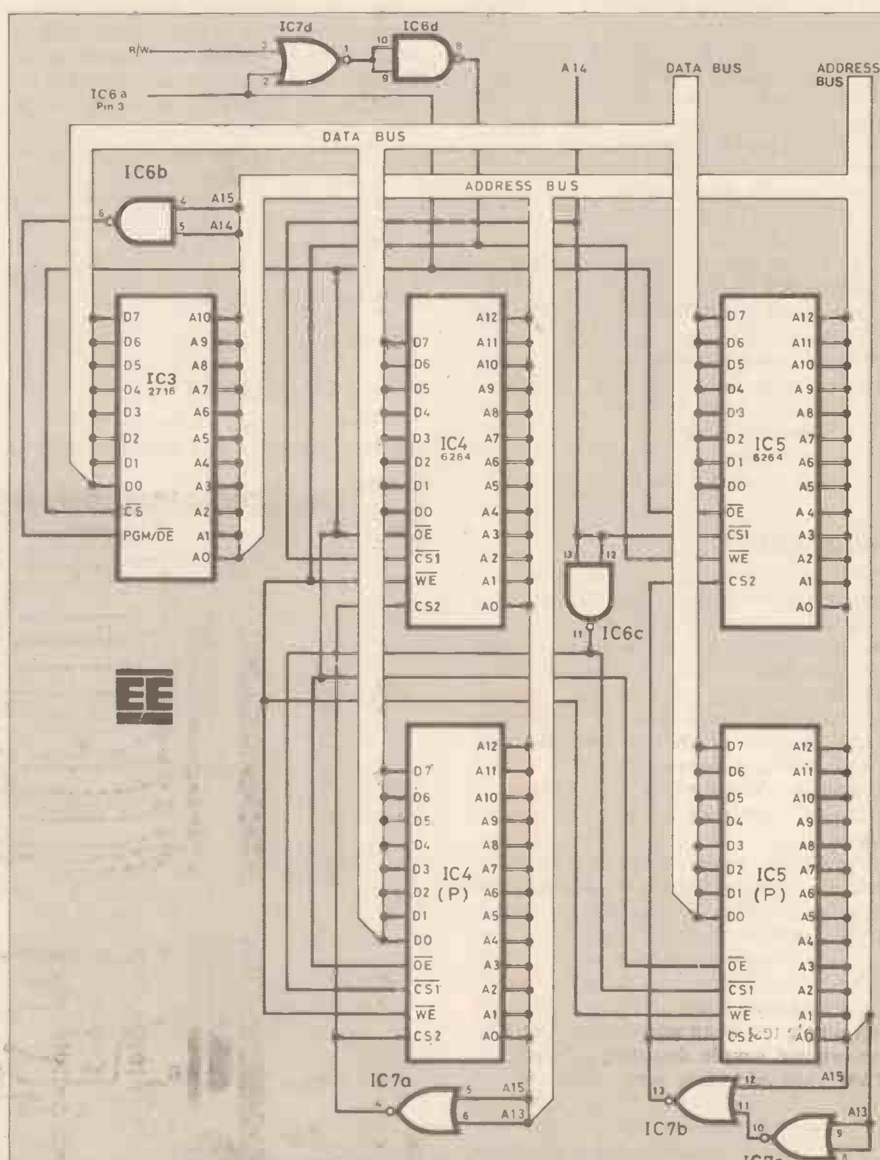


Fig. 1. Simple Printer Buffer expanded circuit

VME.E line went to the CS1 inputs of the RAMs and only allowed the RAMs to become active at the correct time in the cycle.

Modifying the printed circuit board requires tracks to be broken in four places. This is best done with a sharp knife, making two cuts 1 mm apart and removing the track between. The tracks to be cut are the two going to pin 20 on IC5, the one going to pin 20 on IC4, see Fig. 2, **and the one from pin 34 of IC1 to pin 27 of IC4** ***on the component side of the board***. Cut the tracks near those pins, well away from the plated through hole in the middle of IC5 which brings the signals to drive pins 22 on the RAMs and the EPROM.

The cuts have broken the path from the through hole to the pins 22 on the RAMs and EPROM and it is necessary to make a "patch" to restore this connection. To do this, solder a thin insulated wire onto the through hole pad in the centre of IC5 and connect it to pin 22 of IC5 (or the track coming from it). Having done this, patch connections to pin 20 of each RAM chip as follows:

IC4 (original) pin 20 to IC1 pin 24 (Address A14)
IC5 (original) pin 20 to IC1 pin 24 (Address A14)
IC4 (piggyback) pin 20 to IC6 pin 11 (Inverted A14)
IC5 (piggyback) pin 20 to IC6 pin 11 (Inverted A14)

The patches to the piggyback chips will have to be flying leads to the pins of the ICs, on the front of the board. The patches to the original RAM chips can be made on the back of the board, soldering to the pins of the IC sockets. To produce the inverted A14 from IC6 patch the following:

IC6 pin 24 (A14) to IC6 pins 12 and 13

The locations in the address space occupied by each chip are now unique. IC4 is $0000 to $1FFF, IC5 is $2000 to $3FFF, IC4P is $4000 to $5FFF and IC5P is $6000 to $7FFF.

The remaining patching required is to the two spare gates in IC6 and IC7 as follows:

IC6 pin 3 (VMA.E) to IC7 pin 2
IC1 pin 34 (R/W) to IC7 pin 3
IC7 pin 1 to IC6 pins 9 & 10
IC6 pin 8 to IC5 pin 27

PROGRAM

The only remaining modification required is to the program in EPROM. This program checks the available memory during initialisation, and saves the address of one past the last byte in a location called MEMEND. Unfortunately, the original program only checks to see if one or two RAM chips are installed, and does not check for further memory, therefore it must be altered to look for four RAM chips.

The program tests for RAM by simply storing $AA in what would be the first address of the second RAM chip and then checking that the same data is read back from that location. If it is, then the second RAM is present. It then tries the same test on the first location of the second 16K block of RAM to determine whether it is present. Unfortunately a slight problem occurs with this simple test in an unmodified board. In the original simple decoding scheme, the RAM chip addresses were "reflected" at higher addresses, i.e. address $0000 to $3FFF were the same as addresses $4000 to $5FFF. Therefore a simple test which stores data in address $4000 will not be able to differentiate between an unmodified board with 16K of RAM and a modified board with 32K of RAM. To avoid this problem, the new program clears address $0000 after storing data at $4000. If the RAM addresses are being "reflected" 16K higher, this is the same as clearing $4000 and the subsequent test to see if data is unchanged will fail. In this way, the program will rightly deduce that only 16K of RAM is installed.

The program does not check to see if only 24K of RAM is installed as it was felt that if the modification was done it would be pointless installing only 8K more RAM. The original program is modified from address $F906 to form the new program. The segment of program from $F8F8 now reads:

F8F8	86	AA	TESTMEM	LDA	#$AA	
F8FA	CE	40 00		LDX	#$2000	One past 8K
F8FD	A7	00		STAA	0,X	Try storing data
F8FF	A1	00		CMPA	0,X	Test if stored
F901	26	0F		BNE	TSTM1	
F903	CE	80 00		LDX	#$4000	One past 16K
F906	A7	00		STAA	0,X	
F908	7F	00 00		CLR	$0000	Double addr check
F90B	A1	00		CMPA	0,X	Data stored?
F90D	26	03		BNE	TSTM1	
F90F	CE	80 00		LDX	#$8000	32K RAM installed
F912	DF	00	TSTM1	STX	MEMEND	
F914	39			RTS		

EPROM

For any constructor who purchased a ready programmed EPROM for the original circuit and who wishes to expand the buffer, Tayside Microsystems will reprogram the EPROM for a nominal handling charge. Send the original EPROM (in working order!) with 54p in stamps, and your name and address. New constructors may still purchase the printed circuit board (unmodified) for £9.75 and the EPROM (new program) for £8.25 from Tayside Microsystems, 55 Causewayend, Coupar Angus, Perthshire PH13 9DX.

NEXT GENERATION

Following close on the heels of the 6264 is the next generation of RAM chips holding 256K bits. These are now available but the current price is fairly prohibitive. The entire expanded 32K buffer could be held in one of these new memory chips. For instance, a Hitachi HM62256 could be plugged into the socket of IC5.

Decoding would be straightforward, using extra address lines from the CPU, with address A15 acting as an active low chip select. In this case, IC5 pin 26 should be patched to A13 (IC1 pin 23), IC5 pin 1 patched to A14 (IC1 pin 24) and IC5 pin 20 patched to A15 (IC1 pin 25). Existing tracks to these IC5 pins should be cut, and IC4 should be removed. The software in EPROM would be identical to the modified program described above.

UPDATE

Some inaccuracies in the original article have subsequently been pointed out to us. These are as follows:

1. The approximate cost should have been £51 and not £31 as shown, we apologise for misleading readers.
2. R1 is not shown in Fig. 4; it connects across the vacant pads immediately below C9. The p.c.b. is correct in all other aspects.
3. C9 is shown as 470nF on the circuit it should be 470µF as in the components list.
4. The line going to pin 5 of IC6 in Fig. 1 should be labelled A14 and not A16.

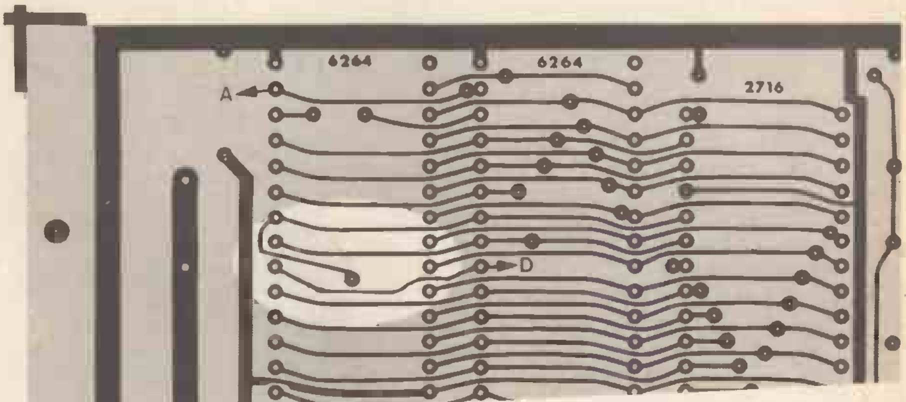
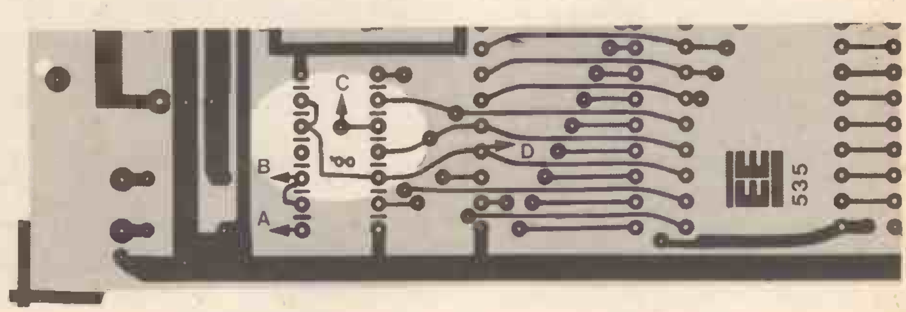


Fig. 2. P.C.B. modification



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DOWN TO EARTH

BY GEORGE HYLTON

HEADPHONE IMPEDANCE

A READER wonders why headphones are made in such a wide range of impedance. Can equipment be damaged by connecting 'phones of the wrong impedance?

In the days of crystal sets headphones were usually made with a high impedance. The figure actually quoted was often, not the true a.c. impedance but the d.c. resistance. A common arrangement was to make each earpiece coil with a resistance of 2000 ohms. The user then had a choice of connecting them in series to make 4000 ohms or in parallel to make 1000 ohms. The true a.c. impedance, as seen by the audio signal was higher than the d.c. resistance, and also frequency dependent.

These old headphones (still sometimes available at jumble sales for a modest sum) worked in two ways, both magnetic. The commonest form had a magnetic diaphragm which was waggled about by using audio currents to vary the attractive force of a magnet. In the other, a magnetic armature, cantilevered with its free end midway between the poles of two magnets, was made to move to and fro by varying the strength of the magnets at audio frequency. Both types were made with sensitivity in mind, rather than fidelity. It was essential to make the utmost use of the feeble audio currents from a crystal detector or simple one-valve receiver.

PROFESSIONAL HEADPHONES

When radio receivers were fitted with loudspeakers the need for headphones passed, in the home, at least. But they were still used by radio operators, telephone engineers and sound studio staff. These phones were often made with a nominal impedance of 600 ohms, which is the typical impedance of an open-wire telephone line. They were usually capable of better quality than the older types. 'Phones of this style are still in use, though the latest models are lightweight jobs.

LOW IMPEDANCE

When transistors came along the need arose for "personal" listening to portable radios. It was logical to give earphones the same sort of impedance as the loudspeaker: typically 8 ohms. Nowadays, the commonest sort of stereo phones incorporate two small loudspeakers, one in each earpiece, each of 8 ohms impedance.

So there were now phones of three classes of impedance: the old 4000 ohm type, the 600 ohm telephone engineer's type and the low-impedance "personal" type. Even this couldn't last. Crystal earphones of very high impedance were soon also available. These are really capacitors, often of around 1000pF, and so have an impedance which is infinite to d.c. but falls with increasing frequency.

Not surprisingly, some of these phones are not compatible with some equipment. Let's take a look inside the equipment and see why.

CLASS B

When you plug a personal earphone into your pocket radio the audio output is diverted from the low-impedance speaker into the earphone. As far as electrical compatibility is concerned it's obvious that the earphone can have the same impedance as the speaker it replaces. If the earphone were sensitive, however, the volume would be excessive. A very inefficient earphone will still give adequate volume. The manufacturer can either use this to reduce the cost of the earphone, or he can trade efficiency for fidelity and make a fairly expensive earphone (or, more likely, stereo headphones) which gives good sound quality.

The amplifier which drives these phones is often of the Class B type. Its output stage, stripped of irrelevancies (for our present need) such as bias circuitry, may well be like Fig. 1. This puts an audio

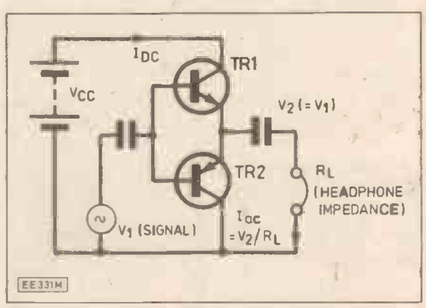

Fig. 1. Class B amplifier essentials. The current drawn is V_2/R_L.

voltage V_2 across whatever load R_L (speaker or phones) is connected. The audio current is V_2/R_L. If V_2 is 4V and R_L is 8 ohms then the current is 0·5A. If R_L were doubled, to 16 ohms, the current would be halved, to 0·25A. If R_L were 4 ohms, the current would be 2A; at least, it would be if the amplifier could supply it.

In practice, as the load impedance is reduced and the amplifier tries to deliver more and more current there comes a point at which the amplifier is overloaded. It tries to deliver the current which the load impedance demands but it fails. In the attempt, the transistors get hot and bothered and may collapse. Even if they don't the audio waveform will be distorted.

Many modern amplifiers incorporate current limiting circuits which deliberately clip the peaks off the audio waves. This protects the transistors and also warns the user by distorting the sound.

SAFE LOADS

From this you can see that for safety and low distortion the load impedance for a Class B amplifier should always exceed a certain minimum value. This value depends on the design of the particular amplifier. With modern designs, it is unlikely that any harm will be done by using too high a load impedance.

Most amplifiers are designed to stay safe even when the load is made infinite by disconnecting the speaker or phones (a few old designs tended to burst into oscillation when this happened). You may, of course, find that if the impedance is much too high you can't get enough volume. If, for instance, you connect phones of 800 ohms instead of 8 ohms, only one hundredth of the current can flow, and so only one hundredth of the power is available.

MONITORS

Listening to personal radios and tape players isn't the only use for headphones. If you make tape recordings using microphones you may well want to monitor what's being recorded. In this case the phones must be somehow bridged across the audio path without affecting the level of the signals getting to the recording head. They must also give good quality sound, so you can hear if there's something wrong. And above all they must not themselves cause distortion, or you'll be led to think that there's something wrong when really there isn't.

A sensible way of preventing the phones from diverting audio signals from their main path is to drive them with a buffer amplifier. This must be placed somewhere before the tape equalization circuitry or the audio will sound wrong. (I'm assuming that the monitoring is done to the audio on its way to the head. Some very expensive recorders use a separate playback head to enable you to monitor what has just been recorded. In this case, of course, playback equalisation must be applied before monitoring.)

It's likely that the monitor outlet will pick up signals at a fairly low level, say under IV peak. Suppose the buffer amplifier is a simple emitter follower (Fig. 2). This is capable of good quality. But it can still be overloaded by the phones.

Received wisdom says that for maximum undistorted power output the Fig. 2

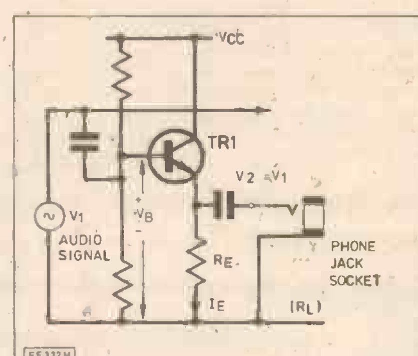

Fig. 2. Class A emitter-follower. The peak undistorted load current cannot exceed I_E.

circuit should have a load of resistance $R_E/\sqrt{2}$, or in round terms. 0·75R_E. So if R_E is 1·4k the headphone impedance for maximum power is 1k. A higher impedance is all right, so long as it gives adequate volume. But a lower impedance tries to make TR1 deliver more current than it's designed to do. The result, in this case, is not damage to the transistor, because the current is fixed by R_E and the bias voltage R_B. No, the result is distortion.

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Published on approximately the third Friday of each month by Wimborne Publishing Ltd., 6 Church Street, Wimborne, Dorset BH21 1JH. Printed in England by Benham & Co. Limited, Colchester, Essex. Distributed by Seymour, 334 Brixton Road, London SW9 7AG. Sole Agents for Australia and New Zealand – Gordon & Gotch (Asia) Ltd.; South Africa – Central News Agency Ltd. Subscriptions INLAND £13 and OVERSEAS £15 payable to "Everyday Electronics" Subscription Department, 6 Church Street, Wimborne, Dorset BH21 1JH.

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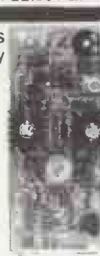

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ADC Q4 mag. cartridge for above. Price **£4.99** ea. P&P 50p.

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TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £6.99 each + 40p P&P.
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TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £5.99 each + 40p P&P.
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STEREO DISCO MIXER with 2 × 5 band L. & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:—
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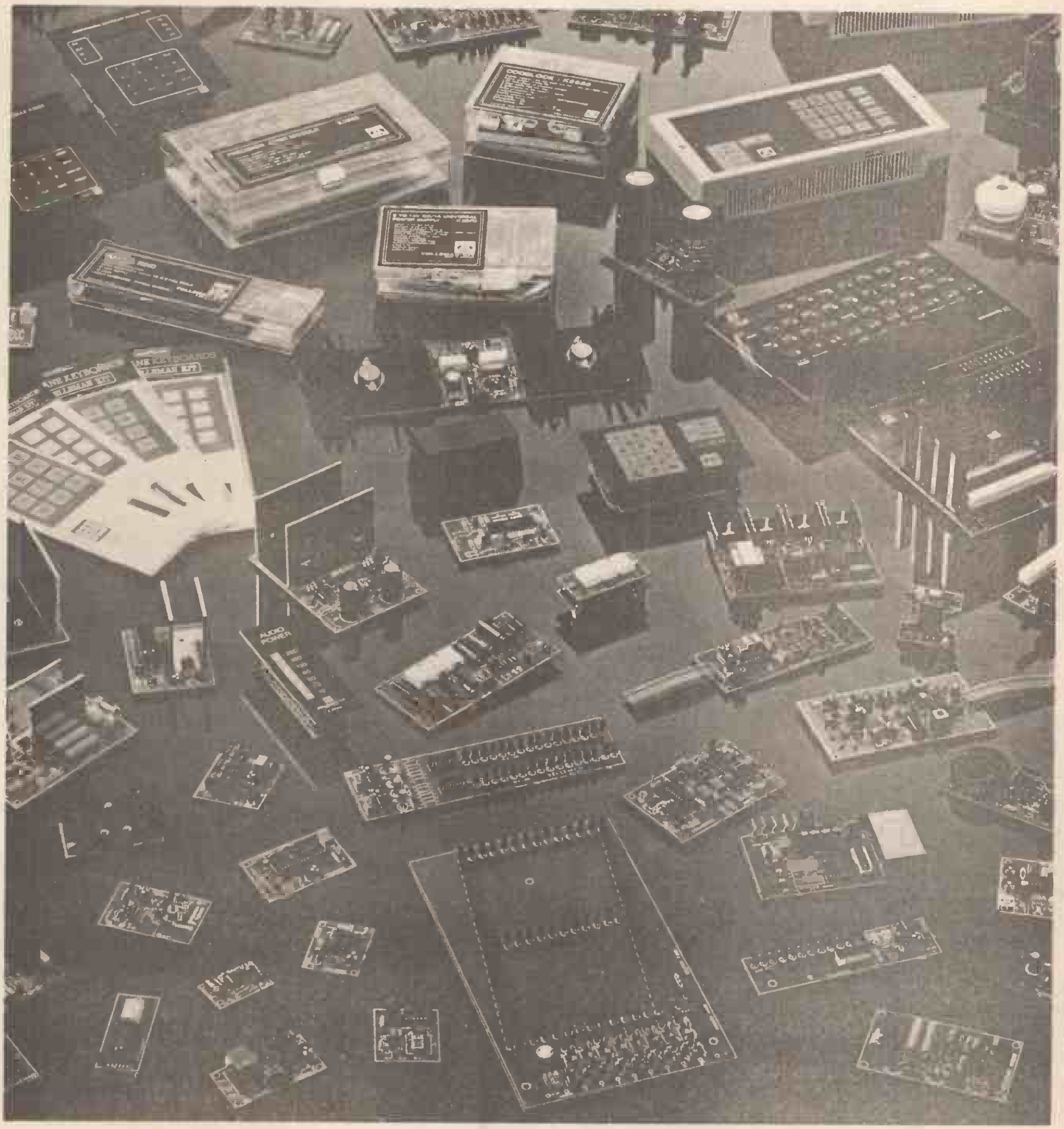

FIRST, may we wish you all a healthy, happy, prosperous, peaceful new year.

And so welcome, to this, the first *Greenweld Kit Cat*. In its 24 pages you will find well over 100 kits complete down to the last resistor, from simple amplifiers to complex microprocessor based projects—and on some of these more advanced kits, the opportunity to buy a professionally assembled piece of equipment.

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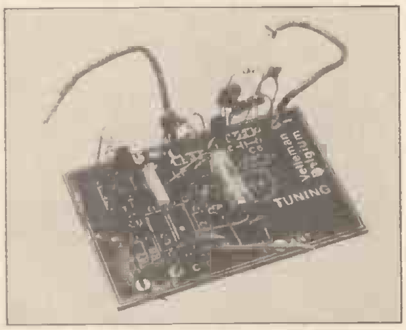
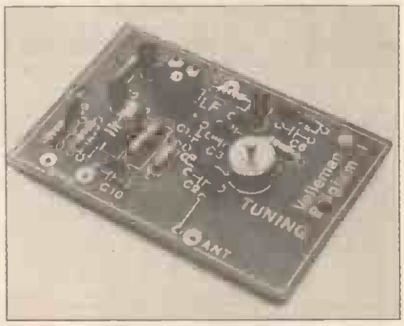
IS BUILDING OF ELECTRONIC KITS A DIFFICULT AFFAIR?



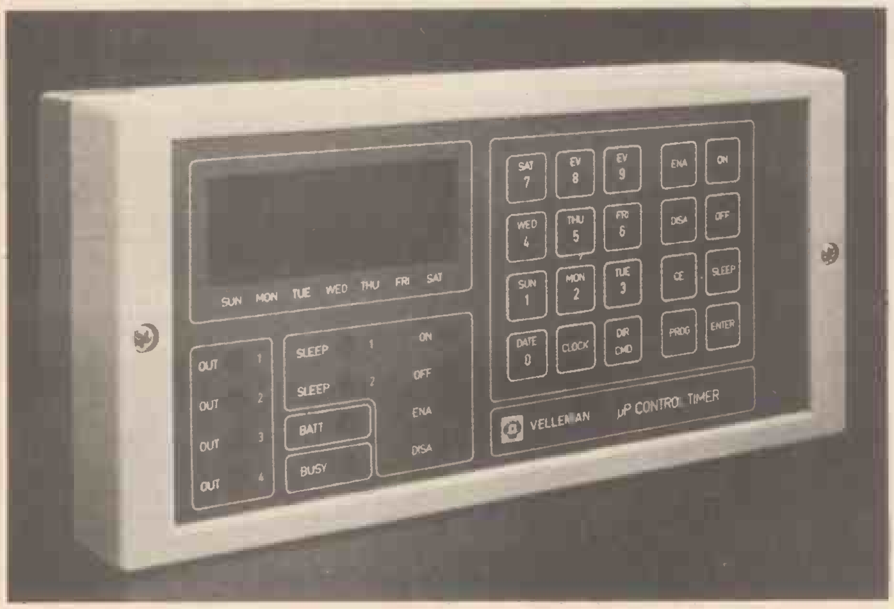


Yes, if you:

- totally ignore the instruction for use.
- want to finish the job in half an hour.
- use a 300 Watt plumberstype soldering iron.
- have only oversized and/or rusty tools available.
- treat technical specs extremely lightheartedly; then you're in for trouble and a catastrophe can hardly be avoided!

Not, if you:

- carefully read the instruction manual and follow the step by step assembly instructions as described.
- take sufficient time to do a proper job.
- use a suitable (± 30W) solderingiron with a tinplated and clean tip.
- apply tools suitable for the job.
- respect the technical data and take care with the connecting and final adjustments of the kit; in that case no major trouble will be experienced, as shown by thousands of succesfully assembled kits every year!



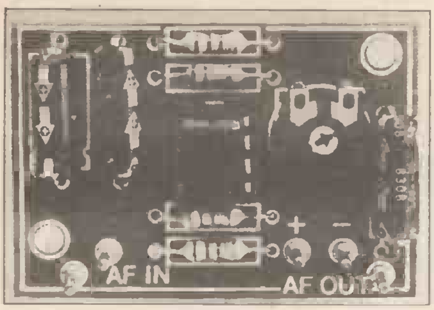
MICROPROCESSOR CONTROL TIMER

KIT NR. K2603 **£152.10**

- Single chip microprocessor.
- Non volatile memory (E^2PROM), holds the program as long as desired, without any power source.
- Auto-start after powerfailure (only 1 penlight alkaline cell required).
- Very easy and logic programming.
- Two independently programmable "sleep" times, from 1 second to 99 minutes and 99 seconds.
- Memory is protected against unauthorised changings.
- Standard memory size is 40 steps, but is expandable to 240 steps.
- Outputs : 4 relay outputs are provided; 1 relay (240v/3A) is included in the kit. Extra relays are available via Hardware Extension kit K2632.
- Velleman membrane keyboard and housing included.
- Stand-alone unit (transformer not included)!
- Dimensions (complete unit 242×116×59mm.).

DON'T FORGET ALL OUR PRICES INCLUDE VAT!

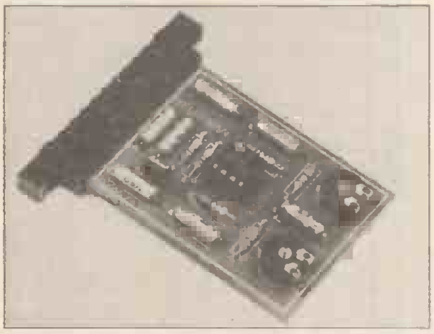
UNIVERSAL MONO PRE-AMPLIFIER
KIT NR. K1803 **£5.22**



The function of this kit is to be used in cases where a too low input voltage is available. It is ideally suited as: microphone amplifier - signal matching of tuner or tape outputs - signal amplification for ceramic and magnete dynamic pick-up cartridges, etc.

- Supply voltage: 10-30VDC.
- Supply current: 10mA at 12V.
- Gain: typ. 40dB.
- Output impedance: 1kOhm.
- Adjustable output level.
- Frequency range: 20Hz to 20kHz ±3dB.
- Max. input voltage: 40mV.

UNIVERSAL STEREO PRE-AMPLIFIER
KIT NR. K2572 **£9.12**

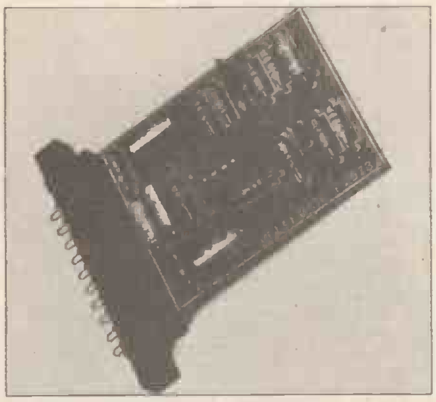


This kit is the stereo version of the universal preamp K1803 and has a number of advantages over the latter, like the application of a low-noise IC.

There exsists also an RIAA correction amplifier which is completely compatible, bearing the reference K2573.

- Power supply: 10 to 30VDC stabilized.
- Supply current: typ. 5mA.
- Gain (pre-settable): 40dB.
- Frequency range: 40Hz-30Hz - 3dB.
- Output impedance: 1KOhm.
- Maximum input signal: 50mV.

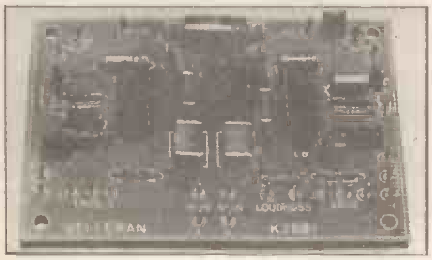
STEREO RIAA CORRECTION AMPLIFIER
KIT NR. K2573 **£10.33**



In addition to the universal preamp K2572, this kit is used as an RIAA stereo preamp, completely compatible with the first mentioned.
Its function is to amplify the signals from magneto-dynamic pick-up cartridges, according to the RIAA curve, to an acceptable level for audio amplifiers.
- Power supply: 10 through 30 V DC, stabilized
- Supply current: typ. 5mA
- Amplification (1 KHz): 35 dB
- Input impedance: 47 K
- RIAA curve
- Input signal: 5 to 10 mV

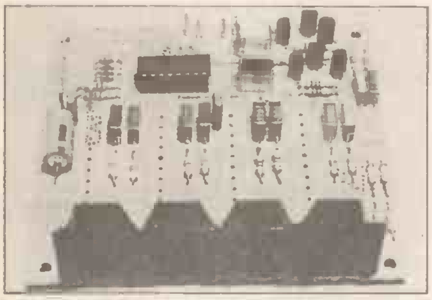
STEREO VOLUME- AND TONE CONTROL
KIT NR. K2581 **£21.00**

This tone control varies from conventional controls because it is build around two bipolar integrated circuits to obtain an active tone and volume control using the minimum of parts.
All controlling is performed by a DC voltage, so there is no need for a complicated wiring.
For both channels (stereo), a common treble and bass control is provided, plus a separate volume control for each individual amplifier.
An inputselector is available under the reference K2582. This may be connected to the tone control and is also driven by DC levels.



- Power supply: 12 to 18V maximum.
- Supply current: typ. 70mA.
- Input impedance: 1KOhm.
- Amplification: 1.
- Frequency response: 20Hz to 20kHz (−1dB).
- Harmonic distortion: typ. 0.2%.
- Bass: +17db to −17dB.
- Treble: +17dB to −17dB.
- Physiologic volume control.
- Separated volume control per channel.
- Common bass and treble control.

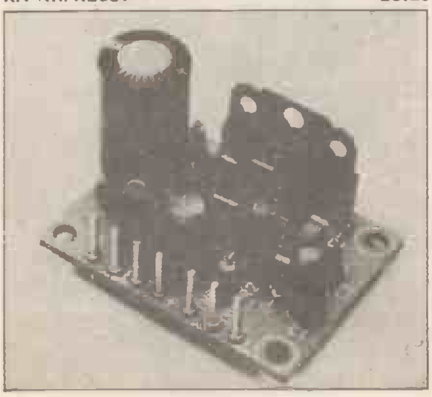
STEREO AUDIO INPUT SELECTOR
KIT NR. K2582 **£16.50**



This kit is to be used as an input selection for the volume and tone controle K2581. It is also possible to use it on its own. The kit has four audio inputs, with DIN connections, and one "tape" output.
A DC signal selects the inputs, avoiding the use of complex and shielded wiring. There is also a location provided to add a preamplifier, one per channel, of the K2572 type (universal stereo preamplifier) or of the K2573 type (RIAA preamplifier).

- Power supply: 10-15VDC, stabilized.
- Supply current: typ. 10mA.
- 4 stereo inputs.
- 1 stereo tape output.
- Channel selection via a DC signal.
- Output impedance: 2K2.
- Maximum input signal: 2V p.p.
- Input impedance (without preamplifiers): typ. 47KOhm.
- Each channel expandable with K2572 and K2573.
- Standard DIN input connectors.

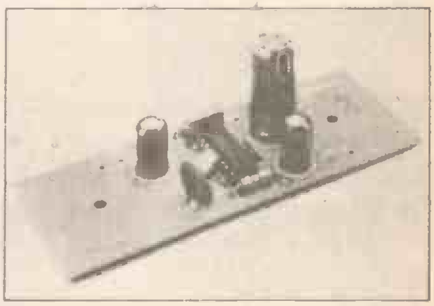
SUPERMINI 2,5W AUDIO AMPLIFIER
KIT NR. K2637 **£8.20**



The IC consists of a pre- and power-amplifier, which can be used separately by cutting a jumper. Its construction is very simple and there is no need for any adjustment. The power supply is not critical so that this kit can also function on a battery, or in the car. The amplifier is short-circuit- and thermal overload protected.

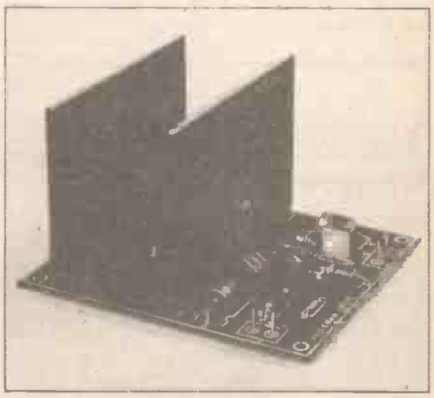
- Power supply: 4,5V to 15V DC.
- Supply current: 400 mA.
- Quiescent current: 12mA.
- Input sensitivity: power-amplifier: 150mV (12V)
  pre-amplifier: 20mV (12V)
- Input impedance: power-amplifier: 20Kohm
  pre-amplifier: 200Kohm.
- Frequency response: 60Hz to 15Khz.
- Short-circuit and thermal overload protected.
- Output Impedance: power-amplifier: 4-8 Ohm.pre-amplifier: 1 kOhm.
- Max. output power: 2.5W (4 Ohm, 12V).
- Dimensions: 42×32×27mm.

7W AUDIO AMPLIFIER
KIT NR. K611 **£7.13**



This easy to build, universal applicable amplifier, is typical for modern integrated design. Extreme wide power supply range is combined with low distortion and thermal overload protection.
- Output power: 7W at 16V/4Ohm
  6W at 14,4V/4Ohm
  2,5W at 9V/4Ohm
  1W at 6V/4Ohm
- Power supply: 4-20VDC.
- Output impedance: 4-8Ohm.
- Input impedance: 5MOhm.
- Input sensitivity: 80mV.
- Distortion: 0.3% at 3W/14V.

20 WATT AUDIO AMPLIFIER
KIT NR. K2592 **£13.44**



This amplifier is based on a monolotic IC: the TDA 2030. A number of interesting features of the amplifier: very compact, short-circuit proof, thermally protected and specifications according to the DIN 45500 HiFi standard.
The kit is very easy to build and needs no final adjustments. The power supply is of the non-stabilized type.

- Power supply: 2×6 through 2×18V, symmetric and unstabilized.
- Current consumption: typ. 900mA.
- Quiescent current: typ. 40mA.
- Input sensitivity: typ. 200mV.
- Input impedance: 10 Kohm.
- Frequency response: 10, ..., 50000 Hz ± 3dB.
- Power supply ripple rejection: 50dB.
- Thermal cut-off: 110°C.
- Output impedance: 4... 8Ohm.
- Dimensions: 88×100×65mm.
- Transformer: 2×12VAC/1A.

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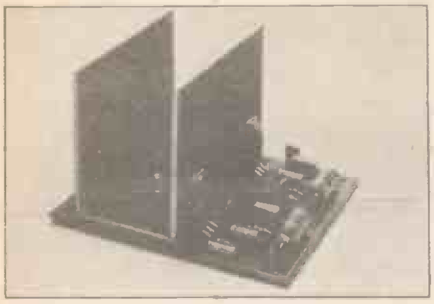
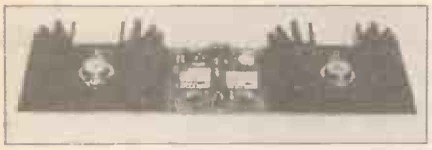
40 WATT AUDIO AMPLIFIER
KIT NR. K2576 **£17.10**



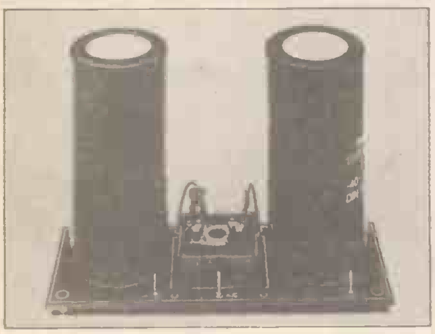
This kit has a number of interesting features; compact construction, universal applicable, non-critical power supply and specifications according to the DIN 45500 HiFi standard. Easy to build and no necessity for adjustments; short-circuit proof and protected against thermal overload, in short; very complete!
- Power supply: 2×6 through 2×18V, symmetric and unstabilized.
- Current consumption: typ. 2A.
- Quiescent current: typ. 40mA.
- Input sensitivity: typ. 250mV.
- Input impedance: 22 KOhm.
- Frequency response: 10... 50.000Hz ±3dB.
- Power supply ripple rejection: typ. 50dB.
- Thermal switch-off: 110°C.
- Output impedance: 4... 8 Ohm.

60W POWER AMPLIFIER
KIT NR. K1804 **£23.84**

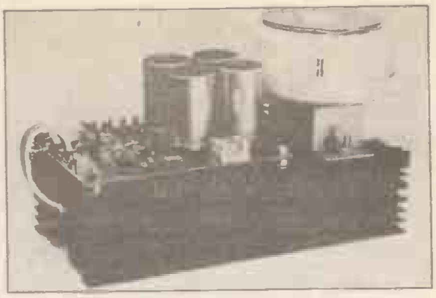


Darlington powertransistors mounted on a heatsink and integrated with the printed circuit make this power amplifier compact and easy to build. Low harmonic distortion and short-circuit proof. A power supply is available under Kit nr. K1861, capable of supplying 2 amplifiers (stereo).
- Output power: 60 W.
- Output impedance: 4 Ohm.
- Input impedance: 2 KOhm.
- Total harmonic distortion: 0,5%.
- Input: 1 V.
- Power supply: 2×28 VDC.
- Short circuit protected.

POWER SUPPLY FOR 60W STEREO POWER AMPLIFIER
KIT NR. K1861 **£24.67**
- Input: 2×18VAC-5A max.
- Output: 2×28VDC.



240W HIFI AUDIO POWER AMPLIFIER
KIT NR. K2587 **£184.80**

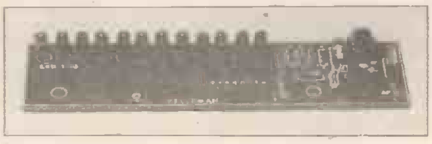


The introduction of MOSFET transistors in poweramplifiers opened a new area in this field.
Wide power bandwidth, low drivingpower, high output power and an almost ideal transient response are only a few of the advantages.
This kit is based on this technology. Apart from the power-amplifier, it also includes the powersupply, heatsink and transformer. Once assembled, its ready for use and can easily be housed. Only 2 final adjustments are required and only needs a multimeter.

Some applications: Discobars and discothèques - Orchestra or theatre - DC coupled powercontrols.

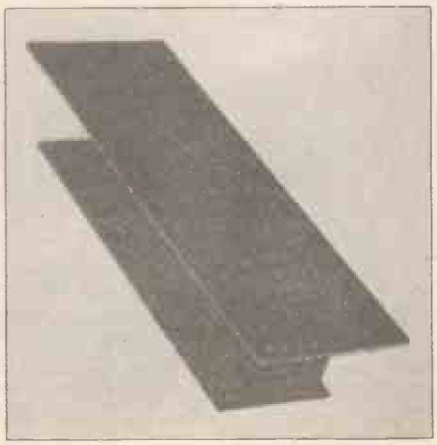
- Powersupply (including transformer): 2×45VDC/5A.
- 240W musicpower at 4 Ohm.
- Distortion (1kHz): 0.05%.
- intermodulation distortion: 0.07%.
- Input impedance: 33K.
- Quiescent current: 60 à 100mA.
- Frequency response: 20Hz ... 20kHz ±0,1dB.
- Dampingfactor (4 Ohm, 40Hz): 200.
- Signal/noise ratio: 100dB.
- Ouput load: 4 ... 8 Ohm.
- Input sensitivity: 800mV.
- Power gain: 31dB.
- Short-circuit proof (shortcircuit current = ±1A.
- Thermal shutdown: 75°C ±5%.
- Quiescent current compensation.

LED VU-METER
KIT NR. K610 **£13.74**



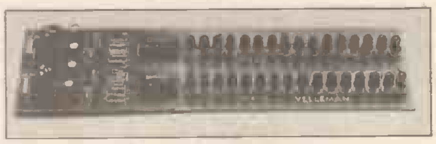
A LED-VU-meter is not only an electronic replacement for the classic moving-coil instrument; It offers a number of advantages as well.
A row of 12 Leds represents the scale. Depending upon the input voltage, more Leds will light, indicating the signal strength. This kit can handle weak, as well as very strong signals.
- 12 Leds.
- Supply: 12VDC.
- Adjustable input sensitivity.
- Lightbar instead of lightspot.

LED AUDIO POWER METER
KIT NR. K2606 **£16.74**



Directly connected to the L.S. output of your amplifier, this kit indicates the power your amplifier delivers.
The power meter is to be used with systems of medium power (up to 50W at 8 Ohm) as well as high power (up to 250W at 4Ohm) and with loads of 4 or 8 Ohm.
No external power supply is needed, and as a metal frontplate is included, this kit is very easy to add to your system.
- Direct connection to the L.S. circuit.
- Metal frontplate included for easy panel mounting.
- Seven led's scale.
- Adapted to 4 and 8 Ohm L.S. impedances.
- Four scale ranges:
  - 2- 40W at 8 Ohm
  - 4- 80W at 4 Ohm
  - 5-100W at 8 Ohm
  - 10-200W at 4 Ohm
- No power supply needed.
- Dimensions: 120×40×28.

STEREO LED VU-METER
KIT NR. 1798 **£25.02**

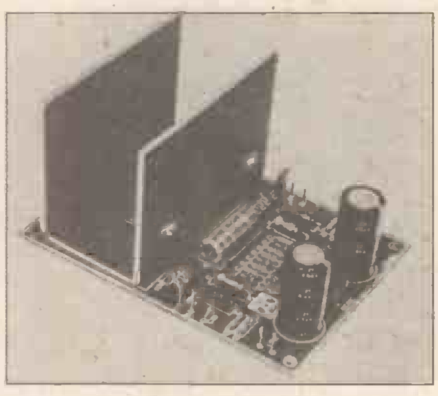


Two rows of 16 Leds each and a "spot" indication instead of a "Bargraph" makes up for the difference between this kit and the mono VU-meter. Thanks to an adjustable input amplifier, matching to almost any kind of pre- or power amplifier can easily be made.
- 2×16 Leds.
- Supply: 12VDC.
- Input impedance: 10kOhm.
- Input sensitivity: adjustable between 100mV to 10V full scale.
- Power consumption: 50mA.

10-30W MONO/STEREO CAR AMPLIFIER
KIT NR. K2598 **£18.15**

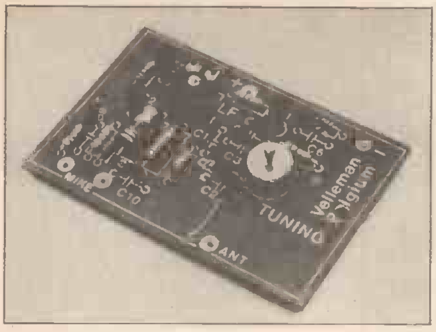
An interesting aspect of this kit is the compact construction, its universal application, the non-critical power supply and the technical characteristics which comply with the DIN 45500 norm.
The kit may be supplied by batteries, or non-stabilized power supplies, and may be used as a mono or as a stereo amplifier. Construction is very easy and no adjustment is required.
Supplementary features are thermal- and short-circuit protection.

- Power supply: 12 ... 24V DC non-stabilized: car battery.
- Current consumption: 50... 2000mA.
- Quiescent current: typ. 40mA.
- Input sensitivity: typ. 200mV.



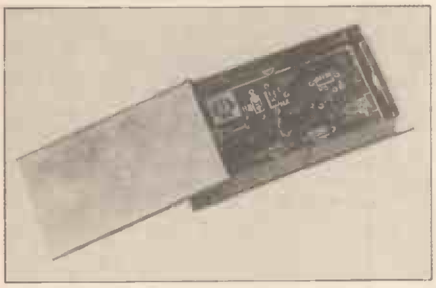
- Input impedance: 100 Kohm (INPA and INPB).
- Frequency response: 20... 20.000Hz ±2dB Mono.
- Power supply ripple rejection: typ. 50dB
- Thermal cut-off: 110°C.
- Output impedance: 4.... 8 Ohm.
- Output power: 12V battery/4 Ohm/mono: 10W.
  12V battery/4 Ohm/stereo: 2×5,5W.
- Dimensions: 119×85×85mm.

FM OSCILLATOR
KIT NR. K1771 **£7.48**



This miniature FM transmitter (50mW) is the ideal solution for wireless communication over short distances (i.e. Babyphones).
Thanks to the Fet input, nearly all types of microphones can be used.
For other sources — like outputs of pre-amps etc. — an attenuater has to be used in order not to saturate the input of LF amplifier, causing high distortion levels.
- Input impedance: 1Mohm.
- Input sensitivity: 5mV.
- Frequency range: 100-108MHz.
- Supply: 9 —12VDC.

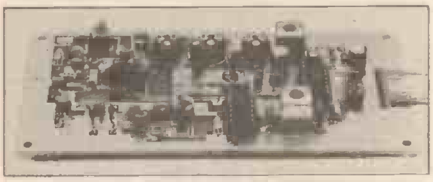
AM-FM ANTENNA AMPLIFIER
KIT NR. K2622 **£10.40**



Although radios and tuners are getting more and more sensitive now, there are still lots of places where an extra amplification of the antenna signal is more than welcome: just think about the car radio or the hifi installation in the city where it is often impossible to install a good antenna.
The construction is very simple and the metal housing makes installation easy.
The power supply can either be derived from a car battery or a 12 VDC power supply (direct, or via the antenne cable).

- Supply voltage: 12-15VDC not stabilised.
- Direct power, or via the coax cable.
- Supply current: 1-3mA.
- Gain: ca. 22dB (10MHz to 150MHz).
- Input impedance: 50-75Ohm.
- Output impedance: 50-75Ohm.
- Dimensions: 86×36×24mm.

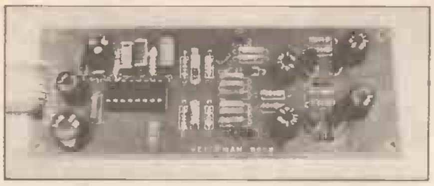
HIGH QUALITY FM TUNER
KIT NR. K2554 **£30.30**



All features of a modern design can be found in this kit. Just to mention a few: built in "strip-line" technique - varicap tuning - adjustable mute level - automatic fine tuning - automatic gain control - tuning meter output - output for digital frequency display

Specifications:
- Tuning Frequency: 88 - 108MHz.
- Operating Voltage: 12DC, regulated.
- Total Drain Current: ± 75mA.
- Input Impedancy: 75Ohm (coax).
- Sensitivity S/N 20dB: 1,2uV.
- Signal + Noise To Noise Ratio 70dB.
- Bandpass LF 10,7MHz: 180KHz at 3dB.
- Total Harmonic Distorision.
  F Mod. 400Hz - Deviation ± 75KHz = 0,5%
- Recovered Audio: Min. 350mV.
- AM Rejection (30% Mod.) 50dB.
- LC/Ceramic Filter 10,7MHz IF.
- RF Stage Dualgate Diode Protected Mosfet.
- Double Balanced Active Mixer.
- Separate Fet Oscillator.
- 3 Stage IF Amplifier, Quadrature Detector, AF Preamplifier.

FM STEREO DECODER
KIT NR. K2553 **£16.26**

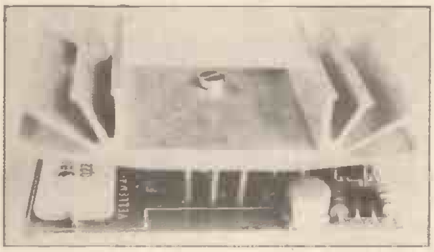


A high-quality FM stereo tuner can be constructed using this kit in combination with the FM tuner K2554. Easy to build and provided with a number of feature like - indicator for stereo reception - stereo on/off switch and 19 KH2 pilot-tone suppression filter to assure interference free taperecording.

- Power supply: minimum 8 to maximum 15VDC
- Current consumption: typ 35mA
- Channel separation (stereo): 40dB
- Gain: typ 1
- Minimum input signal: 20mV effective
- Maximum input signal: 2,5V
- Input impedance: typ 50KOhm
- Output impedance: typ 100Ohm

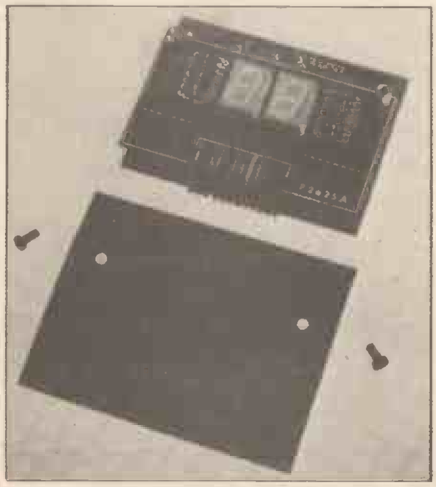
ELECTRONIC IGNITION SYSTEM FOR CAR MOTORS
KIT NR. K2543 **£13.13**

Even the most sceptical one has to admit that the electronic ignition system has a great advantage over the conventional ignition systems. Car manufactorers now already install this superior system on their most expensive models.



Advantages:
- Better starting.
- Less air-pollution.
- Lower fuel consumption.
- Smoother running engine, especially at very high and very low r.p.m.
- Far less wear of the contactbreaker, which means a constant calibrated state.
- Lower service-costs, because the ignition has to be adjusted only after approx. 50.000km.

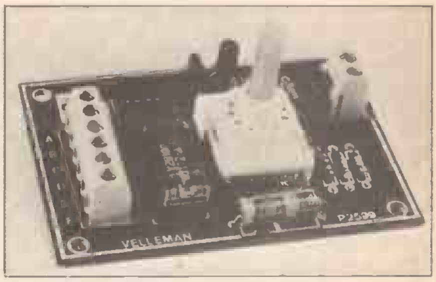
DIGITAL TACHOMETER
KIT NR. K2625 **£30.95**



This tachometer may be adapted to any car or motorcycle equipped with a petrol engine, what ever the number of cylinders.
The displays shows the hundreds and the thousands of all measured values. The intermediate values are of no significance, due to the inherent instability of the real r.p.m. Furthermore, the unit allows to measure the number of revolutions or the number of movements per minute of any rotating or moving mechanical part.
The unit is compact and easy to box, and a frontplate is added to the kit.

- Powersupply: 10... 15DC, not stabilized.
- Supply current: maximum 200mA.
- CMOS technology.
- Resolution: 100 r.p.m.
- Scale: 100... 9900 r.p.m.
- Displays: 1/2" LEDs (static).
- Voltage stabilizer on the print.
- Input sensitivity: minimum 3V, maximum 20V.
- Input impedance: typ. 30K.
- Simple calibration.
- Adjustable brightness.
- Contact bounce suppression.

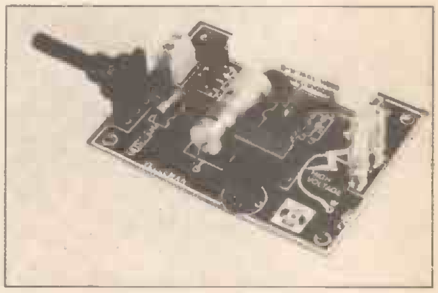
SCREEN WIPER ROBOT
KIT NR. K2599 **£14.83**



Three different time intervals may be selected by using a multipole rotary switch. With small component changes, the intervals may be varied.
Some applications: windscreen wiper delay - diaprojector control - hazard warning via the brakinglights of the car.
In the manual you will find a complete description how to build this kit in a car, with wiring instructions to connect it to the existing wiper installation.
- Power supply: 12-15V DC.
- Intervals: 5-10-15 seconds.
- Relay output: 240V/2×3A.
- Relay output with two change-over contacts.
- Current consumption:
- Output "OFF": 25mA.
- Output "ON": 100mA.
- Dimensions: 82×56×41mm.

STROBOSCOPE
KIT NR. K2601 **£14.78**

In fact, a stroboscope is just a flashbulb with an adequate power supply and a trigger circuit of which the frequency, in most cases, is adjustable. The frequency of this stroboscope is adjustable between 2 and 20Hz.
Some applications: photo-amateurs: making snapshots - film amateurs: lightning imitations for films - choreography - lighting in discotheques - slow motions - shop-window lighting



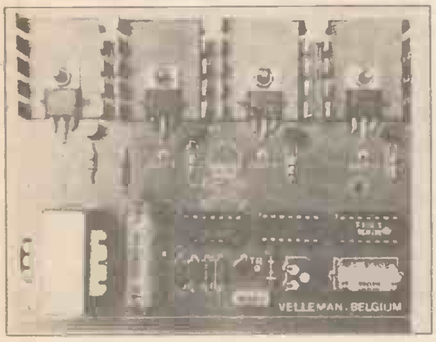
- Power supply: 220-250 VAC.
- Power required: 3-10W.
- Flash frequency: 2-20Hz.
- Nominal flash energy: 11WS.
- Life-time: typ. 800.000 flashes.
- Dimensions: 86 × 65 × 45mm.

3-CHANNEL LIGHTORGAN
KIT NR. K2588 **£29.69**

Due to its adjustable input sensitivity, this "lightorgan" can easily be connected to almost all kinds of outputs: recorder, mixingtable, amplifier; just name it. In case of strong input level changes, only the sensitivity has to be adjusted; the tone controls can be left untouched.
- Power supply: 220VAC.
- Input impedance: 20 Kohm.
- Input sensitivity: 100mV to 10V, at full range.
- Channel separation: 20dB.
- Individual sensitivity adjustment per channel.
- Triac outputs: 500W max. non cooled.

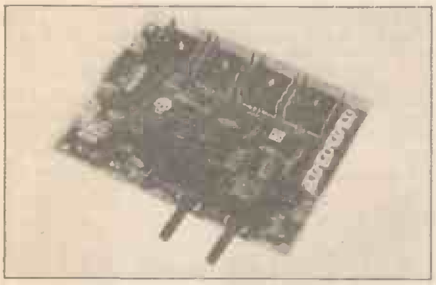
RUNNING-LIGHT
KIT NR. K1874 £23.69

A running light is a unit specially designed to drive a group of lightbulbs, creating very special and surprising effects.
The principle is very simple: a group of four lightbulbs is used.



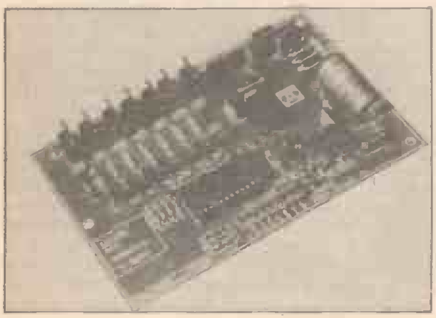
The first bulb lights and extinghuishes after a certain time; then the second bulb lights, etc... After bulb nr. 4, the nr. 1 of the next group lights etc... This gives the impression of a running light.
The extent of the effect depends upon the quantity of lamp groups in use and how they are positioned.
- Supply: 220-240VAC.
- Max load: 1000W/channel.

MUSIC MODULATED RUNNING LIGHT
KIT NR. K2602 £32.22



This kit is a variation to the classic running light: the speed is determined by the strength of the applied music signal.
For the input an isolation transformer is provided, so the circuit may be connected to any signal source capable of delivering 100mV minimum.
Each of the four outputs can handle up to 400W. The sensitivity as well as the speed are adjustable.
- 4 triac outputs: each 400W max.
- Input sensitivity: 100mV up to max. 5V.
- Input impedance: approx. 20 Kohm.
- Power supply: 220/240 VAC.
- Speed (without music signal): adjustable from 0,25 to approx. 3Hz.
- Maximum speed: approx. 30Hz.

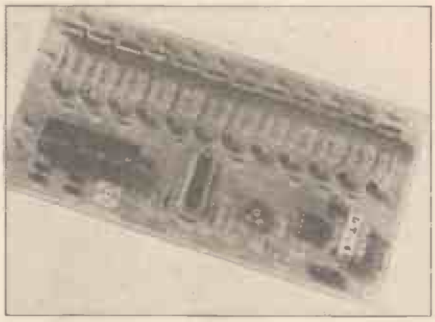
LIGHT COMPUTER
KIT NR. K2590 £31.30



This kit is an improved version of the light computer K2571. In addition to the eight programs of the early version, eight new ones have been added.
Each of the 16 programs offers another lightshow, such as positive and negative running light, flip-flop, and different light advertising functions. Some applications: traffic signalisation, fair illuminations, discobars, light advertising, etc...
All the programs are stored in an Eprom and are selected by a multi-position switch. The kits may be interconnected in cascade, so the number of outputs (7 for each board) is expandable and almost unlimitid. Two of the new programs are especially designed for being used in cascade.

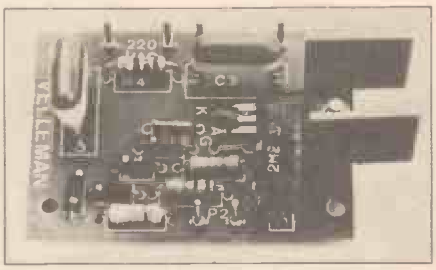
- 7 triac output stages: 2Amps. maximum, non cooled (450W at 220V).
- Power supply load: 24-220VAC.
- Power supply board: 7-8VAC/0.5Amps.
- 16 programs in one Eprom.
- Speed adjustable between approx. 1 and 15Hz.
- Can operate synchronous and in cascade.
- External reset input.
- Input for external clock oscillator (5V CMOS level)

GIANT VU METER
KIT NR. K2620 £36.85



Several circuits providing different light effects, from the simple lightorgan to real "lightcomputers", have already appeared on the market.
This kit is something new... a giant VU-meter with 240V bulbs. The 12 bulbs are mounted as a lightcolumn which varies according to the sound level.
The input is galvanically separated and the sensitivity is adjustable, so there is no danger when connected to a pre-amplifier or to a power amplifier.
- 12 triac outputs: 400W each (non-cooled).
- Input impedance: ca. 20 Kohm.
- Input sensitivity: adjustable from ca. 100mV to 3V at full scale.
- Power supply: 9 VAC/0,5A.

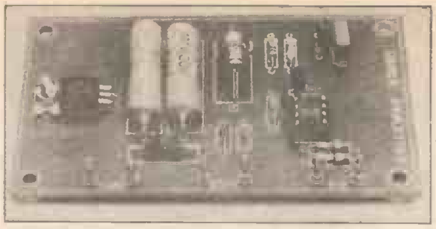
DIMMER
KIT NR. K612 £7.94



Compared to other circuits, two more resistors and four more diodes are used in order to minimise the hysteresis effect. Parallel to the triac an RC network is connected to protect the triac against inductive voltage transients. This dimmer may be used for a resistive load (bulbs, heating elements, etc...) as well as for inductive loads (drills). A trimmer is provided for pre-setting the minimum output voltage or adjusting the minimum position of the potentiometer.
- Supply: 220-240VAC.
- Output power: 1000VA.

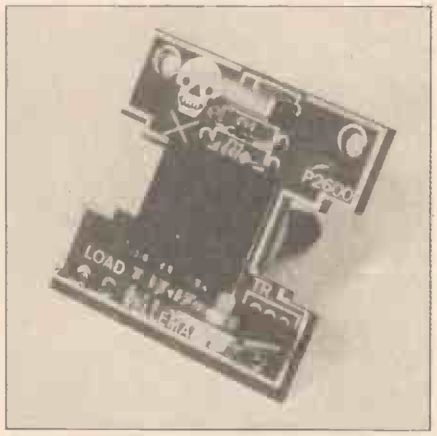
ELECTRONIC POWERSWITCH/DIMMER
KIT NR. K2580 £13.69

This switch/dimmer varies from the classical dimmer circuits because it is modern in design and build around a special CMOS IC, designed especially for this purpose.
To operate it, just push a single-pole pushbutton of which an infinite number can be connected in parallel. So, this circuit can be controlled from different places.
The unit is connected directly to the mains (220V) and does not need a supplementary power supply.



Some applications are: dark-rooms, slide projector controller, power switch-over, all possible dimmer-functions, etc...
- Power supply: 220V/50Hz.
- Maximum output power (non-cooled): typ. 400W.
- MOS Technology.
- ON/OFF and DIMMER functions.
- Single-pole press-button use.
- Dimming time: 5% to 95% - typ. 3.5 seconds.

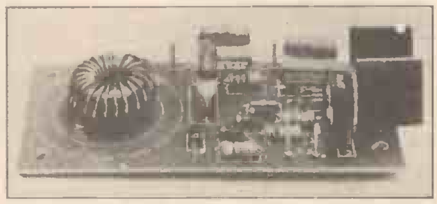
2 AMP.-DIMMER
KIT NR. K2600 £10.12



This very simple circuit is designed especially to dim bulbs up to 400W. This dimmer may not be used for heating elements or for applications with inductive loads (such as an electric drill).

- Power supply: 220VAC/50Hz.
- Maximum load: typ. 400W.
- Adjustment range: 5-95%.
- Dimensions: 44×44×53mm.

INTERFERENCE FREE DIMMER
KIT NR. K613 £12.60



Identical in operation and specification to K612, except that carefull attention has been paid to suppress R.f Interference.

DRILL SPEED CONTROLLER
KIT NR. K2636 £20.25

This kit is especially designed to control universal AC motors (brush-type) and in particular hand drills. Contrary to ordinairy dimmers, the torque of the motor remains high, even on low R.P.M.
- Supply of controller: 125VAC or 220-240VAC.
- Supply of load: 24VAC - 240VAC.
- Max. load: 1200VA (5.5Amp).
- Control range: 5-95%.
- Low R.F. interference level.
- Min R.P.M.: Adjustable.
- Dimensions: 130×75×55mm.

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1 A POWER SUPPLY

KIT NR. 1823 — £9.18

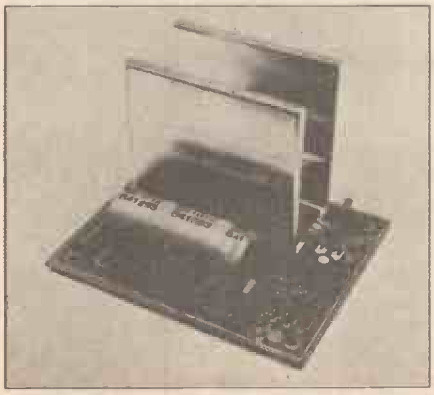
This kit is based on the LM317 type integrated circuit. This IC is a "floating" voltage regulator capable to deliver more than 1.5AMP, over a voltage range adjustable between 1.2 and 35V. This new IC has remarkable better ripple and regulation characteristics than the known standard regulators. In this IC, a current limiter is provided as well as a thermal overload- and safe area protection.

- Adjustable output: from 1.5 to 35V.
- Output current: 1Amp.
- Line regulation: typically 0.01%.
- Load regulation: typically 0.1%.
- 100% electrical burn in.
- 80dB ripple rejection.

UNIVERSAL POWER SUPPLY 5-14VDC/1A

KIT NR. K2570 — £9.18

This kit serves as a supplementary or permanent power supply for all Velleman kits needing a supply voltage of 5 to 14VDC of which the current consumption is less than 1A.

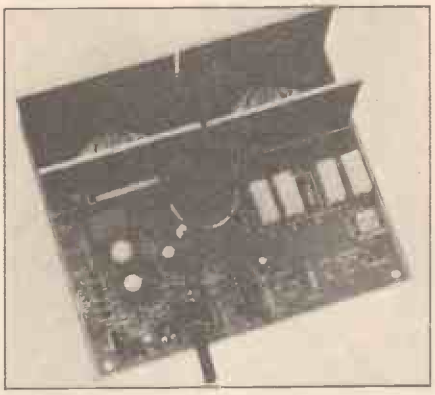


This supply can also be used for other units, but the maximum specs have to be respected.

- Input voltage: 7-16VAC/1Amp.
- Output voltage: 5-14VDC stabilised.
- Output current: max. 1Amp.
- Quiescent current (without load): ±20mA maximum.
- Output noise: typ 40μV.
- Ripple rejection: typ 78dB.
- Temperature stability: 0,025%/°C.
- Line stability: 0,005%/V.
- Current limit.
- Thermal overload protected.

LABORATORY POWER SUPPLY 0-24V/3A

KIT NR. K2623 — £38.40

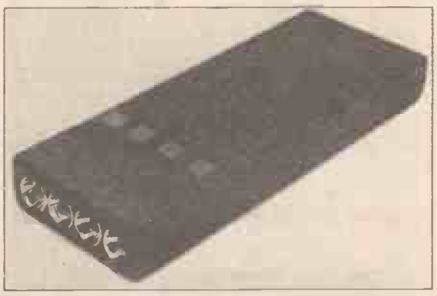


If a multimeter is indispensable for any electronics hobbyist, a good laboratory power supply is undoubtedly second on the list. Owing to its excellent stabilisation and its short-circuit proof design, its linear adjustment range from 0 to 24 Volt, and its three current ranges of 0.5, 1.5 and 3 Ampere, this power supply is at least as good as many other far more expensive professional models.

- Output: adjustable from 0-24VDC.
- Short-circuit proof.
- Output current selectable: 0.5-1.5A.
- Heatsinks included.
- Line regulation: typ. .05%.
- Load regulation: typ. 1%.
- Dimensions: 170×145×60mm.

4-CHANNEL INFRA RED TRANSMITTER

KIT NR. K2547 — £26.28



This unit is designed to work in combination with Kit. Nr. K2548 infrared receiver.

The units are sold separately since some applications may require one receiver together with two or more transmitters, or two or more receivers, with only one transmitter. Which means a possibility of unlimited extension.

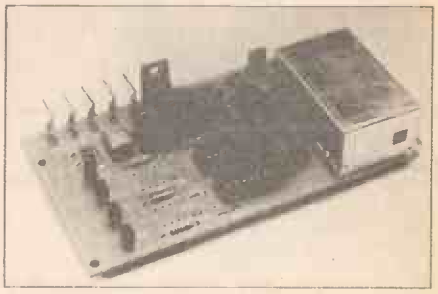
There are lots of applications, such as: switching on/off the lights without leaving your armchair; turn on/off your radioset, opening your garage door without leaving your car... etc...

4-CHANNEL INFRA RED RECEIVER

KIT NR. K2548 — £35.04

This kit, together with the 4-channel IR transmitter Kit Nr. 2547, forms a complete unit.

Together, they make it possible to install a practically trouble-free remote-control, with unlimited applications (see IR transmitter).

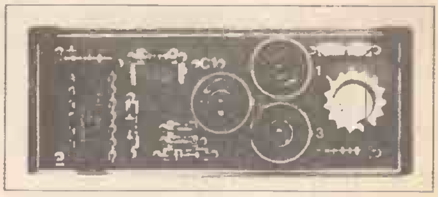


Four independent outputs are available and may be used as you like. This kit is supplied without a housing.

- Max. distance: ±20 meter.
- Supply receiver: 12-14VDC/300mA.
- Dimensions receiver: 120×67mm.
- Supply transmitter: 9VDC (battery).
- Dimensions transmitter: 145×45mm.

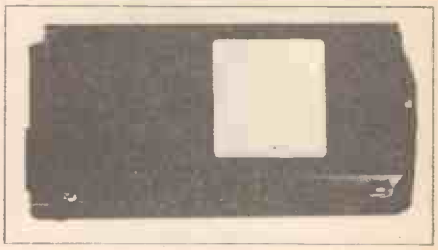
INFRA RED ALARM TRANSMITTER

KIT NR. K2549 — £17.88



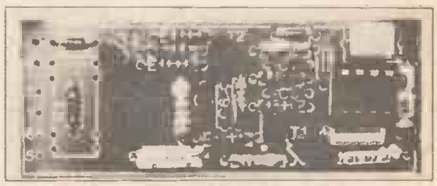
Together with Kit Nr. 2550 (alarm receiver) and Kit Nr. 2551 (alarm central), this kit functions as an infra-red signal source. A defined signal is generated and radiated with a beam-angle of 30 degrees. The aim is to beam the infra-red signal towards the receiver, which receives and detects the signal. If, for any reason, the beam is interrupted or weakened, the receiver will detect this and will activate the output.

The distance between the transmitter and receiver may extend up to 5 metres. But the closer, the higher the reliability of the system.



INFRA RED ALARM RECEIVER

KIT NR. K2550 — £21.37



This kit functions as a receiver-detector of the signals received from the infra-red transmitter (Kit nr. 2549).

If, for instance, the strenght of the received signal fluctuates when, for example, somebody walks through the beam, the AGC circuit will compensate this fluctuation.

This results in activating the output which can be used to trigger an alarmsystem, or can count people or indicates that somebody had entered a shop, etc...

- Distance: approx. 5 meter.
- Supply transmitter: 6-9VDC-250mA.
- Supply receiver: 12VDC-50mA.
- Output receiver: max. 50mA (for reed relay).
- Dimensions: 72×28mm.

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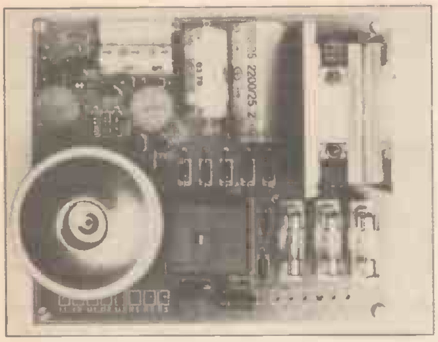
IR ALARM CENTRAL UNIT
KIT NR. K2551 **£25.25**

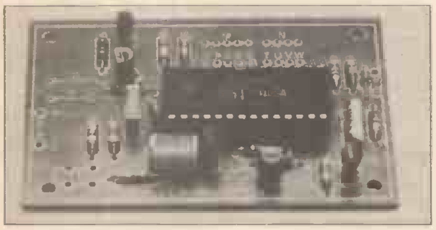


Designed to build a complete and sophisticated alarm-system together with the Kit nr. 2549 (Alarm transmitter) and nr. 2550 (Alarm receiver). Capable of supplying three transmitters and three receivers and to coordinate the functions of these.
Adjustable activating delay-time and alarm trigger delay-time, are important features to make this unit universally applicable.
An automatic changeover on battery - supply is provided, in the event of a mains failure.
- Supply: 2×6VAC-1A.
- Output: relay 220V-3A (included).
- Dimensions: 126×110mm.

3-TONE CHIME
KIT NR. K2569 **£11.22**

The aim of this kit is to make, simply and cheaply an electronic adjustable three tone chime.
The kit is build around a single IC and a few components. The result is a three-tone follow-up, one tone being half of the other's harmonic. The speed and the tone are synchronic and adjustable.
Some applications are: toys, discothèques, doorbells, public-address, paging systems, etc...
- Power supply: 7 to 12VDC.
- Output impedance: 8 Ohm.
- Input impedance (push-button): 10K.
- Output power: ±0.4 Watt.
- C MOS/bipolar.

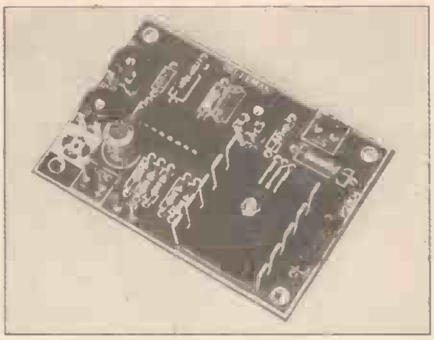
MICROPROCESSOR DOORBELL (NEW VERSION)
KIT NR. K2575 **£23.11**



People looking for a very special doorbell, a melody generator or a selective call, will find it all in this kitt.
24 different tunes from all parts of the world, changing automatically to the next one after pushing the button (supply operation).
The system is microprocessor based, with the algorythm programmed in the IC.

- Power supply: typ. 9V (maximum 12V).
- Power consumption: max. 100mA when playing.
- Output impedance: 8 Ohm.
- Stand by current: supply: typ. 30mA.
  battery: none.
- Output power: typ. 0.5 Watt.
- CMOS technology.

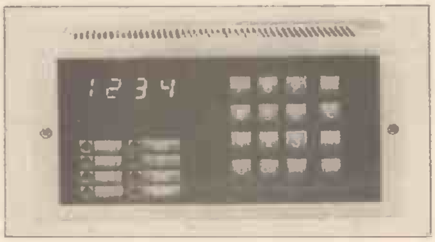
KOJAK SIRENE
KIT NR. K2604 **£9.89**



The aim of this kit is to create a whole series of exasperating electronic noises in a cheap and simple way.
You may imitate any police siren by using in the three adjustable potentiometers. Specifically, this kit can be used as a "Kojak siren". Even with a low power loudspeaker (4-16Ohm/0.5W) it will be possible to make a fantastic noise.

- Power supply: 8-14 DC.
- Current consumption: maximum 1A.
- Output power: ca 2W max.
- Frequency: 800-2000Hz.
- Modulation speed: 0,5-5S.
- Dimensions: 79 × 57 × 15mm.

HEATING CONTROLLER
KIT NR. K2583 **£87.12**



This unit is designed to control the temperature inside rooms, buildings, houses, etc. in a more accurate and therefore more efficient way with energy saving as a result.
It provides a 4 program daily cycle with the desired temperature at a given period. These programs are totally independent. The display functions as clock as well as thermometer. The different programs may be recalled, verified and changed separately at any moment.
This unit replaces conventional mechanical thermostats without additional wiring. Another possibility is to control the unit manually with total priority over the existing programs.
The unit is build around a special designed "Single Chip Microcomputer" and based on the most advanced technologies. Housing, keyboard, transformer and relay are included in the kit.
- Power supply: 220VAC 50/60Hz.
- Switching power: 220V 3Amp. Maximum (600W).
- Power consumption: 4W maximum.
- Thermometer: 0 through 99°C with a 0.1°C resolution.
- 24 hour clock.
- Thermostat function: 1°C resolution.
- 4 independent programs with daily repeating cycle.
- Manual control function.
- Programmable hysteresis.
- Dimensions: 240×116×58mm.

UNIVERSAL START/STOP TIMER
KIT NR. K2579 **£10.92**

Due to its simple structure, and universal character, this mini timer is suitable for the most current applications needing time intervals; from a few seconds through approximately 60 minutes.
By simple modifications it is possible to adjust the maximum time and the timing range.
A relay output provides the necessary flexibility in connecting the most different equipment.
- Power supply: 12VDC.
- Output "OFF"; 20mA.
- Output "ON": 55mA.
- Relay output: 2A/220V.
- Timer interval: adjustable between 0 and ±15 minutes.
- START-/STOP function allowing to switch-over at any desired moment.

PRECISION TIMER MODULE
KIT NR. K2595 **£68.48**

This module, supplied with a front plate and keyboard, allows you to memorize one time, variable from 1 second to 99 minutes and 99 secs.
The output may be switched ON and OFF manually, with or without a running program.
The switching precision is 1 second. Independently from the programmed time, the timer is able to work a second timecycle, which may be displayed without interfering with the programmed time.
A running time cycle may be stopped at any moment and may be interrupted and continued at any time.
Some applications: process control - illuminated signals - model train controller - dark room timer.
- Power supply: 6VAC.
- Relay output: 240V/3A.
- START/STOP and manual functions.
- Maximum time: 99 minutes and 99 seconds.
- Dimensions: 132×120×22mm.
- Transformer: 6V/0.8A.

µP PRECISION TIMER
KIT NR. K2584 **£80.40**

This timer supplied with the housing, transformer and membrane keyboard, allows to memorize 4 time programs, variable from 1 sec. to 99 min. 99 sec. These programs may be recalled separately and independently. Just push the program-key to display, one after the other, the 4 different times. The output may be switched ON/OFF manually, with or without a program.
The switching precision is 1 sec. Independently from the program-times, the timer is able to work a 5th timecycle, which will be displayed without influencing the programs.
Running programs may be stopped at any moment, they may be interrupted or continued.

Some applications: Dark room timer - Process controle - Illuminated signals - Model train controller.
- Power supply: 220VAC/50Hz.
- Relay output: 240V/3A.
- 4 independent programs.
- START/STOP and manual functions.
- Complete with housing and membrane keyboard with contact indication.
- Switching precision: 1 sec.
- Maximum time: 99 min. 99 sec.
- Dimensions: 240×115×58mm.

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PROGRAMMABLE CONTROL AND MEASUREMENT MODULE

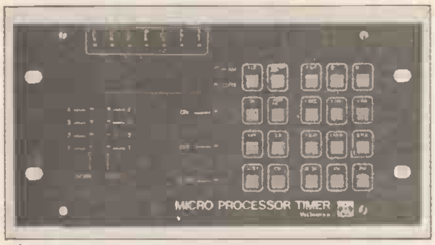
KIT NR. K2591 **£80.33**

The aim of this module (kit) is to function as a control unit in a lot of applications such as: Temperature control (room heating, aquarium etc...) - Humidity control - Acid and chlorine control - Level control.
The circuit consists of a 24 hour clock, 4 programmable registers and an input signal display. This input signal is an analog voltage from 0 through 999mVDC. If, for example, a temperature has to be measured, the input 0V has to correspond with 0°C, and, 999mV with 99,9°C or 999°C, depending on the application.
The module compares the incoming signal with the values which are programmed in its memory and activates an output relay accordingly. Switching accuracy is 10mV with reference to the input signal.
The programs may be loaded individually at any time in a 24 hour cycle, so different values may be compared at differend time periods.
The unit is supplied with a frontplate to simplify the boxing. Also, a battery input is provided so the battery will supply the power in case of mains failure.

- Powersupply: 6... 8VAC/500mA (minimum).
- Battery input: 6VDC.
- 4 independant and daily repeatable programs.
- 24 hours clock.
- Input voltage: 0... 1000mV (displayable).
- 10mV hysteresis switching precision.
- Relay output: 240/3A.
- Transformer: 6... 8VAC/500mA.

MICROPROCESSOR UNIVERSAL TIMER

KIT NR. K1682 **£75.84**



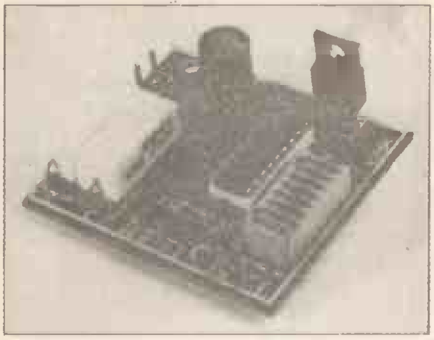
This unique timer is in principle a 24-hour clock provided with 4 relay-switched outputs and a programmation period of 1 week. 20 switching programs can be memorized and via the membrane keyboard be programmed. Outputs or timing periods can be selected at random.
All program steps are indicated by leds.
A printed alu frontplate is included in the kit, making building-in of this timer a simple affair.
This microprocessor timer was primarily designed for industrial and labo purposes, but the amateur can use it in dozens of applications as well.

- 20 daily- or weekly programmable timerfunctions.
- Memory display of programmed timer functions per output or per day.
- 4 independent relay outputs (1 relay included).
- Display of: day of week - AM/PM - output - clock.
- ON/OFF - sleep.
- The timer is based on the TMS 1122 microprocessor.
- Transformer 12VAC/1A (not included).

Wooden housing K1682H **£34.45**

ZERO-CROSS PROGRAMMABLE TIMER

KIT NR. K2594 **£15.24**

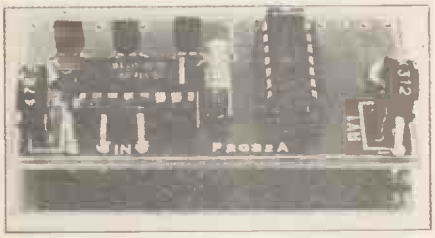


The timer allows to generate time delays from 1 second up to 31,5 hour. As timebase serves the 50Hz linefrequency. The triac output of the timer enables to switch resistive, inductive as well as capacitive loads.
Two starting modes are provided: in the first mode the load is switched on and the timedelay starts instantly when a startingpulse is applied; in the second mode the load is switched-on instantly after application of startingpulse, but the timedelay will only be activated after termination of the startingpulse.
Some applications: automatic money- and gamemachines - industrial controls - darkroom applications - stairslighting.

- Supply voltage: 220VAC.
- Timebase: 50Hz linefrequency.
- Max. output load: 500W.
- Triac control with voltage synchronisation for resistive loads and current synchronisation for inductive- and capacitive loads (zero cross).
- Timing: 8 overlapping periods from 1 second to 31;5 hours.
- Quiescent current: 8mA.
- Dimensions: 59×53×23mm.

DIGITAL PANEL METER

KIT NR. K2032 **£26.82**

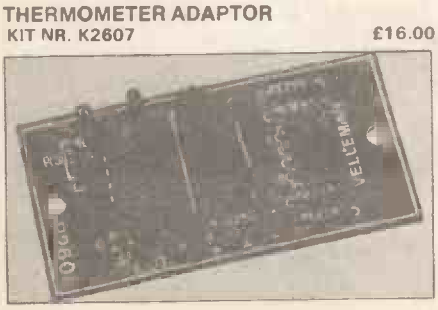


This panel meter is an almost ideal replacement for the traditional moving-coil type instrument.
Not only is its price about the same, but its accuray is many times better. By reading and comparing the technical data and in practice, after building, you will be aware of its high accuracy and its stability. As it is very compact, this unit can be built in all kinds of housings or even into existing equipment.

- Power supply: 5V DC/250mA maximum.
- +999mV and −99mV, full scale.
- Zero adjust.
- Overload indication (positive and negative).
- Resolution: 1mV.
- Linearity: 0.1%.
- Input impedance: 100 Mohm.
- Temperature drift: 20µV/°C.

THERMOMETER ADAPTOR

KIT NR. K2607 **£16.00**

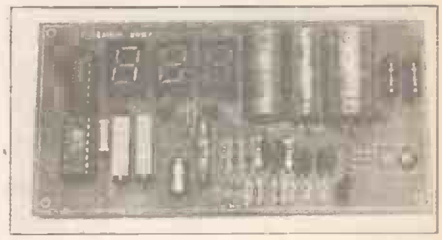


It can be very usefull to have a voltage at your disposal which varies proportionally with the temperature: just think about computerised or non-computerised controlsystems, temperaturecontrolers or just a digital (or analog) thermometer.
The sensitivity can be chosen freely: 10, 20 or 40mV per degree Kelvin (Celcius).
The zero point is adjustable within wide ranges, and it has not to be zero volt for zero degrees.
The output is buffered and can immediately be fed to an analog or digital millivoltmeter.

- Sensitivity: 10, 20, or 40mV per degree Kelvin (Celcius).
- Output resistance: <1 Kohm.
- Range: −25 to +85 degree Celcius.
- Linearity: typically 0,5%.
- Remote sensing capability.
- The zero point is adjustable within wide ranges.
- Supply voltage: + and −12 to 15VDC, not stabilised.

DIGITAL THERMOMETER

KIT NR. K2557 **£37.67**

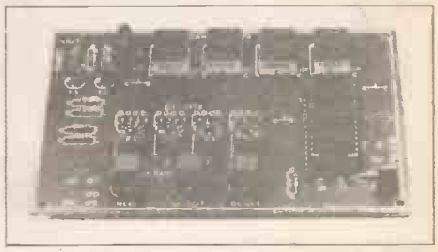


Contrary to the mercury or alcohol thermometer, a digital thermometer offers lots of advantages in particular for certain applications.
The digital thermometer can be read at distance and even tenth of degrees are indicated. The reading of a digital thermometer is error-free (no parallax) and can be calibrated and/or shifted.
Remote-reading is no problem as the sensor can be placed in almost any place (even in a watertank, if incapsulated).
Due to the symmetrical supply of the sensor, lead length is not critical.

- Power supply: 2×12VAC/350mA.
- 3 digit 1/2 inch displays.
- Accuracy: 0.1°C.
- Temperature range: −10°C through +70°C.
- Absolute maximum 85°C.
- Sensor in DIL housing.
- Linear output of the sensor: 10mV/°C.

UNIVERSAL 4 DIGIT UP/DOWN COUNTER WITH COMPARATOR

KIT NR. K2574 **£65.49**



Contrary to the now classic TTL counters, this CMOS version has a lot of advantages and possibilities which makes it universally applicable.
A "reset" is provided which brings the counter completely to zero and a signal is produced each time the counter goes through zero.
By means of BCD switches, it is possible to set a figure which is continuously compared with the content of the counter. If both are equal, the output is activated.
The counter may ad or substract (up or down). It is not only possible to compare a certain value, but also any value may be displayed from which the counter will start.
Another added facility is to fix the displayed value at any time, while the internal counter continues to work.

- Power supply: 5VDC stabilized.
- Max. current: typ 150mA.
- 4 digits (common cathode).
- CMOS technology.
- Input impedance: 15Kohm.
- Carry output (cascade possibilities).
- Zero indication.
- Comparison indication.
- Outputs signals: 5V max. 50mA.
- Integrated Schmitt trigger for the counter input.
- Max. display value: 9999.
- Reset button.
- UP and DOWN selection.
- BCD selection for loading the counter and/or the register.
- Display controle (extinguish, normal display, suppressed leading zero).
- Max. count frequency: 2MHz.

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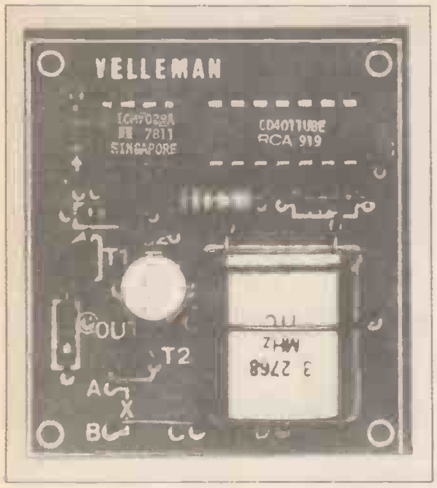
50Hz CRYSTAL TIME BASE
KIT NR. K2545 **£18.65**



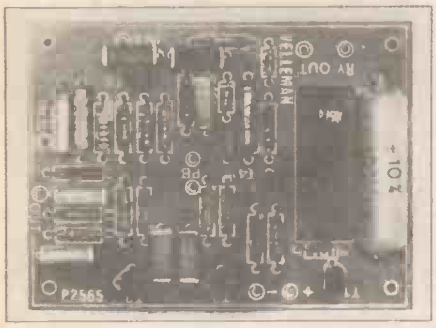
Due to its universal character and its high accuracy, this crystal controlled time base is the ideal extension for a digital clock, chrono or any other time controlled circuit.

It can be connected to any clock, without supply problems or other connecting difficulties. Please, read the "How to connect" point for all Velleman clock circuits.

This high accuracy is necessary when a clock has to be supplied by a battery, or when it has to operate as an emergency supply for — as an example — the MicroProcessor Timer K1682.

- Output frequency: 50Hz.
- Crystal: 3,276800MHz.
- C-MOS techniques.
- Power supply: 5 to 20VDC.
- Current consumption: 5mA.

TAPE/SLIDE SYNCHRONIZER
KIT NR. K2565 **£12.70**



Actually, a lot of tape/slide synchronizers are available on the market. The price of these devices varies from expensive to very expensive.
Those owning a tape- or cassette recorder can with this simple and inexpensive device, record synchronizing pulses and use these pulses to control automatic slide projectors. The circuit is small in seize and can easily be housed.
- Power supply: 9 to 13VDC.
- Current consumption: 40mA.
- Output frequency (tone): ±1.5KHz.
- Output amplitude: ±250mV.
- Input sensitivity A: minimum 1.5V peak to peak.
- Input sensitivity B: minimum 100mV.
- Oscillator: AMV type.
- Input impedance (B): 1 KOhm.
- Output impedance: 15 KOhm.

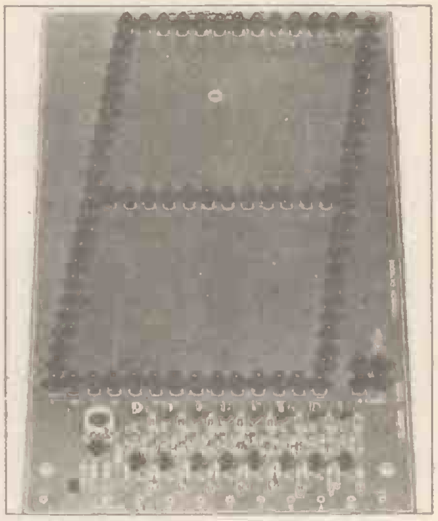
CODELOCK
KIT NR. K2585 **£68.43**

This codelock disposes of two memory levels and 20 numbers of 6 figures may be programmed in each. The memory consists of a CMOS RAM which is supplied by a back-up battery in case of mains failure. So, all the numbers are saved even if the mains failure lasts a month.
To modify the memory, a certain contact is to be made.
If this contact is cut, the content of the memory cannot be altered, under any condition. The codelock is provided with a frontplate having a membrane keyboard and a led indicates when a key is pressed. A second led indicates when the output is activated.
Some applications: protection of rooms where only authorized people may enter - protection of machines - entrance selection for flats - burglar protection In general.

- Power supply: 8VAC/300mA (10 ... 12 VDC/300mA).
- Relay output: 240V/3A.
- LED indication of pressed key.
- 6 digit codenumber (40 numbers maximum).
- 2 level selection of each 20 numbers.
- Write protected levels.
- Codenumbers are individually programmable or reprogrammable.
- CMOS memory (with Ni-Cd battery).
- Operating temperature: 0 ... 70°C.
- Transformer: 8VAC/300mA.
- Dimensions: 120×80×30mm.

20CM DISPLAY "COMMON ANODE"
KIT NR. K2567 **£30.76**

This kit contains a 7-segment display consisting of 12 leds per segment and 4 leds for the decimal point. With the aid of a supplementary power supply, it is possible to connect this kit to any existing circuit equipped with common anode displays of any brand and any dimension.



If the digit and segment drivers of the circuit can supply sufficient current, it will be possible to connect in parallel two or more displays, or even, leave the small display of the circuit in place and connect the 20cm display in parallel.
This latter will not affect the brigthness of the 20cm display due to the special concept of the driver circuit.
- Common anode.
- Power supply: 22 to 26VDC non-stabilized.
- Minimum anode input voltage (on): 2V.
- Maximum anode input voltage (off): 1.2V.
- Segments input impedance: 10K.
- Segment current: static (R6=∞): ±40mA
  multiplex (R6=22Ohm): ±75mA.
- Total current consumption in static mode: maximum 400mA.
- Maximum power (U=22V): 8.8Watt.

20CM DISPLAY "COMMON CATHODE"
KIT NR. K2568 **£31.92**

This kit is in terms of appearance and application identical to K2567 "COMMON ANODE".
As far as specifications are concerned; read cathode for anode.

MICROPROCESSOR CONTROLLED EPROM PROGRAMMER
KIT NR. K2578 **£316.80**

Microprocessor based stand-alone unit complete with power supply, housing and test socket.
Test, verify, copy and program of listed eproms: 2716 (Intel or second source) - TMS2516 (Texas Instruments) - 2732 (Intel or second source) - 2732A (HMOS version of Intel).
No personality modules required.
Controls: 24 Key pad includes hexadecimal keyboard and function keys - 12 address leds - 4 function leds (error, prog, ok and size) - 2 hexadecimal displays.

Functions:
- Blank test.
- Verify test.
- Program with automatic blank and verify test.
- Input or modify data in user ram at any desired address.
- Load ram function to fill the ram area with data from a preprogrammed prom to perform a copy.
- Parallel load capability from a DMA controlled ram field.
- Size selection (16/32K) with single push-button.
- OK indication for succesfull executed functions.
- ERROR indication with error codes on display.
- Blank error.
- Verify error.
- Illegal address acces error.
- Increment function which stores the input data via hex keyboard and jumps to the next address In user ram.
- Reset.
- Standard with 16Kbit ram (2Kbyte), and expandable to 32Kbit (4Kbyte).
- Xtal controlled clock.
- Power supply: 110/220VAC 50/60Hz.
- Supply current: at 110V typ 150mA
  at 220V typ 70mA

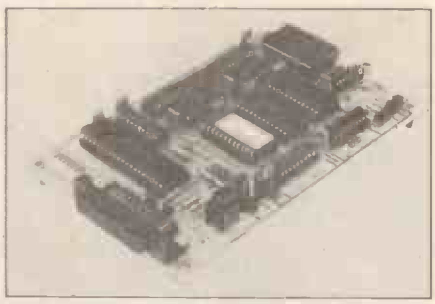
TMS 2532 ADAPTOR FOR K2578
KIT NR. K2532 **£39.45**

This socket is intended to be used with Eprom programmer K2578 for programming TMS 2532 Eproms (Texas Instruments).

2764/27128 ADAPTOR FOR K2578
KIT NR. K2626 **£38.25**

Nowadays, the 8K and 16Kbyte versions of the 2732 are getting more popular due to the acceptable prices. Alas, many Eprom programmers are unable to program these devices; this counts for the Velleman K2578 as well. Under condition that the programmer is capable to program H-MOS Eproms (like Intel 2732A) this problem can be solved by this kit. Intended for the K2578, all programmers with similar specifications can be used.

SERIAL CONTROLLER/EMULATOR
KIT NR. K2586 **£184.80**

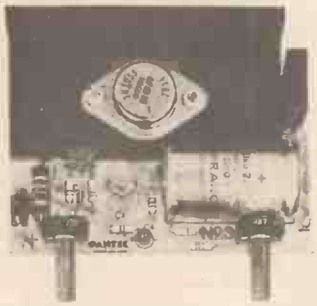


The unit has been designed primarily as a peripheral device to the Velleman programmer K2578. It allows serial dataloading from any computer, mini or microcomputer and development system. With this additional feature, the prom programmer can be used in all kinds of applications where Eprom oriented data storage is required, from small test programs running on a micro, up to prom (re)production downloaded from a mainframe.
- Power supply: 5VDC.
- Supply current: typ. 400mA.
- 8031 CPU (10MHz Xtal).
- 2K byte Ram Standard (expandable to 4K byte).
- 5 baudrate selections: 110 - 300 - 600 - 1200 - 2400.
- Full/Half duplex selection.
- 4 serial formats: 2×binair
  2×ASCII-HEX
  industrial standard
- RS 232 asynchronous communication.
- "Busy" indication.
- "ERROR" indication.
- Access time buffer ram: 250 nS (reading).
- 24 pin IC flat ribbon connector cable for communication with Eprom programmer K2578, or other devices.
- compatible connection with 2716 or 2732 (selectable).
- 10-bit frame.
- Eurocard size: 100×160mm.

F.M. MICROTRANSMITTER
PAN2 £8.63

- Input: 9 V (IEC 6 F 22 type battery)
- Transmission frequency (adjustable): 90 ÷ 105 MHz
- Range in open air: 100 metres (without aerial)
  300 metres (with aerial)
- High sensitivity microphone incorporated
- Size: 57 x 46 x 14 mm.
- Extremely sensitive radiomicrophone pilot light.

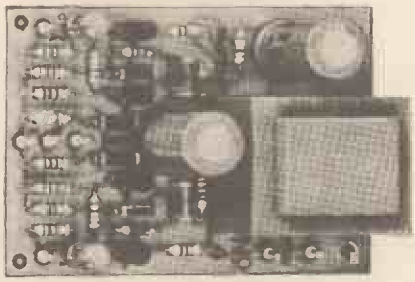
The microphone enables very weak sounds to be picked up up to a distance of 6 metres.
The sounds picked up are transmitted in F.M. up to the distance of a few hundreds of metres.
The low consumption guarantees for 9 V battery a life in excess of 50 hours.



2 ÷ 30 V, 20 mA ÷ 2.2 A STABILIZED POWER SUPPLY
PAN3 £15.76

- Input: max. AC
- Consumption: max. 3 A
- Output voltage: 2 ÷ 30 V d.c.
- Output current: 20 mA ÷ 2.5 A
- Electronic protection against short circuits
- Output with constant current and voltage
- Voltage and current-regulating potentiometers
- Size: 95 x 70 x 24 mm.

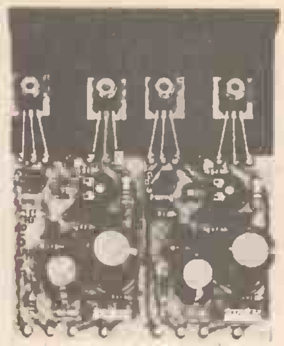
Due to its exceptional features, Kit 3 may be considered a professional power supply. It can be used to feed transmitters receivers stereo units and car radios. The high degree of voltage and current stabilization and regulation is ideal for electronic laboratories.



RIAA 220/240 V STERIO PREAMPLIFIER
PAN4 £12.19

- Input impedance: 47 KΩ
- Input sensitivity: 4 mV
- Output impedance: 10 KΩ
- Output voltage: 4 V max.
- Correction: R.I.A.A.
- Power input: 220/240 V AC
- Consumption: 4 W
- Size: 75 x 53 x 30 mm.

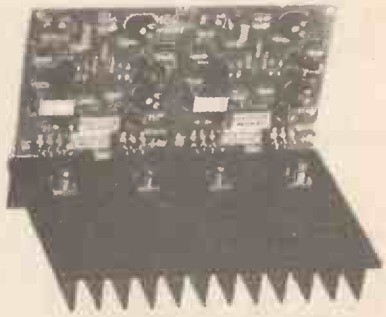
Its ultracompactness, mains input of 220/240 V excellent R.I.A.A. response curve and high amplification factor makes the use of Kit 4 ideal in all magnetodynamic elements (record players and tape recorders). Besides permitting direct earphone reception, the output may be connected to any type of radio an amplifier.



2 x 10 W STEREO AMPLIFIER
PAN5 £16.68

- Power supply: 18 V d.c. - 1.7 A
- Input impedance: 75 KΩ
- Input sensitivity: 100 mV
- Band-pass: 20 Hz ÷ 35 KHz
- Distorsion: < 4% at 10 W; <1% at 8 W
  < 0.5% at 6 W; < 0.2% at 4 W
- Loudspeakers: 4Ω
- Size: 85 x 103 x 25 mm.

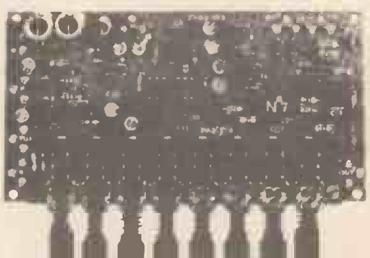
Due to its impedance and input sensitivity values, Kit 5, "compact final amplification stage", may be coupled to any type of preamplifier. Its excellent distortion and stability guarantee good operation also in cars with 12 V system. Kits 7 and 8 are the natural complement to your stereo plant.



2 x 40 W STEREO AMPLIFIER
PAN6 £28.69

- Power supply: +0 —25 V d.c. 3.5 A
- Input impedance: 40 KΩ
- Input sensitivity: 1 V
- Band-pass: 10 Hz ÷ 50 KHz
- Distortion: < 2% at 40 W; < 0.5% at 25 W
- Loudspeakers: 4 Ω (40 W); 8 Ω (25 W)
- Size: 130 x 110 x 50 mm.

Kit 6 is the ideal final power amplifier for anyone requiring a low background noise, high band-pass and good output power.
The "Darlington" final transistors guarantee maximum reliability.
Kits 7 and 8 are the natural complement to your stereo plant.



STEREO PREAMPLIFIER WITH PUSH-BUTTON STRIP
PAN7 £14.72

- Magnetic input sensitivity: 2 mV on 47 KΩ
- Piezo-electric input sensitivity: 100 mV on 1 MΩ
- Stand-by input sensitivity: 1 V on 250 KΩ
- Tuner input sensitivity: 250 mV on 47 KΩ
- Output voltage: 2 V effective
- Scratch: 6 dB/octave at 10 KHz
- Rumble: 6 dB/octave at 60 Hz
- Signal/Disturbance Ratio: 70 dB
- Distortion: 0.1% (at 1 KHz)
- Power supply: 30 V
- Size: 130 x 70 mm.

Kit 7, an extremely compact stereo preamplifier, may be coupled to Kit 8, tone and volume regulator, and to the amplifying units consisting in Kit 5 (2 x 10 W) and Kit 6 (2 x 40 W). The push-button selects inputs in relation to the signals available (PIEZO - TUNER - TAPE - MONITOR) and the SCRATCH and RUMBLE filters.

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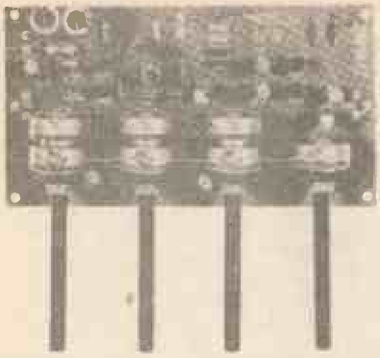
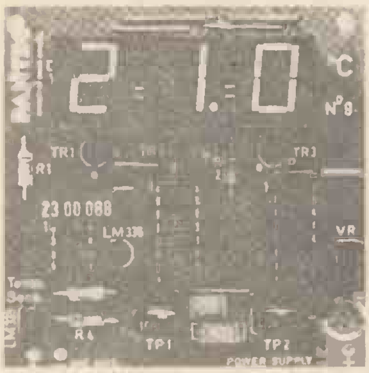


STEREO PREAMPLIFIER: TONE AND VOLUME CONTROL UNIT PAN8 £15.99

- **Input voltage:** 1 V
- **Gain:** 35 dB
- **Low:** ± 12 dB (at 100 Hz)
- **High:** ± 13 dB (at 10 KHz)
- **Signal/disturbance ratio:** 80 dB
- **Frequency response:** 10 Hz ÷ 40 KHz
- **Input impedance:** Over 470 KΩ
- **Output impedance:** Less than 10 KΩ
- **Distortion:** Less than 0.2%
- **Power supply:** 30 V
- **Size:** 130 x 70 mm.

Kit 8 controls and regulates the tones (High and Low) volume and balance of your stereo plant. It may be coupled to preamplifier Kit 7 and to the amplifier units consisting of Kit 5 (2 x 10 W) and Kit 6 (2 x 40 W).



−9.9°C ÷ +99.9°C DIGITAL THERMOMETER PAN9 £30.82

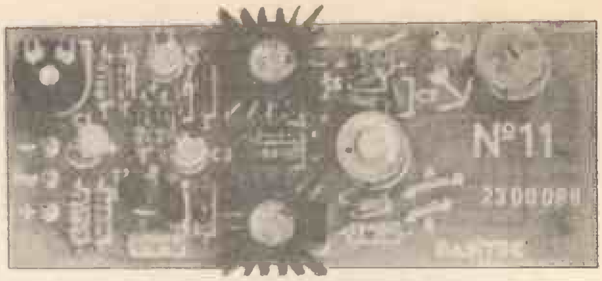
- **Temperature range:** −9.9°C ÷ +99.9°C
- **Display:** LED 3 digit
- **Input:** 7 ÷ 12 V d.c.
- **Consumption:** 150 mA max.
- **Size:** 70 x 70 mm.

Ideal to measure environmental temperature, it may also be used to measure the temperature of liquids, and body temperatures, thus becoming a Medical thermometer.
The sensitive element may be remotely connected, to form a portable thermometer with probe.

"SWITCH MODE" SPEED REGULATOR FOR SMALL ELECTRO-MOTORS PAN10 £11.16

- **Input voltage:** 12 ÷ 16 V
- **Output current:** 0 ÷ 2 A
- **Fully protected output**
- **Size:** 70 x 85 mm.

With this Kit you can vary the speed of the small D.C. motors and reverse the polarity of the input voltage, reversing the direction of rotation and therefore the direction in which the toy moves.
The output current is automatically limited to avoid damage if short circuit occurs.



3 W MF TRANSMITTER WITH AERIAL PAN11 £14.49

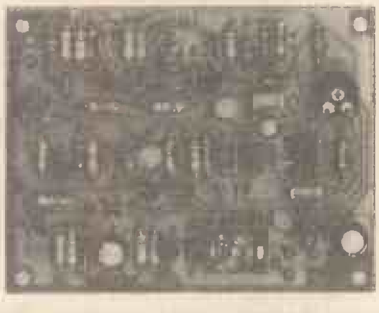
- **Output power:** 3 W
- **Power source:** 12 V d.c. (max. 15 V d.c.)
- **Transmission frequency:** 85 ÷ 115 MHz (adjustable)
- **Type of emission:** Frequency modulation Varicap-controlled
- **Input impedance:** 10 KΩ
- **Input sensitivity:** 10 mV
- **Size:** 35 x 84 x 12 mm.

The high stability in the type of emission, the performances, the compactness, and the aerial circuit males Kit 11 a real professional transmitter ideal for all your applications.

SINGLE CHANNEL RADIO CONTROL TRANSMITTER PAN13 £11.44

- **Input voltage:** 9 ÷ 12 V d.c.
- **Max. consumption:** 50 ÷ 80 mA
- **Transmission frequency:** 27 MHz
- **Signal modulation with double code**
- **Range in open air:** 500 m.
- **Size:** 80 x 50 x 15 mm.

Kit 13 has been disgined to operate in conjunction with Kit 14 "receiver". In this way you can have a remote control system with a range of 500 metres and over. This distance may vary with the type of aerial used with the receiver. Extremely useful for remote control of any electrical apparatus, e.g. garage doors, electromotors and burglar alarms.



SINGLE CHANNEL RADIO CONTROL RECEIVER PAN14 £18.39

- **Input voltage:** 9 ÷ 12 V d.c.
- **Max. consumption:** 60 mA
- **Reception frequency:** 27 MHz
- **Decoding:** with PLL (Phase Booked Loop)
- **Output relay:** 2 A - 220 V
- **Size:** 90 x 70 x 22 mm.

Kit 14 has been designed to operate Kit 13 with the transmitter. In this way you can have a remote control system with a range of 500 metres and over. This distance may vary with the type of aerial used with the receiver. The receiver output operate a 2 A - 220 V relay capable of controlling any electrical apparatus.

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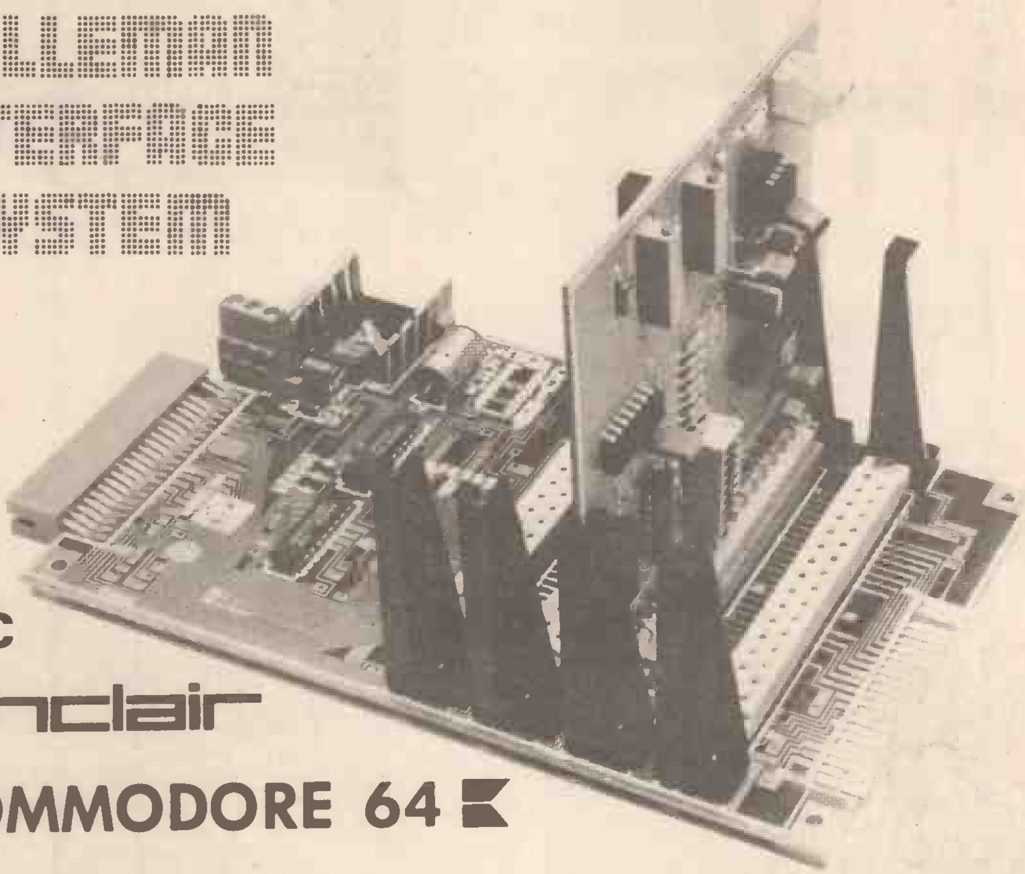
VELLEMAN INTERFACE SYSTEM



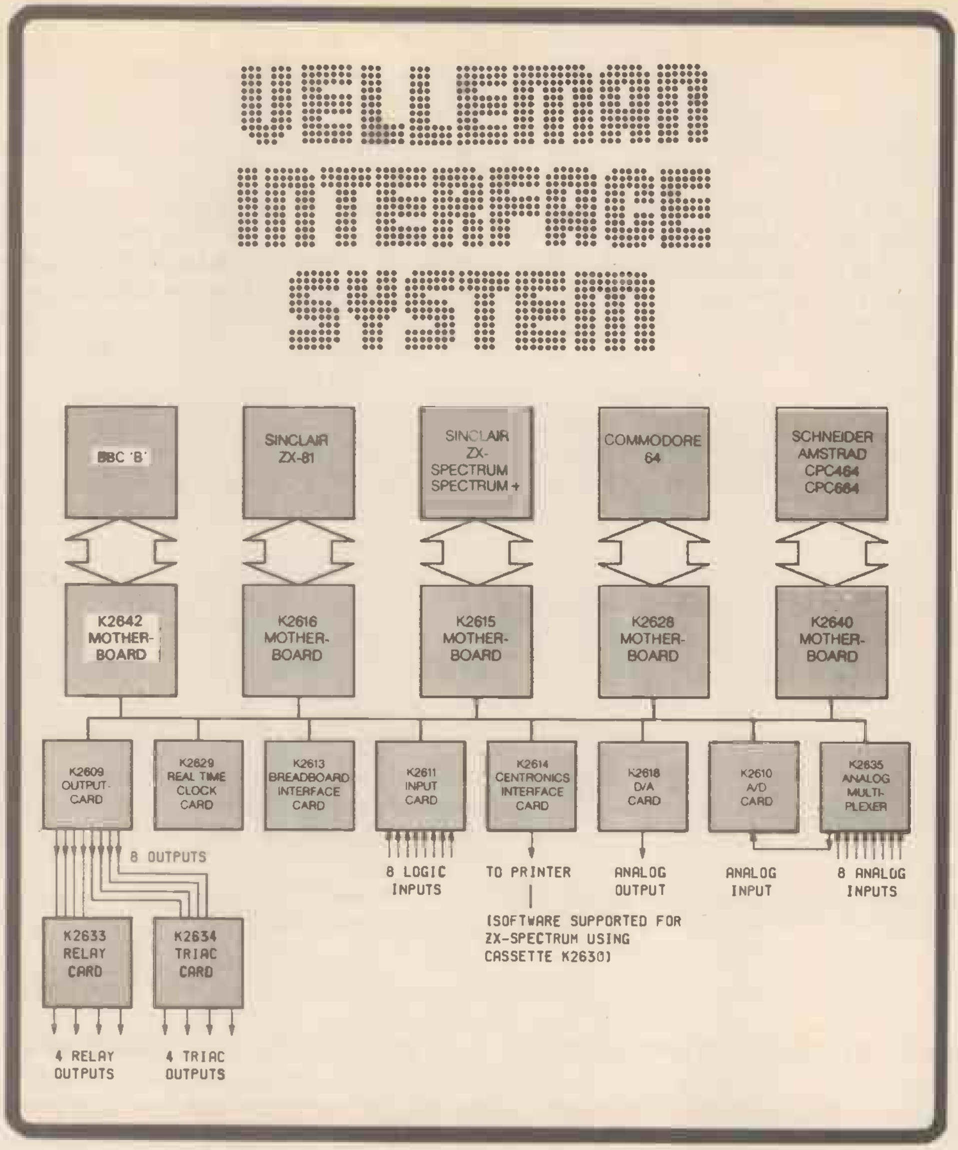
BBC

sinclair

COMMODORE 64

Schneider

AMSTRAD



Many people buy a home computer, in order to introduce themselves to the world of computer fanatics, which is still rather mysterious to them.

As soon as you are familiar with the programming language, you will want to "do" something with the program, which is more than just making a calculation or graph program. At the moment there seems to be very poor communication between the computer and the outside world: apart from the keyboard, joysticks – if any – or a lightpen, there are not many inputs left. The screen, the printer or the sound are the only outputs.

The purpose of an interface system is to do away with these shortcomings as much as possible.

So far, manufacturers have not concerned themselves with standardization in the computerworld. On the contrary: they give you the possibility to connect other apparatures to the computer, but each time in a different way. What's worse: one manufacturer will often use different extension connectors.

In order to avoid that a certain interface can only be connected to one single kind of computer, we have made our system in modules, i.e. we have designed a few cards each having a speical task, such as the input board, which can pass the position of the switches to the computer, or the output board which can switch relays on or off on the command of the computer.

In order to adapt all these cards to the different types of computers, we designed a number of motherboards that plug into the appropriate connector of your computer.
There are two types of motherboard which will be discussed in detail in the following sections: the single pcb types (for ZX-81, ZX-SPECTRUM and SPECTRUM PLUS, and Commodore-64) and the twin-pcb types (Schneider/Amstrad CPC464, MSX).
All types provide space for four interface cards, and the system can be expanded to a maximum of sixteen cards.

They buffer the signals from the computer, generate the necessary control signals, and regulate the power for the interface cards.

All modules are available in kit form or ready assembled.

Single-pcb motherboards

These motherboards can each accommodate up to four interface cards on one doubleside printed circuit board.
They simply plug into the expansion connector of the respective computer (for the Commodore-64: the ROM-cartridge slot). For the standard peripherals, such as the Sinclair ZX-printer of the Commodore ROM-cartridge, a connector is fitted at the back of the motherboard. This connector is identical to that on the computer (except for the K2615 ZX-spectrum motherboard which has a ZX-printer type connector). Consequently, it is possible to cascade up to four motherboards successively, so that up to 16 interface cards can be used at the same time.

K2615 FOR THE ZX-SPECTRUM KIT £40.00 BUILT £63.80

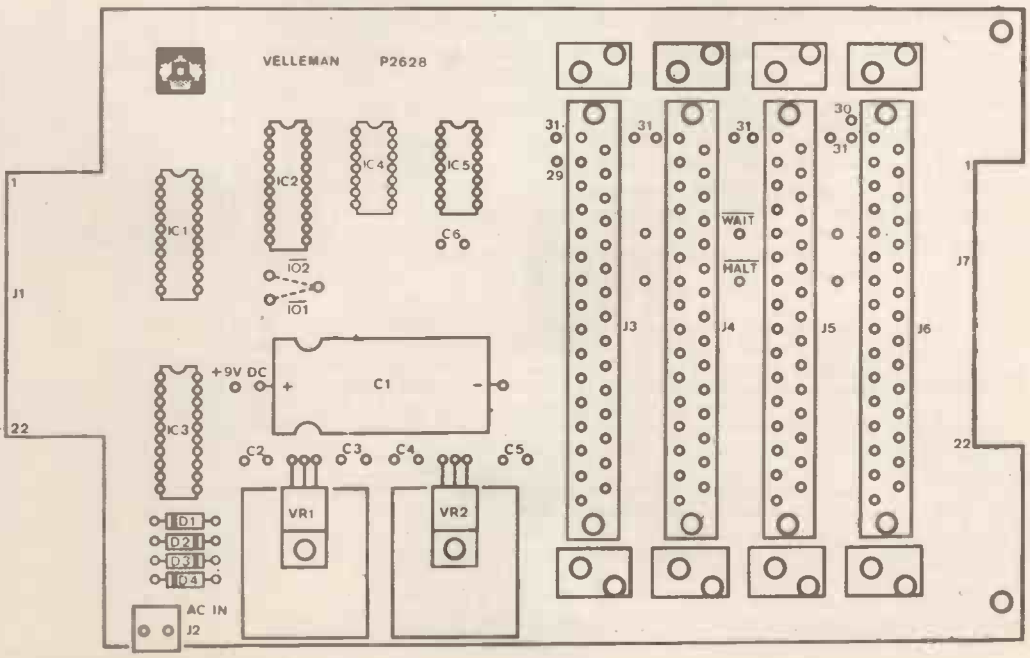
Here the interfaces are considered to be I/O "devices". They are controlled by the BASIC commands IN and OUT. The power supply (9VDC) is, according to the total current consumption of the system, taken from the computer power supply or from an external, non-stabilised power supply of 9 to 12 VDC maximum. (eg. from an adaptor).
Dimensions: 200 x 120 x 120 mm (with the interface cards mounted)
Supply current: 9V/75mA

K2616 FOR THE ZX-81 KIT £38.80 BUILT £63.60

The interfaces are part of the ZX-81 memory, and are controlled by the BASIC commands PEEK and POKE. They are situated on the addresses 8192 to 16384 of the memory map. For this purpose, the BASIC ROM, which normally also reacts to these addresses, is disabled by a special circuit on the motherboard.
The power supply is taken care of in exactly the same way as for the K2615.
Dimensions: 200 x 120 x 120 mm (with the interface cards mounted)
Supply current: 9V/80mA

K2628 FOR THE COMMODORE-64 KIT £51.60 BUILT £80.40

Here also the interfaces are part of the computer memory, and are controlled by the BASIC commands PEEK and POKE. They can be put in either of the two I/O blocks of the memory map. To supply the whole, a transformer of 7 or 8 VAC which can provide 1A should be connected.
An adaptor or power supply of 10 to 12 VDC/1A can also be used.
Dimensions: 235 x 135 x 125 mm (with interface cards mounted)
Supply current: 9V/135mA



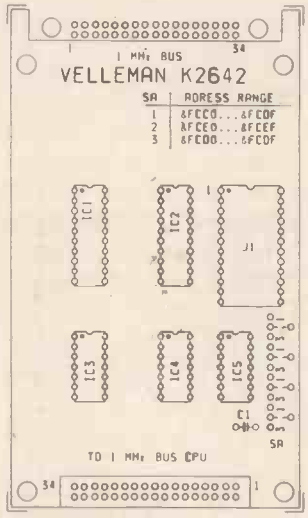
Twin-pcb motherboards

These motherboards consists of two printed circuit boards connected via a ribbon cable:
1. A single sided PCB which accommodates up to four interface cards. The system may be expanded, using extension board K2631, to a maximum of 16 interface cards. (i.e. 1 motherboard plus up to 3 extension boards).
2. A small doublesided board that plugs into the appropriate connector of your computer. This board buffers the signals from your computer and generates all necessary control signals. A connector identical to that on the computer is provided at the rear of this bufferboard. Such that any standard peripheral as e.g. the Amstrad floppy disc drive or an MSX ROM-cartridge can be used without problems.

K2642 MOTHERBOARD KIT
BBC 'B' & MASTER COMPUTERS

KIT £53.10

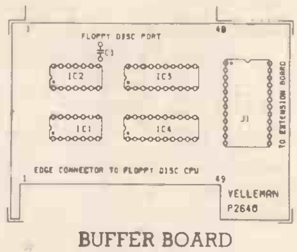
All signals required by the interface system are buffered.
On board rectification and regulation of the required voltages are provided.
Male and female connectors for the interface cards are included in the individual interface card kits.
All other connectors included.
Power supply: 8 Volts AC 1 Amp transformer.
Current: 100 mA if no interface cards are fitted, 1 Amp max load.
Dimensions: bufferboard: 128 × 75 mm.
extension board: 162 × 128 mm.



K2640 MOTHERBOARD KIT
SCHNEIDER/AMSTRAD CPC464

KIT £48.70

The interfaces supported by this motherboard are considered to be I/O "devices" by the parent computer and are controlled by the basic commands "INP" and "OUT".
(This is a Twin P.C.B. motherboard). The buffer board connects into the floppy disc port of the computer. An identical connector is available at the rear of the buffer board to support a disc drive or other peripheral in addition to the motherboard. The motherboard requires 8 V AC. at 1 AMP or in special applications 12 V DC may be used.
Dimensions: buffer board: 96 x 82 mm
mother board: 162 x 128 x 120 mm (with interface cards mounted)
Supply current: 100 mA (motherboard and buffer board only)

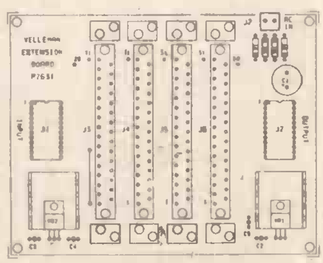


BUFFER BOARD

K2631 EXTENSION BOARD

KIT £21.20

When you need more than four interface cards, and the motherboard for your computer is of the twin-pcb type (at present this is for MSX computers and Schneider/Amstrad CPC464 computers), this extension board should be used to support up to four more interface cards.
This extension requires 8 V AC at 1 AMP or in special applications 12 V DC may be used. Dim.: 162 x 128 x 120 mm.
Your computer can afford max. 4 boards (= 16 cards).
(with interface cards mounted).



EXTENSION BOARD

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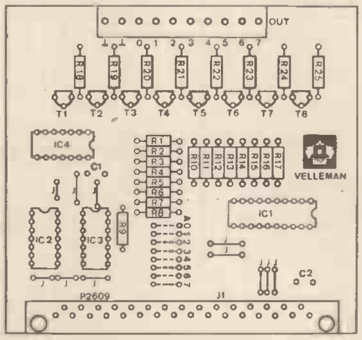
INTERFACE CARDS

Furthermore, our system consists of 7 interfaces, which all have a few features in common:

- There is an 8-bit addressdecoding on the print, so that in principal 256 interfaces can be controlled without influencing one another.
  This gives you possibilities for further developments, eventually having various functions per card, and using therefore more "addresses".
- In all manuals of the interfaces there are program examples in order to explain the functioning and use.
- The dimensions (106 x 106 mm) are the same for all types, except for the K2613 breadboard which is higher. The assembled versions are equipped with screw connectors and with a dil-switch for the address selection. All adjustments, if any, are carried out.

K2609 OUTPUT BOARD KIT £22.55 BUILT £29.95

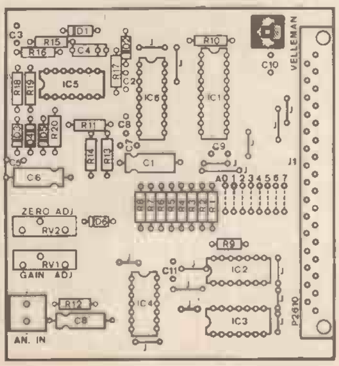
This board makes sure that the computer can give ON/OFF commands. There are 8 outputs per board (open collector) on which print relays can be connected (or eg our relay-card) or electronic switches, to suit your own design and application, so that you can switch off apparatus, lamps, motors, alarm systems, almost anything, which can be switched on or off under program control.
Applications are multiple: in fact, wherever the program has to control something, you already need an on/off function.



Technical data:
- 8 open collector outputs (max 25V/50mA) which are programmed with one single instruction
- current consumption: 5V/70mA (the power supply is taken care of by the motherboard).

K2610 ANALOG TO DIGITAL CONVERTER BOARD KIT £35.50 BUILT £41.90

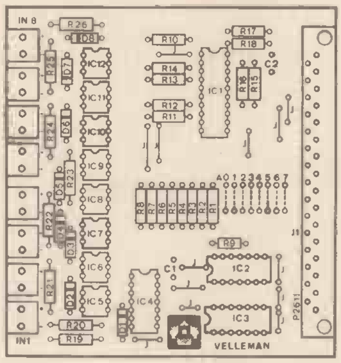
Not all information needed in a program has an on/off shape, but it is rather a continuous varying quantity expressed by a number.
Just think about temperature, humidity, pressure, voltage, current, etc. ... Therefore the computer must be able to measure and this is what is done by an A/D converter. THe latter converts an analog magnitude (in this case 0 to 5,1 Volt) into a number (0-255) which can be read by the computer. You can in fact measure anything provided you have the suitable sensor. (The power supply is provided by the motherboard).



Technical data:
- input sensitivity: 5.10V at full scale.
- 8-bit analog/digital conversion (255 steps of 20mV).
- linearity error: +/- 1LSB.
- current absorption: 5V/95mA, powered by the motherboard.
- dimensions: 106 x 106 x 15 mm.

K2611 INPUT BOARD KIT £26.25 BUILT £40.10

Through this board, the computer can verify the situation of the contacts, security systems, detectors, etc. ...
In general, you could even say that, whenever the computer has to obtain any kind of external on/off or yes/no information, this interface is the one you need.
There are 8 inputs per board, which are electrically isolated from the rest of the computer by means of an optocoupler.
The advantage of this is that you have less parasites on the circuit, coming from machinery, lightning, etc. ...
In addition, the different inputs are not connected to one another, which creates more possibilities concerning the information source. Take for example a control switch on a machine in an industrial surrounding, with a usual (voltage) input it is quite difficult to obtain trouble-free functioning. Since we are dealing here with a "current sensing" input, this can be very simple and the reliability is very high. Possible applications include: time registration, all kinds of security systems, system control, etc. ...



Technical data:

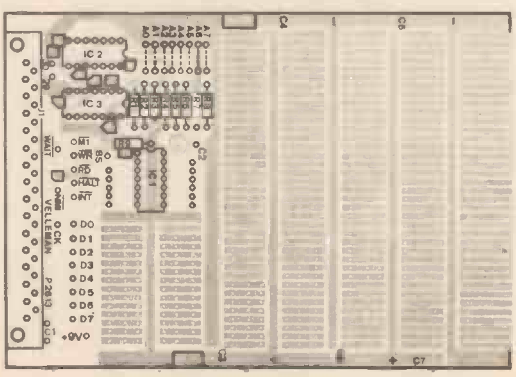
- 8 optocoupler inputs, simultaneously read by one single instruction.
- the electric isolation allows for input signals, derived from different power supplies, even directly from the mains.
- supply current 5V/75mA (the motherboard takes care of the power supply).

K2613 BREADBOARD INTERFACE KIT £32.40

Although our program is quite comprehensive, we can imagine that you might need an interface for certain applications, which we unfortunately cannot provide. The ideal solution is a breadboard which has an address decoding and which leaves some space for your own circuitry.

The major advantages of this system are that changes are easily made while developping, that there is no need to design complex printed circuits before testing can start, and that the card fits without modification on all our motherboards. There are two ways to build your interface on this card: either in the ordinary way (first drilling the holes, and then mounting the components with the wiring at the "copperside"), or with wiring and components at the same side (such as the Velleman mounting strip system).

Attention:
this kit is intended for users who are familiar with the design of electronic circuits, incl. high-speed LS-TTL logic.

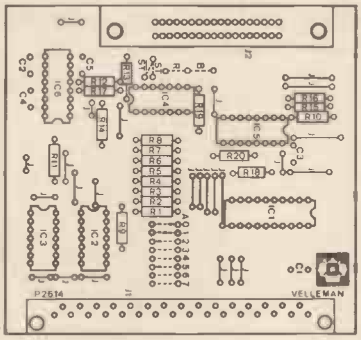


Technical data:

- 8 bit address decoding on the print, positive pulse when the board is selected.
- 80 cm² free space for building a special interface.
- free space is dual sided, offering the possibility to drill holes and to mount the components in the normal way, or to work with the Velleman breadboard system so that the components can be mounted at either side of the print.
- no additional power supply required for the logic.
- dimensions 106 x 156 mm.

K2614 CENTRONICS INTERFACE KIT £39.55 BUILT £45.60

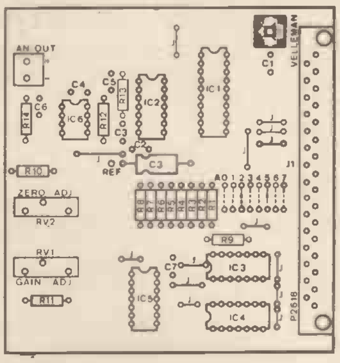
The manufacturer's printer often doesn't give satisfaction when printing out charts, data, programs, etc. ... One of the solutions is then most of the time a "serious" printer, mostly standard equipped with a Centronics communication gate, and optional with RS232 (which is then more expensive). In this case the K2614 is the solution. Also parallel printers with a non-standardized parallel communication gate, which have a Ready or Busy signal, can be connected without difficulty. The necessary software for the application with the standard Basic instructions (LLIST and LPRINT) is available on a separate cassette for the ZX-Spectrum. This interface is only recommended for use with ZX-81 and ZX-Spectrum. Software for use with other computers is not available.



Technical data:
- immediate control of all parallel printers with a standard Centronics communication gate.
- can also control non-standard parallel printers, provided they have a Ready or Busy output (TTL-level signals).
- standard 2 x 18 contacts connector.
- current consumption: 5V/ 140mA (power supply is taken care of by the motherboard).

K2618 DIGITAL TO ANALOG CONVERTER BOARD KIT £32.75 BUILT £36.85

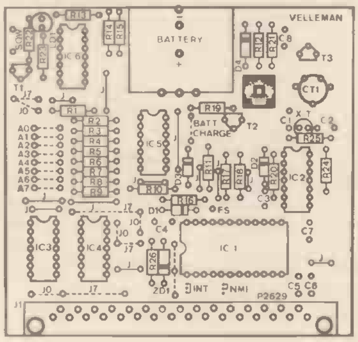
Sometimes just switching apparatus on and off is not enough, but you need to give it a continuous varying steering signal, which depends on other parameters such as time temperature, position, distance, etc. For instance motor speed controllers (in machines, miniatures trains, etc.), heaters that work proportionally to the difference between the real and the ideal temperature, light intensity regulation, and so on.
This kit converts a number from 0 to 255 in a tension from 0 to 1.020 V, in steps of 4mV. (The power supply is taken care of by the motherboard).



Technical data:
- output range: 0 - 1.020 V
- 8-bit digital to analog conversion (255 steps of 4mV)
- non-linearity: +/- 0,5 LSB
- supply current: 5V/75mA
- dimensions: 106 x 106 x 15 mm.

K2629 CMOS REAL TIME CLOCK AND RAM   KIT £41.30   BUILT £58.45

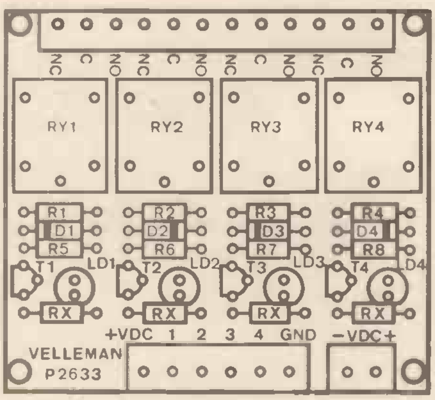
Time is very important in a lot of applications of an interface system. For most of the computers, there are programs which simulate a clock, but these are based on the calculation time of the CPU, so that no other tasks could be executed simultaneously.
Other computers, such as the Commodore-64, have an internal clock, but the latter has the disadvantage of stopping when there is a power failure, so that auto load/auto run programs do not function well.
The K2629 doesn't have this disadvantage, but offers on the contrary a lot of possibilities such as the calendar (with an automatic leap year compensation), the possibility of alarm timing, X-tal time basis, a programmable square wave output (2, 4, 8, 16, ... 8192Hz), the choice between an external 4,5V battery or Nickel Cadmium accu for which some space is left on the board, and last but not least: 50 bytes of RAM to store important data, which then can be used after a power failure by an auto load/auto run program. Of course, a status register is also provided, to show that the data hasn't vanished after a long power failure, due to an insufficient battery voltage. In the manual you will find an extensive demonstration program, which uses most of the features of a K2629 and which explains its functioning.



Technical data:
- low power, high speed CMOS technology.
- battery back-up in option.
- clock with hours, minutes and seconds.
- calendar with automatic leap year compensation.
- programmable daily alarm time.
- 50 bytes of RAM, for the storage of important data.
- demo program explaining most features of the module.
- current consumption: 5V/ 75mA (power supply is taken care of by the motherboard).

K2633 RELAY CARD   KIT £15.20   BUILT £22.30

This kit is intended for use in "slow" switching applications, such as for motors, central heating, alarm sets, etc. ... Thanks to the fact that the relays are controlled by a current instead of a voltage, the relay card can easily be installed at a certain distance from the computer, keeping away electromagnetic disturbances caused by sparks over the contacts, and reducing cabling costs. Although originally designed for use with the output board (there are only 4 or 5 wires required between the output board and the relay card) it can be driven by any open collecor circuit that can sink 15 mA and withstands 9V.
Per card there are four relays and their driving circuitry. The power supply can be the same as for the motherboard (take care not to overload it !), or an additional one (unregulated).

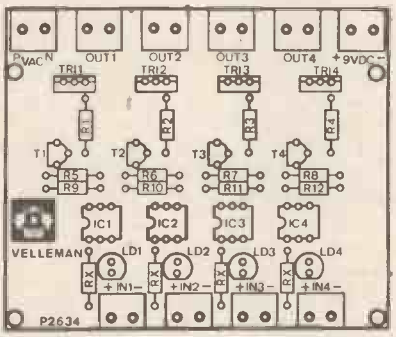


P2633

Technical data:
- four relay outputs, single pole inverters.
- max. load: 240VAC/3A.
- power supply: 9VDC/ 300mA (unregulated)
- indicator LED for each output.
- dimensions: 76 x 69 x 25 mm.

K2634 QUAD TRIAC SWITCH CARD KIT £16.30 BUILT £22.20

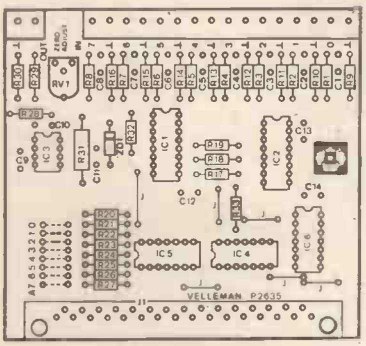
Opposite to the relay card, this kit addresses applications where fast and frequent switching of ac-loads is required, such as for light shows, advertising, display panels etc. ... As for the relay card, it is extremely simple to connect it to the output board, but it can also be driven by any open-collector circuit (15mA, min 9V). Per card there are four triac switches, galvanically isolated from the driving circuit by opto-couplers.
A second advantage of using optocouplers at the input is the high noise immunity: signal cable lengths of 20 to 30 meters from K2609 to the triac card don't influence a correct operation (e.g. in display panels, score display). This works cost-saving as the triac card may be installed in the display panel, eliminating the need for big (and expensive) wire bundles as you can use small signal cables (e.g. telephone cable). Moreover, electromagnetic disturbances caused by the switching are kept away from the computer. The loads supply is common to the four switches and may be in the range from 24 to 240V alternating current. The power supply to the circuit has to be totally independent from the supply of the motherboard and from the load's supply, e.g. by using a separate 9VDC adaptor (or a transformer with rectifier and smoothing capacitor) per triac card.



Technical data:
- four triac outputs.
- optocouplers at the inputs assure isolation and high noise immunity for long control lines.
- loads: 24 to 240VAC (common to the 4 switches) 1,5A per output (max. 4A when triacs are cooled).
- input current: 10 to 12mA DC.
- indicator LED for each switch
- power supply: 9VDC/200mA fully isolated from the load's supply and the supply of the control circuits (separate winding or another transformer).
- dimensions: 78 x 90 x 29 mm

K2635 8 TO 1 ANALOG MULTIPLEXER BOARD KIT £27.60 BUILT £38.60

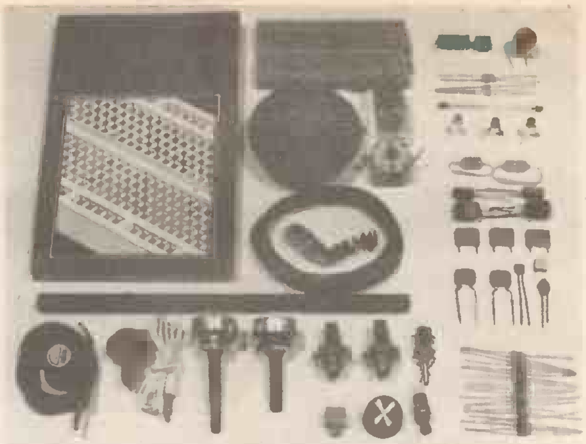
In most control applications there are multiple analog parameters to be monitored. Instead of buying as many A/D converters as there are analog signals to the measured, it is more cost- and space effective to use an analog multiplexer which connects one of eight input signals to the A/D converter.
Programming is extremely simple: only one single instruction to choose another channel. The output signal is buffered and amplified (max: gain = 5). There is room for an input divider and RC-filter on each channel.



Technical data:
- possibility to attenuate each input indepentently.
- input impedances of more than 1 mega-ohm possible
- buffered output: minimum load impedance as low as 1 kilo-ohm.
- possibility to amplify the output signal (max. gain = 5)
- response time of the output: faster than 1ms from selection to output stable.
- supply current: 5V/50mA and 9V/10mA.

ADVENTURES WITH ELECTRONICS KIT

Based on the book by Tom Duncan, the carefully chosen selection of parts enables the complete beginner in electronics to make working projects on the 'breadboard' supplied. No soldering is required, as the components simply push in the holes in the S-Dec breadboard to make contact. Apart from showing how to build specific projects, the book contains a wealth of information on the subject generally, all written in a very readable manner. All parts are supplied in a strong compartment tray with hinged lid. Things to make include simple lamp and battery circuits, parking light; rain detector; fire alarm; flashing lamp; morse buzzer; burglar alarm; organ; metronome; siren; intercomm; 3 radios; timer; computer counter. Everything is supplied including wire and sleeving – you just need a 4½V battery.
Book £3.95 Kit £21.95

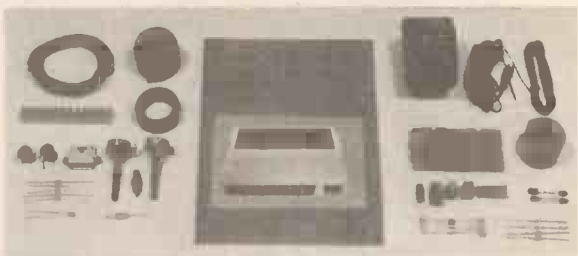


30 SOLDERLESS BREADBOARD PROJECTS—Book 1

Written by R. A. Penfold, this book utilizes the Verobloc Breadboard. The 30 projects featured include simple power amplifiers, light and dark actuated switches and alarms, various oscillators, horns, buzzers etc., touch switches, transistor tester, reaction game, water and moisture alarms and detectors, fuzz unit and several radios.
The introductory chapters provide a wealth of information on breadboards and components.
The kit contains all parts required to build all projects within the book, and they are attractively housed in a sturdy plastic compartment tray with hinged lid for ease of use and subsequent storage.
Book £2.25 Kit £24.95

ADVENTURES WITH MICROELECTRONICS KIT

As with the previous kit, this includes all the parts to build numerous projects, all based on integrated circuits. Again a breadboard is used so no soldering is required, and all the parts can be used again and again. All parts are supplied in a strong compartment tray with hinged lid. Things to make include two tone door bell; warbling wailing siren; two octave organ; light operated alarm; electronic dice; traffic lights; pulsed bleeper; 4-bit binary counter; reaction timer; MW/LW radio etc. All that is required is a 9V battery.
Book £3.95 Kit £29.95



SENSING AND CONTROL PROJECTS FOR THE BBC MICRO

The kits for the projects in this book are designed to use the facilities provided on the BBC computer, but which are not often employed.
They actually link the micro to the 'real world' with practical projects that maybe simple, but although no soldering or knowledge of electronics is required, are certainly not trivial..
Two kits are available, as the book is divided into two distinct sections; Analogue to Digital Converter Projects (Kit 1) and User Port Projects (Kit 2). Both kits contain all parts required to complete all projects in their particular section. All parts are available separately if required.
Kit 1 £11.00 Kit 2 £21.00 Book £5.95

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