

EVERYDAY **ELECTRONICS** and **ELECTRONICS** MONTHLY

APRIL 1986

£1.10

**SPECIAL
OFFER!**

HOME SECURITY SYSTEM

STEREO REVERB



FREELoader

VERSATILE PSU



Newcomers Magazine for Electronic & Computer Projects



£1 BAKERS DOZEN PACKS

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

1. 5-13 amp ring main junction boxes
2. 5-13 amp ring main spur boxes
3. 25-13 amp fuses for ring mains
4. surface mounting switches suitably insulated for mains voltage
5. electrical switches intermediate type, will also replace 1 or 2 way switches, white flush and black
6. 12-glass reed switches
7. 4-in flex line switches with neon
8. -mains transformers with 6V 1A secondaries
9. -mains transformers with 12V 1A secondaries
10. 1-extension speaker cabinet for 6 1/2" speaker
11. 12-glass reed switches
12. ultra transmitters and 2 receivers with circuit
13. light dependent resistors
14. wiper switches - 6p 2 way, 4p 3 way, 2p 5 way, 2p 5 way, 1p 12 way small one half fitting and good length 1/2 spindle your choice
15. 8 digit counter 12V
16. 8 digit counter mains voltage
17. Nicad battery chargers
18. key switch with key
19. 2-neron cuts of 100% dry lubricant
20. 1-metre lengths color-coded connecting wire
21. long and medium wave tuner kit
22. rocker switch 10 amp mains SPST
23. 24-hour time switch mains operated (s.h.)
24. 1-hour clock work time switch
25. 6V operated reed relay
26. neon valves - make good night lights
27. 12V DC or 24V AC, 3 CO relays
28. 12V DC miniature relay very sensitive
29. 12V 4 CO miniature relay
30. mains operated relay 3 x 8 amp changeover (s.h.)
31. rows of 32 gold plated IC sockets (total 320 sockets)
32. locking mechanism with 2 keys
33. miniature selector with circuit for electric jigsaw puzzle
34. ferris rods 4" x 5/16" diameter a/c
35. ferris slab assembly with 8 1/2 wave coils
36. Mullard thyristor trigger module
37. assorted knobs 1/2 spindles
38. 5-different thermostats, mainly bi-metal types
39. magnetic brake stops rotation instantly
40. low pressure 3 level switch can be match operated
41. 25-watt pots 8 ohm
42. 25-watt pots 1000 ohm
43. wire wound pots - 18, 33, 50 and 100 ohm your choice
44. 1250 watt dimmer 120v 320
45. time reminder adjustable 1-60 mins clockwork
46. 10A bridge rectifiers 30V
47. 30A panel mounting systok fuses
48. 1-mains shaded pole motor 1/2" stack - 1/2 shaft
49. 1-mains motor with gear box 1 rpm 24 hours
50. 1-mains motor with gear box 16 rpm
51. thermostat for fridge
52. infra red fire element 1000 watts
53. motorized stud switch (s.h.)
54. 2-3 hours delay timer 240v
55. mains power supply unit - 5V DC
56. mains power supply unit - 6V DC
57. mains power supply unit - 4.5V DC
58. 3-pin flex plug and panel socket
59. 2" speaker size 16 ohm speaker with handle
60. 100 - slider type volume controls
61. musical boxes (less keys)
62. heating pad 200 watts mains
63. FM front with tuning condenser and data
64. 1W amplifier Mullard type
65. wall mounting thermostat 24V
66. teak effect extension 5" speaker cabinet
67. a.c. boards with 2 amp full wave and 17 other recs
68. push push switches for table lamps etc.
69. 10 - mtrs twin speaker flex wire p.v.c. outer
70. 100 - staples for thin flex
71. clear plastic lenses 1/2" diameter
72. pilot bulb lamp metal clip on type
73. very fine drills for pcbs etc.
74. extra thin screws for instruments
75. centre zero panel meters: 100-0-100 uA
76. plastic boxes with windows, ideal for interrupted beam switch
77. 10 - model aircraft motor - require no on/off switch, just spin to start
78. car radio speakers 5" round 4 ohm made for Radiomobile
79. 6 1/2" 4 ohm 10 watt speaker and 3" tweeter
80. 10 - 4 BA speakers 1" end open, other closed
81. 4 read relay bits 3V coil normally open or c/c if magnets added
82. pilot bulbs 6.5V 3A Philips
83. 1 - socket switch kit with data
84. 1 - printed circuit kit with 100 circuits
85. 4 - socket covers (protect inquisitive little fingers) for twin 13A
86. air or gas shut off valve - clockwork operated
87. air or gas shut off valve - thermostat operated
88. 12V drop proof relay - ideal for car jobs
89. 1 - neopap push button for telephones etc.
90. 12 way connector blocks 2A 250V
91. 12 way connector blocks 25A 250V
92. 13A fuse and switched spur for surface mounting or can be removed from box for flush mounting
93. 13A sockets good British make but brown
94. short wave air spaced trimmers 2-30f
95. shocking coil kit with data - have fun with this
96. 12V 8W bulbs Philips n.a.s.
97. sliding amber indicators with filaments 24V
98. round amber indicators with neon 240V
99. p.v.c. grommets 1/2" hole size
100. short wave tuning condenser 50 pf with 1/2" spindle
101. 1 - three gang tuning condenser each section 500 pf with trimmers and good length 1/2"
102. plastic box slipping metal front, 16 x 95mm average depth 45mm
103. double pole 20 amp 250V fluorescent switch - white
104. B.C. lamp holder adaptors white
105. 5 amp 3 pin flush sockets brown
106. B.C. lampholders brown bakelite threaded entry
107. in flex soldermat for electric blanket soldering iron etc.
108. thermostat, spindle setting - adjustable range for ovens etc.
109. rod thermostat for water heater etc. 11" rod
110. mains operated solenoid with plunger 1" travel
111. 10 digit switch pad for telephones etc.
112. computer keyboard switches with knobs, pcb or vero mounting
113. 20 - mtrs 80 ohm, standard type co-ax off white
114. electric clock mains driven, always right time - not cased
115. stereo pre-amp Mullard EP9001
116. 12V solenoids, small with plunger
117. 12V solenoids, small with plunger
118. 12V solenoids, small with plunger
119. 12V solenoids, small with plunger
120. 12V solenoids, small with plunger
121. 12V solenoids, small with plunger
122. 12V solenoids, small with plunger
123. 12V solenoids, small with plunger
124. 12V solenoids, small with plunger
125. 12V solenoids, small with plunger
126. 12V solenoids, small with plunger
127. 12V solenoids, small with plunger
128. 12V solenoids, small with plunger
129. 12V solenoids, small with plunger
130. 12V solenoids, small with plunger
131. 12V solenoids, small with plunger
132. 12V solenoids, small with plunger
133. 12V solenoids, small with plunger
134. 12V solenoids, small with plunger
135. 12V solenoids, small with plunger
136. 12V solenoids, small with plunger
137. 12V solenoids, small with plunger
138. 12V solenoids, small with plunger
139. 12V solenoids, small with plunger
140. 12V solenoids, small with plunger
141. 12V solenoids, small with plunger
142. 12V solenoids, small with plunger
143. 12V solenoids, small with plunger
144. 12V solenoids, small with plunger
145. 12V solenoids, small with plunger
146. 12V solenoids, small with plunger
147. 12V solenoids, small with plunger
148. 12V solenoids, small with plunger
149. 12V solenoids, small with plunger
150. 12V solenoids, small with plunger
151. 12V solenoids, small with plunger
152. 12V solenoids, small with plunger
153. 12V solenoids, small with plunger
154. 12V solenoids, small with plunger
155. 12V solenoids, small with plunger
156. 12V solenoids, small with plunger
157. 12V solenoids, small with plunger
158. 12V solenoids, small with plunger
159. 12V solenoids, small with plunger
160. 12V solenoids, small with plunger
161. 12V solenoids, small with plunger
162. 12V solenoids, small with plunger
163. 12V solenoids, small with plunger
164. 12V solenoids, small with plunger
165. 12V solenoids, small with plunger
166. 12V solenoids, small with plunger
167. 12V solenoids, small with plunger
168. 12V solenoids, small with plunger
169. 12V solenoids, small with plunger
170. 12V solenoids, small with plunger
171. 12V solenoids, small with plunger
172. 12V solenoids, small with plunger
173. 12V solenoids, small with plunger
174. 12V solenoids, small with plunger
175. 12V solenoids, small with plunger
176. 12V solenoids, small with plunger
177. 12V solenoids, small with plunger
178. 12V solenoids, small with plunger
179. 12V solenoids, small with plunger
180. 12V solenoids, small with plunger
181. 12V solenoids, small with plunger
182. 12V solenoids, small with plunger
183. 12V solenoids, small with plunger
184. 12V solenoids, small with plunger
185. 12V solenoids, small with plunger
186. 12V solenoids, small with plunger
187. 12V solenoids, small with plunger
188. 12V solenoids, small with plunger
189. 12V solenoids, small with plunger
190. 12V solenoids, small with plunger
191. 12V solenoids, small with plunger
192. 12V solenoids, small with plunger
193. 12V solenoids, small with plunger
194. 12V solenoids, small with plunger
195. 12V solenoids, small with plunger
196. 12V solenoids, small with plunger
197. 12V solenoids, small with plunger
198. 12V solenoids, small with plunger
199. 12V solenoids, small with plunger
200. 12V solenoids, small with plunger

MULLARD UNILEX AMPLIFIERS

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

CAR STARTER/CHARGER KIT

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

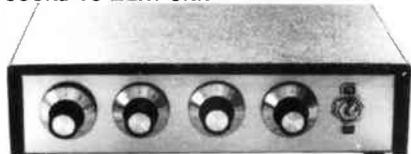


Ex-Electricity Board. Guaranteed 12 months.

VENNER TIME SWITCH

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

SOUND TO LIGHT UNIT



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

FROZEN PIPES

Can be avoided by winding our heating cable around them - 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price 26p/metre or 15m for £3.95.

25A ELECTRICAL PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake - switch on lights to ward off intruders - have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. A dependable 60 minute memory jogger. A beautiful unit at £2.50



THE AMSTRAD STEREO TUNER

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio - easy to carry about and which will give you superb reception.

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

GOODS ARE ON APPROVAL

These notes are often written and technical information sheets are seldom available about the items we have to describe, also advertisements sometimes go to press without our having a chance to correct any mistakes, however, everything we sell is supplied on the understanding that it is not suitable for your project you may return it within 7 days for credit. If there was a definite error of description in our copy then we will pay postage. If not, then you pay the postage. Note this offer applies to kits, but only if construction is not started.

TANGENTIAL BLOW HEATER

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

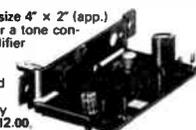
Please add post £1.50 for 1 or 3 for £20 post paid 2.5 Kw KIT Still available: £4.95 + £1.50 post or have 3 for £16 post paid.

CORDLESS TELEPHONES

"IT'S FOR YOU-OU" even if you are in the bath, its an infinite extension any room and even in the garden - have one on approval or come and try one here. BT approved. SOCKETS PLUS ETC for BT phones. Master socket (has surge arrester - ringing condenser etc) and takes B.T. plug £3.95 Extension socket £2.95 Dual adaptors (2 from one socket) £3.95 Cord terminating with B.T. plug 3 metres £2.95 Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 BT extension sockets £11.50

MINI MONO AMP

on p.c.b. size 4" x 2" (app.) Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.



J & N BULL ELECTRICAL

128 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 59L

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. A444 B/C card orders accepted day or night. Haywards Heath (0454) 454563. Bulk orders: phone for quote.

308. 1 T.V. turret tuner (black & white T.V.)
309. 12 adaptable legged knobs 1/2" spindle
310. 2 oven thermostats
311. 2 Clock needed relay
312. 1 pressure pad switch 24 x 18 (Trigger Mast)
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 tangle plug with moulded on lead

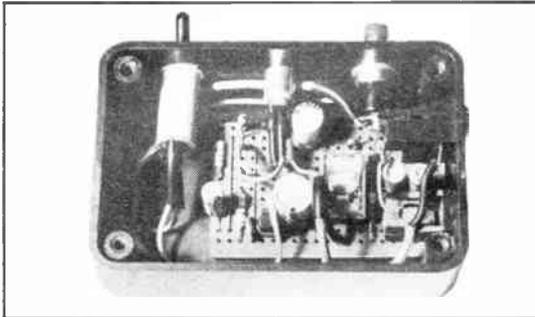
TWO POUNDERS*

- 2P1 - 24 hour time switch with 2 on/off, an ideal heating programmer
- 2P2 - Wall mounting thermostat, high precision with mercury switch and thermistor
- 2P3 - Variable and reversible 8-12v psu for model control
- 2P4 - 24 volt psu with separate channels for stereo made for Mullard UNILEX Amplifiers
- 2P5 - 100W mains to 115V auto-transformer with voltage tappings
- 2P6 - Mini key, 18 button membrane keyboard, list price over £12, as used on PRESTEL
- 2P6 - Mains motor with gear box and variable speed selector. Series wound so suitable for further speed control
- 2P9 - Time and set switch. Boxed, glass fronted and with knobs. Controls up to 15 amps. Ideal to program electric heaters
- 2P10 - 12 volt 5 amp mains transformer - low volt winding on separate bobbin and easy to remove to convert to lower voltages for higher currents
- 2P11 - Power amp module Mullard Unilex EP9000 (two stereo pre-amp module Unilex 9001 is BD218)
- 2P12 - Disk or Tape precision motor - has balanced rotor and is reversible 230v mains operated 1500 rpm
- 2P13 - Sun Lamp switch stays on for 1/2 hr or 1 hr depending on setting of grub screw
- 2P14 - Mug Stop kit - when thrown emits piercing squeak
- 2P15 - Interrupted Beam kit for burglar alarms, counters, etc.
- 2P17 - 2 rev pr minute mains driven motor with gear box, ideal to operate mirror ball
- 2P18 - Liquid/gas shut off valve mains solenoid operated
- 2P19 - Discs switched motor drives 8 or more 10 amp change over micro switches supplied ready for mains operation st
- 2P20 - 20 metres extension lead, 2 cores - ideal most Black and Decker garden tools etc.
- 2P21 - 10 watt amplifier, Mullard module reference 1173
- 2P22 - Motor driven switch 20 secs on or off after push
- 2P24 - Clockwork operated 12 hour switch 15A 250V with clutch
- 2P26 - Counter resettable mains operated 3 digit
- 2P27 - Goodmans Speaker 8 inch round Bohm 12 watt
- 2P28 - Drill Pump - always useful couples to any mains portable drill
- 2P29 - 24 position Yasky switch contacts rated 5A - 1/2 spindle
- 2P31 - 4 metres 98 way interconnecting wires easy to strip
- 2P32 - Hot Wire amp motor - 4 1/2 round surface mounting - old but working and definitely a bit of history
- 2P34 - Solenoid Air Valve mains operated
- 2P35 - Battery charger kit comprising mains transformer, full wave rectifier and meter, suitable for charging 6v or 12v
- 2P36 - 20 Amp meter, with shunt unused but ex-equipment
- 2P38 - 200 R.P.M. Geared Mains Motor 1" stack quite powerful, definitely large enough to drive a rotating aerial or a tumbler for polishing stones etc.
- 2P41 - Liquid crystal display, 8 digit 13mm black on silver.
- 2P42 - Tubular heater, 60 watts per ft, unassisted but slightly stronger sealed, made by E.C. Perfect order (must be collected by appointment as 12hr lang)
- 2P43 - Small type blower or extractor fan, motor inset so very compact, 230V
- 2P44 - Inverter to operate 21" 13 watt fluorescent tube off 12 volts.
- 2P46 - Our famous drill control kit complete and with prepared case.
- 2P47 - Joy switch kit complete as previously sold.
- 2P48 - Telephone ringing unit reduces mains to 50 volts and changes frequency from 50 Hz to 25 Hz to give right ringing tone.
- 2P49 - Fire Alarm break glass switch in heavy cast case
- 2P51 - Stereo Headphone amplifier, with pre-amp
- 2P54 - 2 1/2 kw. blow heater section of coal or log effect fire, this is a sheet metal assembly which holds the elements, the motor with fan, and the lamp holders and bits which give the flickering flame effect. Collect or add £3 to cover p.p.
- 2P55 - Mains motor, extra powerful has 1 1/2" stack and good length of spindle both ends
- 2P62 - 1 pair Goodmans 15 ohm speakers for Unilex
- 2P63 - 1 5Kv 20 ma mains transformer
- 2P64 - 1 five bladed fan 6 1/2" with mains motor
- 2P65 - 2 resettable trips 4.5A mains
- 2P66 - 1 2Kw tangential heater 115v
- 2P67 - 1 12v-0-12v 2 amp mains transformer
- 2P68 - 1 15v-0-12v 2 amp mains transformer
- 2P69 - 1 250v-0-250v 60 mA 8 88.3v 5A mains transformer
- 2P70 - 1 E.M.I. tape motor two speed and reversible
- 2P71 - 1 PAPT 240 5 Hz motor
- 2P72 - 1 115v Muffin fan 4" x 4" approx.
- 2P74 - 1 pocket audio component tester
- 2P75 - 1 6 hour timer, plugs into 13A socket
- 2P77 - 1 auxid tweeter partner to SP26 speaker
- 2P78 - 1 instrument box with key size 12" x 4 1/2" wide 6" deep
- 2P81 - ORACLE VB100 instrument panel, is a MODEM with extras, it is the heart of many viewdata systems including the Prestal unit we recently stocked. It uses 25 I.C.s, 2 crystals, u.h.f. modifier Axtel UM1233 etc. etc. You receive this, new, unused and complete extra for 7 of the plug in I.C.s.

£5 POUNDERS*

1. 12 volt submersible pump complete with a tap which when brought over the basin switches on the pump and when pushed back switches off, an ideal caravan unit.
2. Sound to light kit complete in case suitable for up to 750 watts.
3. Silent sentinel ultra sonic transmitter and receive kit, complete.
4. Dial indicator, measures accurately down to 0.1mm. "John Bull" or equally first-class make, a must for toolmaker or lathe worker.
5. 250 watt isolating transformer to make your service bench safe, has voltage adj. taps, also as it has a 115V tapping it can be used to safely operate American or other 115V equipment which is often only insulated to 115V. Please add £3 postage if you can't collect as this is a heavy item.
6. 12V alarm bell with heavy 8" gong, suitable for outside if protected from direct rainfall. Ex GPO but in perfect order and guaranteed.
7. Tape chuck and matching tape reader, not new but believed in perfect working order if not so we would repair or replace within 12 months. Please add £2.50 postage.
8. Sensitive voltmeter relay, this consists of a 4 1/2" dia moving coil meter with electronics (we will supply cut. dig.) over £120 each, they are new and still in maker's boxes.
9. Box of 25 fluorescent tubes 40 watt daylight or warm white ideal window pelmets, signs, etc. Please collect or add £2 postage.
10. Box of 25 18" fluorescent tubes assorted colours, please collect or add £2 postage.
11. 24 x 8 ft 85-120 watt warm white tubes. Ideal plant growing. Collect or send open cheque to cover carriage.
12. Equipment cooling fan - minin anal type mains operated.
13. Ping pong ball blower - or for any job that requires a powerful stream of air - ex computer. Collect or add £21 post.
14. Unilex motor 380 degrees rotation, 5 poles, 60 ways, 50V coil.
15. Washing machine water pump, main motor driven so suitable for many applications.
16. Control panel case, conventional design with hinged front and finished metallic silver, easily arranged as lockable size approx. 15" x 10" x 5 1/2", wall mounting.
17. Two kits: matchbox size surveillance transmitter and 2 FM receivers.

ISSN 0262-3617

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

FREE! READERS' BUY & SELL SPOT
EE
MARKET PLACE
SEE PAGE 193

© Wimborne Publishing Ltd 1986. Copyright in all drawings, photographs and articles published in EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY is fully protected, and reproduction or imitations in whole or in part are expressly forbidden.

Projects

- STEREO REVERB** by R. A. Penfold 176
Stereo simulator, headphone enhancer or musical effects are possible with this simple design
- FRELOADER** by I. M. Rees 186
Simplifies program loading from cassette
- FET VOLTMETER** 196
by Michael Tooley BA & David Whitfield MA MSC CEng MIEE
Another essential piece of test gear from the Teach-In Series
- CIRCLE CHASER** by M. P. Horsey 202
Adaptable light effects unit
- STEPPER MOTOR DRIVER** 207
Low cost servo control using your Spectrum
- VERSATILE PSU UNIT** by M. P. Horsey 210
Regulated variable voltage from 1.2V to 15V and constant current output suitable for charging NiCad cells

Series

- TEACH-IN '86** 180
by Michael Tooley BA & David Whitfield MA MSc CEng MIEE
Part Seven: Op-Amps Investigated
- BBC MICRO** by R. A. Penfold & J. W. Penfold 192
New regular spot for Beeb fanatics
- AMATEUR RADIO** by Tony Smith G4FA 1
Meet the Club; Question Corner
- ACTUALLY DOING IT** by Robert Penfold 200
Making the right connection
- ON SPEC** by Michael Tooley BA 206
Reader's Sinclair Spectrum page

Features

- EDITORIAL** 175
- MAN BEHIND THE SYMBOL** by Morgan Bradshaw 188
Symbols, and the men they are named after, explained
- NEWS** 190
What's happening in the world of electronics
- MARKET PLACE** 193
Free readers' buy and sell spot
- NEW PRODUCTS** 201
Facts and photos of instruments, equipment and tools
- SHOPTALK** by David Barrington 208
Product news and component buying
- SPECIAL OFFER** 209
Riscomp Security Systems
- DOWN TO EARTH** by George Hylton 214
Ring modulators
- BOOK SERVICE** 215
A new readers' service for EE
- CIRCUIT EXCHANGE** 216
A forum for readers' ideas
- PRINTED CIRCUIT BOARD SERVICE** 218
- SUBSCRIPTIONS** 219
- FOR YOUR ENTERTAINMENT** by Barry Fox 220
Computer Problems; After-Sales Service; Rental

Our May 1986 issue will be published on Friday, 18 April.
See page 189 for details.

For KITS & COMPONENTS
Choose the easy way - with

Send SAE now
for our FREE CATALOGUE
or ring: 01-567 8910 for
the keenest prices on -

CMOS	TRANSFORMERS	BOOKS
TTL	CONNECTORS	TOOLS
OPTO	MICROPROCESSORS	BOXES
TRIACS	HEATSINKS	RELAYS
NICADS	MULTIMETERS	SWITCHES

AND LOTS LOTS MORE
 We also STOCK ANTEX SOLDERING IRONS & VERO PRODUCTS, a wide range of VELLEMAN and PANTEC KITS. PLUS over 30 KITS for Timers, Remote Control, Disco Lights, Temperature Control, etc.

XK 113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio.

Size: 5.5 x 2.7 x 2cms. Requires PP3 9V battery.

IDEAL FOR BEGINNERS £5.50

XK 102 3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS £5.50

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 £14.95
- MK6 Transmitter for above £4.50
- TD300K Touchdimmer £7.75
- TS300K Touchswitch £7.75
- TDE/K Extension kit for 2-way switching for TD300K £2.50

DISCO LIGHTING KITS

DL1000K - This value-for-money 4-way chaser features bi-directional sequence and dimming. 1kW per channel. £15.95
 DL21000K - A lower cost uni-directional version of the above. Zero switching to reduce interference. £8.95
 Optional opto input allowing audio 'beat' / light response (DLA/1). 70p
 DL3000K - 3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. £12.95

ELECTRONIC LOCK KIT

With hundreds of uses indoors, garages, car anti-theft devices, electronic equipment, etc. Only the correct easily changed four-digit code will open it! Requires a 5V to 15V DC supply. Output 750mA. Fits into standard electrical wall box.

Complete kit (excl. front panel) £11.50
 XK101 Electric lock mechanism for use with existing door locks and the above kit. (Requires relay.) 12V AC/DC coil. (701 150). £14.95

24 HR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, LED's, triacs, PCB's and full instructions.
 CT 1000K Basic Kit £14.90
 CT 1000K with white box (56/131 x 71mm) £17.40

DVM/ULTRA SENSITIVE THERMOMETER KIT

Based on the ICL 7126 and a 3 1/2 digit liquid crystal display, this kit will form the basis of a digital multimeter (only a few additional resistors and switches are required - details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°. The kit has a sensitivity of 200mV for a full-scale reading, automatic polarity and overload indication. And a low power requirement giving a 10 year typical battery life from a standard 9V PP3. £15.50



ELECTRONICS
13 BOSTON RD
LONDON W7 3SJ

SEND 9"x6" S.A.E.
 OR CALL AT SHOP
 MON-FRI 9-5pm
 SATURDAY 10-4pm

ORDERING INFORMATION:
ALL PRICES EXCLUDE VAT

FREE P&P on orders over £20 (UK only), otherwise add 75p + VAT. Overseas P&P: Europe £2.75. Elsewhere £6.50. Send cheque/PO/Barclaycard/Access No. with order. Giro No. 529314002.

LOCAL AUTHORITY AND EXPORT ORDERS WELCOME
GOODS BY RETURN SUBJECT TO AVAILABILITY

AFFORDABLE ACCURACY
QUALITY MULTIMETERS FROM ARMON

ILLUSTRATED
 HC-5010
 £36.50 + VAT



A comprehensive range of Analogue and Pushbutton or (Rotary Switched) Digital Models

ANALOGUE

- HM-102BZ 10ADC Range, 20kΩ/VDC, Buzzer, Battery Test Scale £13.00
- 19 measuring ranges
- HM-102R Low end voltage & current ranges, Jack for Audio clip Voltages £11.00
- 20 measuring ranges
- HM-1015 Rugged, Pocked sized meter, for general purpose use £7.50
- 16 measuring ranges

Battery, Test Leads and Manual Included with each model.

DIGITAL

- HC-7030 0.1% Accuracy, Standard Model £39.50
 - HC-6010 0.25% Accuracy, Standard Model £33.50
 - HC-5010T 0.25% Accuracy, TR Test Facility £39.50
 - DM-105 0.5% Accuracy, Pocketable £21.50
- All models have full functions and ranges and feature:
- 3 1/2 digit 0.5" LCD display
 - Low battery indication
 - Auto zero & Auto polarity
 - ABS Plastic Casing
 - DC AC 10amp Range (not DM-105)
 - Overload Protection on all ranges.
 - Battery, Spare Fuse, Test Leads and Manual.



FULL DETAILS ON APPLICATION FROM:-

ARMON ELECTRONICS LTD

DEPT.S HERON HOUSE, 109 WEMBLEY HILL ROAD, WEMBLEY, MIDDLESEX HA9 8AG

TELEPHONE 01-902 4321 TELEX 923985

PLEASE ADD 15% to your order for VAT. P&P Free of charge. Payment by cheque with order

Trade enquiries invited Offer applicable to mainland UK only Please allow 28 days for delivery

Universal Semiconductor Devices Ltd.

17 GRANVILLE COURT, GRANVILLE ROAD, HORNSEY, LONDON N4 4EP, ENGLAND.
TEL. 01-348 9420/9425 * TLX. 25157 usdco g



WE OFFER ONE OF THE LARGEST RANGES OF SEMICONDUCTORS AT HIGHLY ECONOMICAL PRICES. THE FOLLOWING SEMICONDUCTOR TYPES ARE AVAILABLE FROM STOCK. IF WE DON'T STOCK WHAT YOU NEED THEN WE CAN GET IT FAST FROM OUR FACILITIES IN WEST GERMANY AND USA UPON REQUEST.

TRANSISTORS - BIPOLARS - GERMANIUM AND SILICON

- SMALL SIGNAL POWER
- DARLINGTONS - ALL SHAPES AND SIZES
- VHF/UHF DEVICES - ALL SHAPES AND SIZES

FETS - POWER MOSFETS UNIJUNCTIONS



DIODES - GERMANIUM AND SILICON RECTIFIERS AND BRIDGES OPTO-ELECTRONIC DEVICES LEDS OF ALL SHAPES AND SIZES



THYRISTORS AND TRIACS - ALL SHAPES



INTEGRATED CIRCUITS:

- CONSUMER - DIGITAL/ANALOGUE
- MICROPROCESSORS AND PERIPHERALS
- IC SOCKETS



JAPANESE COMPONENTS - VAST RANGE OF DISCRETES AND CONSUMER IC's.

MAIL ORDER CUSTOMERS: PLEASE SEND FOR OUR COMPREHENSIVE PRICE LIST, ENCLOSING 75 PENCE IN STAMPS, CHEQUE OR POSTAL ORDER. THIS SUM IS REFUNDABLE WITH A FIRST ORDER VALUE OF £5.00 OR MORE.

CATALOGUE SENT FREE OF CHARGE, WHEN REQUESTED ON OFFICIAL LETTERHEAD (WITHOUT REFUND), TO OEM'S, SCHOOLS, COLLEGES, UNIVERSITIES, GOVERNMENT INSTITUTIONS, COMPUTER FIRMS, ELECTRONIC REPAIR FIRMS AND DISTRIBUTORS.

SPECIAL DISCOUNTS AND PAYMENT TERMS ARE AVAILABLE TO ABOVE INSTITUTIONS.

PLEASE ENQUIRE FOR QUANTITY DISCOUNTS.

WE WELCOME TELEPHONE AND TELEX ENQUIRIES!



PE & EE PUBLISHED EFFECTS



MONO-STEREO ECHO-REVERB (P.E. Sept. '84) 200ms echo (extendable), lengthy reverb, multitracking. Kit as published. Set 218BK	£57.66
ENHANCED PHASER (P.E. Oct '84) Enhanced phasing with modulated filter shifting. Kit as published. Set 226BK	£42.36
RING MODULATOR (P.E. NOV. '84) Fabulous effects generation. With multiwaveform VCO, noise gate & ALC. Kit as published. Set 231BK	£45.58
MONO-STEREO CHORUS-FLANGER (P.E. Jan. '84) Superb dual mode music enhancement. Kit as published. Set 235BK	£59.99
CYBERVOX (E.E. Apr. '85) Amazing robot type voice unit, with ring modulator and reverb. Kits as published. Set 228BK	£44.76
STEREO NOISE GATE & VICA (P.E. May '85) Automatic noise reduction circuit for mono or stereo. Kit as published. Set 227BK	£26.61
SIGNAL GENERATOR & F-Y (P.E. Jan. '85) Audio test equipment. Multiwaveform VCO, & freq. to voltage converter & sweep gen. Kit as pub. Set 233	£46.96
SIMPLE REVERB (E.E. Oct '85) Super little lengthy reverb, mono. Set 232BK	£27.35
DISCO LIGHT CONTROLLER (P.E. Nov '85) 3 Chan sound to light, with chasers, auto level & computer interface (BBC, C64, Pet, etc.) Set 245FK	£62.50
MIXER - 4 Chan Stereo (P.E. Nov '85) Separate input gain, level pan, filters, echo send, PFL. Voltage controlled. Set 229SBK	£89.95
MIXER - 4 Chan Mono (P.E. Nov '85) Separate input gain, level, filter, twin output. Voltage controlled. Set 229MBK	£49.95

OTHER SUPER SOUND KITS

BLOW BOX: Voice operated VCF & VCA for fascinating effects	SET 214 BK	£29.33
COMPANDER: Mono or stereo compression-expansion, switchable	SET 238 BK	£22.99
ENVELOPE SHAPER: Note triggered ADRS with VCA	SET 98 BK	£25.20
FREQUENCY DOUBLER: Guitar octave raiser & tone changer	SET 96 BK	£15.30
FUZZ: Smooth distortion, retains attack & decay character	SET 209F BK	£19.58
GUITAR SUSTAIN: Extends note decay time, with noise gate	SET 222 BK	£25.31
GUITAR TO SYNTH INTERFACE: With voltage & trigger outputs	SET 173 BK	£41.41
HAND CLAPPER: Auto & manual variable clap effects	SET 197 BK	£26.69
MOCK STEREO: Splits mono signal into stereo simulation	SET 213 BK	£24.37
MUSIC MODULO: 8 variable tremolo & wah guitar effects	SET 196 BK	£23.56
RHYTHM GENERATOR: Computer driven, BBC, Apple, 64 & similar	SET 185 BK	£34.64
STORM EFFECTS: Auto & manual wind, rain & surf effects	SET 154 BK	£23.60
TOM-TOM SYNTH: Sound triggered, multivariable drum effects	SET 190 BK	£19.37
TREMOLO: Mono variable depth & rate modulation	SET 136 BK	£15.62
VOCODAVOX: Modular vocoder, 7 chans extendable	SET 152 BK	£79.95
VODALEK: Simple robot type voice modulator	SET 155 BK	£18.31
WAH-WAH: Auto, manual & note triggered, switchable	SET 140 BK	£24.36

Boxes are black steel & aluminium. All kits include PCBs, parts, instructions, boxes, wire, solder. For catalogue of over 70 kits send 9 x 4 SAE. (For overseas catalogue send £1 or 5 IRC-s). Mail Order. Payment to Phonosonics, CWO, CHQ, PO. Access: Visa. Insurance cover 50p per £50 (obligatory on credit card orders). Details correct at press. E&OE.

Add 15% VAT. Add P&P £1.50 each kit. (Overseas Rates in Catalogue).

BECKER-PHONOSONICS, DEPT. EE64,
8 FINUCANE DRIVE, ORPINGTON, KENT BR5 4EO.
TEL: ORPINGTON 37821 (STD 0689, LONDON 66).

TEACH-IN '86

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

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

or separately: M102B2 **£14.95**; Verobloc etc. **£6.21**; croc clip leads **£1.97.**

EXTRA COMPONENTS required for parts 1 and 2	£1.50
EXTRA COMPONENTS required for parts 3 and 4	£3.60
EXTRA COMPONENTS required for parts 5 and 6	£4.95
EXTRA COMPONENTS required for parts 7 and 8	£1.90
PSU – EE Special Offer mains adaptor	£4.95
REGULATOR UNIT: All parts including case, also in-line fuseholder, fuse and 2mm plugs for PSU	£16.95
LCR BRIDGE: All parts including case	£23.95
DIODE/TRANSISTOR CHECKER: All parts inc. case	£15.95
AUDIO SIGNAL TRACER: All parts inc. case	£11.95
AUDIO SIGNAL GENERATOR	£19.50
RF SIGNAL GENERATOR	£19.95
FET VOLTMETER	£19.40

1986 CATALOGUE BOING . . . BOING . . . BOING

Spring supplement to now 16 pages of bargains FREE
Big 64 page catalogue packed with thousands of items from humble resistors to complex disco mixers, 8 page Bargain List & order form included, also Bulk Buyers List & £1.20 discount vouchers. All this for just £1.00 inc. post.

BUGGY KIT

Make your own computer controlled buggy – very simple circuit, an ideal introduction into the world of robotics. Uses our very popular motorized gearbox. All parts inc. gearbox and wheels, connectors, wires etc.

Spectrum/ZX81	£13.95
C64/IC20	£11.95
BBC/Electron	£12.95
Amstrad	£12.95

Full instructions and circuit + program listing supplied free with kit, or 50p separately.

AMP/PRE-AMP PANELS

Z974 Mixer Amp Panel 115x115mm. 1 watt output from TBA820M chip. 2 inputs (1 via pre-amp) from phono sockets and separate volume controls. A third pot is used to fade from one input to the other. There are also 2x4p3w rotary switches. All pots and switches have black knobs. Attached to the main panel by flying leads is a socket panel with the 2 phono i/p sockets, 2x5 pin DIN sockets and a 2 pin DIN speaker socket. Also on the panel are 2x3.5mm monitor sockets. Data sheet supplied. Very good value at just **£2.50**

Z914 Audio amp panel 95x65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol. control. Just connect batt. and speaker. Full details supplied. **£1.50**

Z915 Stereo version of above 115x65mm featuring 2xTBA820M and dual vol. control. **£3.50**

AM Tuner Panel

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

Radio Kit

Z900 Radio Kit utilizing the AM Tuner and the mono amp panel. An inexpensive radio can be easily constructed using a V216 case & A301 speaker. Total cost of all parts including knobs etc. **£4.95**

THIS MONTHS PROJECTS RING FOR PRICES!



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

BUZZERS

Piezo ceramic sounders by STC offered 1/2 original price. Up to 115dB output. SAE full list and spec (B/L 23).
Z101 – Type U535, 40mm sq. 12V 75dB **£2.15**
Z102 – Type U350, 60mm sq. 12V 80dB **£3.25**
Z105 – Type U150, 80x60mm continuous or long pulsed tone 12V 85dB **£4.50**
Z107 – Type U250 60mm dia x 33mm cont. short or long pulsed tone 12V 85dB **£4.95**
Z113 – Type RHA101 175x150x150mm 2 diff tone outputs 12V 110dB **£14.35**
Z117 – Type RHA104 147x203x232 warble tone 12V 115dB **£23.25**
(All above also available in 24V).

99p BOOKS – see SPECIAL READER OFFER PAGE 191

PACKS! – PACKS! – PACKS!

K539 Led Pack – not only round but many shaped leds in this pack in red, yellow, green, orange and clear. Fantastic mix. 100 **£5.95** 250 **£13.50**
K517 Transistor Pack – 50 assorted full spec. marked plastic devices PNP NPN RF AF. Type numbers include BC114 117 172 182 183 198 239 251 214 255 320 BF198 255 394 2N3904 etc., etc. Retail cost £7 + Special low price **£2.75**

K518 200 Disc Ceramic Caps – Big variety of values and voltages from a few pF to 2.2uF; 3V to 3kV **£1.00**

K520 Switch Pack – 20 different assorted switches – rocker, slide, push, rotary, toggle, micro etc. Amazing value at only **£2.00**

K503 100 Wirewound Resistors – From 1W to 12W, with a good range of values **£2.00**

"SENSING & CONTROL PROJECTS FOR THE BBC MICRO"

Have you ever wondered what all those plugs and sockets on the back of the BBC micro are for? This book assumes no previous electronic knowledge and no soldering is required, but guides the reader (pupil or teacher) from basic connections of the user sockets, to quite complex projects. The author, an experienced teacher in this field, has provided lots of practical experiments, with ideas on how to follow up the basic principles. A complete kit of parts for all the experiments is also available. Book, 245x185mm 120pp **£5.95** Kit **£29.95.**

CRICKLEWOOD ELECTRONICS LTD



It's no secret!

... that there is a real difference at Cricklewood Electronics.

That's why you should never be without the **FREE CRICKLEWOOD ELECTRONICS COMPONENTS CATALOGUE**, for sheer variety, *competitive prices* and *service* from the U.K.'s number one 100% component shop. No gimmicks, no gadgets or computers, just components, millions of them, all easily available by mail order, calling or credit card telephone orders. Just pick up the phone (or a pen) to get your **FREE** copy now (no S.A.E. required). You have nothing to lose.

CRICKLEWOOD ELECTRONICS LTD.

40 Cricklewood Broadway NW2 3ET
01-450 0995 & 01-452 0161

ALL MAJOR CREDIT CARDS ACCEPTED

Telex 914977

Phone or write today

BI-PAK BARGAINS

VALUE PACKS

Pak No	Qty	Description	Price
VP1	300	Assorted Resistors Mixed Types	£1.00
VP2	300	Carbon Resistors 1/4-1/2 Watt Pre-Formed	£1.00
VP3	200	1/8 Watt Min Carbon Resistors Mixed	£1.00
VP4	200	1/2-1 Watt Resistors Mixed	£1.00
VP5	200	Assorted Capacitors All Types	£1.00
VP6	200	Ceramic Caps. Miniature - Mixed	£1.00
VP7	100	Mixed Ceramic Disc 1pf-50pf	£1.00
VP8	100	Mixed Ceramic Disc. 50pf-0.15pf	£1.00
VP9	100	Assorted Polyester/Polystyrene Caps.	£1.00
VP10	60	C280 Caps. Metal Foil Mixed	£1.00
VP11	50	Electrolytics - All Sorts	£1.00
VP12	40	Electrolytics 47mf-150mf Mixed Vts	£1.00
VP13	30	Electrolytics 150mf-1000mf Mixed Vts	£1.00
VP14	50	Silver Mica Caps. Mixed Values	£1.00
VP15	25	01/250v Min Layer Metal Caps.	£1.00
VP16	50	Wirewound Res. Mixed Wand Values	£1.00
VP17	50	Metres PVC Single Strand Wire Mixed Cols	£1.00
VP18	30	Metres PVC Multi Strand Wire Mixed Cols	£1.00
VP19	40	Metres PVC Single/Multi Strand Wire	£1.00
VP20	6	Rocker Switches 2x 240V	£1.00
VP21	10	Assorted Switches Slider/Push Etc	£1.00
VP22	200	Sq Inches Total Copper Clad Board	£1.00
VP23	10	40mm Slider Pots. 100K Lin	£1.00
VP24	10	125" Clear Showing Red LED's	£1.00
VP25	10	Mixed Shape and Colours LED's	£1.00
VP26	15	Small 125" Red LED's	£1.00
VP27	15	Large 2" Red LED's	£1.00
VP28	10	Rectangular 2" Red LED's	£1.00
VP29	30	Asst Vits Zeners 250mw-2w	£1.00
VP30	10	Asst Volts 10w Zeners Coded	£1.00
VP31	10	5a SCR's T066 50-400v Coded	£1.00
VP32	20	3a SCR's T066 Up to 400v Uncoded	£1.00
VP33	200	Sil. Diodes Like IN4148	£1.00
VP34	200	Sil. Diodes Like 0A200/BAX13/16	£1.00
VP35	50	1a IN4000 Diodes All Good Uncoded	£1.00
VP36	100	Sq Inches Total Copper Fibreglass Board	£1.00
VP37	8	Black Pointer Knobs 1/4w Std	£1.00
VP38	100	Sil. Trans NPN Plastic Coded Data	£1.00
VP39	100	Sil. Trans PNP Plastic Coded Data	£1.00
VP40	40	TTL I.C.s All New Gates - Flip Flop - MSI Data	£1.00
VP41	40	CMDS I.C.s All New Inc Data	£1.00
VP42	10	Black Heatsinks Fit T0-3 T0-220 Drilled	£1.00
VP43	4	Power-Fin Heatsinks 2 x T0-3 2 x T0-66	£1.00
VP44	15	Asst Heatsinks T0-1 3-5 18-220	£1.00
VP45	50	BC107/8 NPN Transistors Good Uncoded	£1.00
VP46	50	BC177/8 PNP Transistors Good Uncoded	£1.00
VP47	10	Sil Power Trans. Similar 2N3055 Uncoded	£1.00

Pak No	Qty	Description	Price
VP48	5	Pairs NPN/PNP Plastic Power Trans. Data 4a	£1.00
VP49	30	Asst Sil. Rects. 1a-10a Mixed Vits	£1.00
VP50	60	NPN Sil. Switching Trans T0-18 - T0-92	£1.00
VP51	60	PNP Sil. Switching Trans T0-18 - T0-92	£1.00
VP52	25	Asst Audio Plugs Phono-Din-Jack Etc	£1.50
VP53	25	Asst Audio Sks Phono-Din-Jack Etc	£1.50
VP54	20	Asst I.C. Dtl Sks 8-40 Pin	£2.50
VP55	10	I.C.s 4116 Memory's	£2.00
VP56	100	Semiconductors From Around the World	£4.00
VP57	25	Dp'to Special Pack. Assorted	£5.00
VP58	10	Hybrid LED Colour Displays	£4.00
VP59	20	Asst. I.C.s Coded, Linear, Etc	£2.00
VP60	100	All Sorts Transistors NPN/PNP	£1.00
VP150	20	BC183B Sil. Trans. NPN 30v 200mA Hfe240+	T092 £1.00
VP151	25	BC171B Sil. Trans. NPN 45v 100mA Hfe240+	T092 £1.00
VP152	15	TI890 Sil. Trans. NPN 40v 400mA Hfe100+	T092 £1.00
VP153	15	TI891 Sil. Trans. NPN 40v 400mA Hfe100+	T092 £1.00
VP154	15	MPSA56 Sil. Trans. PNP 80v 800mA Hfe50+	T092 £1.00
VP155	20	BF595 Sil. Trans. NPN Evtl. BF184 H.F.	T092 £1.00
VP156	20	BF495 Sil. Trans. NPN Evtl. BF173 H.F.	T092 £1.00
VP157	5	ZTX500 Series Sil. Trans. PNP Plastic	£1.00
VP158	15	ZTX107 Sil. Trans. NPN eqvl. BC107 Plastic	£1.00
VP159	15	ZTX108 Sil. Trans. NPN eqvl. BC108 Plastic	£1.00
VP160	20	ES024 Sil. Trans. NPN eqvl. BC214L	T092 £1.00
VP161	25	BC183L Sil. Trans. NPN 30v 200mA	T092 £1.00
VP166	10	BC478 eqvl. BCV71 PNP Sil. Trans.	T018 £1.00
VP169	10	BXS21 eqvl. BC394 NPN Sil. Trans. 80v 50mA	T018 £1.00
VP170	10	Assorted Power Trans. NPN/PNP Coded & Data	£1.00
VP171	10	BF355 NPN T0-39 Sil. Trans. eqvl. BF258 225v 100mA	£1.00
VP172	10	SM1502 PNP T039 Sil. Trans. 100v 100mA Hfe100+	£1.00
VP173	150	De-soldered Silicon Trans from boards all good	£1.00

LED DISPLAYS

VP130	6	RED 7 Seg. CC 14mm x 7.5mm RDP	FND353 £2.00
VP131	4	GREEN 7 Seg. CA. 6' LDP	XAN6520 £2.00
VP132	5	RED 7 Seg. CC 6' LDP	XAN6940 £2.00
VP133	6	RED Over-flow. 6' 3 x CA 3 x CC	6S3050 £2.00
VP134	5	GREEN Over-flow. 6' CA	XAN6530 £2.00
VP135	5	RED 7 Seg. CA. 3'	XAN3061 £2.00
VP136	3	DUAL RED 7 Seg. 5' CA DL527 DPR	£2.00
VP137	3	DUAL RED 7 Seg. 5' CA DL727 DPR	£2.00
VP138	20	Assorted LED Displays - Dur mix with Data	£5.00

CC = Common Cathode RDP = Right Hand Decimal Point
CA = Common Anode LDP = Left Hand Decimal Point

TECASBOTY '86

THE ELECTRONIC COMPONENTS AND SEMICONDUCTOR BARGAIN OF THE YEAR FOR 1986

A parcel of Components and Semiconductors for the hobbyist, bigger and better than ever before. Unbeatable value and Bi-Pak's money back guarantee if not completely satisfied. You get, in every parcel, a selection of the following: Resistors, Carbon and Wirewound of Assorted Values; Capacitors, all types, sorts and sizes, including Electrolytics; Potentiometers, Single and Dual, Slider and Pre-set; Switches; Fuses; Knobs; Heatsinks; Wire; PCB Board; Plugs; Sockets; Etc. Plus a selection of Semiconductors for every day use in popular Hobby Projects, including Transistors, Diodes, SCR's, rectifiers, Zeners and I.C.s. In all, we estimate the value of this parcel, based on current retail catalogues, to be well over £25. So help yourself to a great 1986 component surprise and order a box today. Only at Bi-Pak.

Ring now on our Hot Line

0763-48851

and order with your Barclaycard or Access Card for immediate delivery. Order No: VP86, or post with cheque or P.O.s for this TECASBOTY '86. JUST £8.00

BI-PAK PCB ETCHANT & DRILL KIT

Complete PCB Kit Comprises:

- 1 12v Mini Drill, 2 Twist Bits
- 1 Sheet PCB Transfers, 1 Etch Resist Pen
- 1/2 lb Pack Ferric Chloride Crystals
- 6 Sheets Copper Clad Board-Paper-Fibre Glass & Double Sided.

Full instructions for making your own PCB Boards.

Actual Retail Value £16.

OUR SPECIAL PRICE **£10.50 ONLY**
Order No: VP81

BI-PAK

Send your orders to Dept EE BI-PAK, PO BOX 6, WARE HERTS

TERMS CASH WITH ORDER. SAME DAY DESPATCH. ACCESS, BARCLAYCARD ALSO ACCEPTED. TEL 0763-48851. GIRO 388 7006
ADD 15% VAT AND £1.00 PER ORDER POSTAGE AND PACKING

Use your credit card. Ring us on 0763-48851 NOW and get your order even faster. Goods normally sent 2nd Class Mail.

Remember you must add VAT at 15% to your order. Total Postage add £1.00 per Total order.

You can depend on

ELECTROVALUE

for your supplies of world famous QUALITY COMPONENTS by

SIEMENS

and other leading names

52 PAGE FREE CATALOGUE
Write, phone or call
● Priced & illustrated
● Over 8000 items
● Real discounts
● Prompt despatch

- I.C.s
- semi conductors
- capacitors
- inductors
- ferrites
- connectors

ELECTROVALUE LTD 28 St. Jude's Road, Englefield Green, Egham, Surrey TW20 0HB Phone Egham (0784) 33603. Telex 264475
North Branch, 680 Burnage Lane, Manchester M19 1NA
Telephone 061 432 4945
Please mention this publication when replying

BRITAINS FOREMOST QUALITY COMPONENT SUPPLIERS

TEACH IN '86

BASIC ITEMS

- Regulator Unit Kit
- Universal Bridge Kit
- Diode/Transistor Tester Kit
- Audio Signal Tracer Kit
- Audio Signal Generator Kit
- R.F. Signal Generator Kit
- FET Voltmeter

- Project 1 **£23.70**
- Project 2 **£17.95**
- Project 3 **£20.50**
- Project 4 **£12.45**
- Project 5 **£ 9.80**
- Project 6 **£17.95**
- Project 7 **£21.00**
- Project 8 **£16.45**

Save 5%. Order any two of the above kits, deduct 5% from total price. Article reprint 60p if required.

Extra Components - Part 1 70p, Part 2 £1, Part 3 £1.45, Part 4 £2, Part 5 £1.90, Part 6 £6.85, Part 7 45p.

SPECIAL PRICE FOR LATE STARTERS - ALL ABOVE ITEMS £143 plus £2.50 P & P

EVERYDAY ELECTRONICS KITS

Graphic Equaliser	June '85	£22.50p
Across the River	June '85	£13.45p
Caravan PSU	June '85	£9.95p
Electronic Doorbell	July '85	£5.25p
High Z Multimeter (Exc. Case)	June '85	£26.35p
Continuity Tester	July '85	£8.35p
Train Signal Controller	July '85	£10.45p
Drill Control Unit (Exc. Case)	Aug. '85	£18.45p
Tremolo/Vibrator	Sept. '85	£31.00p
Fridge Alarm	Sept. '85	£7.45p
Caravan Alarm	Sept. '85	£15.00p
Strain Gauge Amplifier	Oct. '85	£24.95p
Dport	Jan. '86	£9.25p
Dne Chip Alarm	Jan. '86	£5.90p
Mains Delay Switch	Jan. '86	£17.85p

ELECTRONICS MONTHLY KITS

Visual Doorbell (PCB Version)	June '85	£14.60p
Footpedal Flanger	June '85	£22.85p
Heartbeat Monitor	July '85	£22.90p
Freezer Alarm	July '85	£6.95p
Sound Effects Box	July '85	£13.75p
Hi-Fi Intercom	Aug. '85	£22.90p
Hot Water Indicator (with ABS Box)	Aug. '85	£8.95p
Intelligent Windscreen Wiper	Aug. '85	£21.80p
AF Signal Generator	Sept. '85	£22.45p
Household Battery Checker	Sept. '85	£13.45p
Sinewave Generator	Sept. '85	£21.95p
Compressor/Sustain Pedal	Oct. '85	£19.95p

PRACTICAL WIRELESS KITS

FET Dip Oscillator	Oct. '85	£19.90p
Capacitance Meter	Oct. '85	£23.90p
Meon-50MHz Transverter (+£1.50p&p)	Oct. '85	£49.50p
Two Tone Oscillator	Dec. '85	£22.45p
Crystal Calibrator	Jan. '86	£19.95p
RTTY/Morse Modem	Jan. '86	£35.85p

TEACH IN COMPONENTS

Case-Black ABS-213x142x57mm	£2.75p	
Veroboard-36 stripsx50 holes	£1.35p	
Pot.Lin Carbon-1K, 4K7, 10K, 100K etc.	ea. 49.20p	
Pot.Lin Wirewound-1K etc.	ea. £2.20p	
Dual Pot.-5K etc.	ea. £1.45p	
Rotary Switches 2P6W, 3P4W, 4P3W, 1P12W etc.	65p	
SPST Toggle Switch	55p	
Push to Make Switch	23p	
BZY88 Series Zener-All Voltages	10p	
Jack Socket - Standard Switched	28p	
Test Leads - 10 Leads with Croc Clips	£1.80p	
Terminal Posts - Various Colours	ea. 45p	
4mm Sockets - Various Colours	ea. 18p	
4mm Plugs - Various Colours	ea. 18p	
1mm Sockets - Red or Black	ea. 17p	
1mm Plugs - Red or Black	ea. 17p	
Adhesive Feet - Per 4	32p	
Edgewise Meter	£4.35p	
Knob Black/Red Cap	18p	
T03 Heatsink	87p	
T05 Heatsink	15p	
BC10814p	IN4001 4p	7805 43p
BC10914p	IN4148 3p	555 24p
BC46162p	0A4712p	LM317K£2.85p
BFY5032p	0A913p	LM3808£1.10p
2N305339p	W00524p	TL084£1.05p
2N381942p		

ALL KITS COMPLETE (LESS BATTERIES) UNLESS SPECIFIED. INCLUDE ALL COMPONENTS, PCB (DR VERO), CASE AND HARDWARE. ALL COMPONENTS NEW AND FULL SPEC. DO NOT ADD V.A.T. ADD 70P P&P PER ORDER & SEND CHEQUES DR POSTAL ORDERS TO:

C.P.L. ELECTRONICS

8 Southdean Close, Hemlington, Middlesbrough, Cleveland TS8 9HE.

FREE PRICE LIST ON REQUEST

Rapid Electronics

Unit 3,
Hill Farm Industrial Estate
Boxted, Colchester
Essex CO4 5RD



Fast component distribution

Telephone orders: 0206 36412
Telex: 987756

LINEAR		ICM7555	55	LM336	85	ML924	290	SL486	240	TL084	80
555 CMOS	55	LF347	90	LM393	40	ML925	290	SL490	280	TL170	80
556 CMOS	180	LF353	70	LM393	45	ML926	275	SN78477	300	TL170	80
708	100	LF354	90	LM711	44	ML928	275	SP0258AL2	425	ULN2003	80
741	16	LM301A	30	LM725	270	ML929	275	Data on above	50	ULN2004	80
748	36	LM311	45	LM741	18	NE531	136	TBA810	65	XL2208	395
AY-3-8910	290	LM318	110	LM747	60	NE555	20	TBA820M	60	ZM4414	75
AY-3-8912	430	LM324	40	LM458	35	NE568	45	TCA940	65	ZM4223	100
CA3046	60	LM334Z	65	LM4217	170	NE585	95	TDA1022	270	ZM4242	70
CA3086	65	LM33Z	130	LM3809	65	NE586	95	TL061	40	ZM4256	340
CA3130E	75	LM359	40	LM3814	180	NE587	100	TL062	65	ZM4435E	360
CA3140E	38	LM348	60	LM3915	190	NE570	230	TL064	06	ZM4272E	580
CA3240E	100	LM358	40	LM13000	100	NE571	196	TL071	32	ZM4292E	435
ICL7106	680	LM377	210	MC3302	75	NE5532	180	TL072	55	ZM4435E	360
ICL7811	100	LM430	80	MC3340	130	NE5534	106	TL074	106	ZM4448E	825
ICL8038	395	LM381	130	MP10CN	330	RC4136	65	TL081	28	ZM459	190
ICL8211A	200	LM382	130	ML922	415	RC4558	45	TL082	45	ZM1034E	190

BREADBOARDS

Protobloc breadboards are extremely useful for quick construction of electronic circuits without soldering. All sockets are on a 2.54mm pitch enabling DIL circuits and a wide range of components to be plugged in to the board. The contact pattern contains two separate contact groups each of rows of 5 inter-connected contact sockets. Bus strips are provided for power use. All contact positions are clearly marked on an alphanumeric grid. Supplied complete with approx 20 layout sheets. Two sizes are available.



length	width	tie points	rows	max no pins devices	prices
80mm	60mm	390	29	3	396p
172mm	65mm	840	64	7	695p

CAPACITORS

Mini polyester 63V DC type 1u, 2u, 4u7, 10u, 22u, 5u, 47n, 100n, 5p, 220p, 5p, 470n, 15p. Electrolytic Radial head type 1u, 2u, 4u7 @ 63V DC, 100u, 22u @ 25V 5p, 47u 25V 7p, 100u 25V 8p, 220u 25V 13p, 470u 15V 14p, 1000u, 18V 20p, 1000u 25V 40p, 2200u, 18V 3p, 2200u 25V 42p.

Tantalum bead 0.1u, 0.47u, 1u @ 35V DC, 2u @ 25V 5p, 4u7 @ 25V 8p, 10u @ 25V 14p, 22u @ 16V 18p, 47u @ 16V 40p. Ceramic disc 50V 100p-100n 25V 5p.

TRANSISTORS

AC127	30	BC148	10	BC214L	10	BC131	40	MPF102	40	TP42A	45	2N2904A	28
AC128	30	BC169C	10	BC229	5	BC109	35	TP29A	35	TP121	60	2N2905A	28
AC176	25	BC171	10	BC327	6	BF244B	35	TP30A	35	TP122	60	2N2907A	24
AC187	25	BC176	16	BC328	6	BF180	35	TP30A	35	TP125	70	2N2907A	24
AC188	25	BC179	18	BC477	22	BF480	25	TP31C	40	VM446F	94	2N3054	55
BC107	10	BC182	10	BC478	22	BF485	30	TP32A	35	VM85AF	110	2N3055	50
BC107B	12	BC182L	10	BC479	22	BF488	30	TP32C	40	VM88AF	120	2N3070	9
BC108	10	BC184	10	BC513	10	BF517	35	TP33A	65	ZT1106	11	2N3070	10
BC108C	12	BC183L	10	BC547	5	BF515	28	TP33C	76	ZT3300	14	2N3070	10
BC109	10	BC184	10	BC548	5	BF522	27	TP34A	70	ZT3500	13	2N3070	10
BC109C	12	BC184L	10	BC549	10	BF519	60	TP34C	80	ZT3502	18	2N3073	196
BC140	20	BC212	10	BC557	6	BSY95A	30	TP35A	105	2N2221A	28	2N3819	32
BC141	30	BC212L	10	BC558	6	BU208	170	TP35C	125	2N2222A	28	2N3886	90
BC142	26	BC213	10	BCY70	16	MJE265	99	TP36A	118	2N2369	18	2N3904	10
BC143	30	BC213L	10	BCY71	16	MJE340	100	TP36C	130	2N2645	40	2N3906	60
BC147	10	BC214	10	BCY72	16	MJE3055	70	TP41A	45	2N2904	28	2N4587	30

RESISTORS

Carbon film 1/4-25+
1/4W 5% 4 70hm-10M 2p 1p
1/2W 5% 4 70hm-4M7 3p 2p
Metal film
1/4W 1% 100hm-1M 3p 3p
25p price applies to 25p per value.
SIL resistor networks
8 resistor 9 pin type 20p

COMPONENT KITS

Our component kits offer a considerable saving when buying a complete range of components, ideally suited for re-stocking etc.

0.25W Resistor kit. Contains 1000 0.25W 5% resistors from 47ohms thru to 10M. Quantities depend upon popularity i.e. 10x10, 30x470, 30x10K, 25x470K. Just £7.90 each.

Ceramic capacitor kit. Total of 240 miniature ceramic capacitors from 22pF thru to 0.1uF. Just £6.90 each.

Polyester capacitor kit. Total of 110 miniature polyester capacitors from 0.01u to 0.47uF. Just £6.90 each.

Radial electrolytic kit. Total of 83 miniature radial electrolytics from 10uF thru to 1000uF. Just £7.50 each.

Press kit. Total of 110 miniature horizontal mounting preforms from 100R thru to 1M. Just £6.90 each.

BRIDGE RECTIFIERS

1A 50V	20	2A 200V	40
1A 200V	25	2A 400V	65
1A 400V	30	8A 400V	85
1A 800V	30	8A 400V	85

CABLES

20 metre pack angle core connecting cable ten different colours 75p
Speaker cable 16p/m
Standard screened 16p/m
Twin screened 24p/m
3 core 2.54 mains cable 23p/m
Four core screened 35p/m

REGULATORS

78L05	30	LM338K	600
78L12	30	LM723	40
78L15	30	79L05	80
7805	40	79L12	50
7912	45	79L15	60
7915	45	7905	45
LM317K	230	7912	45
LM317T	80	7915	45
LM323K	420	78H05	550

RELAYS

Ultra-miniature SPDT relay rated 2A 6 or 12V 100
Ultra-miniature DPDT relay rated 2A 6 or 12V 100
Miniature relay SPDT rated 10A 6 or 12V 180
Miniature relay DPDT rated 5A 6 or 12V 180

OPTO

3 or 5mm red 8
3 or 5mm green 11
3 or 5mm yellow 11
3 or 5mm clips 3
5mm superbright 30 TL132 40
5mm incandescent 30 TL38 35
LD74 95 TL78 40
LD74 185 TL100 75
MOC3020 180 GPRI2 85

Seven segment displays
0.5in common anode or cathode 95
0.5in common anode or cathode 100
0.5in common anode or cathode 105
10 pin DIL LED array (20pin DIL) high efficiency rated 140

DIODES

BY127	12	1N4001	4	DIN	Plug	3x	Jack	Plug	Sat
0A47	10	1N4002	5	2 pin	8	2.5mm	10	9	
0A90	8	1N4006	7	3 pin	13	3.5mm	10	9	
0A91	7	1N5401	12	4 pin	14	2.5m	17	20	
0A200	6	1N5404	14	4 pin	10	14	Stereo	25	25
0A202	6	1N5406	15	4mm plugs and sockets red or black					
1N614	4	4000W zeners	5	Plugs 12				Sockets	12
1N614B	3	1.3W zeners	33	4mm terminals	36				

AUDIO CONNECTORS

ULN2003 80
ULN2004 80
ULN2005 80
ULN2006 80
ULN2007 80
ULN2008 80
ULN2009 80
ULN2010 80
ULN2011 80
ULN2012 80
ULN2013 80
ULN2014 80
ULN2015 80
ULN2016 80
ULN2017 80
ULN2018 80
ULN2019 80
ULN2020 80
ULN2021 80
ULN2022 80
ULN2023 80
ULN2024 80
ULN2025 80
ULN2026 80
ULN2027 80
ULN2028 80
ULN2029 80
ULN2030 80
ULN2031 80
ULN2032 80
ULN2033 80
ULN2034 80
ULN2035 80
ULN2036 80
ULN2037 80
ULN2038 80
ULN2039 80
ULN2040 80
ULN2041 80
ULN2042 80
ULN2043 80
ULN2044 80
ULN2045 80
ULN2046 80
ULN2047 80
ULN2048 80
ULN2049 80
ULN2050 80
ULN2051 80
ULN2052 80
ULN2053 80
ULN2054 80
ULN2055 80
ULN2056 80
ULN2057 80
ULN2058 80
ULN2059 80
ULN2060 80
ULN2061 80
ULN2062 80
ULN2063 80
ULN2064 80
ULN2065 80
ULN2066 80
ULN2067 80
ULN2068 80
ULN2069 80
ULN2070 80
ULN2071 80
ULN2072 80
ULN2073 80
ULN2074 80
ULN2075 80
ULN2076 80
ULN2077 80
ULN2078 80
ULN2079 80
ULN2080 80
ULN2081 80
ULN2082 80
ULN2083 80
ULN2084 80
ULN2085 80
ULN2086 80
ULN2087 80
ULN2088 80
ULN2089 80
ULN2090 80
ULN2091 80
ULN2092 80
ULN2093 80
ULN2094 80
ULN2095 80
ULN2096 80
ULN2097 80
ULN2098 80
ULN2099 80
ULN2100 80
ULN2101 80
ULN2102 80
ULN2103 80
ULN2104 80
ULN2105 80
ULN2106 80
ULN2107 80
ULN2108 80
ULN2109 80
ULN2110 80
ULN2111 80
ULN2112 80
ULN2113 80
ULN2114 80
ULN2115 80
ULN2116 80
ULN2117 80
ULN2118 80
ULN2119 80
ULN2120 80
ULN2121 80
ULN2122 80
ULN2123 80
ULN2124 80
ULN2125 80
ULN2126 80
ULN2127 80
ULN2128 80
ULN2129 80
ULN2130 80
ULN2131 80
ULN2132 80
ULN2133 80
ULN2134 80
ULN2135 80
ULN2136 80
ULN2137 80
ULN2138 80
ULN2139 80
ULN2140 80
ULN2141 80
ULN2142 80
ULN2143 80
ULN2144 80
ULN2145 80
ULN2146 80
ULN2147 80
ULN2148 80
ULN2149 80
ULN2150 80
ULN2151 80
ULN2152 80
ULN2153 80
ULN2154 80
ULN2155 80
ULN2156 80
ULN2157 80
ULN2158 80
ULN2159 80
ULN2160 80
ULN2161 80
ULN2162 80
ULN2163 80
ULN2164 80
ULN2165 80
ULN2166 80
ULN2167 80
ULN2168 80
ULN2169 80
ULN2170 80
ULN2171 80
ULN2172 80
ULN2173 80
ULN2174 80
ULN2175 80
ULN2176 80
ULN2177 80
ULN2178 80
ULN2179 80
ULN2180 80
ULN2181 80
ULN2182 80
ULN2183 80
ULN2184 80
ULN2185 80
ULN2186 80
ULN2187 80
ULN2188 80
ULN2189 80
ULN2190 80
ULN2191 80
ULN2192 80
ULN2193 80
ULN2194 80
ULN2195 80
ULN2196 80
ULN2197 80
ULN2198 80
ULN2199 80
ULN2200 80
ULN2201 80
ULN2202 80
ULN2203 80
ULN2204 80
ULN2205 80
ULN2206 80
ULN2207 80
ULN2208 80
ULN2209 80
ULN2210 80
ULN2211 80
ULN2212 80
ULN2213 80
ULN2214 80
ULN2215 80
ULN2216 80
ULN2217 80
ULN2218 80
ULN2219 80
ULN2220 80
ULN2221 80
ULN2222 80
ULN2223 80
ULN2224 80
ULN2225 80
ULN2226 80
ULN2227 80
ULN2228 80
ULN2229 80
ULN2230 80
ULN2231 80
ULN2232 80
ULN2233 80
ULN2234 80
ULN2235 80
ULN2236 80
ULN2237 80
ULN2238 80
ULN2239 80
ULN2240 80
ULN2241 80
ULN2242 80
ULN2243 80
ULN2244 80
ULN2245 80
ULN2246 80
ULN2247 80
ULN2248 80
ULN2249 80
ULN2250 80
ULN2251 80
ULN2252 80
ULN2253 80
ULN2254 80
ULN2255 80
ULN2256 80
ULN2257 80
ULN2258 80
ULN2259 80
ULN2260 80
ULN2261 80
ULN2262 80
ULN2263 80
ULN2264 80
ULN2265 80
ULN2266 80
ULN2267 80
ULN2268 80
ULN2269 80
ULN2270 80
ULN2271 80
ULN2272 80
ULN2273 80
ULN2274 80
ULN2275 80
ULN2276 80
ULN2277 80
ULN2278 80
ULN2279 80
ULN2280 80
ULN2281 80
ULN2282 80
ULN2283 80
ULN2284 80
ULN2285 80
ULN2286 80
ULN2287 80
ULN2288 80
ULN2289 80
ULN2290 80
ULN2291 80
ULN2292 80
ULN2293 80
ULN2294 80
ULN2295 80
ULN2296 80
ULN2297 80
ULN2298 80
ULN2299 80
ULN2300 80
ULN2301 80
ULN2302 80
ULN2303 80
ULN2304 80
ULN2305 80
ULN2306 80
ULN2307 80
ULN2308 80
ULN2309 80
ULN2310 80
ULN2311 80
ULN2312 80
ULN2313 80
ULN2314 80
ULN2315 80
ULN2316 80
ULN2317 80
ULN2318 80
ULN2319 80
ULN2320 80
ULN2321 80
ULN2322 80
ULN2323 80
ULN2324 80
ULN2325 80
ULN2326 80
ULN2327 80
ULN2328 80
ULN2329 80
ULN2330 80
ULN2331 80
ULN2332 80
ULN2333 80
ULN2334 80
ULN2335 80
ULN2336 80
ULN2337 80
ULN2338 80
ULN2339 80
ULN2340 80
ULN2341 80
ULN2342 80
ULN2343 80
ULN2344 80
ULN2345 80
ULN2346 80
ULN2347 80
ULN2348 80
ULN2349 80
ULN2350 80
ULN2351 80
ULN2352 80
ULN2353 80
ULN2354 80
ULN2355 80
ULN2356 80
ULN2357 80
ULN2358 80
ULN2359 80
ULN2360 80
ULN2361 80
ULN2362 80
ULN2363 80
ULN2364 80
ULN2365 80
ULN2366 80
ULN2367 80
ULN2368 8

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

THIS MONTH'S KITS SAE or 'phone for prices

BBC MIDI INTERFACE Mar 86	£25.34
INTERVAL TIMER Mar 86	£17.11
STEREO HI-FI PRE-AMP	£44.62
MAINS TESTER & FUSE FINDER Mar 86	£7.98
FUNCTION GENERATOR Feb 86	£22.53
POWER SUPPLY FOR ABOVE	£7.26
TOUCH CONTROLLER Feb 86	£11.67
pH TRANSDUCER (less Probe) Feb 86	£22.01
LIGHT EFFECTS/GAMES UNIT Feb 86	£10.37
SPECTRUM OUTPUT PORT Feb 86	£10.21
HEADLIGHT ONE SHOT Feb 86	£10.69
OPORT Jan 86	£6.80
TACHOMETER Jan 86	£23.40
MAIN DELAY SWITCH left case Jan 86	£17.93
ONE CHIP ALARM Jan 86	£7.90
MUSICAL OODOR BELL Jan 86	£16.98
TTL LOGIC PROBE Dec 85	£8.59
OPTICAL INTENSIFIER TRANSDUCERS Oct 85	£16.34
DIGITAL CAPACITANCE METER Dec 85	£35.98
DIODE/TRANSISTOR TESTER Dec 85	£15.98
UNIVERSAL LCR BRIDGE Nov 85	£23.49
FLUX DENSITY TRANSDUCER Nov 85	£28.15
FLASHING PUMPKIN less case Nov 85	£3.82
SQUEAKING BAT less case Nov 85	£8.63
SCREAMING MASK less case Nov 85	£9.98
STRAIN GAUGE AMPLIFIER Oct 85	£25.46
SIMPLE AUDIO GENERATOR Oct 85	£2.59
SOLOERING IRON POWER CONTROLLER Oct 85	£4.72
VOLTAGE REGULATOR Sept 85	£6.78
PERSONAL STEREO P.S.U. Sept 85	£8.99
R.I.A.A. PRE-AMP Sept 85	£14.49
CARAVAN ALARM Sept 85	£9.37
FRIDGE ALARM Sept 85	£6.82
SEMI-CONDUCTOR TEMP. SENSOR Sept 85	£18.93
RESISTANCE THERMOMETER Sept 85 Less Probe	£18.83
PLATINUM PROBE Extra	£22.00
LOW COST POWER SUPPLY UNIT Aug 85	£16.72
TRI-STATE THERMOMETER (Batt) Aug 85	£6.06
TREMOLO/VIBRATO Aug 85	£34.48
STEPPER MOTOR INTERFACE FOR THE BBC COMPUTER less case Aug 85	£13.99
1035 STEPPER MOTOR EXTRA	£14.50
OPTIONAL POWER SUPPLY PARTS	£4.67
EMERGENCY LIGHTS FLASHER less lamps July 85	£6.39
CONTINUITY TESTER July 85	£5.37
TRAIN SIGNAL CONTROLLER July 85	£8.78
AMSTRAO USER PORT July 85	£15.33
ACROSS THE RIVER June 85	£17.97
ELECTRONIC OODORBELL June 85	£6.55
COMPUTERISED SHUTTER TIMER June 85	£10.81
GRAPHIC EQUALISER June 85	£23.33
AMSTRAO CPC 464 May 85	£15.34
MAINS VERSION	£22.48
AUTO PHASE May 85	£16.39
INSULATION TESTER Apr 85	£16.96
LOAD SIMPLIFIER Feb 85	£16.98
SOLID STATE REVERB Feb 85	£39.98
GAMES TIMER Jan 85	£7.63
SPECTRUM AMPLIFIER Jan 85	£5.98
TV AERIAL PRE-AMP Dec 84	£12.36
Optional PSU 12V £2.03 240V £9.86	
MINI WORKSHOP POWER SUPPLY Dec 84	£434.98
OODOR CHIME Dec 84	£14.91
BBC MICRO AUDIO STORAGE SCOPE INTERFACE Nov 84	£28.77
PROXIMITY ALARM Nov 84	£17.98
MAINS CABLE DETECTOR Oct 84	£4.39
MICRO MEMORY SYNTHESIZER Oct 84	£47.98
DRILL SPEED CONTROLLER Oct 84	£6.89
GUITAR HEAD PHONE AMPLIFIER Sept 84	£6.38
SOUND OPERATED FLASH less lead Sept 84	£5.91
TEMPERATURE INTERFACE FOR BBC MICRO Aug 84	£19.70
CAR RADIO BOOSTER Aug 84	£13.67
CAR LIGHTS WARNING July 84	£7.99
VARICAP AM RADIO May 84	£10.43
EXPERIMENTAL POWER SUPPLY May 84	£18.72
SIMPLE LOOP BURGLAR ALARM May 84	£13.62
MASTERING TIMER May 84	£5.44
FUSE/DIODE CHECKER Apr 84	£3.45
QUASI STEREO ADAPTOR Apr 84	£10.80
DIGITAL MULTIMETER add on for BBC Micro Mar 84	£24.88
NI-CAO BATTERY CHARGER Mar 84	£9.85
REVERSING BLEEPER Mar 84	£6.78
PIPE FINDER Mar 84	£3.60
IONISER Feb 84	£23.98
ZX81 EPROM PROGRAMMER Feb 84	£14.48
SIGNAL TRACER Feb 84	£14.89
CAR LIGHT WARNING Feb 84	£3.76
GUITAR TUNER Jan 84	£17.73
BIOLOGICAL AMPLIFIER Jan 84	£18.16
CONTINUITY TESTER Dec 83	£9.99
CHILDREN'S DISCO LIGHTS Dec 83	£8.42
NOVEL EGG TIMER Dec 83 inc. case	£10.24
SPEECH SYNTHESIZER FOR THE BBC MICRO Nov 83 less cable + sockets	£21.98
MULTIMOD Nov 83	£16.98
LONG RANGE CAMERA/FLASHGUN TRIGGER Nov 83	£13.50
HOME INTERCOM less link wire Oct 83	£14.38
DIGITAL TO ANALOGUE BOARD Oct 83 less cable, case & connector	£19.98
HIGH POWER DAC DRIVER BOARD Oct 83 less case	£12.62
HIGH SPEED A TO D CONVERTER Sept 83 less cable & connector	£27.98
SIGNAL CONDITIONING AMP Sept 83 no case	£8.98
STORAGE SCOPE INTERFACE FOR BBC MICRO Aug 83 less software	£15.38
PEDESTRIAN CROSSING SIMULATION BOARD Aug 83 no case	£10.29
HIGH POWER INTERFACE BOARD Aug 83 no case	£10.38
USER PORT I/O BOARD less cable + plug	£10.49
USER PORT CONTROL BOARD July 83 less cable + plug + case	£25.14
GUITAR HEADPHONE AMPLIFIER May 83	£7.82
MW PERSONAL RADIO less case, May 83	£7.62
MOISTURE DETECTOR May 83	£5.48
CAR RADIO POWER BOOSTER April 83	£11.99
FUNCTION GENERATOR April 83	£45.98
FLANGER SOUND EFFECTS April 83	£24.17
NOVELTY EGG TIMER April 83 less case	£5.48
DUAL POWER SUPPLY March 83	£59.38
BUZZ OFF March 83	£4.61
PUSH BIKE ALARM Feb 83	£11.73
ZX TAPE CONTROL Nov 82	£7.13
CONTINUITY CHECKER Sept 82	£5.47
2-WAY INTERCOM July 82 no case	£4.52
ELECTRONIC PITCH PIPE July 82	£5.40
REFLEX TESTER July 82	£7.77
SEAT BELT REMINDER July 82	£4.10
EGG TIMER July 82	£5.44
CAR LEO VOLTMETER less case, May 82	£3.18
V.C.O. SOUND EFFECTS UNIT Apr 82	£12.71
CAMERA OR FLASH GUN TRIGGER Mar 82	£13.85
less tripod bushes	
POCKET TIMER Mar 82	£4.10
GUITAR TUNER Mar 82	£17.19
SIMPLE STABILISED POWER SUPPLY Jan 82	£26.98
MINI EGG TIMER Jan 82	£4.40
SIMPLE INFRA RED REMOTE CONTROL Nov 81	£18.70
CAPACITANCE METER Oct 81	£25.81
SUSTAIN UNIT Oct 81	£13.99
TAPE NOISE LIMITER Oct 81	£4.98
HEADS AND TAILS GAME Oct 81	£2.75
CONTINUITY TESTER Oct 81	£4.48
PHOTO FLASH SLAVE Oct 81	£3.80
FUZZ BOX Oct 81	£7.98
SOIL MOISTURE UNIT Oct 81	£6.39
0-12V POWER SUPPLY Sept 81	£19.48
COMBINATION LOCK July 81 less case	£21.58
SOIL MOISTURE INDICATOR E.E. May 81	£4.48
GUITAR HEADPHONE AMP E.E. May 81	£4.59
PHONE BELL REPEATER/BABY ALARM May 81	£5.15
INTERCOM April 81	£24.43
MODULATED TONE OODORBELL Mar 81	£7.35
2 NOTE OODOR CHIME Dec 80	£11.35
LIVE WIRE GAME Dec 80	£12.87
GUITAR PRACTICE AMPLIFIER Nov 80 £14.10 less case. Standard case extra	£4.99
SOUND TO LIGHT Nov 80 3 channel	£23.40
TRANSISTOR TESTER Nov 80	£12.80
AUDIO EFFECTS UNIT FOR WEIRO SOUNDS Oct 80	£14.40
IRON HEAT CONTROL Oct 80	£6.30
MICRO MUSIC BOX Feb 80	£17.86
Case extra	£3.80
SPRING LINE REVERB UNIT Jan 80	£27.20
UNISOBOO BURGLAR ALARM Dec 79	£6.70
DARKROOM TIMER July 79	£3.20
MICROCHIME OODORBELL Feb 79	£17.48
SOUND TO LIGHT Sept 78	£9.20
CAR BATTERY STATE INDICATOR LESS CASE Sept 78	£2.29
R.F. SIGNAL GENERATOR Sept 78	£31.20
IN SITU TRANSISTOR TESTER July 78	£7.60
WEIRO SOUND EFFECTS GENERATOR Mar 78	£6.20
Electronic Dice Mar 77	£4.96

TOOLS

ANTEX MODEL C IRON	£6.98
ANTEX X5 SOLDERING IRON 25W	£7.25
ST4 STAND FOR IRONS	£2.85
HEAT SINK TWEEZERS	45p
SOLDER HANDY SIZE 5	£1.39
SOLDER CARTON	£2.80
SOLDER REEL SIZE 10	£4.67
LOW COST PLIERS	£1.98
LOW COST CUTTERS	£1.99
BENT NOSE PLIERS	£1.99



MINI DRILL 12V (M01)	£8.38
MULTIMETER TYPE 1 10000ppv	£6.98
MULTIMETER TYPE 2 20,000ppv	£17.98
MULTIMETER TYPE 3 30,000ppv	£27.98
MULTIMETER TYPE 4 10M DIGITAL	£38.98
DESOLDER PUMP	£5.48
SIGNAL INJECTOR	£2.98
CIRCUIT TESTER	78p
HELPING HANDS JIG & MAGNIFIER	£7.98
MINIATURE VICE (PLASTIC)	£1.85



FUN WITH ELECTRONICS

Enjoyable introduction to electronics. Full of very clear full colour pictures and easy to follow text. Ideal for all beginners — children and adults. Only basic tools needed. 64 full colour pages cover all aspects — soldering — fault finding — components (identification and how they work). Also full details of how to build 6 projects — burglar alarm, radio, games, etc. Requires soldering — 4 pages clearly show you how.

COMPONENTS SUPPLIED ALLOW ALL PROJECTS TO BE BUILT AND KEPT. Supplied less batteries & cases. FUN WITH ELECTRONICS, COMPONENT PACK £16.98 BOOK EXTRA £1.76. Book available separately.

INTRODUCTION TO ELECTRONICS

An introduction to the basic principles of electronics. With lots of simple experiments. Uses soldering. Lots of full colour illustrations and simple explanations. A lovely book. Ideal for all ages.

INTRODUCTION TO ELECTRONICS COMPONENT PACK £8.99 BOOK EXTRA £2.45

Book also available separately.



BOOKS

A practical Introduction to Microprocessors. Penfold	£2.10
Basic Electronics. Hodder & Stoughton	£8.98
Beginners Guide to Building Electronic Projects. Penfold	£2.25
DIY Robotics & Sensors Billingsley. BBC Commodore 84	£7.95
Commodore 84	£7.99
Elementary Electronics. Steadlin	£5.98
Science Experiments with Your Computer	£2.43
How to Design & Make Your Own PCBs. BP121	£2.16
How to Make Computer Controlled Robots. Potter	£3.20
How to Make Computer Model Controllers. Potter	£3.19
Interfacing to Microprocessors & Microcomputers. Machine Code for Beginners. Usborne	£2.45
Micro Interfacing Circuits Book 1	£2.45
Microprocessors for Hobbyists. Coles	£4.98
Practical Computer Experiments. Parr	£1.95
Practical Things to Do with a Microcomputer. Usborne	£2.19
Questions & Answers — Electronics. Hickman	£3.45
Understanding the Micro. Usborne	£1.95

TEACH IN 86

MULTIMETER TYPE M102B2 as specified. Guaranteed. Top quality. 20kV, w/vr with battery check, continuity tester buzzer and fuse and diode protection. 10A dc range. Complete with leads, battery and manual. £13.98
VEROBLOC BREADBOARD, DESIGN PAD, MOUNTING PANEL AND 10 CROCODILE CLIP CONNECTING LEADS. £6.98
REGULATOR UNIT FOR SAFE POWER SUPPLY. All components including the specified case. Also the plugs, fuse and fusesolders to suit the EE mains adaptor. £16.78
COMPONENTS FOR PRACTICAL ASSIGNMENTS. Parts 1 and 2 (Oct & Nov) £1.94. Part 3 (Dec) £1.37. Part 4 (Jan) £2.48. Part 5 (Feb) £2.22. Part 6 (Mar) £5.31. Part 7 (April) 58p

All the above include VAT. P&P 60p. Plus FREE CATALOGUE with Teach in orders over £20.00.

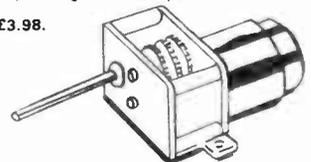
UNIVERSAL LCR BRIDGE Nov 85	£23.49
DIODE/TRANSISTOR TESTER Dec 85	£17.98
USEFUL AUDIO SIGNAL TRACER Jan 86	£15.95
AUDIO SIGNAL GENERATOR Feb 86	£24.96
R.F. SIGNAL GENERATOR March 86	£23.32

THIS MONTH'S PROJECT

FET VOLTMETER £20.46

MOTOR — GEARBOX ASSEMBLIES

Miniature precision made. Complete with quality electric motor. Variable reduction ratios achieved by fitting from 1-6 gearwheels (supplied) as required. Operates from 1.5V to 4.5V. Small unit type MGS speed range 3rpm-2200rpm depending on voltage & gear ratio. Large unit type MGL (higher torque motor) 2rpm-1150rpm. Long 3mm die output shafts. Ideal for robots and bugs. Small Unit (MGS) £3.49. Large Unit (MGL) £3.98.
Pulley wheels 3mm bore. Metal flange with brass hub. 10mm dia. £1.75. 20mm dia. £1.84. 30mm dia. £1.99.
Metal collar with fixing screw, 3mm bore 24p. Flexible spring coupling 5mm. Length 31mm 68p.
Flexible metal coupling (universal) 3mm £2.98.



CATALOGUE

FULLY REVISED CATALOGUE. Brief details of each kit, our books, & illustrations of our range of tools & components. Also step-by-step motor, interface kit & simple robotics. Plus circuit ideas for you to build. If you read Everyday Electronics then you need a copy of the MAGENTA catalogue.

CATALOGUE & PRICE LIST — Send £1 in stamps etc. or add £1 to your order. Price list — 9x4 size. Catalogue FREE TO SCHOOLS/COLLEGES REQUESTED ON OFFICIAL LETTERHEAD.

ADVENTURES WITH ELECTRONICS

An easy to follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-Dec Breadboard. Gives clear instructions with lots of pictures. 18 projects — including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-Dec breadboard and all the components for the projects. Adventures with Electronics £3.58. Component pack £2.98 less battery.

OUR PRICES INCLUDE VAT

MAGENTA ELECTRONICS LTD.

EE39, 135 HUNTER ST., BURTON-ON-TRENT, STAFFS, DE14 2ST. MAIL ORDER ONLY. 0283 66435, Mon-Fri 9-5. Access/Barclaycard (VISA) by phone or post. 24 hr Answerphone for credit card orders.

ADD 60P P&P TO ALL ORDERS. PRICES INCLUDE VAT. SAE ALL ENQUIRIES. OFFICIAL ORDERS WELCOME.

OVERSEAS: Payment must be sterling. PPSH REPUBLIC and DPO UK PRICES EUROPE. UK PRICES plus 10% ELSEWHERE: write for quote.



EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

VOL 15 No 4

APRIL '86

PLANNING FOR THE FUTURE

ONE of the items we take seriously is the planning of issues of EE. We plan our editorial content for each issue well in advance and try to make sure each issue has a well balanced content and that particular projects appear at the right time of the year. Just as an example we like to have at least one item of test gear in each issue since test gear projects are always well received, however through the summer months projects like portable radios or camping/car-avanning items are more popular and so we reduce the level of test gear in the mid-summer issues.

Such planning is based on our experience of readers' requirements and a "feel" for what might go down particularly well at any one time. We hope that we please most of the readers most of the time but please bear in mind that if you have a particular interest in one section of our hobby we may not be able to deal with it in every issue.

By the way please do not just ignore a certain project because, on the face of it, it has little relevance to your particular interest. Take for instance the *Stereo Reverb* in this issue; it would be very easy to think "I have no interest in playing or singing pop music, so this is not for me". Just take a closer look at the article and you will find a project that can be used as a stereo enhancer or quadraphonic synthesiser in addition to more straightforward musical effects. A similar situation occurs on other projects where a certain section of the circuit could easily be employed to meet your special requirements, maybe a simple timer could be adapted to control a particular item or process you have. While we try to give a full circuit description with each project, and this will help you to make minor modifications to meet your requirements, we are not able to advise on how to modify our projects.

The more you understand electronics the easier you will find it is, not only to modify circuits, but also to design your own projects. Follow *Teach In* or buy some books (see our book service) and get to grips with basic theory so you can understand how each circuit works. This month's *Teach In* is a good example of how a little knowledge can be very useful. It deals with the very popular 741 op-amp and is well worth reading even if you are not following the series.



BACK ISSUES & BINDERS

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

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

Editorial Offices
EVERYDAY ELECTRONICS EDITORIAL,
6 CHURCH STREET, WIMBORNE,
DORSET BH21 1JH
Phone: Wimborne (0202) 88 1749

We regret that lengthy technical enquiries cannot be answered over the telephone

Advertisement Offices
EVERYDAY ELECTRONICS ADVERTISEMENTS
4 NEASDEN AVE., CLACTON-ON-SEA, ESSEX
CO15 1SP. Clacton (0255) 436471

Editor MIKE KENWARD
Personal Assistant PAULINE MITCHELL
Assistant Editor/Production
DAVID BARRINGTON
Assistant Editor/Projects
DAVID BRUNSKILL
Editorial: WIMBORNE (0202) 88 1749
Advertisement Manager
PETER J. MEW Clacton (0255) 436471
Classified Advertisements
Wimborne (0202) 88 1749

READERS' ENQUIRIES

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

ADVERTISEMENTS

Although the proprietors and staff of EVERYDAY ELECTRONICS take reasonable precautions to protect the interests of readers by ensuring as far as practicable that advertisements are *bona fide*, the magazine and its Publishers cannot give any undertakings in respect of statements or claims made by advertisers, whether these advertisements are printed as part of the magazine, or are in the form of inserts.

The Publishers regret that under no circumstances will the magazine accept liability for non-receipt of goods ordered, or for late delivery, or for faults in manufacture. Legal remedies are available in respect of some of these circumstances, and readers who have complaints should address them to the advertiser or should consult a local trading standards office, or a Citizen's Advice Bureau, or their own solicitor.

COMPONENT SUPPLIES

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

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

OLD PROJECTS

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

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

SUBSCRIPTIONS

Annual subscription for delivery direct to any address in the UK: £13.00. Overseas: £15.00. Cheques should be made payable to Everyday Electronics and Electronics Monthly and sent to EE Subscription Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Subscriptions can only start with the next available issue. For back numbers see the note on the left.

STEREO REVERB

R.A.PENFOLD

Stereo simulator, headphone enhancer or quadraphonic synthesiser plus musical effects—all these applications from this simple design

PROBABLY most readers will be familiar with reverberation units which give the so called "big hall" sound to the processed signal. Although most people seem to think of reverberation devices solely as musical effects units, reverberation units, especially the stereo type, can in fact be used in other applications.

The stereo reverberation unit described here is a simple type which is built around a single springline, but despite its simplicity it has a creditable level of performance. Apart from use as a musical effects unit, the main applications for a unit of this type are as a stereo simulator, headphone enhancer, or quadraphonic synthesiser.

SYSTEM OPERATION

Before considering these applications it would probably be as well to consider the way in which the unit functions, and the block diagram of Fig. 1 helps in this respect.

The left and right hand channel input signals are combined in a mixer stage. The output of the mixer drives an equalisation amplifier, and this provides treble boost to counteract the rather bass heavy response of a springline unit. This eliminates the "boominess" that plagues many springline reverberation unit designs and gives a much more realistic effect.

The springline consists of two transducers mechanically linked by (usually) two springs. The input signal is fed to one transducer where the electrical signals are converted into corresponding sound waves. These travel along the springs to the second transducer where they are converted back to electrical signals again.

The sound waves travel down the springs considerably less than instantly as the springs are specifically designed to have characteristics that give a significant delay. The delay time is typically about 35ms, and in the case of the springline used in this design it is 25 to 35ms.

The springline does not give a straightforward delay as the soundwaves tend to be

reflected by the transducers, so that they travel backwards and forwards along the springs, gradually decaying to an insignificant level. The time taken for the signal to decay is normally between about 2 and 7 seconds, and is 2.5 to 3 seconds for the springline specified for this project.

This is the time taken for the output signal from the springline to decay by 60dB after the input signal has been cut off. In practice the reverberation signal may only be mixed into the main signal at a fairly low level, and the reverberation will then decay to an inaudible level in substantially less than 2.5 to 3 seconds.

This system of delayed and reflected sounds gives a good analogy to sounds being bounced around the walls and ceiling of a large hall, and produces an effect which

APPLICATIONS

Obviously the unit can be used as a mono reverberation effects unit by using just one channel, and although only a single springline is incorporated in the circuit it can still be used as a stereo reverberation effects unit by using both channels. The reverberation content on each output signal is the same, but as the reverberation signals are out-of-phase they do not produce a strong central stereo image.

Instead the reverberation signal tends to spread out across the sound stage, and this gives quite a good effect. There is, in fact, little to be gained by using a separate springline for each channel, bearing in mind that with the real reverberation, sounds produced at various points in the hall tend

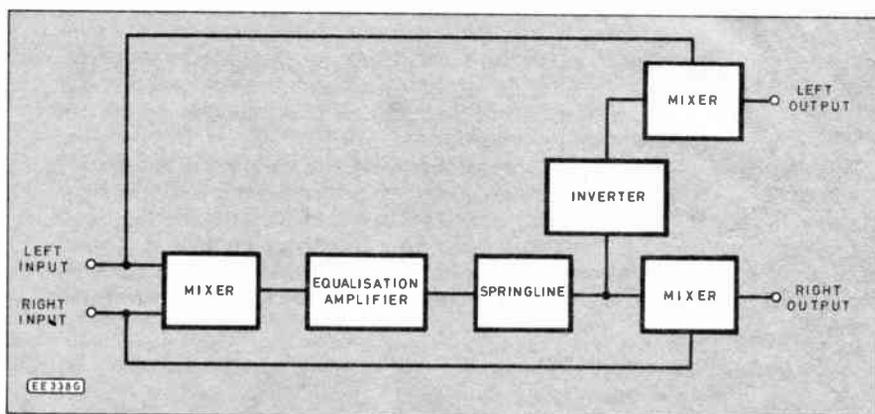


Fig. 1. Block diagram of the Stereo Reverb.

closely resembles the real reverberation that is generated by this process.

Some of the output from the springline is fed to a mixer where it is combined with the right hand channel input signal. The output from the springline is not very large as there are inevitably substantial losses through the unit, but the mixer circuit is designed to provide amplification that boosts the reverberation signal to a suitable level. A variable attenuator enables the strength of the reverberation signal to be varied from zero up to a maximum level that is almost equal to the main signal.

The left hand channel is treated in a similar manner to the right hand one, but the output from the springline unit is inverted prior to being mixed with the left hand input signal. The unit therefore provides an output signal that consists of the two stereo input signals, plus a controlled amount of reverberation signal that appears out-of-phase at the two outputs.

to bounce around the walls and ceiling, merging into a hubbub that has no single point of origin.

A unit of this type can be very effective in an audio system to give a synthesised quadraphonic effect. The front channels are merely the ordinary stereo channels, and these are processed by the reverberation unit to generate the rear channel signals. In this application a fairly high reverberation level is likely to give the best results.

The obvious drawback with any system of this type is that an extra amplifier and set of loudspeakers are required, and could be quite costly. On the other hand, when upgrading the amplifier and loudspeakers of a system it is well worthwhile retaining the old units and trying them as the rear channels in a four channel set-up. Results can be quite spectacular with many programme sources.

When used as a stereo simulator the input signal is applied to both inputs of the

reverberation unit, and the two outputs of the unit provide a form of pseudo stereo signal. The main signal appears in-phase at both outputs and consequently gives a strong central stereo image. The reverberation signal is out-of-phase at the outputs and therefore tends to spread out across the sound stage, giving a better spatial effect. In this application it is usually best to opt for only a modest amount of reverberation signal on the output.

A problem that occurs when using stereo headphones with a normal stereo signal is that the sound stage tends to extend from one ear to the other, through the listener's

overall frequency response from springline circuitry, but is merely intended to overcome the excessive low frequency response and to give a subjectively much improved effect from the unit.

The drive level applied to the springline has to be something of a compromise. The input transducer is capable of handling power levels of up to a few hundred milliwatts, and it is actually a low impedance electromagnetic type which provides a load that is similar to a loudspeaker.

A small power amplifier is therefore the obvious choice as the driver circuit, but in practice driving the input transducer at

springline. Resistor R9 prevents the springline's input transducer from excessively loading the output stage of IC1b.

The level control VR1 controls the reverberation level for both channels. IC2 mixes the reverberation signal with the right hand channel input, and this is another summing mode mixer circuit.

Resistors R11 and R12 have been made equal in value so that there is unity voltage gain from the right hand input to the right hand output. Resistor R10 has been given a relatively low value so that the output from VR1 is boosted by a little over 20dB to compensate for losses in the springline.

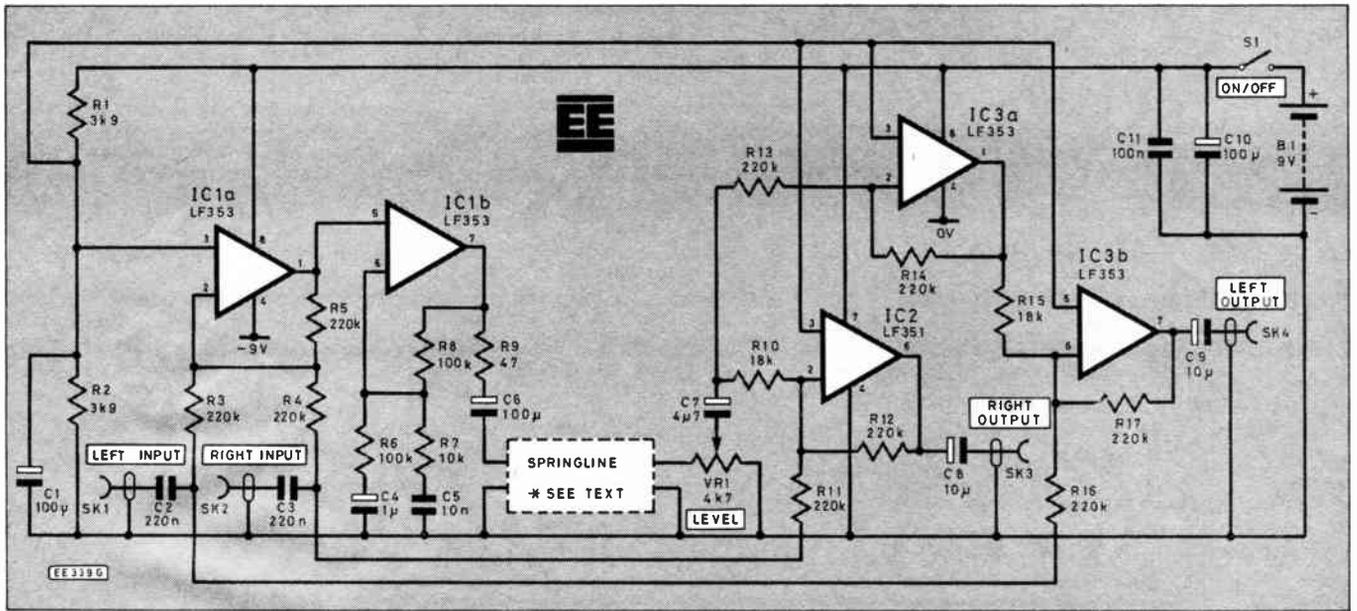


Fig. 2. Full circuit diagram of the Stereo Springline Reverberation Unit.

head. This obviously gives an unrealistic effect, and one that some people find positively unpleasant.

By processing the stereo signal using a reverberation unit greater ambience and a more spatial effect is obtained, with the reverberation signal seeming to emanate from outside the normal and congested stereo sound stage. This can be quite effective but, again, it is advisable to use only a moderate amount of reverberation signal.

CIRCUIT DESCRIPTION

The full circuit diagram of the Stereo Reverberation Unit appears in Fig. 2.

IC1a acts as the input mixer stage, and this is a conventional operational amplifier summing mode mixer circuit. The circuit is powered from a single 9V supply rail, rather than the normal (for operational amplifier circuits) dual balanced supplies.

However, R1, R2 and C1 provide a centre tapping on the supply which effectively gives dual balanced 4.5V supplies. All the stages in the circuit are based on operational amplifiers and they all make use of the centre tap on the supply lines for biasing purposes.

The equalisation amplifier uses IC1b in the non-inverting mode. R6 and R8 set the voltage gain of this amplifier at 6dB (two times), but at high frequencies C5 and R7 provide a boost in gain of up to about 20dB (ten times). It must be emphasised that this is not designed to give a perfectly flat

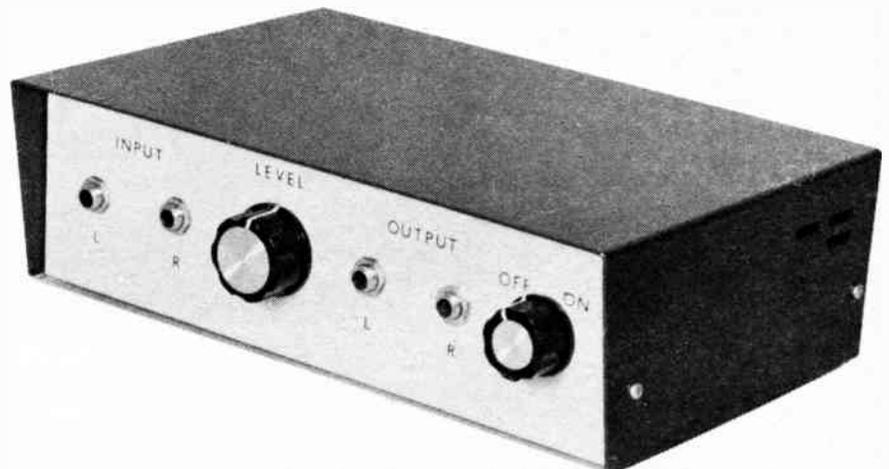
something approaching its maximum power level seems to provide relatively poor audio quality. A low drive level gives a much better quality output signal, but one which is at a very low level.

This necessitates the use of a high level of amplification at the output of the springline, and increases the likelihood of problems with vibration producing unwanted output signals. The risk of problems with acoustic feedback is also increased.

In this circuit a medium drive level is used, with IC1b being used to drive the

The inverter stage, IC3a, is a simple unity voltage gain inverting mode amplifier. The inverted signal is mixed with the left hand channel input signal by IC3b. As for the right hand channel, the main signal receives unity voltage gain, but the reverberation signal is boosted by over 20dB.

As the circuit has a current consumption of only about 8 milliamps it can be powered from a small (PP3 size) 9V battery. However, if it is likely to be used a great deal it would probably be more economic to use a larger battery such as a PP7 or PP9 size.



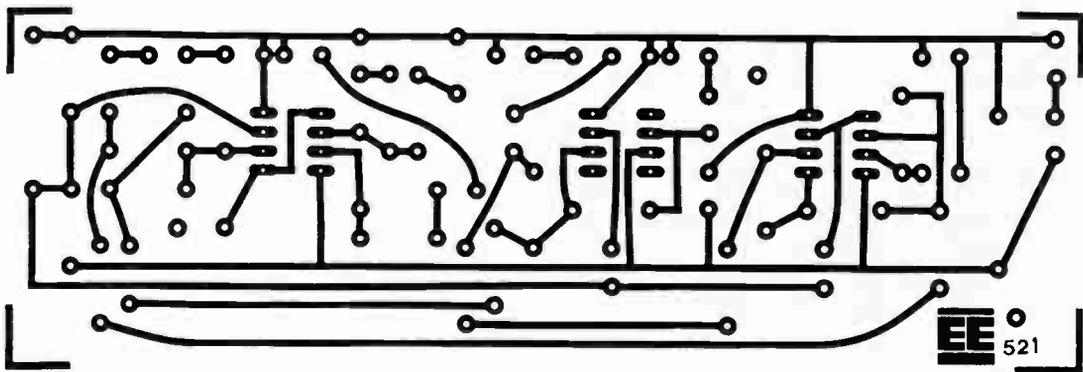
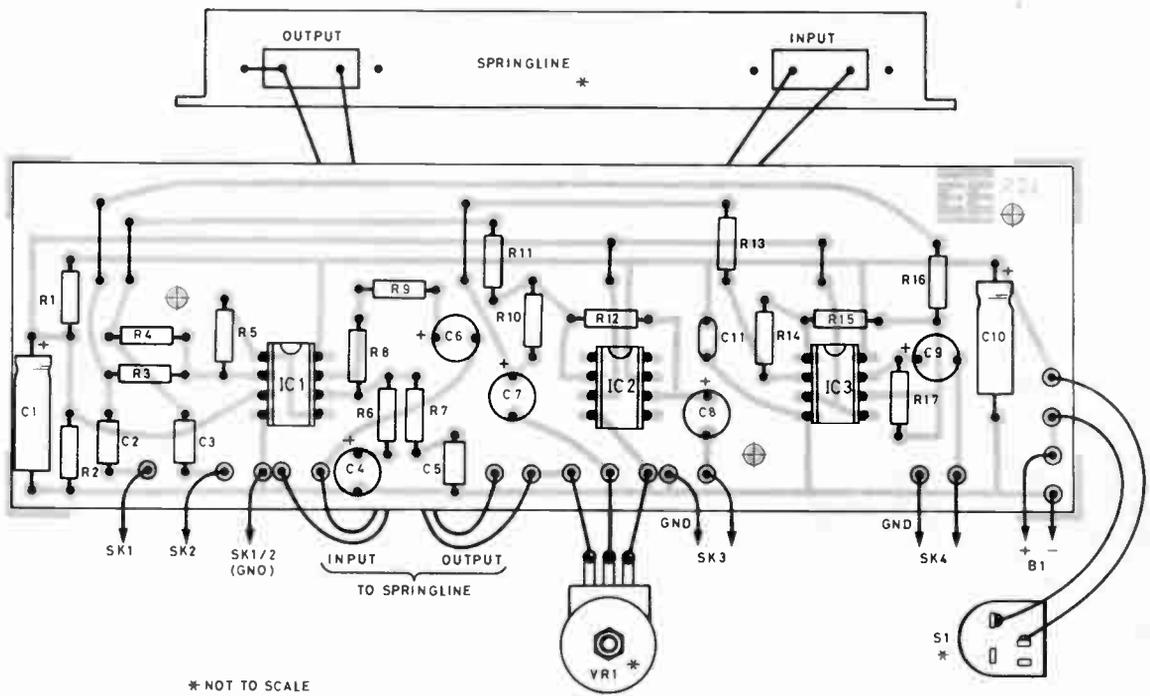
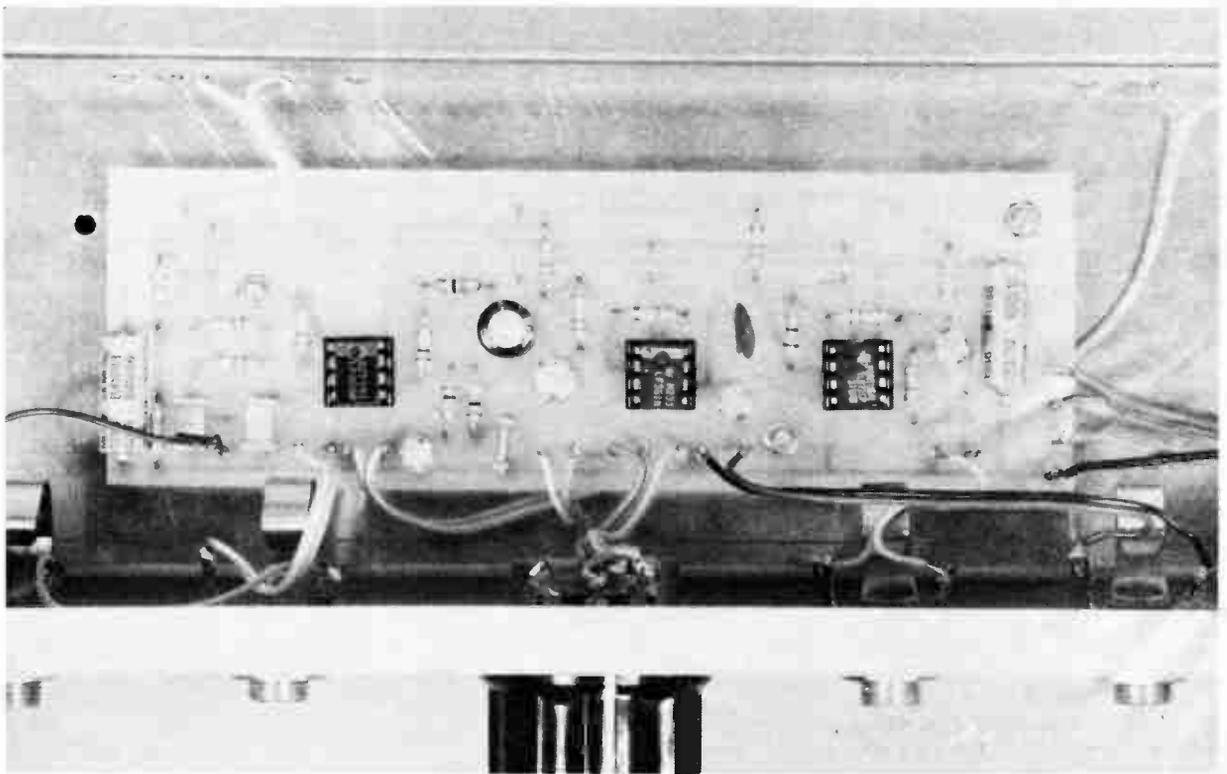


Fig. 3. Layout of components on the printed circuit board and interwiring details. (Above) Full size printed circuit master. This board is available from *EE PCB Service*; code EE521. (Below) Close-up photo of the wiring to the p.c.b.



CONSTRUCTION starts here

CIRCUIT BOARD

Most of the components are fitted onto a printed circuit board, as detailed in Fig. 3. This board is available from the *EE PCB Service*, order code EE521.

COMPONENTS

Resistors

R1,R2	3k9 (2 off)
R3,R4,R5, R11,R12, R13,R14, R16,R17	220k (9 off)
R6,R8	100k (2 off)
R7	10k
R9	47
R10,R15	18k (2 off)
All	$\frac{1}{2}$ W 5% carbon film

Potentiometer

VR1	4k7 log.
-----	----------

See
**Shop
Talk**
page 208

Capacitors

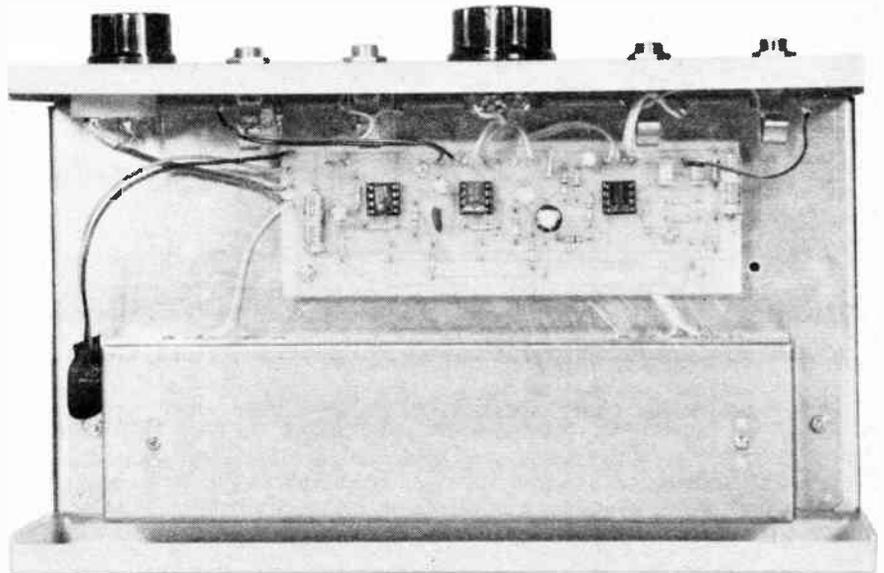
C1,C10	100 μ 10V axial elec. (2 off)
C2,C3	220n carbonate (2 off)
C4	1 μ F radial elec. 63V
C5	10n carbonate
C6	100 μ radial elec. 10V
C7	4 μ 7 radial elec. 63V
C8,C9	10 μ radial elec. 25V (2 off)
C11	100n ceramic

Semiconductors

IC1,IC3	LF353 or TL072 dual op-amp (2 off)
IC2	LF351 or TL071 op-amp

Miscellaneous

SK1,SK2,	Standard jacks
SK3,SK4	(4 off)
S1	Rotary on/off switch
B1	9V battery (PP3 size)
Short springline (Maplin); printed circuit board, available from the <i>EE PCB Service</i> ; order code EE521; two control knobs; battery connector; three 8-pin DIL i.c. holders; case about 250mm x 150mm x 75mm, wire, solder, etc.	



Completed Stereo Reverb showing positioning of printed circuit board, springline and wiring to front panel components.

Provided the specified types of capacitor are used all the components should fit onto the board without difficulty and construction should not give any real problems. Do not overlook the five link-wires.

None of the integrated circuits are MOS input types, but the use of holders is still recommended, especially if you are new to electronics construction. Fit pins to the board at the points where connections to the springline, VR1, and the other off-board components will eventually be made.

CASE

A fairly large case is needed in order to accommodate the length of the springline. The prototype is housed in a case which measures approximately 250mm by 150mm by 75mm, and this is about the minimum size that is likely to be satisfactory.

The springline is mounted on the base panel or chassis, well towards the rear of the unit, using two short M3 or 6BA bolts and fixing nuts. Make sure that the connections are facing towards the front of the case so that they are easily accessible.

The printed circuit board is mounted in front of the springline, leaving sufficient space for the battery to the right of the board. M3 or 6BA fixings are used, and these must include spacers about 6mm long to hold the connections on the underside of the board away from the metal chassis or case.

Potentiometer VR1, switch S1, and the four sockets are mounted on the front panel. Although standard jack sockets are specified in the components list, these can in fact be phono, DIN, or any other type that matches the equipment with which the unit will be used.

The complete interwiring between the springline, front panel components and the printed circuit board is shown in Fig. 3. Use ordinary multistrand insulated connecting wire here.

One output terminal of the springline unit is connected to the metal case of this component and therefore to the case of the whole unit. Make sure that this is the terminal that is connected to the negative supply rail of the printed circuit board. The

leads to the input transducer can be connected either way around.

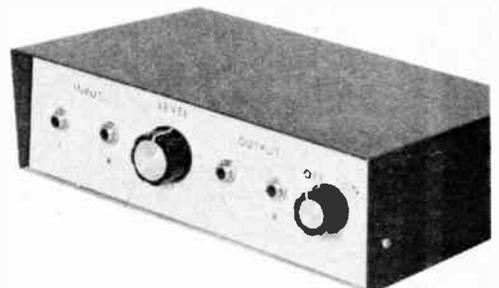
IN USE

There should be no difficulty in connecting the unit into an audio or electronic music system using ordinary screened audio leads. In order to avoid problems with acoustic feedback do not position the unit close to loudspeakers. In fact, it is a good idea to keep the unit at least half a metre or so away from any other item of equipment if possible, and this is particularly important with items of equipment that incorporate a transformer.

The input impedance at each input is about 100k and input levels of up to about 1V r.m.s. can be accommodated. The unit is therefore compatible with a wide range of equipment.

Problems with noise and acoustic feedback would almost certainly arise if the unit was to be used with a very low input signal level, such as the output from a microphone or a low output guitar pick-up. A preamplifier to boost the input signal to a higher level is required if it is to be used with equipment of this type. It is advisable to use a peak signal level of no less than about 100 millivolts.

The Level control VR1 is adjustable to any setting you judge to provide the best effect. When used as a headphone enhancer or stereo simulator VR1 needs to be adjusted very carefully in order to obtain a good effect. Slightly too little reverberation and the unit will have no significant effect; slightly too much and the reverberation signal can become dominant, producing a very unrealistic and unconvincing effect. □



Approx. cost
Guidance only **£18** plus case

PART 7 • Michael Tooley BA David Whitfield MA MSc C Eng MIEE

THE whole of this month's instalment of "Teach-in" is devoted to just one topic; the operational amplifier. The operational amplifier usually takes the form of nothing more than an 8-pin dual-in-line i.c.; nevertheless its range of applications is immense. These devices are now found in such apparently diverse applications as d.c. power supplies, automotive instrumentation, alarm systems, computers, and hi-fi equipment. In fact, it is hard to think of an area of electronics which has remained untouched by the humble operational amplifier.

THE OPERATIONAL AMPLIFIER

An operational amplifier is essentially a multi-stage direct coupled amplifier which acts as what might aptly be described as a "universal gain block".

Operational amplifiers were originally employed in the field of analogue computing and control systems, the first generation of such devices being based purely on discrete components. Due to various factors including the need to reduce the noise and drift inherent in high-gain direct coupled amplifiers to an acceptable level, these devices were extremely costly.

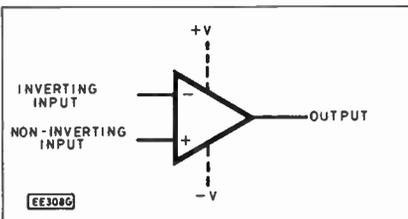


Fig. 7.1. Symbol used for an operational amplifier.

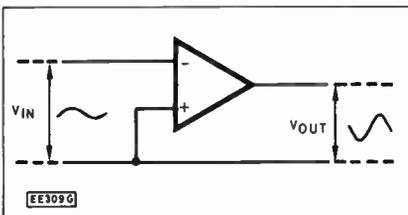


Fig. 7.2(a). Basic configuration for an inverting amplifier.

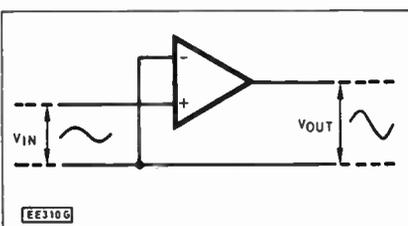


Fig. 7.2(b). Basic configuration for a non-inverting amplifier.

Now, with the advent of mass produced i.c. technology, prices have fallen to an absolute minimum (20p, or less, for a typical "industry standard" device!). A further effect of the falling price has been that industry at large has found a host of new applications which, in turn, has increased demand and further reduced the cost.

The symbol used for an operational amplifier is shown in Fig. 1. It should be noted that the device has two signal inputs (labelled "+" and "-") and one output. Operational amplifiers generally require both positive and negative supplies, often between $\pm 9V$, and $\pm 15V$. Furthermore, these supply connections are sometimes omitted from circuit diagrams and it is simply assumed that all devices are connected to the requisite common positive and negative supply rails!

The two signal inputs are distinguished by the internal phase shift produced using the output as a reference. The input marked "-" is also known as the "inverting input" (i.e. the output voltage is 180° out of phase with this input) whereas the input marked "+" is called the "non-inverting input" (i.e. the output voltage is in-phase with this input). This idea leads to the two basic amplifier configurations shown in Fig. 7.2.

Fig. 7.2a shows the basic configuration of an inverting amplifier in which the signal is applied to the inverting input and the non-inverting input is returned to the common rail. Fig. 7.2b shows the basic configuration of a non-inverting amplifier in which the signal is applied to the non-inverting input and the inverting input is returned to the common rail.

Readers should note that neither of the circuit arrangements of Fig. 7.2 is complete. The reason is that, since the open loop voltage gain of the device is so large (typically 100,000 or more) the stage would almost certainly be unusable in this form. What is required, of course, is some form of negative feedback to reduce the stage gain to a sensible value and make the operation of the stage both predictable and repeatable.

IDEAL CHARACTERISTICS AND INTERNAL CIRCUITRY

The ideal characteristics of an operational amplifier are shown below with typical values shown in brackets:

- Open loop voltage gain: Infinite (200,000)
- Input resistance: Infinite (2M)
- Full-power bandwidth: Infinite (100kHz)
- Output resistance: Zero (20 ohm)

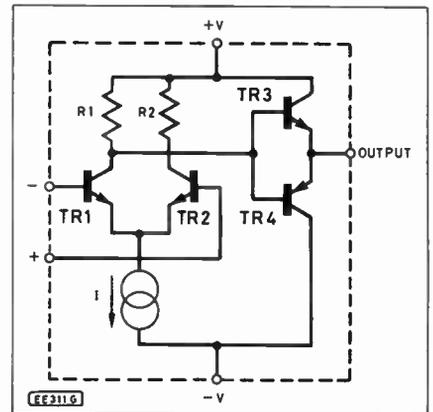


Fig. 7.3. Simplified internal circuitry of an operational amplifier.

Fig. 7.3 shows the internal circuitry of an operational amplifier in much simplified form. The input consists of a symmetrical arrangement of balanced transistors. This circuit is sometimes called a "Differential Amplifier" or "Long Tailed Pair". (The "tail" simply refers to the constant current source connected in the emitter circuit.)

There is nothing particularly special about a constant current source; it can be very easily realised by just one transistor with its base voltage held constant by means of one or more forward biased diodes.

The constant current source simply ensures that the *total* emitter current remains constant. If the emitter current of one transistor increases (by virtue of an applied signal) the emitter current of the other transistor *must* decrease by the same amount.

In practical operational amplifiers, the differential input stage can be augmented by one, or more, emitter followers which effectively raise the input impedance. Alternatively, where exceptionally high values of input resistance are required, f.e.t. devices can be used.

To produce the low value of output resistance (and to ensure a symmetrical output voltage swing) the device should incorporate some form of low-power output stage. This can be achieved using nothing more than a complementary symmetrical output stage (like those described in Part Four).

PRACTICAL AMPLIFIER STAGES

Three basic practical operational amplifier circuits are shown in Figs. 7.4 to 7.6. Each of these circuits employs negative feedback which is instrumental in reducing the voltage gain. Fig. 7.4 shows an inverting amplifier using input and feedback

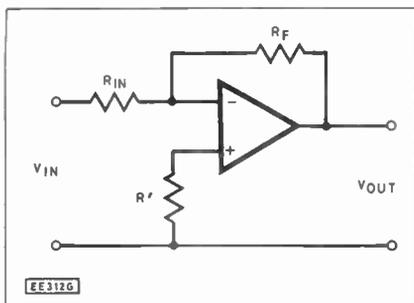


Fig. 7.4. A practical inverting amplifier.

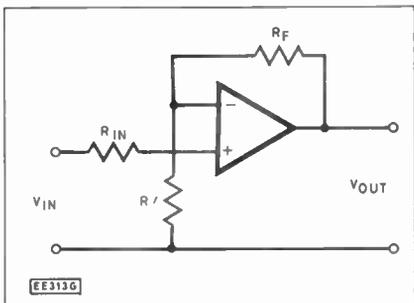


Fig. 7.5. A practical non-inverting amplifier.

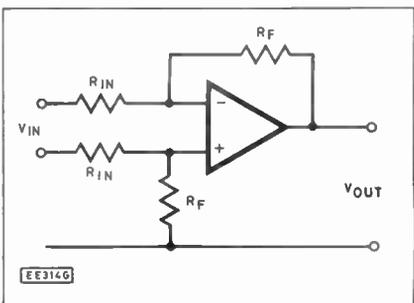


Fig. 7.6. A differential amplifier.

resistances, R_{in} and R_f respectively. In order to improve the symmetry of the arrangement, rather than return the non-inverting input directly to the common rail we have included a resistance R' . This resistance is equivalent to the parallel combination of R_{in} and R_f and ensures that both the inverting and non-inverting inputs "see" the same resistance externally. In practice R_f is usually much greater than R_{in} , thus, in a practical case, R' is often made equal to R_{in} .

Provided that the open-loop voltage gain is large, the voltage gain of the inverting amplifier is dependent purely on the amount of negative feedback applied. This, in turn, simply depends upon the ratio of R_f to R_{in} , hence:

$$\text{Closed loop voltage gain, } A_v = -\frac{R_f}{R_{in}}$$

Readers should not worry over-much about the minus sign (-) it merely indicates that the output and input act in the opposite sense (i.e. the output is 180° out of phase with the input). It does *not* indicate a loss!

Since the open-loop voltage gain is very large, the voltage appearing at the inverting input is very small (typically no more than a few millivolts). Hence the inverting input is sometimes called a "virtual earth" (i.e. it is only a few millivolts above true earth potential). The true resistance seen looking into the input terminals of the amplifier stage must therefore be very nearly equal to R_{in} .

All of this makes the operational amplifier very easy to use. Suppose, for example, we wish to make an inverting amplifier with a voltage gain of 100 to match an input resistance of one kilohm. We simply make R_f equal to 100k and R_{in} equal to 1k. What could be more simple!

Fig. 7.5 shows a practical non-inverting amplifier, whilst Fig. 7.6 shows a true differential amplifier (neither of the inputs are earthed). This latter arrangement is possible by virtue of the balanced symmetrical internal arrangement of the operational amplifier.

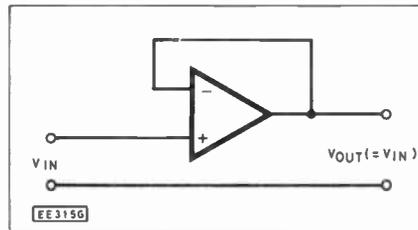


Fig. 7.7. A voltage follower.

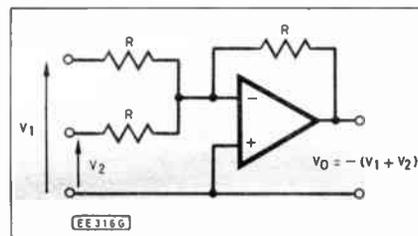


Fig. 7.8. A summing amplifier.

A voltage follower stage is shown in Fig. 7.7. The operation of this stage is somewhat analogous to that of an emitter follower; 100% voltage negative feedback is applied so that the overall closed-loop voltage gain falls to unity. The input impedance of the stage is, however, raised to an exceptionally high value.

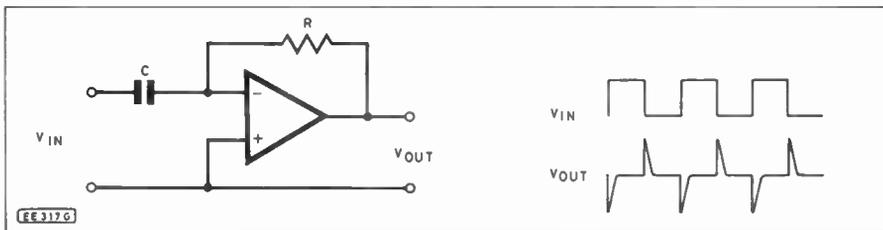
MATHEMATICAL OPERATIONS

As mentioned previously, operational amplifiers have their origins in analogue computers. In this application they were used to perform mathematical operations such as summation, integration, and differentiation.

Fig. 7.8 shows a simple summing amplifier. If all resistors are made equal, the output voltage is the inverse of the sum of the two input voltages. A typical practical application of such an arrangement (away from the world of analogue computers) would be a simple audio mixer in which each signal input is fed to its own input resistor. We could easily extend the circuit to incorporate as many additional inputs as required with, perhaps, a variable "gain" control fitted in place of the fixed input resistor.

Fig. 7.9 shows an operational differentiator. If this sounds a bit of a mouthful, it simply means that, provided the time constant ($C \times R$) is very much less than the periodic time of

Fig. 7.9. An operational differentiator.



TEACH-IN SOFTWARE

To complement each published part of the Teach-In series, we have produced an accompanying computer program. The Teach-In Software is available for both the BBC Micro-computer (Model B) and the Sinclair Spectrum (48k) or Spectrum-Plus. The programs are designed to reinforce and consolidate important concepts and principles introduced in the series. The software also allows readers to monitor their progress by means of a series of multi-choice tests, with scores at the end.

Tape 1 (Teach-In parts 1, 2 and 3) is now available for £4.95 (inclusive of VAT and postage) from Everyday Electronics and Electronics Monthly, 6 Church Street, Wimborne, Dorset, BH21 1JH.

IMPORTANT State BBC or Spectrum; add 50 pence for overseas orders; allow 28 days for delivery.

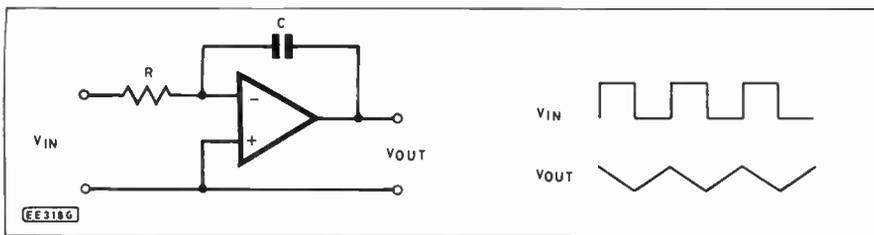
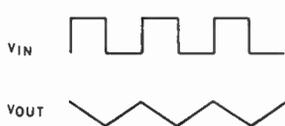


Fig. 7.10. An operational integrator.

the applied signal input, the output voltage will be proportional to the rate of change of the input voltage. If the input voltage changes very rapidly from one voltage level to another (e.g. on the rising or falling edge of a square wave) a large output voltage will be produced. If the input voltage remains constant for a relatively long period of time (i.e. it remains at a fixed level) no output voltage will be produced. A typical application of such an arrangement is in the synchronisation of oscillator stages.

Fig. 7.10 shows an operational integrator. This, effectively, provides the opposite function to that of the differentiator. Provided the time constant ($C \times R$) is very much greater than the periodic time of the input, this arrangement produces an output voltage which is proportional to the area under the input voltage curve. A typical application of such an arrangement is in a waveform generator where, for example, we might wish to convert a square wave input into a triangular wave output.



THE 741 OPERATIONAL AMPLIFIER

The 741 is the most common operational amplifier and it is available in a variety of packages including the ubiquitous 8-pin d.i.l. encapsulation, the pin connections for which are depicted in Fig. 7.11.

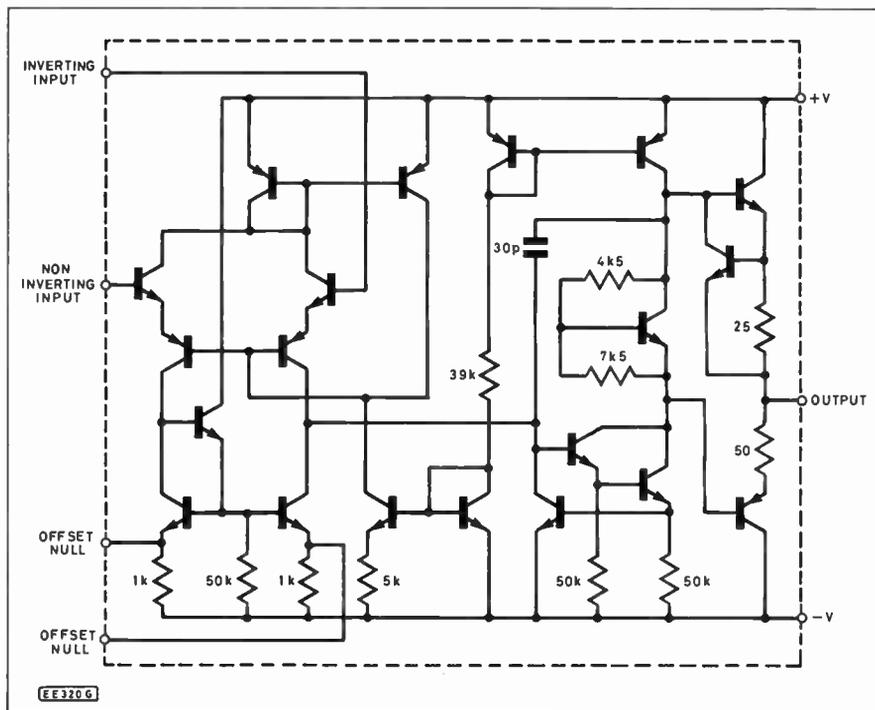
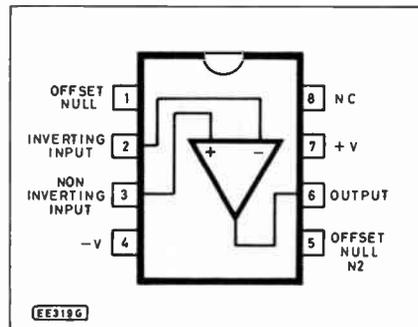


Fig. 7.12. Internal circuit of a 741.

Fig. 7.11. 741 8-pin d.i.l. pin connections.



The internal circuit of the 741 operational amplifier is shown in Fig. 7.12. Readers may like to compare this with that shown in Fig. 7.3—hopefully some similarity will be detected!

The characteristics of the ubiquitous 741 operational amplifier (when operating from $\pm 15V$ supply rails at $25^\circ C$) are summarised below:

Input offset voltage	1mV
Max output voltage (10k ohm load)	28V pk-pk
Differential voltage gain	200,000
Input resistance	2M
Output resistance	75
Input capacitance	1.4p
Common mode rejection ratio	90dB
Short-circuit output current	$\pm 25mA$
Supply current (no signal)	1.7mA
Total power dissipation (no signal)	50mW
Slew rate	1V/ μs

TERMS USED

Before we take a look at a typical operational amplifier, it is worth introducing some of the terms which are frequently used in conjunction with such devices.

Common mode rejection ratio

Common mode rejection ratio is the ratio of differential voltage gain to common mode voltage gain (i.e. the voltage gain that would be produced if the inverting and non-inverting inputs were to be shorted together and the signal applied between them and common 0V). Common mode rejection ratio is normally expressed in dB.

Differential voltage gain

Differential voltage gain is the ratio of peak-peak output voltage to the peak-peak input voltage applied differentially (i.e. between the inverting and non-inverting inputs).

Input offset voltage

Input offset voltage is the d.c. voltage which must be applied at the input terminals in order to make the d.c. output voltage exactly 0V.

Input resistance

Input resistance is simply the resistance "seen" between the input terminals of the operational amplifier.

Maximum pk-pk output voltage

Maximum peak-peak output voltage is the maximum voltage swing that can be obtained at the output before clipping occurs. (For obvious reasons it is very much dependent upon the supply rail voltages).

Output resistance

Output resistance is simply the resistance "seen" between the output terminal and common 0V.

Short-circuit output current

Short-circuit output current is the current produced at the output terminal when it is directly shorted to the common 0V rail.

Slew rate

Slew rate is the rate of change of output voltage with time when the input is supplied with a step voltage change. It is normally expressed in volts per microsecond.

Total power dissipation

The total d.c. power dissipation is the total d.c. power supplied to the device less any power delivered to a load. (Under no-load conditions this is simply equal to the product of the voltage and current in each rail.)

Like many operational amplifiers, the 741 is provided with two inputs which can be used to set the d.c. output voltage exactly to zero. This facility is known as "offset null" and it simply uses an external potentiometer to balance the internal differential stage, as shown in Fig. 7.13.

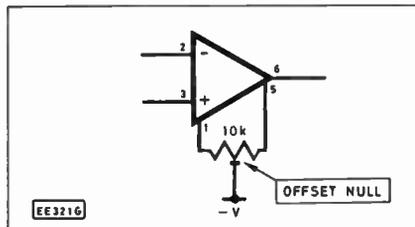


Fig. 7.13. Offset null provision for the 741.

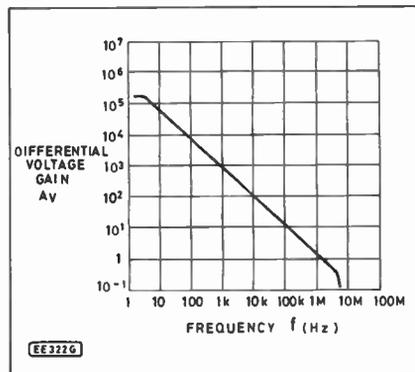


Fig. 7.14. Typical frequency response of a 741.

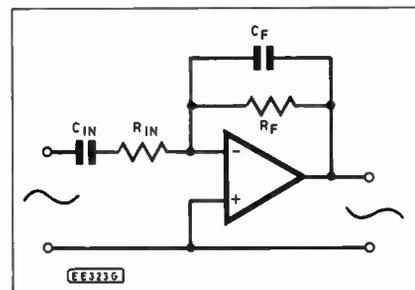


Fig. 7.15. Bandwidth limited amplifier.

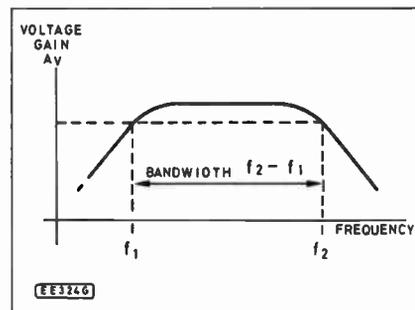


Fig. 7.16. Frequency response for the arrangement shown in Fig. 7.15.

FREQUENCY RESPONSE AND BANDWIDTH

The typical frequency response of a 741 operational amplifier is shown in Fig. 7.14. Readers should note from this that unity gain is achieved at a frequency of approximately 1MHz.

The product of closed-loop voltage gain and bandwidth of any particular operational amplifier is a constant. This means that there is a trade-off

between closed-loop voltage gain and frequency response. Taking a typical 741 for example, we could have the following options:

Closed loop voltage gain	Bandwidth
1	1MHz
10	100kHz
100	10kHz
1,000	1kHz
10,000	100Hz

Clearly we should not be too greedy when it comes to selecting a closed-loop voltage gain or an unacceptable loss of bandwidth may result!

Despite this, there will be numerous applications in which it is desirable to limit the frequency response of an amplifier to within precise limits. This can be achieved using the arrangement depicted in Fig. 7.15.

The frequency response of the arrangement of Fig. 7.15 is shown in Fig. 7.16. The upper and lower cut-off frequencies are respectively given by:

$$f_2 = \frac{1}{2\pi C_f R_f} \quad \text{and} \quad f_1 = \frac{1}{2\pi C_{in} R_{in}}$$

The bandwidth of the stage is simply given by: $B/W = f_2 - f_1$

COMPARATORS

One important application of the operational amplifier is that of comparing two voltages. A simple comparator based on an operational amplifier is shown in Fig. 7.17. In this arrangement the stage is operated without any negative feedback and thus it exhibits a very high value of voltage gain. Whenever the voltage present at the non-inverting input exceeds that present at the inverting input, the output voltage will rise to just less than that of the positive supply. Alternatively, when the voltage present at the non-inverting input is less than that at the inverting input, the output voltage will fall to slightly more than that of the negative supply. The voltage present at the inverting input is thus effectively a "reference voltage" (V_{ref}) against which we are comparing the input. The transfer characteristic of this circuit arrangement is shown in Fig. 7.18.

An extension of the comparator arrangement is shown in Fig. 7.19. Here the reference voltage is 0V and hence any input signal of more than a few millivolts in amplitude is converted to a square wave output regardless of its actual waveform. This circuit can be useful in a variety of applications including intruder alarms, motion detectors and digital counters.

OSCILLATORS

Whilst operational amplifiers can be used to replace the transistor(s) used in most of the oscillator circuits described in Part Five, there is just time to introduce a useful square wave oscillator circuit. This oscillator is shown in Fig. 7.20 and uses just five components, including the operational amplifier itself.

To understand how the circuit operates assume that the output of the operational amplifier initially goes high to just less than the positive supply. The capacitor will initially be uncharged and will thus commence charging with current supplied by R. The voltage at the inverting input will

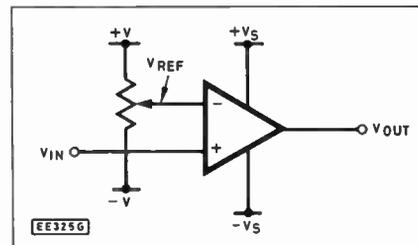


Fig. 7.17. An operational comparator.

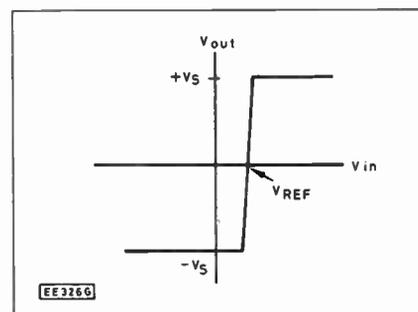


Fig. 7.18. Transfer characteristic of the arrangement shown in Fig. 7.17.

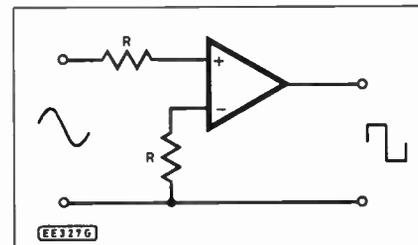


Fig. 7.19. Square wave converter.

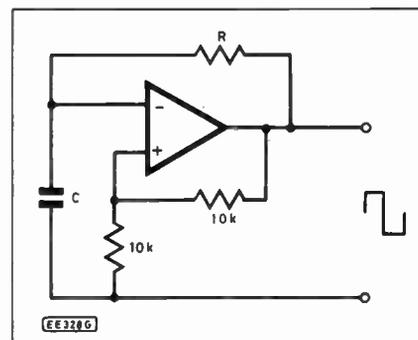


Fig. 7.20. Simple square wave oscillator.

therefore rise steadily until, at some later time, it will exceed the voltage at the non-inverting input (which will be approximately half that of the positive supply by virtue of the resistive potential divider formed by the two 10k resistors).

At this point the output voltage will rapidly fall to a level which is just less than the negative supply. C will then discharge through R until the voltage at the inverting input falls to less than

that present at the non-inverting input (which will be approximately half that of the negative supply). At this point the circuit reverts to its original state and the cycle repeats continuously.

NEXT MONTH

Next month we shall be taking a look at digital circuits.

PROBLEMS

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

7.1 An operational amplifier is to be used in an inverting configuration to provide a voltage gain of 20. If the input resistance is to be 5k determine the value of feedback resistance required. (e)

7.2 Two inverting operational amplifiers are used in tandem. If each amplifier has a voltage gain of 50 determine the overall voltage gain and phase shift. (e)

7.3 An operational amplifier has a gain x bandwidth product of 4MHz. If the device is to be used in a single stage amplifier with a bandwidth of 20kHz determine the maximum value of closed-loop voltage gain that can be allowed. (m)

7.4 A pre-amplifier is to be built using an operational amplifier. If the unit is to have the following specifications, produce a complete circuit design and include all component values (specify the nearest preferred value in each case): (d)

Mid-band voltage gain: 40
Input resistance: 5k
Frequency response: 400Hz to 10kHz

ANSWERS TO LAST MONTH'S PROBLEMS

- 6.1 Between 3-833V and 4V (approx.)
6.2 200 ohm
6.3 500m
6.4 150MHz
6.5 Maximum capacitance, 253p
Minimum capacitance, 28p

Practical Assignments

COMPONENTS

Beside the items specified for earlier parts you will need two 741 operational amplifier i.c.s in order to complete this month's assignments.

ASSIGNMENT 7.1

This assignment is designed not only to demonstrate the operation of a single stage inverting amplifier but also to allow readers to confirm the equation (quoted earlier in the text) for the voltage gain of a closed loop inverting amplifier.

PROCEDURE

Connect the circuit shown in Fig. 7.21 on your breadboard using the wiring diagram shown in Fig. 7.22. Carefully check that the i.c. has been correctly oriented before connecting the supply which consists of four 4-5V batteries wired in series and having a centre common 0V connection.

Initially set VR1 to mid-position and connect the multimeter (switched to the 10V d.c. range) to read V_{in} . Adjust VR1 for exactly 0V input then transfer the multimeter to read V_{out} (this should be exactly 0V).

Transfer the meter back to the V_{in} position and adjust VR1 for an input of exactly +1V. Transfer the meter to

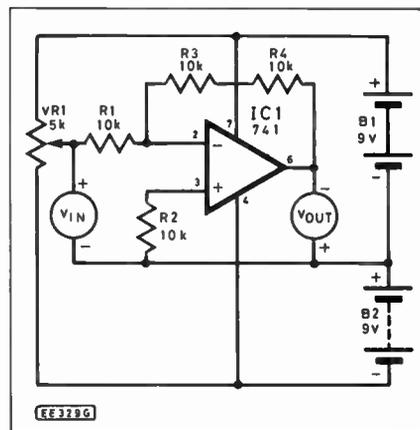
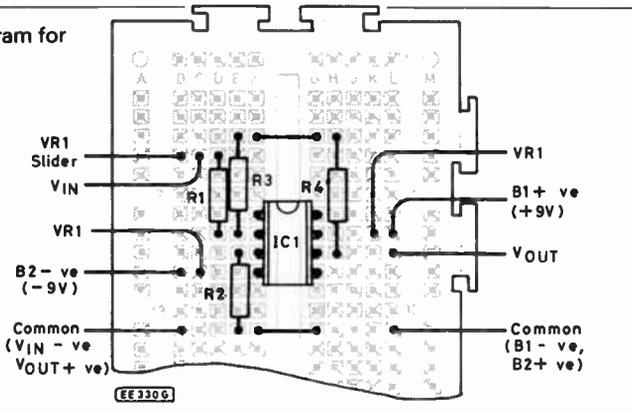


Fig. 7.21. Circuit for Assignment 7.1.

Fig. 7.22. Wiring diagram for Assignment 7.1.

COMPONENTS	
R1	10k
R2	10k
R3	10k
R4	10k
VR1	5k
IC1	741



the output and measure V_{out} (this should be -2V).

Repeat the procedure measuring V_{out} for each of the following input voltages; +2V, +3V, -1V, -2V, -3V. Confirm, in each case, that the voltage gain is -2.

If desired, add an extra 10k resistor in series with R4. Repeat the previous measurements and confirm that the closed loop voltage gain is now -3.

ASSIGNMENT 7.2

This assignment demonstrates the operation of a bandwidth limited amplifier. In order to complete this, and the next assignment, readers should have access to an audio amplifier or tape recorder having an "auxiliary" input.

PROCEDURE

Connect the circuit shown in Fig. 7.23 on your breadboard, using the

wiring diagram given in Fig. 7.24. As before, take care to ensure that the i.c. is correctly connected.

Connect the output of Fig. 7.23 to

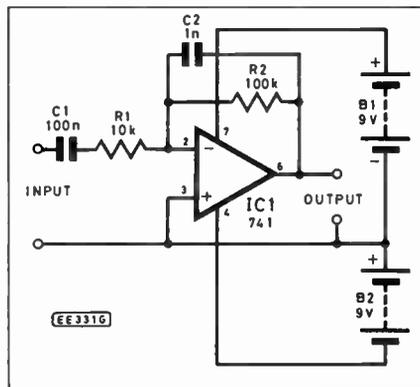
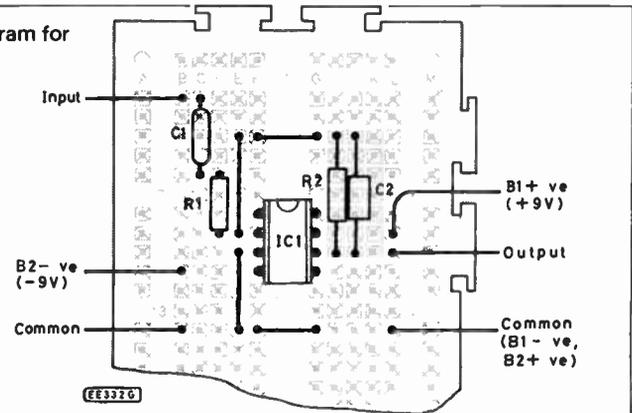


Fig. 7.23. Circuit diagram for Assignment 7.2.

Fig. 7.24. Wiring diagram for Assignment 7.2.

COMPONENTS	
R1	10k
R2	100k
C1	100n
C2	1n
IC1	741



the input of the audio amplifier or tape recorder taking care to ensure that the common 0V line is taken to earth or chassis. The input of Fig. 7.23 can be derived from a microphone, radio tuner, record or cassette deck.

Readers should compare the signal quality with, and without, the bandwidth limited amplifier connected. The frequency response of the amplifier is approximately 159Hz to 1.59kHz.

Readers having access to a variable frequency audio signal generator may like to plot the frequency response of the stage. The multimeter (switched to the 10V a.c. range) can be used to measure the output voltage resulting from a constant input voltage of, say, 250mV r.m.s. from the generator. Results should be compared with the frequency response curve shown in Fig. 7.16.

ASSIGNMENT 7.3

This assignment demonstrates the action of a simple square wave oscillator using an operational amplifier.

PROCEDURE

Connect the circuit of Fig. 7.25 using the wiring diagram shown in Fig. 7.26. Set VR1 to maximum resistance (corresponding to a minimum output frequency) and connect the output of the oscillator to the "auxiliary" input of an audio amplifier or tape recorder.

Monitor the signal using the amplifier and investigate the effect of varying VR1. Change C1 first to 1 μ and then to 100n, and repeat the experiment. Typical output frequency ranges are shown.

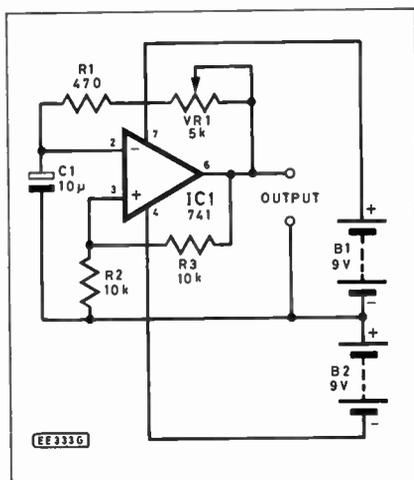


Fig. 7.25. Circuit for Assignment 7.3.

ASSIGNMENT 7.4

This assignment demonstrates a linear ramp generator comprising an operational integrator with positive feedback applied.

PROCEDURE

Construct the circuit diagram of Fig. 7.27 using the wiring diagram shown in Fig. 7.28. Switch the meter to the 50V d.c. range and connect it between the output (meter positive) and the -ve rail (meter negative).

C1	Minimum frequency	Maximum frequency
10 μ	9Hz	90Hz
1 μ	90Hz	900Hz
100n	900Hz	7kHz

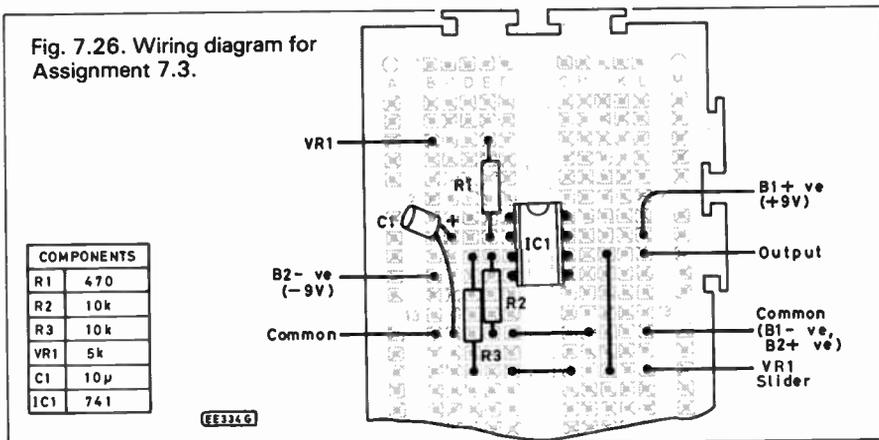


Fig. 7.26. Wiring diagram for Assignment 7.3.

COMPONENTS	
R1	470
R2	10k
R3	10k
VR1	5k
C1	10 μ
IC1	741

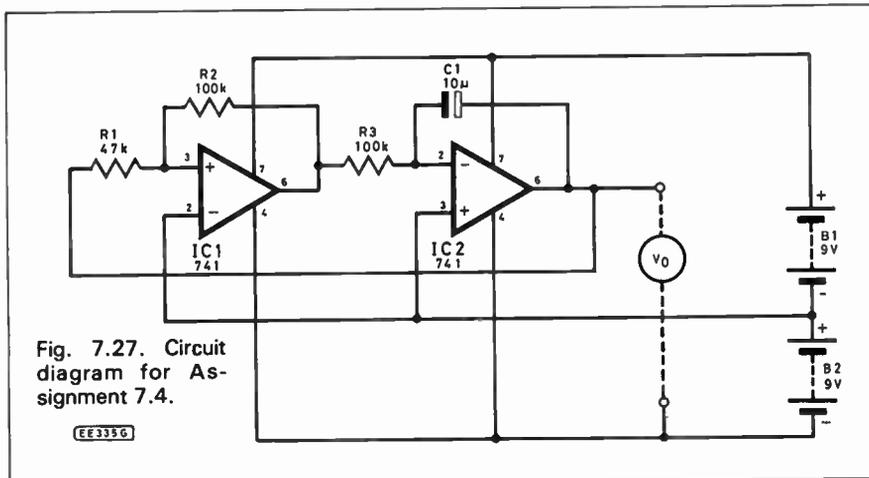


Fig. 7.27. Circuit diagram for Assignment 7.4.

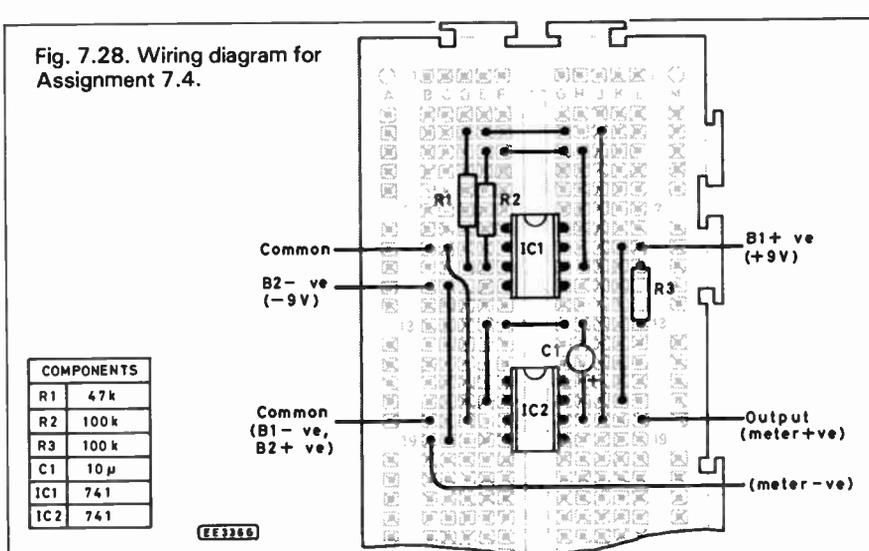


Fig. 7.28. Wiring diagram for Assignment 7.4.

COMPONENTS	
R1	47k
R2	100k
R3	100k
C1	10 μ
IC1	741
IC2	741

The output consists of a triangular waveform of approximately 9V pk-pk and frequency 0.5Hz. At the low operating frequency, the nature of this waveform can readily be recognised by simply observing the meter deflection. If time permits, readers may like to experiment with a range of values for C1 (say, 1 μ , 100n, 10n and 1n). If a square, rather than triangular, output is required this may be obtained simply by taking the output from the first stage (i.e. pin-6 of IC1).

NEXT MONTH

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

Resistor 270 $\frac{1}{4}$ W 5% carbon (1 off)
Semiconductors 7400, 7402, 7408, 7432 i.c.s. Red light emitting diode (LED)

FREELoader

IAN REES

Allows programs to be located and loaded easily. Can control most types of recorder

THE FREELoader prevents faulty loading caused on some computers when the program is loaded from cassette after its Header Tone. This occurs on several computers, including the Dragon 32/64 and the Tandy CoCo.

Freeloder is connected inline between the computer and recorder and ensures that no signal is present from the ear socket at the instant loading starts. If a signal is present, the unit holds off the loading until a silent period between programs is detected. The unit then drops out and the next program is loaded.

STACKED PROGRAMS

The main advantage of the unit comes when programs are stacked one behind the other on the same tape. The need to accurately position the tape using the counter is no longer required.

Indeed it is desirable to start loading on the tail of the previous recording. "Fast forwarding" timed menu directories will not have as large a gap between programs now that the gap need not be landed on.

Incorporated in the design is a "Motor On" press button which enables the cassette to be switched on without either calling it from BASIC or pulling out the "Remote" plug. The l.e.d. indicates loading status.

CIRCUIT

The circuit for the unit is shown in Fig. 1. With the Freeloder S1 in the "OUT" position, the data signal is routed directly from the cassette recorder ear jack through RLA to the computer as normal.

The unit draws its supply from the recorder. The positive voltage comes via the "Remote" socket, the negative is returned through the "EAR" socket chassis return.

If S1 is switched to the "IN" position, the positive supply comes on immediately the computer turns on the cassette's motor supply. Transistor TR2 operates RLA as C5 slowly charges. The output from the ear jack (if present) is directed by RLA through C1 and C2, to be rectified by D1 and D2, then smoothed by C3 before turning on TR1. TR2 turns off after approximately 5 seconds but RLA will be held by TR1 until the

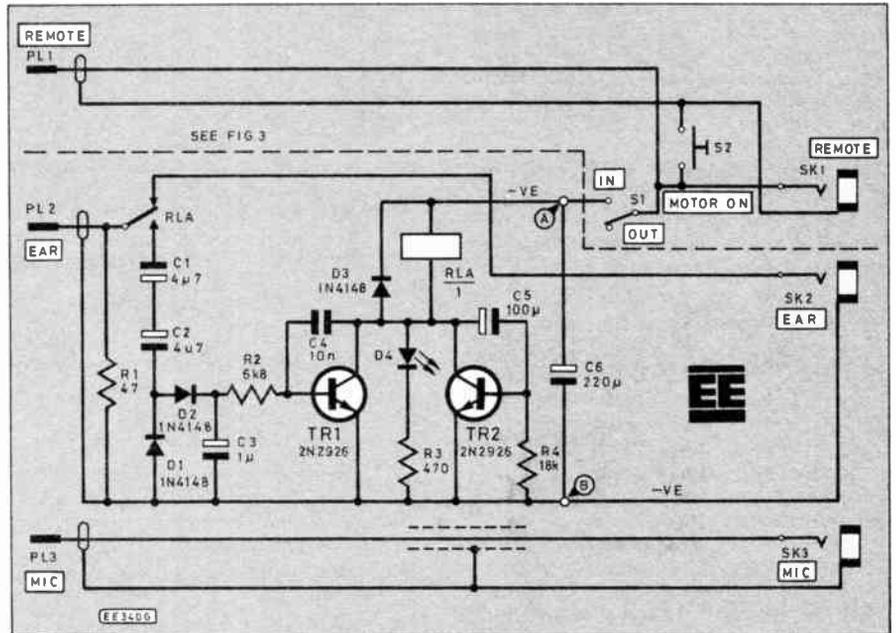


Fig. 1. Complete circuit diagram of the Freeloder when powered by the cassette recorder.

input ceases. The green l.e.d. is illuminated when the supply comes on but is dimmed or extinguished if the Freeloder detects a signal.

The majority of "Computer compatible" cassette recorders currently available have their supply lines configured as Fig. 2. When operated from the mains, around 7V will be available from the "Remote" socket

(battery operation is not satisfactory with this attachment). I have used Morphy Richards C440, Murphy 2022 and a Bush 3160 without problems.

In the real world there are bound to be machines which do not conform. Fig. 3 shows how to add extra circuitry to make the Freeloder compatible with all recorders.



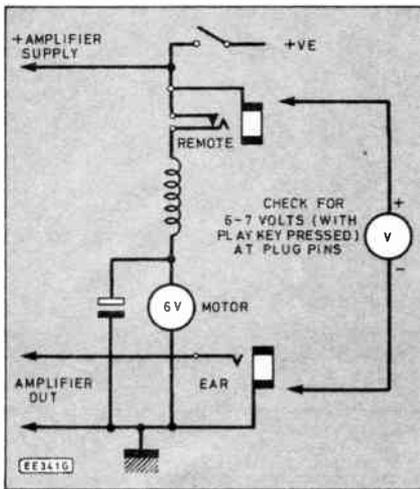
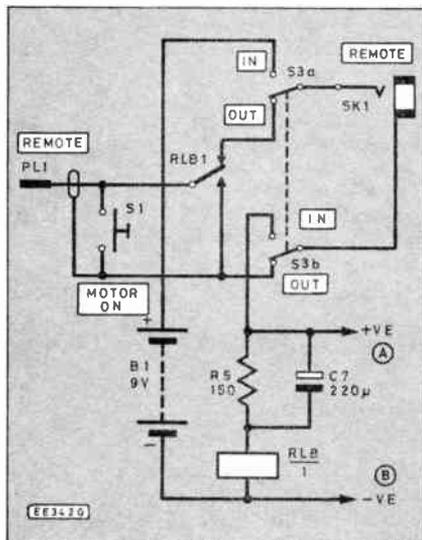


Fig. 2. Remote wiring connections on most recorders.

Fig. 3 (Right). Universal circuit which replaces that above the dotted line in Fig. 1 and joins at points A and B. C7 reduces battery drain by allowing a smaller relay holding current—current is only drawn during loading.



CONSTRUCTION

The universal version will require a larger case than the standard described to house the extra relay and PP3 battery.

The simpler unit was built on a piece of Veroboard (Fig. 4) and mounted in an inexpensive Tandy Experimenter's Box.

The "REMOTE" (SK1) and "EAR" (SK2) jacks are mounted directly onto the board after enlarging the holes. The circuit board can then be secured by the jack nuts after suitable size holes have been drilled in the end of the case.

The "MIC" feed could obviously go direct to the computer. After an early prototype, I found the lead dressing looked much neater when all were terminated at the Freeloader. S1, S2, SK3 and the l.e.d. are mounted and interwired on the side of the case. The "MIC" lead to the cassette should be screened. On the Prototype I used 30cm screened fly leads with their braids in separate PVC sheaths—(jack plugs should be marked).

RLA and RLB (if used) must be able to operate at 5 volts. TR1 and TR2 can be any npn general purpose a.f. transistors with a gain of at least 50.

OPERATION

No setting up is required other than to connect the Freeloader to the "EAR", "MIC" and "REM" sockets on the cassette recorder. The lead from the computer is connected to the same connectors on the Freeloader.

With a program tape in the recorder and

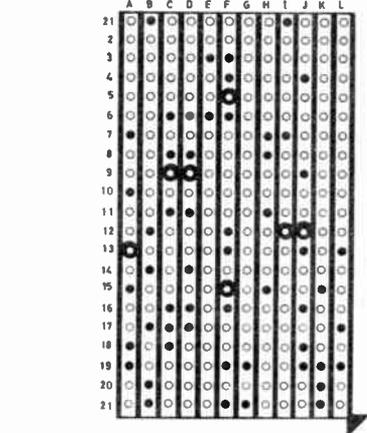
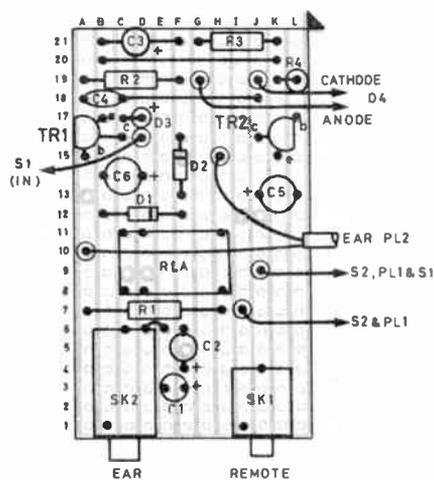


Fig. 4. Veroboard layout and wiring for the Freeloader. The board is mounted by SK1 and SK2.

S1 set to "OUT" loading should be as normal.

Rewind the tape by pressing the "Motor On" button. Dump the program and load again. Note that this time the l.e.d. will light, going out when the program has loaded.

Finally, rewind as before, but stop somewhere before the start. Commence loading. This time the l.e.d. will flicker or dim, signifying a hold of data from the computer. Nothing should load.

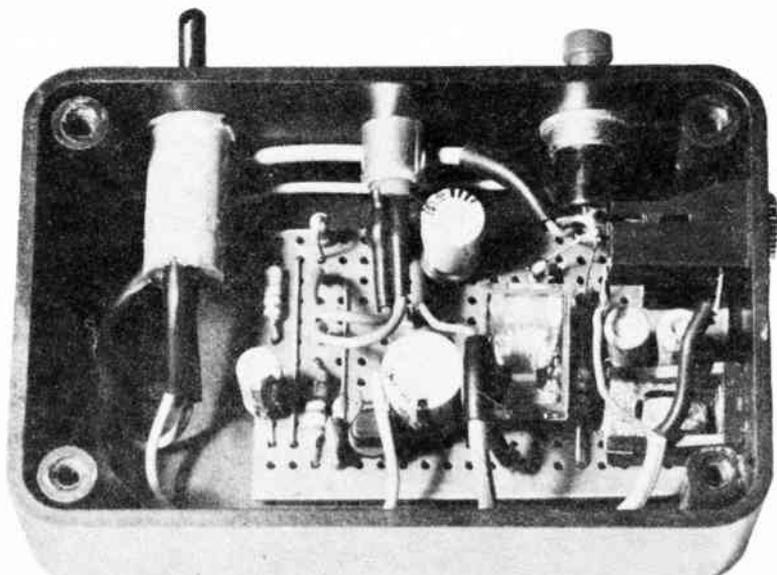
There are circumstances when you will need to switch "OUT" the Freeloader: for example, if data is being loaded which rapidly cycles the control relay (files, etc.). Otherwise it can be left "IN".

COMPONENTS

Resistors		See
R1	47	Shop Talk page 208
R2	6k8	
R3	470	
R4	18k	
R5	150	
	(if required)	
	All 1/4W ±5%	
Capacitors		
C1,C2	4µ7 10V p.c. elect.	
	(2 off)	
C3	1µ 10V p.c. elect.	
C4	10n 30V disc ceramic	
C5	100µ 10V p.c. elect.	
C6,C7	220µ 10V p.c. elect.	
	(2 off) (C7 may not be required—see text)	
Semiconductors		
D1,D2,D3	1N4148 (3 off)	
D4	5mm green l.e.d. (with mounting clip)	
TR1,TR2	2N2926 (2 off)	
Miscellaneous		
RLA,RLB	s.p. changeover relay, 5V 56 ohm coil (2 off) (RLB may not be required—see text)	
S1	s.p.s.t. min. toggle switch	
S2	s.p.n.o. press-switch	
S3	d.p.d.t. min. toggle switch (if required)	
SK1	2.5mm o.c. jack socket	
SK2,SK3	3.5mm o.c. jack socket (2 off)	

Case—dimensions approx. 82 x 54 x 28mm (see text); 0.1 inch matrix stripboard 12 strips by 21 holes; 2.5mm jack plug; 3.5mm jack plug (2 off); screened leads.

Approx. cost
Guidance only **£7.50**



The Man Behind the Symbol

NO8 Michael Faraday

by Morgan Bradshaw

IN THIS, the first half of a two part article, we meet the man once described as the "Columbus of Electricity"—Michael Faraday—who discovered how to make electricity by mechanical means, and gave his name to the unit of electric capacitance (see Table 1).

Michael Faraday was born at Newington Butts, Walworth, on the Surrey side of the Thames, on 22 September 1791, the third son of a Yorkshire blacksmith who had migrated to London.

At the age of fourteen Michael was apprenticed to George Riebau, a bookbinder, who gave young Michael time to study the many learned books they were binding. Michael was a good worker, with an aptitude for learning and in April 1812 as a reward Mr. Riebau took him to a series of four lectures, on chemistry given by Sir Humphrey Davy of Miner's Safety Lamp fame.

GREATEST DISCOVERY

The young Faraday was spellbound not only by Davy but by the content of the lectures, so much so that he made notes, bound and illustrated them, and sent them to Davy requesting an interview as an assistant. Although impressed, Davy wrote to Faraday saying that he should stick to his trade of bookbinding, "Science is too precarious for a young man".

Then fate took a hand, Davy's assistant was dismissed for fighting and Faraday was

offered a job, and Davy made what he later described as "My greatest discovery". The man who in later years was to succeed him as Director of the Royal Institute.

ROYAL INSTITUTE

Faraday started work at the Royal Institute on 1 March 1813, in a humble capacity assisting lecturers and keeping the apparatus polished for a weekly salary of twenty five shillings. Soon he became Davy's experimental assistant, and together from October 1813 to April 1815, they toured Europe lecturing.

On 12 June 1821 Faraday married Sarah Barnard and they moved to apartments at

Photo: Courtesy Science Museum



Diorama showing Faraday in his laboratory.

the Royal Institute where he had been promoted to Superintendent, at a salary of £100 a year.

Taking up original work in chemistry Faraday made a number of discoveries, among them benzol, and two new chlorides of carbon. He was also much in demand as a lecturer.

BIRTH OF THE DYNAMO

Gradually his work in chemistry was eclipsed by his electrical discoveries.

Faraday proved that a conductor carrying a current also induced currents in neighbouring conductors. On a wooden core he wound two coils of insulated wire, and sent electricity through one, while the other was connected to a meter which measured current. He noticed that while the battery current flowed steadily through one coil, the meter connected to the other coil did not move, but when the current was started or stopped, the needle jerked back and forth.

Picking up where Ampere left off, Faraday concluded that since electricity pro-

duced magnetism, so magnetism might produce electricity. He discovered that if a magnet is thrust into a coil of wire an electric current is "generated" in the coil, when the magnet is withdrawn the current direction is reversed proving that movement can produce electricity. This great discovery—that electricity could be produced by magnetism—was dated in Faraday's notebook as 29 August 1831.

Table 1: FARAD (F)

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

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

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

The unit was first suggested in 1867 by Latimer Clark, the English engineer and electrician, who besides inventing the Clark standard cell took a leading part in the movement for the systemisation of electrical standards. The farad was adopted as the unit of electric capacitance, at the first meeting of the International Electrotechnical Conference in 1881.

Faraday then set about making a small dynamo in which a current was produced by rotating a loop of wire between the two poles of a magnet. At each half turn of the wire loop the direction of the current was reversed so that it flowed back and forth (a.c.). Faraday eventually fitted a commutator to turn the a.c. into d.c. He demonstrated his dynamo and reported his two discoveries of electrodynamic induction and magnetolectric induction to the Royal Society on November 24th 1831.

This is generally regarded as the birth of the modern dynamo and transformer, and led to the development of the electric motor.

But Faraday had not finished yet as we shall be seeing in Part 2, next month.

Photo: Courtesy Science Museum



MAY FEATURES...

PA AMPLIFIER



Twenty watts r.m.s. for around £20. Designed for the home constructor using just three i.c.s and a handful of discrete components. This unit is capable of a respectable performance while still being inexpensive to build.



MINI STROBE

Recently a range of "ultra bright" l.e.d.s have become available, this feature together with their ability to be flashed at a very high speed has enabled us to present a versatile project. Freeze rotating objects, time the car or use the Mini Strobe as a tachometer.

AUTOMATIC FIRING JOYSTICK ADAPTOR

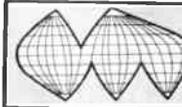
Add automatic fire to your joystick. This unit uprates your scores with a variable preset fire rate of between 3 and 30 times a second. This unit is inexpensive and easy to build.



EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

MAY ISSUE ON SALE FRIDAY, APRIL 18

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



TOP AWARD FOR WOMEN

A DEVELOPMENT engineer with Hoover plc has been voted the 1985 Girl Technician of the Year.

At a ceremony in London recently, Mr. T. P. Jones, CB, Chairman of the Electricity Council presented Sharon Howes, age 28, with the prize of £250 and an inscribed rose bowl. Sponsored by The Caroline Haslett Memorial Trust and The Institution of Electrical and Electronics Incorporated Engineers, this award is intended to focus attention on electrical and electronic engineering as a worthwhile professional career for women.

In addition to the main award, The Mary George Memorial Prize for the most promising young woman technician engineer went to Michelle Richmond, age 20, from Plessey Radar, Isle of Wight.

As a Development Engineer, Sharon's duties include the testing and assessment of Hoover domestic electrical appliances and evaluating new design models with a view to improving product performance, manufacturability and cost.

Michelle is currently involved in computer programming for analysis of microwave patterns. At present she is busy

setting up a test system for monitoring detection pulses in an air surveillance radar system.

In 1984 she gained public acclaim in local newspapers, TV and radio for her part in the design and construction of a baby alarm system to prevent cot deaths.



APPOINTMENTS

Roger Graham, Group Managing Director of the Business Intelligence Services (BIS) Group of Companies, has been elected President of the European Computing Services Association (ECSA) at a recent council meeting in Istanbul, Turkey. He is the first British President of ECSA in its eleven-year history, although the ECSA Secretariat has always been based in London.

ECSA was formally established in 1975 as the voice of the

European Computing Services Industry. It brings together the national industry associations of sixteen European countries.

British Telecom has appointed Mr John McMonigall as Deputy Managing Director of British Telecom Enterprises.

He has executive responsibility initially for consumer products where he will be conducting an operational review of BTE's consumer electronics factory in South Wales.

SPACE STUDY

The British National Space Centre has announced that it will support proof-of-concept studies on Hotol, the horizontal take-off and landing space plane being investigated by British Aerospace and Rolls-Royce.

Hotol is an advanced concept for a horizontal take-off and landing launch vehicle for satellites. It is based on Swallow, a new power plant, proposed by Rolls-Royce.

The novel propulsion system reduces the need for Hotol to carry large quantities of liquid fuel by utilising a hybrid engine arrangement which combines air-breathing and rocket propulsion. Details of the engine are at present confidential. Hotol will be developed as an unmanned automatic vehicle capable of being adapted for manned operations at a later date.

Studies of Hotol and its propulsion system will last for up to two years and cost £3 million. The contracts placed with the two companies contain a break point after the first six months when the position will be reviewed. The cost of studies up to that point will be about £750,000 which will be shared equally by the BNSC and industry.

The world's first all-digital public telephone link spanning the world's oceans has been set up by British Telecom International (BTI) and its Japanese counterpart KDD.

A new satellite link interconnects modern digital exchanges in London and Tokyo by using a new satellite transmission technique known as TDMA—time division multiple access—via an *Intelsat* satellite over the Indian Ocean and BT's earth station at Madley in Herefordshire.

FIBRE RECORD

A new world record for optical fibre transmission set by British Telecom promises to help contain the cost of expanding the network. A team of engineers have succeeded in transmitting data over 32km of singlemode fibre at a rate of 2.4 Gbit/s, the fastest rate yet achieved over an installed cable.

Unlike previous laboratory demonstrations this feat was achieved over an existing cable. It illustrates the feasibility of upgrading existing optical systems without the need to replace cables.

The data rate achieved, 2,400 million bits of information per second, represents a 16-fold capacity increase over the existing 140 Mbit/s systems. It is equivalent to passing 30,720 separate speech channels, or 32 full-bandwidth colour television pictures, down the same single optical fibre.

Rapid Silicon now have a Bonded Store and Military Standard components which complies with BS9000.

Amstrad has announced that 0277 230222 has been designated as the Customer Service number at the company's Brentwood headquarters.

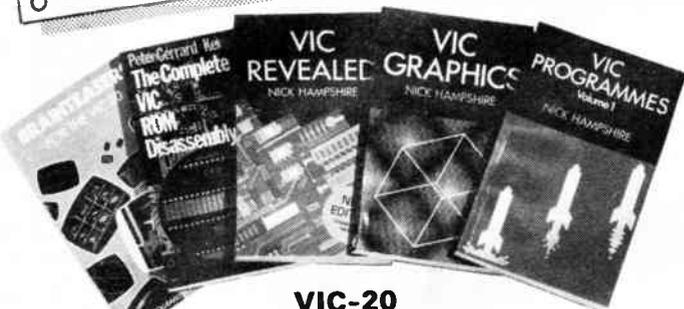
Computer Book Sale

Everyday Electronics is pleased to be able to offer this range of books to readers, all at 99p each, plus £2 per order postage and packing.

99p EACH plus postage

To order your choice of Books simply send a cheque or postal order, made payable to Greenweld Electronics, for the correct amount. Add £2 post to all orders (£5 for all overseas orders) and send to address below.

EE Computer Book Sale, Greenweld Electronics Ltd, 443 Millbrook Road, Southampton SO1 0HX. Tel: 0703 772501.



VIC-20

Brainteasers for the VIC-20 Pub. Price £5.95

G. Ludinski. Size 215 x 134mm 133pp
Book of programs built around a competition element—logic, general knowledge, maths, whodunnits, etc. Graphics fully exploited.

The Complete Vic ROM Disassembly Pub. Price £6.95

Peter Gerrard & Kevin Bergin. Size 215 x 134mm 157pp
For the serious programmer, complete disassembly of all ROM routines, also complete 6502 m/c instruction set, etc.

Vic Revealed Pub. Price £9.95

Nick Hampshire. Size 215 x 134mm 267pp
How and why the Vic works. 5 sections in the book covering functional blocks—6502, 6561, 6522, software and I/O functions plus appendices of codes and circuit diagram.

Vic Graphics Pub. Price £6.95

Nick Hampshire. Size 215 x 134mm 185pp
How to generate graphic displays—graph and colour plotting. Hi-res graphics, scaling, rotating and 3D displays, all fully explained.

Vic Programmes Vol. 1 Pub. Price £6.95

Nick Hampshire. Size 215 x 134mm 184pp
Useful and interesting collection including music, games, utilities, graphics and functional programs, 36 altogether.

A Pocket Handbook for the VIC Pub. Price £2.95

Peter Gerrard & Danny Doyle. Size 215 x 135mm 95pp
A must for all serious VIC-20 users—tables, disk commands, memory, maps, m/c inst. set, details of all sockets, sound, etc., etc. Cover design similar to Dragon version.



SPECTRUM MSX & ATARI

Introducing MSX Basic Pub. Price £6.95

Paul Kuzora & Christine King. Size 210 x 150mm 242pp
First steps in MSX BASIC, sound and graphics, sprites + 5 programming projects. Essential guide for all MSX owners.

Getting Started with the Atari 600XL Pub. Price £5.95

Peter Goode. Size 215 x 134mm 141pp
Aimed at first time users, this book guides you through BASIC, graphics, designing progs and filing data on cassette. Example progs shown.

Spectrum Graphics Pub. Price £6.95

Nick Hampshire. Size 215 x 135mm 192pp
Hi-res graphics, graph plotting, using the video memory, 3D and rotating displays are all included. Many progs with full explanations.

Spectrum Programmes Vol. 1 Pub. Price £6.95

Nick Hampshire. Size 315 x 134mm 182pp
A wide range of interesting and useful progs: music, games, utilities, graphics, functional progs, etc.—26 altogether.

My Atari XL & Me Pub. Price £2.95

Jack Walker. Size 196 x 125mm 89pp
For children, this book starts at the beginning. Nicely illustrated, well written, finishing with complete game.

My Spectrum Computer & Me Pub. Price £2.95

Meyer Solomon. Size 196 x 125mm 83pp
For children, this book starts at the beginning. Nicely illustrated, well written, finishing with a complete game. Cover design similar to Atari version.

Spectrum Crib Card Pub. Price £1.99

Everything needed on a fold-out, double-sided, glossy card. 12 panels. Size 210 x 98mm. Similar style to the CBM 64 version.



CBM 64

The Sensible 64 Pub. Price £5.95

David Highmore & Liz Page. 208 x 150mm 122pp
Covers what the manual doesn't!—keyboard, user defined graphics, displays, sprites, sound and music, disk drives and printers.

Commodore 64 Games Pub. Price £6.95

Kevin Bergin. Size 215 x 134mm 190pp
21 exciting games—making full use of graphics and soundcard dodge, air attack, hangman, etc. All are accompanied by notes.

CBM 64 Programs Vol. 1 Pub. Price £6.95

Richard Franklin & Nick Hampshire. Size 215 x 134mm 191pp. 20+ progs covering a wide variety of interests. Includes Hi-res graphics, music, games, utilities, sprites etc. plus full length adventures.

C64 Crib Card Pub. Price £1.99

Everything needed on a fold-out, double-sided, glossy card. 12 panels. Size 210 x 98mm

A Pocket Handbook for the Commodore 64 Pub. Price £2.95

Peter Gerrard & Danny Doyle. Size 215 x 135mm 95pp. Essential for all serious C64 users—Tables, memory, maps, m/c inst. set, cartridge and joystick connexions RS232/Centronics data, sound chip registers, sprites, etc., etc. Cover design similar to Dragon version.



DRAGON

Brainteasers for the Dragon 32 Pub. Price £5.95

G. Ludinski. Size 215 x 135mm 144pp
Book of programs built around a competition element—logic, general knowledge, maths, whodunnits, etc. Graphics fully exploited.

Dragon Programs Pub. Price £6.95

Nick Hampshire. Size 215 x 135mm 173pp
20 exciting and interesting programs—Star Trek, Breakout, Logic games, sound effects, graph plotting, etc.

A Pocket Handbook for the Dragon Pub. Price £2.95

Peter Gerrard & Danny Doyle. Size 215 x 135mm 91pp. For machine code enthusiasts, it contains ASC11 codes, tables, assembly/dissassembly, BASIC keywords/errors, etc. plus useful hints and tips.



BBC/ELECTRON

Exploring Adventures with the BBC/Electron Pub. Price £6.95

Peter Gerrard. Size 215 x 135mm 244pp
Starting with an introduction to adventures and their early history, this book takes you through the steps necessary to write your own games. Highly readable. Versions for BBC and Electron available—state which is required.

BBC Programs Vol. 1 Pub. Price £6.95

Carl Graham & Nick Hampshire. Size 215 x 134mm 176pp
27 interesting progs covering games, utilities, graphics, etc. A basic book for all Beeb users!

Electron Programs has 24 progs.

BBC Micro Crib Card Pub. Price £1.99

Everything needed on a fold-out, double-sided, glossy card. 12 panels. Size 210 x 98mm. Similar style to CBM 64 version.

Apart from books listed here, we have small quantities of other titles at greatly reduced prices. SAE for list, or free with order. To Greenweld Electronics, 443 Millbrook Rd., Southampton SO1 0HX.
Post and Packing: £2.00 per order for up to 100 books UK only. £5.00 per order for up to 50 books overseas. Additional Discounts for large quantity buyers: 1-24 books 99p, 25-99 books 89p, 100-249 books 69p + carr, 250-999 books 49p + carr, 1000+ books 29p + carr.

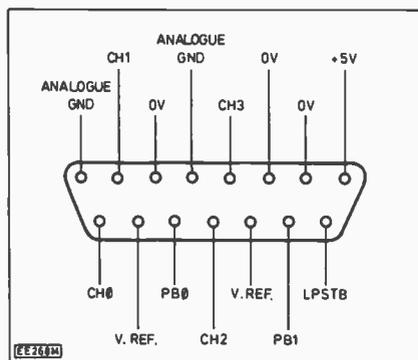
ANYONE involved with home computers professionally tends to get asked the dreaded question; "which is the best computer to buy?" This is very much a "how long is a piece of string?" type question, and the right answer depends entirely on the intended applications of the machine. However, for someone who is interested in connecting home constructed gadgets to a computer the BBC model B remains the obvious choice. It is not so much that it has greater add-on potential than the competition, but is more a case of its range of ports making it easier to add practically any type of add-on to this machine than any other. Its fast version of BASIC and built-in assembler are also plus points which must be taken into account.

With around 400,000 BBC computers in circulation, and many of these in the hands of electronics enthusiasts and educational establishments, no excuse is made for this new series which will deal with interfacing to the BBC machine. Do not worry about this series being devoted to masses of software; we will be primarily concerned with circuits that you can build, and any software will be applications or demonstration programs to accompany these devices. The circuits will in the main be quite simple types, and it is surprising how much can be achieved using the BBC machine in conjunction with a few very simple add-ons. None of the circuits will involve delving into the interior of the machine and making modifications. All will connect to one or more of the computer's many externally accessible ports.

Analogue Port

For someone who is just starting at computer interfacing, especially if they are more familiar with linear circuits than digital types, the analogue port of the BBC computer probably represents the easiest introduction to the subject. This is one of the ports at the rear of the machine, and it uses a 15-way "D" type socket. Connections

Fig. 1. Connection details for the BBC micro analogue port.



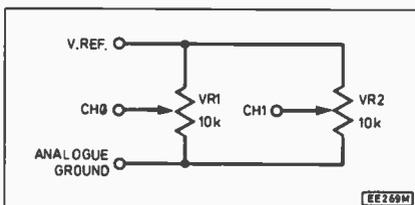
to it are accordingly made by way of a matching 15-way "D" type plug, although I have found it possible to use one millimetre plugs as a cheaper solution in cases where only two or three connections are to be made. Fig. 1 gives connection details for the analogue port.

The main purpose of this port is to enable two joysticks to be connected to the machine. The joysticks must be of the type which contain potentiometers, rather than the Commodore/Atari switch type. One potentiometer is operated by vertical movement of the stick—the other is controlled by horizontal movement. With this type of joystick the idea is to have the position of some on-screen character related to the position of the joystick (e.g. placing the stick over to the extreme right hand side and centrally top to bottom would place the character on the extreme right hand side and half way up the screen). This is unlike the more common switch type joystick where the stick is used to indicate movement in a particular direction rather than to directly indicate a precise screen position.

A joystick connects to the port in the manner shown in Fig. 2. The V.Ref outputs provide a reference potential of 1.8V, which is equal to the full scale value of the analogue inputs (CH0 to CH3). The two potentiometers are connected between analogue ground and V.Ref, and can each therefore supply any voltage between zero and the full scale value of the port. The potentiometers of the second joystick have the same method of connection, but their outputs feed into the CH2 and CH3 inputs. Most joysticks have a "firebutton", and PB0 and PB1 are used to monitor these. The pushbuttons are wired so that they take these inputs to ground when operated. Incidentally, the analogue ground inputs are used instead of the 0V supply rail as the analogue ground inputs, in theory at any rate, give less severe noise problems.

The converter in the BBC machine is a μ PD7002 12-bit type. It includes an analogue multiplexer which provides the four inputs, but it is not a high speed type and only about 100 readings per second are taken, or 25 per channel with all four in use. From BASIC the analogue inputs are read using the ADVAL function, with

Fig. 2. Joystick connection to the analogue port.



ADVAL(1) to ADVAL(4) somewhat confusingly corresponding to CH0 to CH3 respectively. The values returned are in the range 0 to 65520, but increment in 16s. Returned values must be divided by 16 to give a 0 to 4095 range with increments of 1. In practice noise prevents the full 12-bit accuracy from being obtained, and a true accuracy of no better than 10-bit resolution is likely to be obtained. This is not too important as most applications require only 7 or 8-bit resolution, and as we shall see in later articles the analogue inputs can be used very successfully in a wide range of measurement applications.

We will consider the analogue port in more detail in next month's article, which will include a touch controller circuit.

REVIEW

BBC Diagnostics

Has your Beeb ever coughed or sneezed? If so, to the rescue come Watford Electronics with a disc-based program to tell you what the trouble is. Well, perhaps not quite, but the Diagnostics Disc is an effective way of checking most of the main components and systems of the BBC micro.

As the well-written and comprehensive instruction book rightly says, to fully check all the Beeb's bits would take a very large program several years. This program makes a good effort, however, checking the RAM, OS ROM (the program is for OS 1.20 only), the keyboard, the video components and RAM, the user port, RS432 interface, analogue port, cassette system, the sound system, and the printer port.

The program can also be used to check some add-ons, such as sideways RAM, joysticks, the disc system, speech system, and second processors (6502 and Z80) if these are fitted. However, the "TUBE" circuitry cannot be checked if a second processor is not fitted.

There is also a means of testing sideways ROMs. The program will perform a Cyclic Redundancy Check on these, and report the checksum, which you can record on a special page in the instruction book. The idea is that you check ROMs as soon as possible after you obtain them, when presumably they are working correctly.

If at some later date, a ROM appears to go faulty, you can perform the test again, and if the checksum has changed, a ROM fault is indicated.

Certain tests on some of the ports require connections to be made, and leads are supplied with the disc for this purpose.

The instruction book contains a lot of general advice about how to treat the components of a computer (static sensi-

tivity, etc.) and though some of this will be old hat to readers of this magazine it is nice to see it included. In fact, much praise could be heaped on the documentation. It is very readable, and includes clear diagrams where necessary.

As well as taking you through all the stages of the program, the instructions include suggestions for further tests when a fault is located, and also advice on possible cures.

This program is, perhaps, of limited interest to individual owners of BBC computers (though it has considerable "play value" for the technically minded) but it could be invaluable to schools and institutions using many computers. In particular, it will be of value where BBC computers are being used for data acquisition in laboratories, as it will allow both RAM and ports to be checked before and after experiments. If an unexpected result should then occur, the

possibility of malfunction can be eliminated.

In any case, this is certainly an interesting and unusual addition to the wide range of software available for the BBC micro. It is available direct from Watford Electronics, for £24.15, including VAT, postage and packing. (Please mention this EE review when ordering.) Watford Electronics, Dept EE, 250 High St., Watford WD1 2AN. Tel. 0923 37774.

FREE! READERS' BUY & SELL SPOT EE MARKET PLACE

RULES Maximum of 16 words plus address and/or phone no. Private advertisers only (trade or business ads. can be placed in our classified columns). Items related to electronics only. No computer software. EE cannot accept responsibility for the accuracy of ads. or for any transaction arising between readers as a result of a free ad. We reserve the right to refuse advertisements. Each ad. must be accompanied by a **cut-out valid "date corner"**. Ads. will not appear (or be returned) if these rules are broken.

British Amateur Electronics Club for all interested in electronics. Quarterly newsletter U.K. £7. For details send s.a.e. to Cyril Bogod, 'Dickens', 26 Forrest Road, Penarth, S. Glam. CF6 2DP.

Wanted: oscilloscopes type 3031. Good picture and working inc. probes. £100 or under. Mr. P. S. Boulton, 25 Tudor Road, Intake, Doncaster, S. Yorks DN2 6EN.

Oscilloscope, Cossor 339A. Dual trace, uncalibrated. Quite old. £25 o.n.o. or swap for multimeter/other test gear. Mr. Walls. Tel: 0371 2900.

YAESU FRG 7700 comms. receiver. 0-30MHz boxed with manuals. Little used. £270 o.n.o. Tel: Bradford 594880.

Set Everyday Electronics first issue November 1971 to date. As new. Four copies missing. Offers. Mr. J. G. Hill, 13 Grange Avenue, Ben Rhydding, Ilkley, W.

Yorkshire LS29 8NU. Tel: 0943 608366.

Wanted: Spectrum computer hardware, add/ons and uses satellite TV. Slow scan TV. Telephone: 0408 21870 evenings.

For sale approximately 3,000 circuits and service manuals, TV, radios, electrical appliances. From 1940-1980. Offers. Mr. R. Macdonald, 35 Langdon Road, Folkestone, Kent CT19 4HX. Tel: 0303 75541.

Aquarius computer new, unused £40 o.n.o. Rhythm ACE drums unit £50 o.n.o. Excellent professional keyboard £15. J. Howells, 118 Heritage Park, St. Mellons, Cardiff, S. Glam. Tel: 0222 797956.

Wanted: microwave radiation detector with or without circuit. Working or not, construction details or any info. Mr. H. D. Speed, 18 Chaucer Avenue, Andover, Hants SP10 3DS. Tel: Andover 54966.

Wanted: stereo push button FM tuner.

As bi-pak S450. Any condition. Ayres, 31 Barr Common Road, Aldridge, Walsall. Tel: 0922 51591.

For sale main parts to build MR Rayers solid state oscilloscope. All work. Offers. Mr. D. Corder, Low Weasdale, Newbiggin-on-Lune, Kirkby Stephen, Cumbria CA17 4LY. Tel: 05873 246 after 6 p.m.

Wanted: circuit, manual and/or transformer for Mullard L203 or similar valve oscilloscope. Aidan Mitchell, 78 Castlemore Avenue, Belfast BT6 9RG. Tel: Belfast 799111.

Electronic Piano Wanted: Full size. Touch sensitive. Reasonable price. Mr. A. Wood, 1 Straight Road, Short Heath, Willenhall, West Midlands WV12 5QY. Tel: Bloxwich 476815.

Wanted: Acorn Atom BBC Basic board. Telephone: Reading (0734) 712348.

Please read the **RULES** then write your advertisement here— one word to each box. Add your name, address and/or phone no. Please publish the following small ad. **FREE** in the next available issue. I am not a dealer in electronics or associated equipment. I have read the rules. I enclose a **cut-out valid** date corner.

Signature Date

COUPON VALID FOR POSTING BEFORE 21 APRIL, 1986
(One month later for overseas readers.)

**SEND TO: EE MARKET PLACE, EVERYDAY ELECTRONICS,
6 CHURCH STREET, WIMBORNE, DORSET BH21 1JH.**

BLOCK CAPITALS PLEASE

Name & Address:			

For readers who don't want to damage the issue send a photostat or a copy of the coupon (filled in of course) with a **cut-out valid "date corner"**

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

AMONG radio amateurs there are a number of operators regarded as slightly mad by their colleagues. These are the QRP (low power) enthusiasts, and I admit to being one myself. They make contact over the air with a fraction of the power used by everyone else. In the face of ever increasing noise and interference on the bands, they persist in this practice even when, sometimes, it is almost impossible to hear each other's signals!

Why do they do it? Because of the challenge in completing a contact under such conditions; because the equipment required is so simple it can all be home-made and need cost very little; because it brings back something of the atmosphere of early amateur radio.

I mention this because I had the pleasure of attending the Yeovil Amateur Radio Club's annual QRP Convention recently. Well over a hundred keen QRPer's from many parts of the UK converged for an enjoyable day out. This included lectures, an exhibition of home-constructed equipment, and the opportunity to buy components for further construction.

Three stations were on the air, using less than three watts output, including a B2 spy set originally carried in a small suitcase by SOE operators during WW2. Visitors could operate these stations, and contacts were made with other QRPer's unable to attend the convention.

A fascinating lecture by Rob Micklewright, G3MYM, posed the question, "Can we work VK (Australia) on QRP?" Most of his audience knew the answer already, but he analysed the various factors involved, i.e. propagation path, noise level, optimum frequency, station site, antenna, losses in signal hops, time of year, time of day, and the sunspot count.

Most of us just wait until we hear Australian stations. We call them using anything from three watts down, and just occasionally someone is successful. Rob showed us there was considerably more to it than that and how, with some forethought, we could increase our chance of success.

MEET THE CLUB

The convention is the only one of its kind in Britain, and the Yeovil Club are to be congratulated on organising it. Back in the fifties, they operated what may have been the first amateur transistor transmitter. Constructed around an experimental point-contact transistor, this made an historical transmission on the 80 metre band, over a distance of 90 miles, with an input power of just 30 milliwatts. The club celebrates its 40th anniversary in 1986, and still has four founder members going strong.

Amongst many activities, there is a radio amateur's examination course, where newcomers make a simple direct-conversion receiver as a practical introduction to both construction and short-wave listening. RSGB slow Morse practice transmissions are put out under the club call-

sign, G3CMH/A, and the club station can be heard at times on all amateur bands from 160m to 70cms.

They have built, and maintain, a 70cms repeater, GB3YS. This receives weak signals, amplifies, and re-transmits them over a wider area than would otherwise be possible, a facility particularly useful for mobile operators. Special event stations, where the public can see the club in action, are mounted at the Mid-Somerset Show, the Yeovil Festival of Transport, and at various other events.

There is much more. If you live in or around Yeovil, telephone Eric Godfrey, G3GC, on Yeovil 75533, for further information. There are similar clubs in most parts of the country, where newcomers to the hobby are always welcome.

50MHz ALLOCATED

The new 50MHz allocation became effective on 1st February. As anticipated, there are a number of restrictions to prevent interference with European broadcast stations. The power permitted is considerably less than that on other bands, and antenna heights are limited. Mobile, portable, temporary premises, or repeater operation is not allowed. Fortunately, the possibility of restricted operating times has not materialised, for the DTI has agreed to review the use of the band in a year's time.

Since the preliminary announcement last year, a number of magazine articles have anticipated the new allocation. These show how to get on the new band in various ways, and some commercial equipment has arrived on the market.

The sunspot minimum provides poor propagation conditions at present, however, and, with the restrictions imposed, it is difficult to see the amateur population at large getting too excited about the new band. When conditions begin to improve in the next two or three years, it may be a different story!

QUESTION CORNER

Q. What is an s.w.r. bridge, and what does it do?

A. This is a device inserted in a feeder line to indicate to the operator that there is

Nobby Clark, G3BEC, a founder member of the Yeovil club, operating a B2 spy set at the QRP convention.

(hopefully) a good match between a transmitter and an antenna. Assume that a simple dipole antenna is in use. This is a length of wire with a physical length calculated as a half-wavelength for the frequency to be used. For 7MHz—the 40 metre band—this would be approximately 20 metres long. If this wire is broken in the middle to provide a feed point, the impedance will be such that it will provide a reasonable match (50–70 ohms) to an amateur transmitter, and a satisfactory transfer of power for the antenna to radiate. To help in this, matching coaxial cable of, say, 50 ohms impedance is used as a feeder.

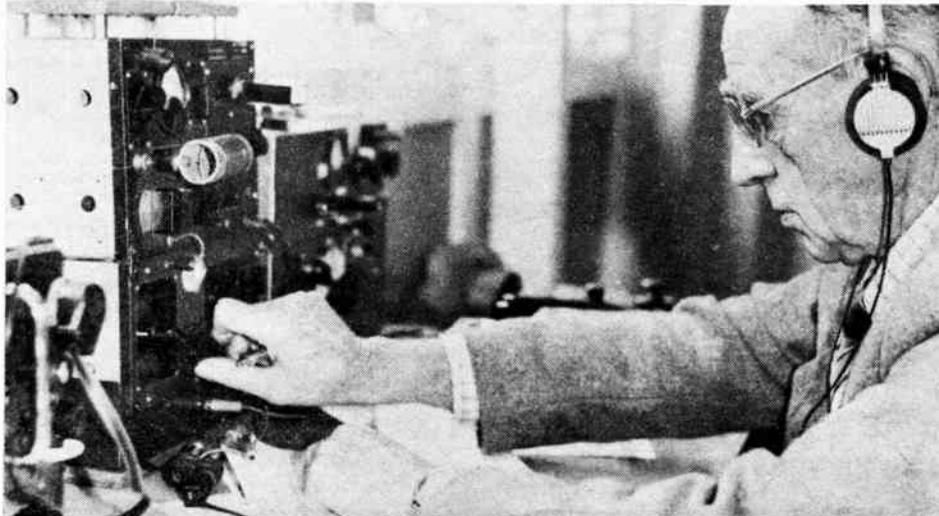
When there is not a satisfactory match at the feed point for any reason, a portion of the power is reflected back down the feeder in the form of "standing waves". The ratio between the "forward" and "reflected" power is the "standing wave ratio", and the function of an s.w.r. bridge is to indicate this ratio.

The actual instruments may have one or two meters. A single meter can be switched to show forward and reflected readings separately, while twin meters show them simultaneously. When a forward reading gives full-scale deflection of the meter, the reflected reading should never exceed 3:1, which is usually half-scale. An s.w.r. of 2:1 is better, and anything down to 1:1 is best of all, normally indicating that most of the power is being taken by the antenna.

Some transmitters automatically reduce output in the face of a mismatch, a situation the bridge will indicate immediately. It is invaluable in antenna experiments, and in the forward mode some versions can be calibrated to give an indication of actual power output. An s.w.r. bridge is an essential part of an amateur station, which can be either purchased or easily built. In the latter case it makes a very good introduction to amateur radio home construction.

QUESTIONS PLEASE!

If you have a question about amateur radio, write to me c/o the editor. I can, however, only reply through this column. 73 de G4FAI.



DIGITAL ELECTRONICS

**MADE
EASY**



SUPERKIT £22.00
SUPERKIT II £16.00
(£35.00 if bought together)

The SUPERKIT series introduces beginners to practical digital electronics. SUPERKIT (SUP I) is the first kit, which contains an instruction manual, a solderless breadboard, and components (7 integrated circuits, switch, resistors, capacitors, LEDs and wire). It teaches boolean logic, gating, flipflops, shift registers, ripple counters and half adders. SUPERKIT II (SUP II) extends SUPERKIT. It contains an instruction manual and components (10 integrated circuits, 7-segment display, resistors, capacitors and wire), and explains how to design and use adders, subtractors, counters, registers, pattern recognisers and 7-segment displays.

DIGITAL COMPUTER LOGIC £7.00
DIGITAL COMPUTER DESIGN £9.50
MICROPROCESSORS & MICROELECTRONICS £6.50

The SUPERKIT series is backed by our theory courses. DIGITAL COMPUTER LOGIC (DCL), the beginners' course, covers the use and design of logical circuits, flipflops and registers. DIGITAL COMPUTER DESIGN (DCD), a more advanced course, covers the design of digital computers both from their individual logic elements and from integrated circuits. MICROPROCESSORS and MICROELECTRONICS (MIC) teaches what a microprocessor is, how it evolved, how it is made and what it can do.

GUARANTEE. If you are not completely satisfied, return the item to us in good condition within 28 days for a full refund. All prices include worldwide surface postage (ask for prepayment invoice for airmail). Orders despatched within 48 hours. Overseas payment by international credit card or by bank draft drawn on a London bank.

**CAMBRIDGE LEARNING LTD, Unit 39, Rivermill Site,
FREEPOST, St. Ives, Huntingdon, Cambs. PE17 4BR, England
Telephone: 0480 67446.**

VAT No. 313026022 Transcash No. 2789159 Reg. No. 1328762

Please send me (initial letters used):

..... SUP I	@ £22.00 DCL	@ £7.00
..... SUP II	@ £16.00 DCD	@ £9.50
..... SUP I + II	@ £35.00 MIC	@ £6.50

Full details of all your courses (please tick)

I enclose a cheque/PO payable to Cambridge Learning Ltd.

for £.....

Please charge my credit card.

No. Expiry date

Telephone orders from credit card holders accepted on 0480 67446 (24 hrs).

Name

Address

..... Signature

CAMBRIDGE LEARNING LTD
Unit 39, Rivermill Site, FREEPOST,
St. Ives, Huntingdon, Cambs PE17 4BR
England.



* BARGAINS! *



UNBEATABLE VALUE!

£1 PACKS!

- Pack 1 350 assorted resistors $\frac{1}{2}W$, $\frac{1}{4}W$, $2\frac{1}{2}W$ etc. Excellent range of values. All have full length leads. £1
- Pack 2 200 Assorted capacitors, polystyrene, polycarbonate, polyester film. Super range of values. £1
- Pack 3 10 Assorted switches, rotary, slider, push, including 4p3w, 2p3w types £1
- Pack 4 15 Assorted control knobs, silver, black, silver/black £1
- Pack 5 50 Assorted carbon track pre-sets. Such as: 220K, 1M 2M2, 470R, 50K etc. £1
- Pack 6 15 Assorted Jack & DIN sockets £1
- Pack 7 20 Assorted semiconductors: Such as, 74LS367, 2N5457, BC109, BCY72, MPSU05, BFR79, 7915 etc. £1
- Pack 8 10 Assorted single rotary potentiometers, log & linear. Excellent range of values £1
- Pack 9 10 Assorted single slider potentiometers, log & linear. Excellent range of values £1
- Pack 10 1 Pair of heatsinks, black anodized & drilled for T03 can size. Dimensions 87mm x 70mm x 46mm approx. Cross section as illustrated. Weight of each sink 125gm £1

£2 PACKS!

- Pack 11 100 Assorted electrolytic capacitors including miniature single ended and axial leads. Excellent range of values such as 220mf 25V, 0.47mf 100V, 1mf 63V, 470mf 10V, 470mf 35V, 47mf 25V, 100mf 10V etc. £2
- Pack 12 650 Assorted resistors $\frac{1}{2}W$, $\frac{1}{4}W$, $2\frac{1}{2}W$ etc. Excellent range of values. All have full length leads £2
- Pack 13 450 Assorted capacitors, including polystyrene, polycarbonate, polyester film. Excellent range values £2
- Pack 14 2 four bank interlocking push-button switches with black/silver knobs £2
- Pack 15 300 Assorted metal oxide & metal film resistors all $\frac{1}{2}$ %, 1% or 2%. Excellent range of values, all have full length leads £2
- Pack 16 100 Assorted resistors, wirewound $2\frac{1}{2}W$, 4W, 5W, & Carbon film 1W, 2W etc. All have full length leads £2
- Pack 17 50 Assorted semiconductors such as 74LS367, 2N5457, BC109, BCY72, MPSU05, BFR79, 7915 and many more! £2
- Pack 18 10 Assorted dual slider potentiometers Log & Linear. Excellent range of values £2
- Pack 19 10 Assorted dual rotary potentiometers Log & Linear. Excellent range of values £2
- Pack 20 2 pieces, 2 bank rotary mode switch 2P5W £2

'Hardware Pack'

- Pack 21 50 Assorted pieces of hardware including a selection of the following: Edge connectors, molex plugs, panel fuse holders, fuses, mains neons, jack sockets, DIN sockets etc. Irresistible value at only 8p per piece! Postage & Packing for our Hardware Pack is 0.80p

£4

Postage & Packing £1.00 on Packs 1-21 (any quantity!)

'Beefy Capacitor Pack'

£5

- Pack 22 4700mf 30V x 4, 2200mf 100V x 4, 3300mf 40V x 2. Fantastic value, Limited Quantity Only So Hurry! Postage and Packing on these capacitors is £1.

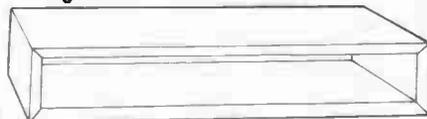
'Pot Luck'

- Pack 23 40 Assorted potentiometers including rotary & slider, single & dual, lin & log and 20 turn adjusters etc. Excellent range of values. Amazing value at

£5

Postage & Packing. Sorry, because of the weight we have to charge £1.50 on this pack.

'Calling All Kit Builders'



Pack 24 Cabinet 15.5" x 8.7" x 2.8". Postage & Packing £2.23.

Build into one of these high quality cabinets and give your project a professional finish. Teak exterior, balancing veneer interior



Pack 25 Cabinet 18.3" x 12.7" x 3.1". Postage & Packing £2.85.

Free 'Goodie bag'

Each cabinet comes complete with FREE 'Goodie Bag'. Example contents: Selection of several different coloured wires (at least 8 different colours), potentiometers, switches, capacitors, fuses, mains neon, heatsink and Printed Circuit Board (mostly old ETI projects, sorry no instructions) to experiment with. Absolutely Unbelievable Value. Limited Stock so Hurry, Offer cannot be repeated.

ORDERING: Please send Postal Order, Cash or Cheque with order. Do not forget to add postage and packing charge as indicated for your packs.
DESPATCH: Your order will receive our prompt attention and will be despatched from stock within 48 hours of receipt.
SATISFACTION GUARANTEED: We are so confident that you will be completely satisfied with the value of these packs that we offer a 14-day MONEY BACK GUARANTEE.

AES Ampert Electronic Supplies

The Old Oaks, Furzedown Lane,
Amport, Andover, Hampshire
Telephone: Weyhill (0264 77) 2763

FET VOLTMETER

Michael Tooley BA David Whitfield MA MSc CEng MIEE

MEASURING instruments are an essential aspect of almost every type of practical electronics. This month's project in the *Teach-In '86* project is a FET Voltmeter.

One of the important features of any measuring instrument is that it should not significantly disturb the circuit under investigation. It is, after all, little use having an ammeter in series with a 5V power supply rail if it introduces a 1V drop in the process.

VOLTAGE MEASUREMENT

With voltage measurements, the increasing use of low power technologies such as

CMOS has made the situation even more extreme. A general purpose multimeter on the d.c. voltage ranges has an effective impedance which varies according to the range selected; typically this will be around 20k Ω per volt of the range selected. Such a voltmeter, if set to the 5V d.c. range, would thus impose a load of 100k Ω on the circuit under test.

In high power circuits, this would cause little problem, amounting as it does to an additional drain of 50 μ A on a 5V signal. However, in circuits which have very low operating currents and hence impedances which may run to many megohms, it is clear

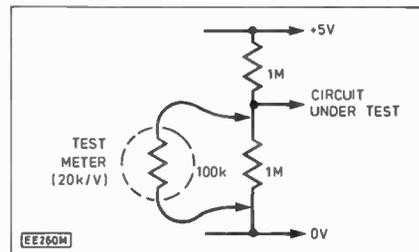


Fig. 1. Voltmeter impedance effects.

that the load imposed by such a voltmeter could significantly disturb the operation of the circuit.

For example, referring to Fig. 1, if we try to measure the potential at the centre of a simple 1M Ω + 1M Ω resistive divider across a 5V rail using a 20k Ω per volt meter, the result would be a reading of 0.42V. This is a significant error when compared to the correct value of 2.5V!

The FET Voltmeter to be described is an electronic voltmeter which presents a constant input impedance of 10M Ω , irrespective of the range selected. It thus presents a very significantly higher impedance than is possible with a conventional multimeter for the measurement of d.c. and a.c. voltages. In addition, the load imposed on the circuit under test is not affected by the range selected.

CIRCUIT DESCRIPTION

A block diagram for the FET Voltmeter is shown in Fig. 2, with the corresponding circuit diagram in Fig. 3. The input attenuator formed by R1 to R12 presents an impedance of 10M Ω between SK1 and SK2.

The range selection is performed by S1, and the input impedance of the following stages is so high as not to impose any significant loading on the attenuator. At full-scale input on the selected range, the output from S1 is 900mV.

For d.c. measurements, the output from the attenuator is applied directly to the input of the meter buffer amplifier, IC1b. This stage uses a low noise BI-FET operational amplifier which has an input impedance of 10¹²ohms.

The gain of the stage is set by R20 and R21 to produce a 1V output from a 900mV input. The output is arranged by suitable setting of VR2 to produce 1mA through the meter, ME1, for a full-scale input.

For a.c. measurements, the input signal is switched to the active rectifier circuit by S2. The rectifier uses the second amplifier in the IC1 package, IC1a. A capacitor, C1, is connected in series with the input to remove any d.c. component present on the signal.

COMPONENTS

Approx. cost £22
Guidance only

Resistors

R1,R4,R5	1M (3 off)
R2	6M8
R3	200k
R6	680k
R7	20k
R8,R9	100k (2 off)
R10	68k
R11	2k
R12	30k

All 2% or better

R13,R20	1M (2 off)
R14,R15	18k (2 off)
R16	6k8
R17,R18,R22	10M (3 off)
R19,R21	100k (2 off)

All 1/4 W \pm 5% carbon film

Potentiometers

VR1	4k7 horizontal preset
VR2	1k horizontal preset

Capacitors

C1	47n polyester
C2,C3,C4	100n polyester (3 off)
C5,C7	10 μ elec. 25V (2 off)
C6,C8	100n polyester (2 off)

Semiconductors

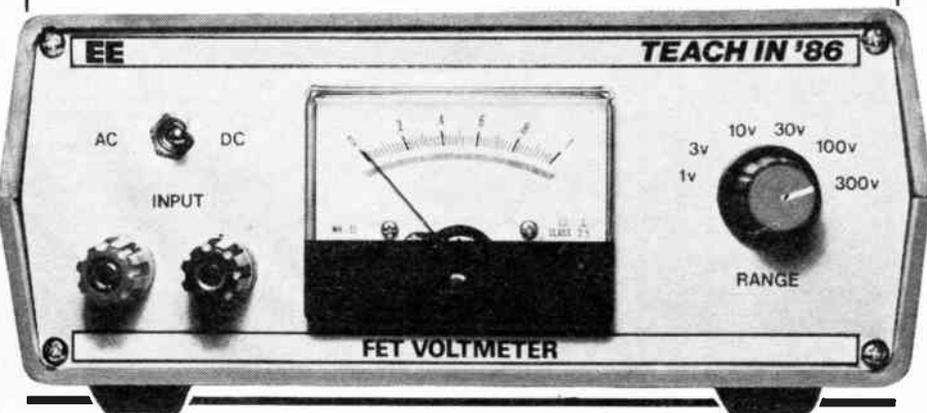
D1,D2	1N4148 (2 off)
D3,D4	1N4001 (2 off)
IC1	TL072 BI-FET Operational Amplifier

Miscellaneous

ME1	1mA meter (e.g. 2in Panel Meter)
S1	2-pole 6-way rotary switch
S2	DPDT toggle switch
SK1	4mm terminal (red)
SK2	4mm terminal (black)
SK3	4mm socket (red)
SK4	4mm socket (black)
SK5	4mm socket (blue)

One knob, with pointer; 4 stick-on plastic feet; Veroboard 0.1" pitch 5in x 3.75in and mounting hardware; Vero terminal pins (7 off); Case: West Hyde Developments type TEK A22, available in black, grey or lobster red at £6.18 + VAT, inclusive of carriage.

See **Shop Talk** page 208



The precision rectifier then uses D1 and D2 to rectify the alternating input cycles. The positive component of the signal is sampled by R19 and C4. The circuit is arranged to sense the mean value of the input, while the output is calibrated to indicate the r.m.s. value of a sine wave by suitable adjustment of VR1.

CONSTRUCTIONAL DETAILS

The meter is built in the standard project case, and uses a circuit board for mounting most of the small components. The layout for the main circuit board is shown in Fig. 4.

However, before soldering any components in place on this board, four mounting holes of suitable diameter need to be drilled, and 6 track cuts are required. These are best made using a proprietary track cutter, or a large diameter sharp drill rotated slowly by hand.

When the board has been prepared, the components may be fitted in the positions shown in Fig. 4. The order of assembly is not critical, but a methodical approach (e.g. left to right across the board) is to be recommended.

Care should be taken to correctly orientate the polarised components (the integrated circuit, electrolytic capacitors and the diodes). The use of terminal pins is recommended for all off-board connections, since this will simplify the later installation of the interconnection wiring.

Before moving on, it is well worth spending a few moments at this point making a careful visual inspection of the completed

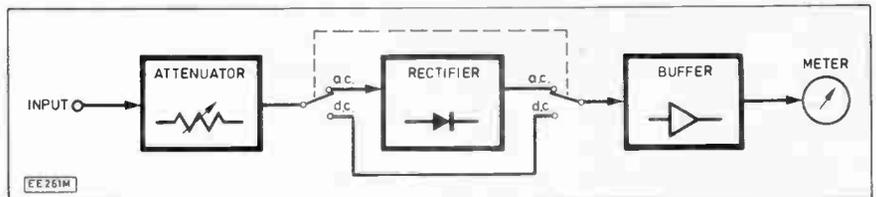
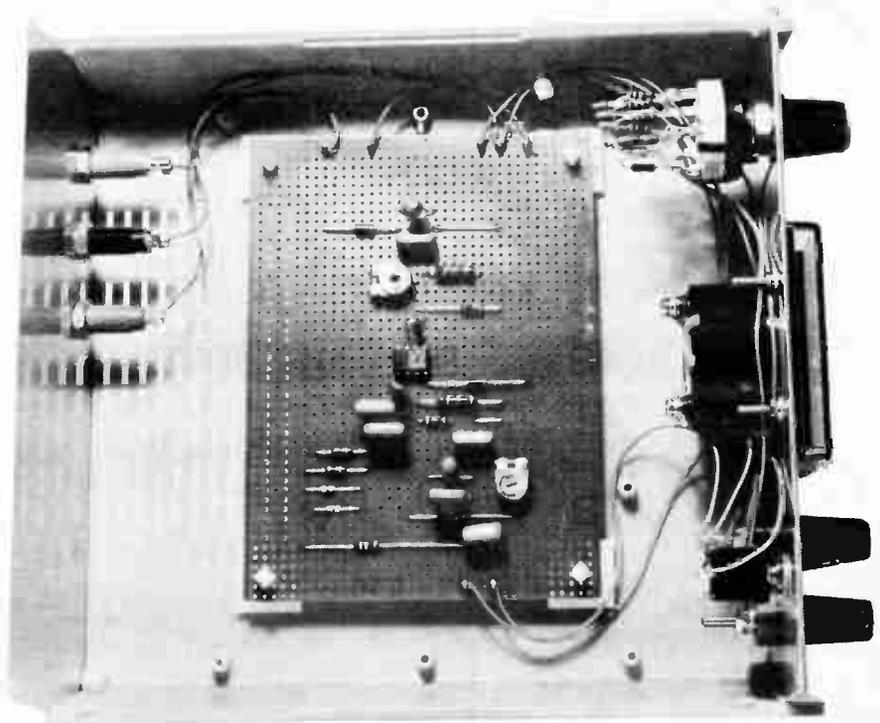
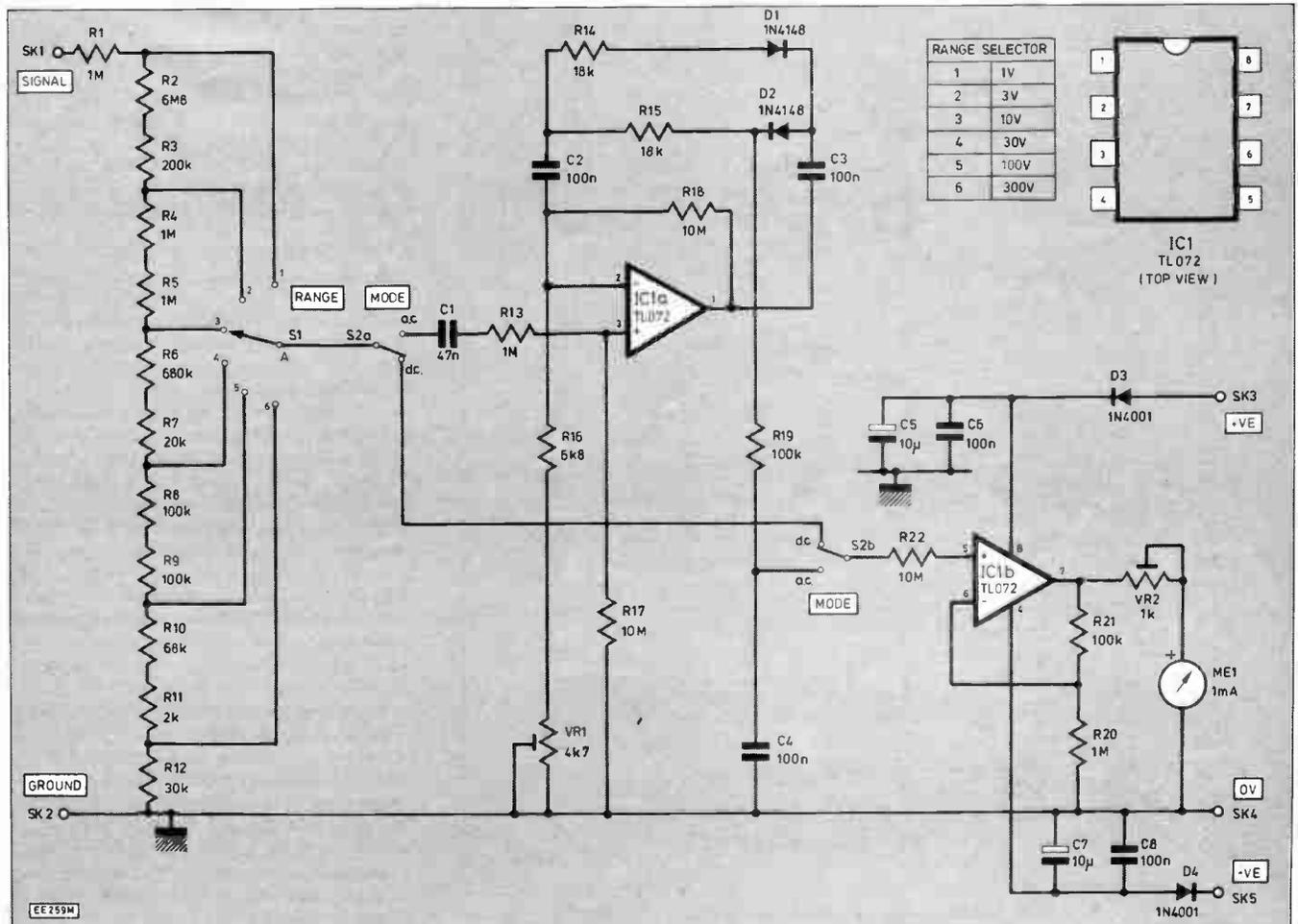


Fig. 2. Block diagram for the FET Voltmeter.

Fig. 3. Complete circuit diagram for the FET Voltmeter.



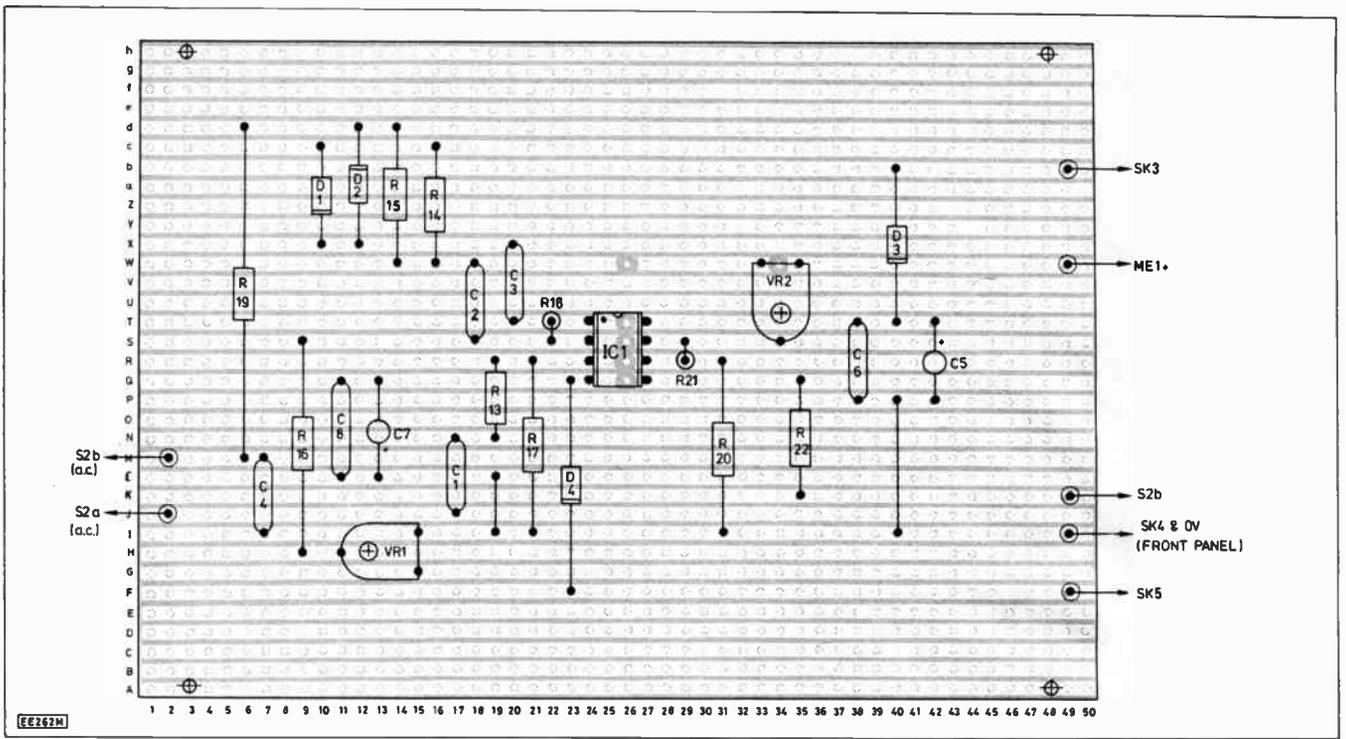


Fig. 4. Circuit board component layout and details of breaks to be made in the copper strips on the underside of the board. Breaks are required at Q26, R26, S26, T26, W26 and W34.

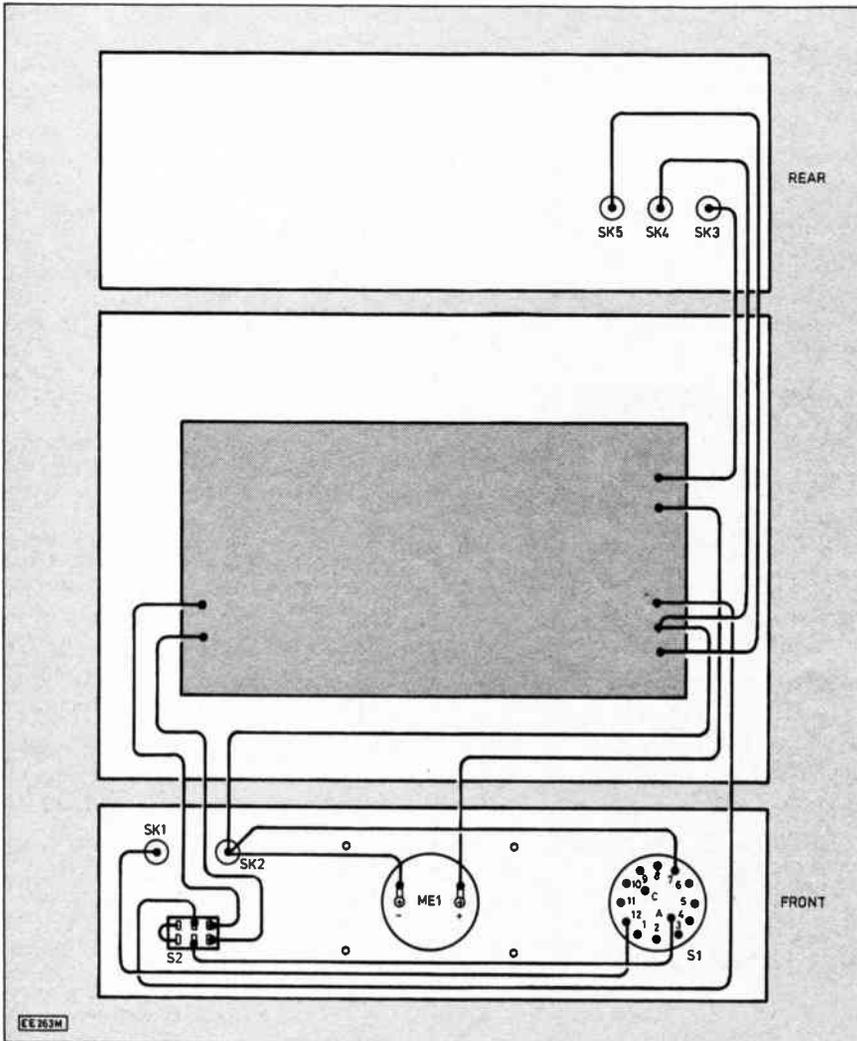


Fig. 6. Assembly and interwiring details.

board. Particular points to look for are: missing links, wrongly fitted components, solder splashes and short circuits caused by accidental solder bridges on the track side of the board. A little time spent in checking at this stage can save many hours of troubleshooting later on.

After the check, the board should be mounted in the base of the case. Enough space should be left to ensure adequate clearance for all panel mounting components. Plastic feet on the base of the case will prevent the mounting hardware from scratching bench or table surfaces.

FRONT PANEL

The next step is to drill the front panel in accordance with the layout given in Fig. 5. The hole diameters required may vary a little from those shown, depending on the exact dimensions of the components used.

When cutting the large-diameter hole for the meter, a number of different approaches may be taken, depending on the tools available. Constructors may use a tank cutter or a proprietary sheet metal punch to cut the hole in a single operation. An alternative, used in the construction of the prototype, is to drill a series of intersecting holes just *inside* the outline of the cut-out to remove the bulk of the metal, and then clean up the rough edge with a half-round file.

Once the panel has been drilled, the overlay in Fig. 5 (or a photocopy) should be fixed to the panel; a layer of self-adhesive transparent library film can then be used for protection. The rear panel requires three holes in any convenient position to allow mounting of SK3, SK4 and SK5. The panel mounting components (i.e. the meter, sockets, and switches) can then be fitted as shown in Fig. 6.

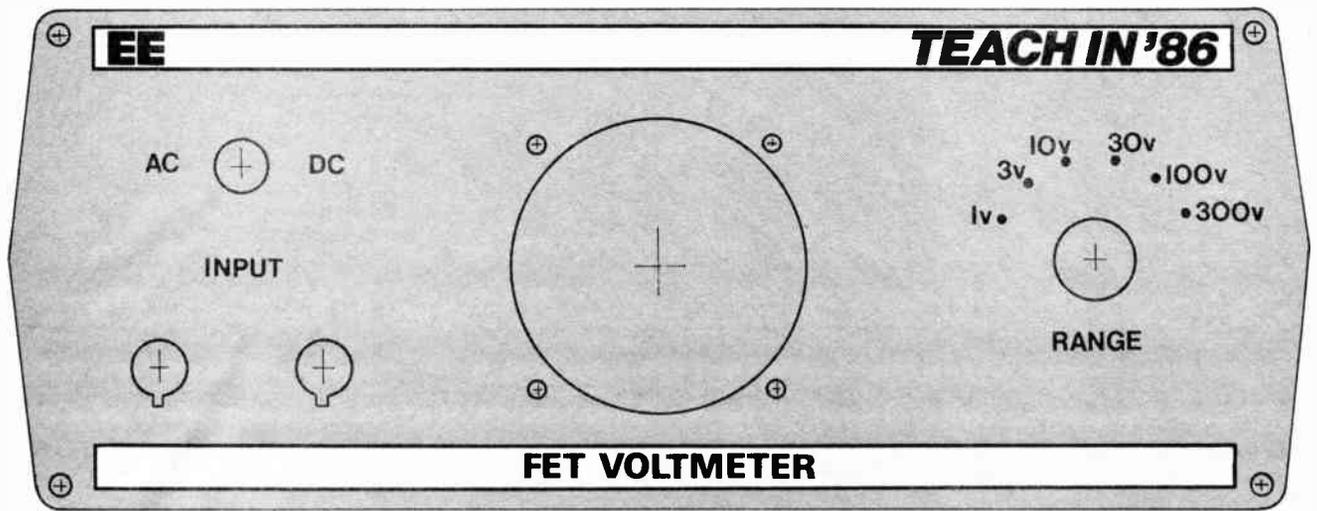


Fig. 5. Front panel layout (full size).

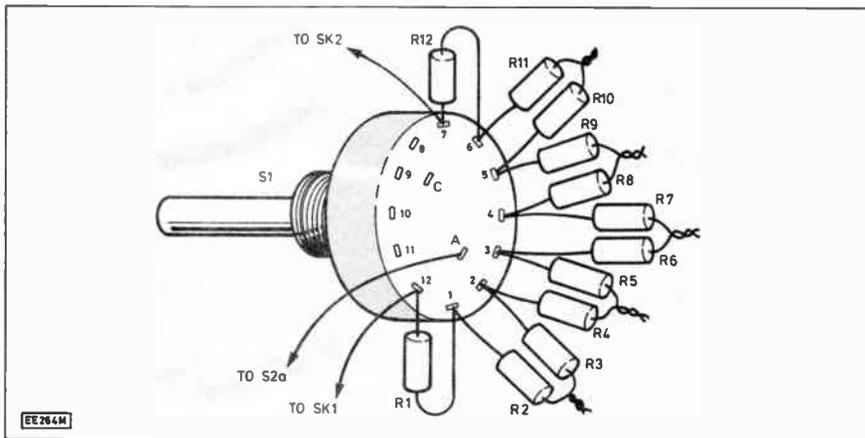


Fig. 7. Range selector switch S1 detailed assembly. The "free ends" of the resistors should be twisted together in pairs and soldered.

RANGE SWITCH

The remaining components (which should comprise R1 to R12) are fitted directly to the tags of S1. The accuracy of the components will significantly affect the accuracy of the instrument, and 2 per cent tolerance or better is recommended.

The assembly of the resistors on the switch S1 is illustrated diagrammatically for clarity in Fig. 7. The interconnection wiring should then be fitted as shown in Fig. 6.

The front and rear panels may now be attached to the top of the case using the screws provided, but the top cover should not be fitted as there are a number of adjustments to be made. The preset potentiometers VR1 and VR2 should finally be set to maximum resistance, and the unit is then ready for testing and use.

TESTING

The first step, when testing the meter, is to measure the supply current drawn by the unit. This should typically be in the range 1mA to 5mA for supply voltages of $\pm 12V$ to $\pm 15V$, although the unit will operate quite satisfactorily from any d.c. supply in the range $\pm 10V$ to $\pm 18V$.

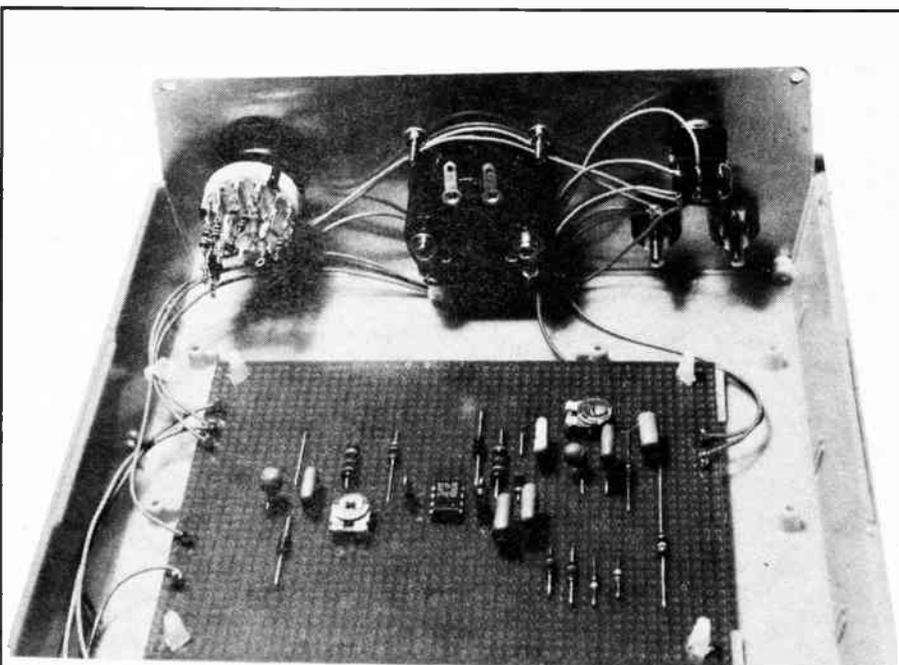
Any significant deviation from the supply current figures given should be investigated before proceeding. Particular attention should be paid to the orientation of IC1, D3 and D4, and to the interconnection wiring.

The next step is to set the instrument to the d.c. mode and, using a known d.c. voltage source, adjust VR2 to give the correct indication on the meter. The meter used in the prototype had an internal resistance of 200 ohms, and so the correct position for VR2 is at around 80 per cent of maximum.

Checks should be made on a range of voltage sources to verify correct operation of the input attenuator. The final step is to set the unit to a.c. mode, and adjust VR1 to give the correct indication when being used to measure a known sine wave source.

The unit is now ready for use. It will be noticed in operation that the unit is very sensitive to capacitively stray coupled signals, e.g. by holding the test leads connected to the input terminals. This is a natural consequence of the very high input impedance of the unit.

NEXT MONTH: Project 8 is a Pulse Generator, the last in this series of test instruments.



Wiring to the front panel range switch, meter, mode switch, input terminals and the solder pins on the circuit board.

Actually Doing it!!

IN THE previous article the subject of wiring up a project was commenced, and in the main we were concerned with how to connect the wires, rather than exactly where they should be connected. How difficult or otherwise the task of deciding exactly where wires must be added depends very much on the source of the project. A full constructional article in *Everyday Electronics And Electronics Monthly* will be accompanied by illustrations which will usually make it perfectly clear where every single wire must be connected. Problems are then only likely to arise if a component you are using is physically different to the one illustrated. It is important to realise that there are often marked physical differences between two components of the same type, and that both are probably perfectly suitable for a given application provided they are connected correctly.

If the source of the project is something like a circuit diagram in a book with no constructional details being provided, then the task of wiring up the unit can be an awkward one for a beginner. In fact it is advisable to only try projects for which constructional information is provided.

The connections to standard switched and unswitched jack sockets are shown in Fig. 1. If the socket is feeding into something like a pair of headphones it does not actually matter if the connections to the "earth" and "signal" tags are reversed. The same is not true if the equipment is something that will feed into an amplifier, mixer, or some similar piece of audio equipment. Reversing the connections to the plug or socket will at best result in a lot of "hum" and other electrical noise being picked up, and at worst no output at all will be obtained.

You may sometimes encounter the term "insulated" socket, particularly when dealing with jack types. The switched jack socket of Fig. 1 is an example of an insulated type. The socket has a plastic body, which consequently is not electrically in contact with the panel on which it is mounted (if this should be made of metal). Sockets such as the unswitched type of Fig. 1 have a metal mounting bush and fixing nut which do make electrical contact with a metal panel if they should be mounted on one.

In wiring diagrams there may be no connections shown going to the earth tags

nections, since they will not be provided via the chassis. The same is also true if a plastic case is used where the project designer has assumed that the case will be a metal type. Sometimes insulated sockets are specified because it is important that connections between the sockets are not provided via the case. Just because a socket or control of some kind has a metal body, do not assume that one of the tags connects to the body. Many switches, potentiometers, and other components have metal bodies which are electrically isolated from any of the tags.

The popular 3.5 millimetre size of jack socket is a common cause of confusion. This occurs because many projects only require two of the three tags that most 3.5 millimetre sockets possess. The extra tag is included as most sockets of this type have a break contact. These sockets were originally used as earphone sockets in small transistor radios, and the break contact was required to automatically switch out the loudspeaker when the earphone was plugged in. This is still a common use for these sockets. The correct method of connection is shown in Fig. 2, but in applications where the break contact is not needed the two output leads are just omitted.

EVERY TAG?

It is easy to assume that every tag of a component must connect to something, but this is far from true. Often components offer facilities that are not required for a particular project, leaving one or more of the tags unconnected. A few components (particularly transformers and coils) seem to have tags which are totally unnecessary. This is presumably where a number of similar components are built from the same basic parts, with some components requiring all the tags while others do not.

With some components a careful physical examination will reveal the correct method of connection, but sooner or later you are bound to encounter a socket, switch, or other component where there is no obvious way of telling which connection is which. A continuity tester of some kind is then invaluable as it usually enables any uncertainties to be resolved before you start wielding the soldering iron. For instance, with a rotary switch you can test to see which tags are connected together at each setting of the switch. With a plug and socket they can be fitted together, and connections from one to the other can be traced. By testing for continuity between tags with the plug inserted and removed it is possible to determine exactly how any switch contacts are organised. Any "dummy" tags should also be revealed by a lack of connection to anything else.

If at all possible you should always find the correct method of connection before connecting anything. This may be a little time consuming, but it is probably quicker in the long run. Simply trying all the possible methods of connection in an attempt to find the right one by trial and error should be regarded as a desperation measure. It is something which should never be tried in any part of a circuit where the mains supply is involved, or anywhere in the circuit that is handling high powers (at the output of a hi-fi amplifier for example). Apart from the fact that expensive components would almost certainly be destroyed, it could also be extremely dangerous.

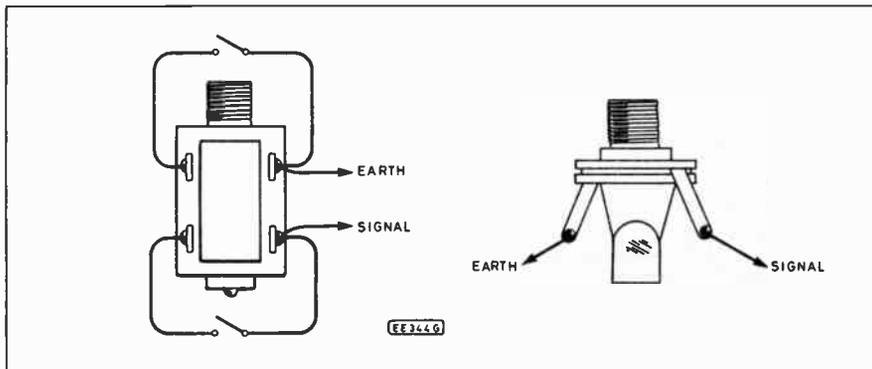


Fig. 1. These jack sockets differ in that one has d.p.s.t. contacts while the other has none. Both are suitable for most applications.

WHICH WAY ROUND

Jack sockets are a good example of components which vary physically and can cause confusion. Apart from the fact that there are three common sizes (2.5, 3.5 and 6.35mm), plus stereo and mono versions of the two larger sizes, there are physical variations on each type, and one component catalogue lists some thirty different jack sockets. Sometimes there may be electrical variations as well as physical differences, such as some sockets having built-in switch contacts while others do not. A socket which has integral switch contacts is electrically suitable for use where no switch contacts are required, and the additional tags are just ignored. Physical differences between components are not always unimportant, and in this case the larger size of a switched socket might make it unsuitable if there is little space to accommodate it.

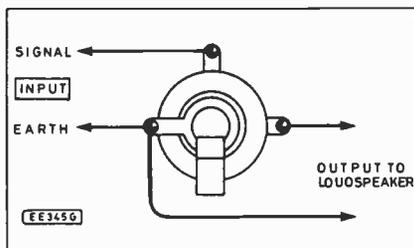


Fig. 2. The 3.5mm jack sockets normally have a break contact which can be used in this fashion. In many applications the switched output is not required, and the third tag is left unused.

of non-insulated sockets, and this is where connections to these are made via the metal chassis and panels of the project. If insulated sockets are used then it is obviously necessary to add in the earth con-

When having difficulty with a component it is often worthwhile checking through some component catalogues. These often give useful information and connection details for transformers, switches, etc., and can sometimes prevent a great deal of time being wasted trying to figure out which tag is which.

POTENTIOMETERS

Potentiometers can cause problems as they can be used in two ways. Usually when used in volume control and similar applications all three tags are employed, and Fig. 3a shows the appropriate method of connection. A common and easy error to make is to accidentally swop over the track connections. This is pretty obvious when the finished project is tested, as the volume control (or whatever) operates in reverse (clockwise rotation giving reduced volume).

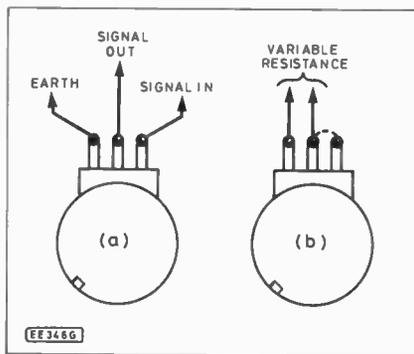


Fig. 3. Using a potentiometer as a volume control (a) and a variable resistance (b).

Potentiometers are often used as what are really variable resistances rather than true potentiometers, and then only two

connections are needed, as shown in Fig. 3b. The third tag is often connected (as indicated by the broken line), and this can give better results with less noise during adjustment from a well worn component, but it is essentially the same method of connection. With the method of wiring shown in Fig. 3b the component gives increased resistance when it is adjusted in a clockwise direction, but some applications require the opposite of this. This can be accomplished by swopping the track connections. It will be obvious if you have the track terminals connected the wrong way round as the control will work "backwards".

Robert Penfold

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

ELECTRONIC MAIL KIT

EVERYTHING you need to get started in electronic mail is now available in a complete package, from Brother, for £399, plus VAT.

Of special benefit to anyone who needs to write and send copy, quickly, whilst on the move, the new Brother "start up" pack fits in a briefcase and can be used anywhere where there is a telephone. The package comprises a Brother EP-44 portable teleprocessor, an acoustic coupler, connecting

leads, a mains unit, subscription for a One-to-One electronic mailbox and an electronic mail guide book.

The EP-44, which is the terminal used to prepare the written material, can also be used as a portable electronic typewriter or computer printer, operating at 16 characters per second. With 4Kbytes memory, it can hold and recall up to three full pages of text at any one time. There is also a 15-character display to facilitate simple and



accurate inputting and editing of text.

Other features include 44 international characters, basic arithmetic calculation facilities, a letter quality typeface plus a variety of standard electronic typewriter functions. The RS232C interface enables the unit to be linked up as a computer printer.

Completing the package is the One-to-One electronic mailbox,

with individual password and identity number, now subscribed to by over 6,000 users in the UK alone.

The Brother "start-up" pack is available from Brother dealers and distributors. For details of nearest stockists contact:

**Brother Computer Peripherals
Division,
Dept EE, Shepley Street,
Guide Bridge, Audenshaw,
Manchester M34 5JD.**

LOGIC PROBE

IDEAL for checking out both TTL and CMOS circuits, two useful logic probes have just been released by Thandar Electronics.

The TP1 Logic Probe can show up to fourteen different circuit conditions and can detect pulses down to typically 10ns.

The TP2 Logic Pulsar can, it is claimed, inject a signal directly into a circuit without damaging any sensitive components.

The two probes cost £23 each, plus VAT, and for details of local stockists contact:

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

DIGITAL TRIP

A NEW digital residual current trip tester, complying with IEE wiring regulations, has just been marketed by Harris Electronics (London). The TEM1400B is designed to make safe and accurate measurements of the "trip time" of Residual Current Circuit Breakers (RCCB) at various required levels of fault current.

Sporting a 3½ digit l.c.d. display, with bright l.e.d. indication of P-E and P-N, trip times are measured from 0 to 200ms with a 1ms resolution to a ± 5ms accuracy. Trip times can be held for up to 40s until the "test" button is released.

Seven measuring ranges of test current give 15, 30, 50, 100, 150, 250 and 300mA outputs

and are accurate to ± 3 per cent. A slide switch gives the choice of start readings on a negative going cycle or a positive going cycle. Ideal for most RCCB applications, the TEM1400B can be used for 3-pin plug testing, single-phase breaker tests, 3-phase breaker tests and can carry out half rated tests, full rated tests and fast trip tests as laid down by the IEE regulations.

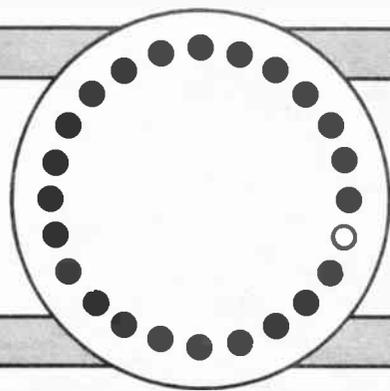
For details of prices and suppliers readers should contact:

**Harris
Electronics
(London) Ltd.,
Dept EE, 138
Grays Inn Road,
London, WC1X 8AX.**



CIRCLE CHASER

M.P. HORSEY



With a little ingenuity you can have your name in "lights"

THE PROJECT to be described comprises a self-contained unit, housing 30 l.e.d.s, arranged in a circle. Six l.e.d.s light up together, and these are spaced equally around the circle.

At a rate determined by a preset potentiometer, the illuminated l.e.d.s go out, and the ones next to them light up. Thus the circle appears to revolve, at a speed set by the preset. The unit may be connected to the line output (or speaker output) of a record player, radio, etc., in which case the apparent speed increases with the volume of sound.

The unit includes a mains power supply, or may be used with a battery. Relays may be used to power large bulbs if required.

CIRCUIT DESCRIPTION

The circuit diagram for the Circle Chaser is shown in Fig. 1.

Two CMOS i.c.s are used, to keep current consumption to a minimum. IC1 is a type 4007, and produces pulses, the frequency of which depends upon the voltage at pin 3.



The input from an audio source, such as an amplifier, radio, tape, etc., is fed to the base of TR1 via d.c. blocking capacitor C1. Preset potentiometer VR1 provides control over the strength of signal received, and resistor R1 provides base bias.

The output from TR1 passes via C2 and diode D2, to charge capacitor C3. The voltage on C3 is reduced by potential divider resistors R3 and R4, and the result is applied to pin 3 of IC1. Preset potentiometer VR2 also controls the voltage at pin 3, and allows the user to select the minimum desired frequency.

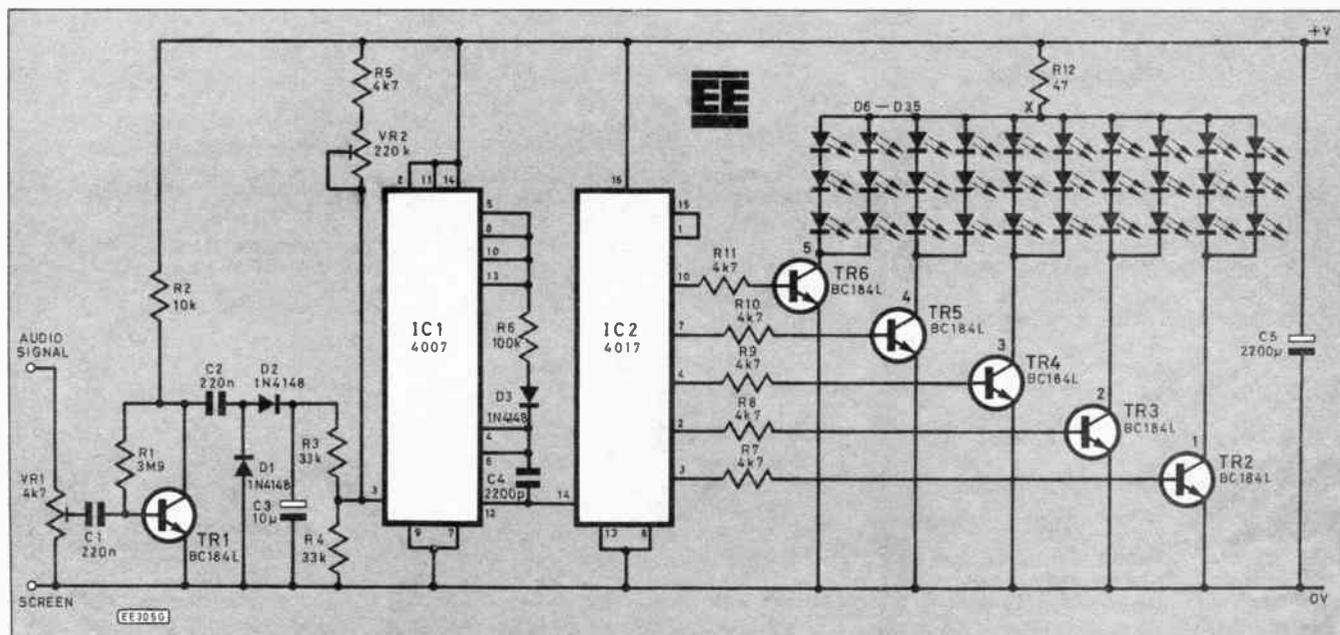
IC1, which contains pairs of complementary transistors, oscillates, the rate of which is determined by the value of C4, and the voltage at pin 3. The output from IC1 is connected to the input (pin 14) of IC2. This is a decade counter, and each of its outputs goes "high" in turn, as pulses are received at pin 14.

Thus, at switch on, IC2 output pin 3 is "high", and hence transistor TR2 is turned on. At the first pulse from IC1, the next output from IC2 (pin 2), goes "high", and TR3 turns on, as TR2 turns off. This continues, until the sixth pulse is received at pin 14, when the output from pin 1, is fed to the reset pin 15. IC2 now resets, and pin 3 goes "high" again.

A single resistor R12, controls the current drawn by the display, and is wired in series with each chain of l.e.d.s (D6 to D35). The l.e.d.s are arranged in three's—wired in series and parallel.

Each pulse is delivered to IC2, which is a 4017 decade counter/divider. Thus each pulse from IC1 causes the output from IC2 to increment by one. The display is connected to IC2, via transistors TR2 to TR6.

Fig. 1. Complete circuit diagram for the Circle Chaser, except the mains power supply.



Each transistor is connected to two of these groups, wired in parallel with each other. Thus with the value of R12 shown, a total of about 40mA is used by the six i.e.d.s lit at any one time.

The only external control on the prototype, is a sub-miniature mains on/off switch. Some constructors may prefer the spindle or control type potentiometers instead of presets VR1 and VR2. This is particularly useful if the unit is to be operated in a variety of situations, or if full manual control of the speed is required.

CONSTRUCTION

The circuit is constructed on a piece of 0.1in. matrix stripboard (14 strips x 60 holes), measuring 18cm by 5.2cm. The component layout and underside of the circuit board showing breaks in the copper strips is shown in Fig. 3.

Begin by drilling the four mounting holes in the stripboard and make the required breaks in the tracks (44 altogether). Next solder the i.c. holders and presets in position.

Solder the wire links, noting that one link is angled (F33-B35), so that the breaks may be made in a neat straight line. Next solder in the resistors, capacitors, diodes and transistors, noting the polarity of those components which must be fitted the correct way round. Note that the transistors are BC184L types; BC184 transistors have different connections.

The audio input should be a screened cable, with the screen connected to track J1. The miniature transformer will probably have wires fitted, and these may be soldered

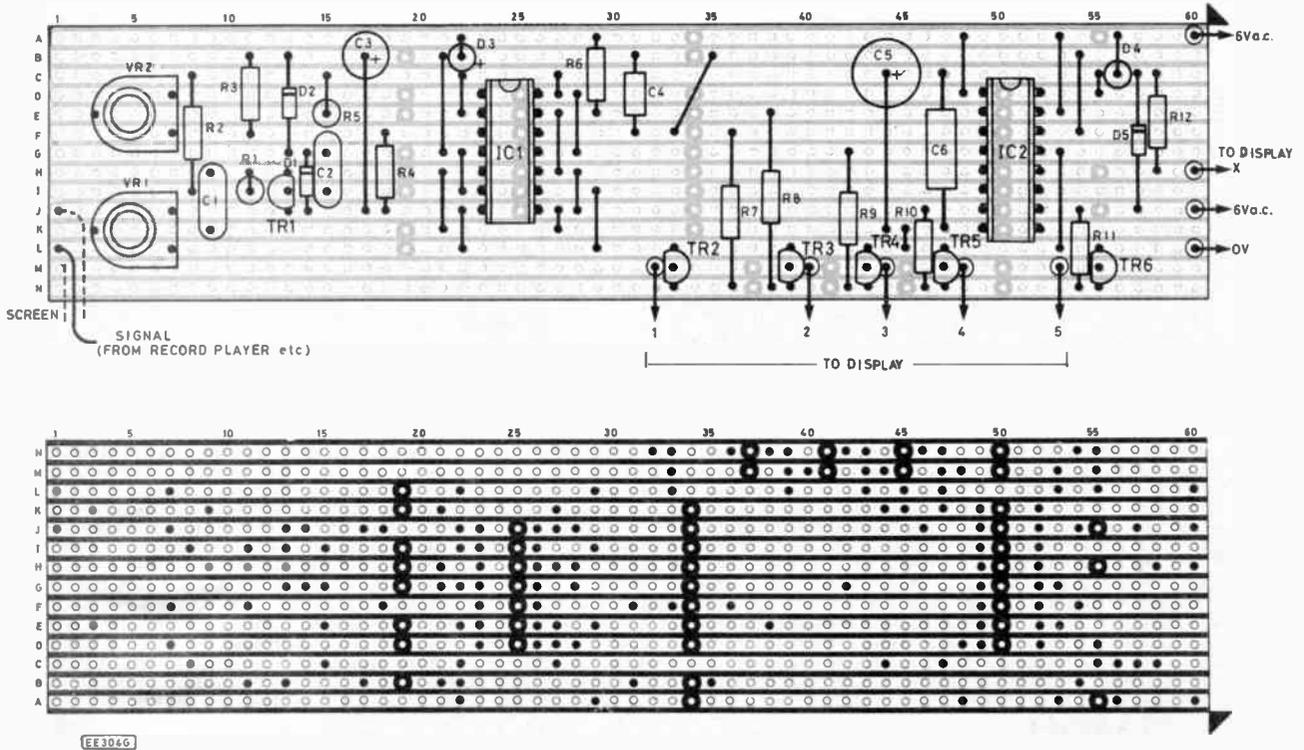


Fig. 3. Component layout, underside showing breaks (44 off) in the copper strips and interwiring details. Use screened cable for the input signal lead.

POWER SUPPLY

The project was originally designed for battery use, and if a battery is to be the only power supply, resistor R12 should be

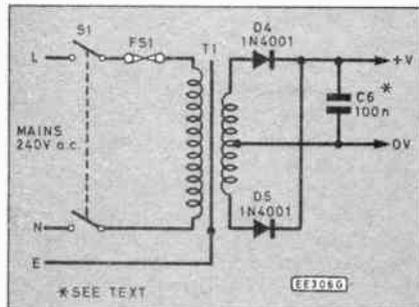


Fig. 2. Suggested mains power supply circuit. Capacitor C5 forms part of the power supply but is shown on the main circuit Fig. 1.

increased to 100 ohms, in order to prolong the battery life. Decoupling capacitor C5 may be reduced to 1000µ if desired, to save a few pence.

A mains transformer was included upon the discovery that it was actually cheaper than a PP9 battery. The transformer used is a miniature 6-0-6V type, supplying 100mA. Diodes D4 and D5 together with capacitors C5 and C6 provide a smooth d.c. supply.

COMPONENTS

Resistors

R1	3M9
R2	10k
R3,R4	33k (2 off)
R5	4k7
R6	100k
R7-R11	4k7 (5 off)
R12	47 (see text)
All 1/4W ± 5% carbon	

Potentiometers

VR1	4k7 sub min. preset, horizontal
VR2	220k sub min. preset, horizontal

Capacitors

C1,C2	220n polyester (2 off)
C3	10µ elec. 16V
C4	2200p polystyrene
C5	2200µ elec. 16V
C6*	0.1µ polyester

Semiconductors

IC1	4007 CMOS dual complementary pair + inverter
IC2	4017 CMOS decade counter/divider
TR1-TR6	BC184L npn silicon (6 off)
D1,D2,D3	1N4148 (3 off)
D4*,D5*	1N4001 (2 off)
D6-D35	5mm red i.e.d.s (30 off)

Miscellaneous

S1	Mains d.p.s.t. sub min. switch
T1*	240V primary, 6-0-6V sec. (100mA) trans
FS1*	100mA fuse and holder

Case 19cm x 11cm x 9cm, with transparent top; 0.1in. matrix stripboard, 14 strips x 60 holes; 14-pin i.c. holder; 16-pin i.c. holder; screws; screened cable; connecting wires; card; red acetate; grommets; etc.

* These items not required if Circle Chaser is battery powered.

Approx. cost
Guidance only

£14.50

See
**Shop
Talk**
page 208

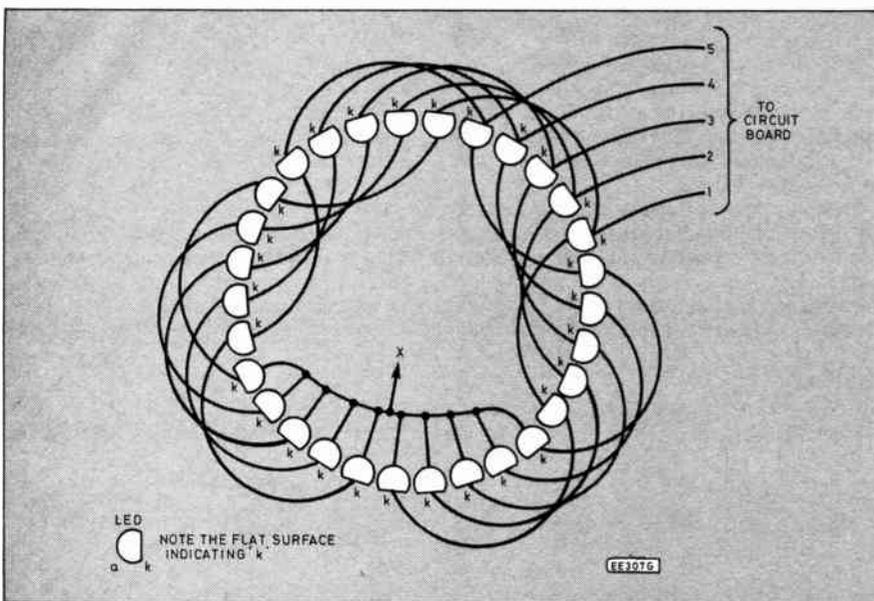


Fig. 4. Wiring to the display l.e.d.s D6 to D35. The polarity of the l.e.d.s can be ascertained by referring to the pinning diagram.

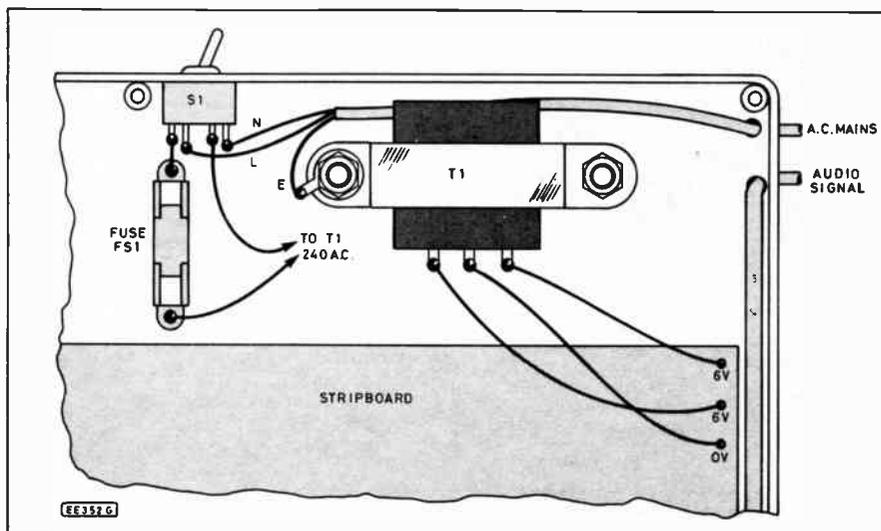


Fig. 5. Wiring details for the mains power supply. The mains lead should be held in position by a plastics P-clamp.

directly to the stripboard, ensuring that the centre (0V) tapping goes to track L60.

Of the two transformer output wires left, either may be connected to tracks A60 and J60 respectively. Do ensure that proper breaks have been made in the tracks to prevent a.c. reaching the chip.

A 9 volt battery may still be used if desired, in which case it should be connected to track C60 (positive) and L60 (negative). The display will be a little brighter than intended, and although not a problem in itself, the battery will have a shortened life. Thus resistor R12 should be increased to 100 ohms if substantial battery use is contemplated.

If a battery is never likely to be used, R12 could be reduced to increase the display brightness. However, a value of less than 39 ohms is not recommended.

The transformer need not be disconnected from the circuit if a battery is used, but **DO NOT CONNECT THE UNIT TO THE MAINS, WHILST THE BATTERY IS CONNECTED.**

DISPLAY WIRING AND CONSTRUCTION

All the outputs from the circuit, are taken at points along track M, with the common source from track H60. If possible, use a variety of colours, to avoid confusion at the display end.

The display consists of 30 round 5mm l.e.d.s. Whilst a variety of colours may be used, red only was chosen, to allow a red filter to be fitted in front of the display.

The l.e.d.s may be fitted on a piece of board, or thick cardboard, which must be cut for an exact fit in the case.

Begin by drawing a circle of 7cm diameter, on the board. The 30 l.e.d.s should be spaced at 12 degree intervals, and some care is required at this stage, to achieve a pleasing effect.

Small holes must be drilled in the cardboard for the l.e.d. leads. A small circuit board drill is ideal for this purpose. The l.e.d.s may be glued into place, but this is quite difficult, and in the prototype it was

found sufficient to secure them by bending their leads.

The wiring to the display l.e.d.s, D6-D35, is shown in Fig. 4. Take great care to connect the leads in the correct way, with special regard to the polarity of D6 to D35. The series/parallel arrangement can be very confusing.

CASE DETAILS

A plastic case measuring 19cm by 11cm by 9cm, with a transparent top, was used. The depth of 9cm is larger than necessary, and only about 6cm is really needed. However, cases with transparent tops are not available in a wide variety of sizes.

Begin by drilling the required holes in the case, to mount the stripboard, transformer (if required), fuse holder (if required), and switch. Two additional holes are required for the mains cable, and audio cable. These two holes should be fitted with grommets.

The position of the transformer or battery should be chosen carefully, in order to increase stability when the unit stands vertically. If potentiometers are used instead of presets, additional holes will be required. Do not mount them too close to the mains section of the unit.

MOUNTING THE DISPLAY

The lower half of the transparent top, together with its sides, were covered with plain blue card on the inside. Any similar material is suitable, according to taste. The card should be cut exactly to size, in order to ensure a good fit, as parts which show from the front, cannot be glued. Small pieces of double sided sticky tape, or glue may be used to secure the card mounted at the sides, where it crosses the supports.

A sheet of red acetate material may be cut exactly to size, and placed inside the transparent top. It need not be glued, as the display will hold it in position.

Finally, the circle of l.e.d.s may be eased into position, and secured with small pieces of sticky tape.

TESTING

The Circle Chaser may be tested without an audio signal, in the first instance. Set preset VR2 fully clockwise (slowest speed). Switch on, taking care not to touch the "live" parts. Alternatively, use a battery for testing.

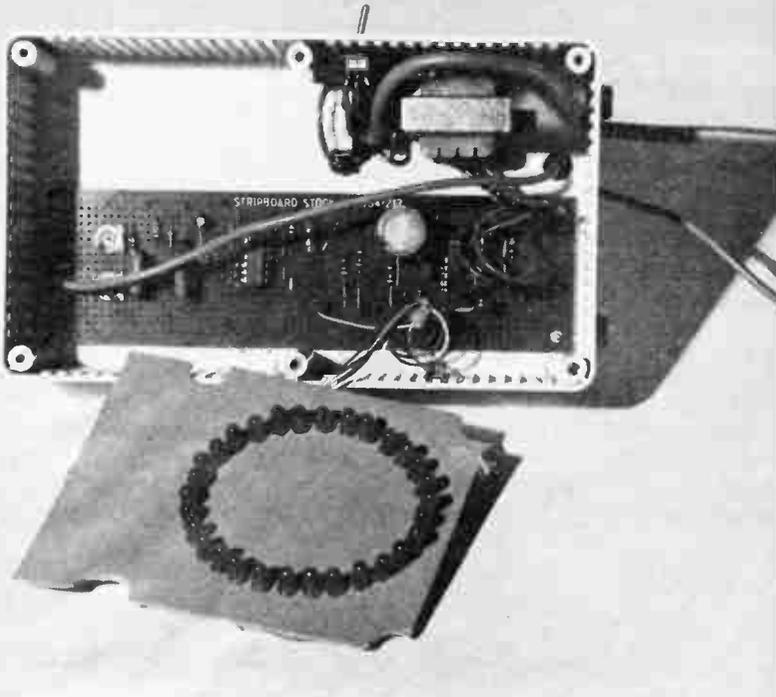
The display should light at six points, which appear to revolve slowly. Move VR2 anti-clockwise. The speed of the display should increase, to a point where all the l.e.d.s appear to be on. Set VR2 to a point about midway along its track.

Connect an audio signal to the screened lead, either from a speaker output, or line output. Adjust preset VR1 fully anti-clockwise (full gain). The speed of the display should increase with the volume of the sound. High frequencies have more effect than low frequencies, and very rapid changes of volume will have less effect than slower changes. Classical music works particularly well.

Preset VR1 may be reduced in gain if required, in order to achieve the correct effect. Preset VR2 may then be adjusted to achieve the desired speed for the quietest sounds.

FINAL ASSEMBLY

When the adjustments are finalised, switch off, and secure the lid of the unit,



The completed Circle Chaser with the display card removed.

checking that no display wires accidentally touch metal parts inside the case. Note that the lid must be placed so that the display is away from the transformer, i.e. the transformer must be in the lower section, when the unit stands upright. Ensure that the display cannot make contact with the live mains parts inside the case.

FAULT FINDING

If the display fails to light, the most common mistake is incorrect polarity on one or more I.e.d.s. Connect a voltmeter between point X, and display line 1. Set VR2 fully clockwise (slow), and switch on. The voltmeter should indicate a reading of 4V or more, for a short time. This reading should then pulse, as display line 1 switches on.

If this test does not work, the fault lies elsewhere. The obvious checks to make include voltage checks across pins 7 and 14 of IC1, and across pins 8 and 16 of IC2. The

readings should be between 7V and 9V.

The circuit divides into two sections, with an angled wired link joining pin 12 of IC1, to pin 14 of IC2. The voltage on this link should appear to be 7V to 9V.

A check with an oscilloscope at this point should reveal very short negative pulses, at a rate determined by the voltage at pin 3 (about 2V with VR2 midway) of IC1. The presence or absence of these pulses will reveal which half of the circuit is at fault.

ADDITIONS

The Circle Chaser can form the heart of any chaser system, and the outputs from transistors TR2 to TR6 can be used to drive power transistors which in turn can drive larger bulbs. Alternatively, relays may be driven directly from transistors TR2 to TR6, in which case protection diodes must be connected across the relay coils to prevent high voltage spikes (e.m.f.) damaging the transistors.

★ BAKER ★

GROUP P.A. DISCO
AMPLIFIERS post £2

150 watt Output, 4 input, All purpose. Illustrated **£99**
150 watt Output, Slave 500 mv. Input 4+8=16 ohm. Outputs **£80**
150+150 watt Stereo, 300 watt Mono Slave 500 mv. Input **£125**
150 watt P.A. Vocal, 8 inputs. High/Low Mixer Echo Socket **£125**
100 watt Valve Model, 4 inputs, 5 Outputs. Heavy duty **£125**
60 watt Mobile 240v AC and 12v DC. 4-8-16 ohm+100v line **£89**
MIKES Dual Imp £20, Floor Stand £13, Boom Stand £22, PP £2.
Reverb Unit for Microphone or Musical Instruments **£35 PP £1**.
Electronic Echo Machine for mic/etc. **£85, Deluxe £95 PP £1**.
30 WATT COMBI 12ins Speaker Triple, Base, Triple Boost, Switch, Black Vinyl Finish, Carrying Handle **£95 PP £5**.
DITTO Amplifier only **£65 PP £4**.

DISCO CONSOLE Twin Docks, mixer pre amp **£145, Carr £10**.
Ditto Powered 120 watt **£199**; or Complete Disco 120 watts **£300**.
150 watt **£300**; 350 watt **£410, Carr £20**.

DISCO MIXER. 240V, 4 stereo channels, 2 magnetic, 2 ceramic/tape, 1 mono mic channel, twin v.u. meters, headphone monitor outlet, slider controls, panel or desk mounting, matt black fascia. Tape output facility. **£59, Post £1**.

DELUXE STEREO DISCO MIXER/EQUALISER as above plus L.E.D. V.U. displays 5 band graphic equaliser, left/right fader, switchable inputs for phone/line, mike/line. **£129 PP £2**
Headphone Monitor, Mike Talkover Switch **£129 PP £2**
As above but 3 deck inputs, 4 line/aux inputs, 2 mic inputs, 2 headphone monitors **£145**.

DELUXE MIXER DESK. 8 Channels, built-in echo **£250 PP £4**.

FAMOUS LOUSPEAKERS - SPECIAL PRICES					
SIZE	POWER	OHMS	PHYSICAL SIZE	NOMINAL MAX FRAM	DIMENSIONS
IN	WATTS	IMP	MAKER	APPLICATION	PRICE POST
3 1/2"	10	8	Audax	Mini-Woofler	£4
5"	20	4 or 8	Goodmans	Ford Car Radio	£9
5 1/4"	80	8	Sound Lab	Hi Fi Twin Cone Full Range	£10
5 1/2"	25	8	Audax	Bextone Cone Woofler	£10.50
6 1/2"	60	8	Sound Lab	Hi Fi Twin Cone Full Range	£11
6 1/2"	25	4	Audax	Woofler, Hi Fi	£2.50
6 1/2"	15	8 or 15	EMI	Woofler, Hi Fi	£3.50
6 1/2"	35	8	Audax	Bextone Cone woofler	£17.50
8"	20	8	Far East	Twin Cone, Hi Fi, Full Range	£5.95
8"	30	8	Wharfedale	Roll Surround Woofler	£9
8"	50	8	I.M.F.	Ribbed Batema Cone Woofler	£16
8"	40	8	Audax	Hi Fi Woofler Bextone Cone	£16.50
8"	60	8	Sound Lab	Hi Fi Twin Cone Full Range	£14
8"	60	8	Goodmans	PA & Hi Fi Woofler	£14
8"	60	8	Goodmans	Guitar PA Woofler	£16
8"	60	8	Goodmans	Disco-Guitar-PA	£16
10"	30	4 or 8	Far East	Bass Woofler, Hi Fi	£14
10"	50	8	SEAS	Bass Woofler Hi Fi	£19.50
10"	15	8	Reposol	General Purpose	£2
10"	20	8 or 16	Celestion	Disco-PA Full Range	£15
10"	50	8 or 16	Baker	Disco-Guitar-PA	£20
10"	50	8 or 16	Celestion	Disco-PA	£21
10"	80	8	Sound Lab	Twin Cone Full Range	£19.50
10"	300	8	WEM	Woofler Guitar PA	£36
12"	30	4 or 8 or 16	Baker	Twin Cone Full Range	£18
12"	45	4 or 8 or 16	Baker	Disco-Guitar-PA	£18
12"	80	8	Baker	Bass Woofler	£25
12"	75	4 or 8 or 16	Baker	Disco-Guitar-PA	£22
12"	100	8	Goodmans	Woofler PA Hi Fi	£20
12"	120	8 or 16	Goodmans	Disco-Guitar-PA	£26
12"	100	8	H + H	PA	£28
12"	100	8 or 16	Baker	Disco-Guitar-PA	£28
12"	150	8	Celestion	Disco-Bass Guitar	£95
12"	200	8	H + H	PA-Disco	£69
12"	300	8	WEM	Woofler	£44
13x8"	10	3	EMI (450)	Hi Fi with Tweeter	£5
15"	100	8	Celestion	Disco + Group	£69
15"	100	8 or 16	Baker	Disco-Guitar-PA	£29
15"	100	4 or 8 or 16	H + H	PA-Disco	£49.50
15"	250	8	Goodmans	Disco + Group	£74
18"	230	8	Goodmans	Disco + Group	£87
18"	200	8 or 16	Celestion	Disco + Group	£110

P.A. CABINETS (empty) Single 12 £34; Double 12 £40, carr £10.
WITH SPEAKERS 45W £27, 75W £37, 150W £84.
200 WATT COMPACT SYSTEM £100, 400 Watt £150, carr £12.
300 WATT MID-N-TOP SYSTEM Complete £125 carr £12.
TWEETER HORNBOXES 200 Watt £32, 300 Watt £38, PP £2.
WATERPROOF HORN SPEAKERS 8 ohms. 25 watt £20, 30 watt £23, 40 watt £29, 20W plus 100 volt line £38, Post £2.
MOTOROLA PIEZO ELECTRONIC HORN TWEETER 3 3/8" square **£6**
100 watts. No crossover required. 4-8-16 ohm. 7 1/2" x 3 1/8". **£10**
METAL GRILLES 8" £10, £3.50, 12" £4.50, 15" £5.50, 18" £7.50.

R.C.S. DISCO LIGHTING EQUIPMENT
READY BUILT DELUXE 4 CHANNEL 4000 WATT sound chaser + speed + 4 programs **£69, MK2 16 programs, £89 PP £2**
PARTY LIGHT 4 coloured Flood Lamps Flashing to Music. Self-contained Sound to Light 410 x 196 x 115mm **£34.95 PP £2**
FULL STOCK OF COMPONENTS, PLUGS, LEADS, ETC.
MAINS TRANSFORMERS Price Post
250-0-250V 80mA, 6.3V 3.5A, 6.3V 1A. **£7.00** £2
350-0-350V 250mA, 6.3V 6A CT. **£12.00** £2
220V 25mA, 6V 1 Amp **£3.00**, 220V 45mA, 6V 2 Amp **£4.00** £1
LOW VOLTAGE MAINS TRANSFORMERS **£5.50** each post paid
9V, 3A; 12V, 3A; 16V, 2A; 20V, 1A; 30V, 1 1/2A; 30V, 5A + 17-0-17V, 2A; 35V, 2A; 20-0-60V, 1A; 12-0-12V, 2A; 20-0-20V, 1A; 50V, 2A.
LOW VOLTAGE TAPPED OUTPUTS AVAILABLE
1 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 volts **£6.00** £2
Ditto 2 amp **£10.50**, 3 amp **£12.50**, 5 amp **£16.00** £2
31'26'0'26'31 volt 6 amp **£14.00** £2

£8.50 post 50p MINI-MULTI TESTER
Pocket size instrument, AC/DC volts, 15-150-500-1000.
DC current 0-150mA, Resistance 0-100K 1000 ohm p.v.
De-Luxe Range Drotler Meter, 50,000 o.p.v. 7 x 5 x 2in.
Resistance 0/20 meg in 5 ranges. Current 50mA to 10A.
Volts 0.25/1000V DC, 10v/1000v AC. **£25.00 PP £1**
PANEL METERS 50mA, 100mA, 500mA, 1mA, 5mA, 100mA, 500mA.
1 amp, 2 amp, 5 amp, 25 volt, VU 2 1/4" x 2 1/4" in. **£5.50** post 50p

PROJECT CASES, Black Vinyl Covered Steel Top, Ali Base
4 x 2 1/2" x 2 1/4" in. **£2.50**; 6 x 4 x 1 1/2" in. **£3.60**; 8 x 5 x 2 in. **£4.00**; 11 x 6 x 3 in. **£5.50**; 11 1/4 x 6 x 5 in. **£9.00**; 15 x 8 x 4 in. **£12.00**.
ALUMINIUM PANELS 18 s.w.g. 12 x 12 in. **£1.80**; 14 x 9 in. **£1.75**;
6 x 4 in. **55p**; 12 x 8 in. **£1.30**; 10 x 7 in. **96p**; 8 x 6 in. **90p**; 14 x 3 in. **72p**;
12 x 5 in. **90p**; 16 x 10 in. **£2.10**; 16 x 6 in. **£1.30**. PP Extra.
ALUMINIUM BOXES, MANY OTHER SIZES IN STOCK.
4 x 2 1/2 x 2 in. **£1.20**; 3 x 2 x 1 in. **£1**; 6 x 4 x 2 in. **£1.90**; 8 x 6 x 3 in. **£3**;
£2; 12 x 5 x 3 in. **£3.60**; 6 x 4 x 3 in. **£2.20**; 10 x 7 x 3 in. **£3.60**
HIGH VOLTAGE ELECTROLYTICS
16/450V 50p 220/400V £2 32+32/500V £2
20/500V 75p 8+8/450V 75p 32+32/350V 50p
32/350V 45p 20+20/350V 75p 16+32+32/500V £2

RECORD PLAYER DECKS, P&P £2
Make Drive Model Cartridge Price
BSR Single Belt 240v Magnetic £20
BSR Single Belt 12 volt Ceramic £22
BSR Single Rim 240v Ceramic £22
AUTOCHANGER BSR Ceramic £22
AUTOCHANGER GARRARD Ceramic £24
Many others in stock. Phone for details.

DECCA TEAK VENEERED PLINTH space for small amplifier.
Board cut for Garrard 1834in. **£16.45**, Post £2

RADIO COMPONENT SPECIALISTS

Dept 4, 337, WHITEHORSE ROAD, CROYDON

ACCESS SURRY, U.K. Tel: 01-684 1665 VISA

Post 65p Minimum. Callers Welcome. Full Lists 34p Stamps. Same day despatch. Closed Wednesday

DIY ALARMS

DOOR ENTRY PHONE CLOSED CIRCUIT TV



D.I.Y. OR
PROFESSIONALLY
INSTALLED TO
BS 4737 STANDARD
SHOW ROOM
DEMONSTRATIONS
FREE ESTIMATES,
SURVEY &
CATALOGUE

01-965 1230 01-961 3997
SMITHS SECURITY SYSTEMS
DEPARTMENT EE
43 PARK PARADE, LONDON NW10

ON SPEC

*a regular
feature for
the Spectrum
Owner...*

by Mike Tooley BA

LAST month we provided some guidance for programming the "Programmable I/O Interface" described in February's *On Spec* page. This month we take our first look at the computer language known as FORTH. We also feature a Stepper Motor Interface for the Spectrum

FORTH

FORTH stands for "Forth Generation Language" and it was invented by Charles Moore as a means of controlling an astronomical telescope at the Kitt Peak Observatory. It is fair to say that no other high level language is as comfortable and versatile in real-time control applications as FORTH. The breadth and scope of its applications are enormous and anyone wishing to use a microcomputer in a control situation would be well advised to use FORTH rather than either BASIC or assembly language.

Fortunately, the Spectrum is well catered for as several excellent implementations of the language are available. Abersoft's FORTH, in particular, conforms with the "FIG" (Forth Interest Group) standard and yet contains a number of additional Spectrum goodies!

Having loaded FORTH from cassette or microdrive (FORTH requires an interpreter), the user is greeted with FORTH's somewhat cryptic "ok" prompt. Regular FORTH users have to come to terms with this—it merely indicates that FORTH has understood your last command and is awaiting further input.

One other peculiarity of FORTH is that it employs "Reverse Polish Notation" (remember the first generation of pocket calculators?) when performing arithmetic. This means that, for example, instead of writing $2 + 3$ we will need to enter $2\ 3\ +$.

The Stack

The most crucial structure in FORTH programming is the "stack". Whenever a numerical input is received from the keyboard (as opposed to a FORTH "word"

such as $+$, $-$, $*$, $/$, and $.$), FORTH places it in a temporary storage location which forms part of the stack. When further numerical values are input, they too are placed in the stack. Numbers are, in effect, "pushed" onto the stack, operations are carried out on the contents of the stack, and then values are "pulled" or "popped" off the stack. The last input value occupies the top of the stack (*we shall refer to this as "TOS"*), the previous value occupies the second place on the stack (*hereafter referred to as "2OS"*), and so on. It should now be apparent that the stack operates on a last-in first-out (LIFO) basis.

When executed, the FORTH word $.$ ("dot") removes TOS and sends it to the display. The remainder of the stack (i.e. that which exists from 2OS downwards) moves up one place such that 2OS becomes TOS, 3OS becomes 2OS, and so on.

Now suppose that we wish to determine the average of three numbers; 2, 4, and 6. The following keyboard entry could be used:

```
2 4 6 ++ 3 / .(ENTER)
```

FORTH's integer arithmetic operators have the following actions:

$+$ adds TOS to 2OS and places the result in TOS.

$-$ subtracts TOS from 2OS and places the result in TOS.

$*$ multiplies TOS and 2OS and places the result in TOS.

$/$ Divides 2OS by TOS and places the result in TOS.

After all four of these operations, TOS and 2OS are destroyed and the remainder of the stack (i.e. that which exists from 3OS downwards) moves up one place. Hence 3OS becomes 2OS, 4OS becomes 3OS, and so on.

FORTH Words

In FORTH, a word is a string of characters which may include punctuation but which should not contain blank characters (i.e. spaces). We have already made use of simple FORTH words like $+$, $/$, and $.$

Unfortunately not all FORTH words have such obvious actions. Words like DO, FORGET, and REPEAT will provide us with some pretty good clues to their action whereas $.$, S, !, C!, @, and C@ (which all qualify as FORTH words) may be somewhat obscure.

Words can be either typed in at the keyboard for immediate execution or can form part of a definition of another word. In the latter case it is, of course, essential that the word contained within the definition has already been defined. Most FORTHS provide between 150 and 200 ready defined words contained in what is appropriately known as the "resident FORTH dictionary".

A powerful property of FORTH (and one which makes it a most attractive language for many applications) is the ability to extend the dictionary. This is done whenever the programmer defines a new word. This must, as we mentioned earlier, be in terms of existing words since otherwise the new word cannot be compiled into the dictionary.

The FORTH word VLIST can be used to display the entire dictionary contents. When typed at the keyboard, VLIST displays the resident dictionary (together with those words relating to any current application) starting with the most recently defined word.

Colon Definitions

To add a word to the resident FORTH dictionary, it is merely necessary to define the word in terms which are acceptable to the FORTH compiler. A definition is valid if it uses existing FORTH words and is entered in the correct form.

When the more recently defined word is executed, the words contained in its definition are also executed. If the words contained in the definition have not been previously defined the new word will make no sense to the compiler and hence an error message is generated.

The rules for making a colon definition of a new FORTH word are as follows:

(a) Start the definition with a colon. This tells the FORTH compiler that the next character string is the name of a new word. The colon must be followed by a space which acts as a delimiter.

(b) The new word name should then follow. The name can consist of a string of alphanumeric characters (including punctuation) but should not contain any blank characters (which would otherwise be taken as delimiters). As far as possible the word name should be meaningful.

(c) Follow the word name with a space and then enter the definition of the word. This may consist of numbers (which will be placed in the stack), text strings (which will be sent to the output device) and, of course, previously defined FORTH words.

(d) Close the definition with a semi-colon preceded, of course, by a space. This tells the compiler that the definition is complete.

Here is a simple colon definition of a word which simply divides the value at the top of the stack by 100, multiplies it by 15, and then prints the result. For obvious reasons we shall call the word "VAT":

```
: VAT 100 / 15 * . ;
```

Now, supposing that we wished to find the VAT payable on an item costing say, £4500 we would simply key:

```
4500 VAT
```

The value 675 should then appear on the screen. This is obviously a rather trivial example but should at least serve to illustrate some of the features of FORTH.

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

Mike Tooley,
Department of Technology,
Brooklands Technical College,
Heath Road, WEYBRIDGE,
Surrey KT13 8TT
P.S. Don't forget to include a large (A4 size) stamped addressed envelope if you would like to receive a copy of our "Update"!

STEPPER MOTOR DRIVER

This month's constructional project features a Stepper Motor Driver for use with the Programmable I/O Interface described in the February 1986 issue. The interface can also be used with the simple Four-Channel Output Interface described in June 1985.

The complete circuit of the Stepper Motor Driver is shown in Fig. 1. The circuit is based on a purpose designed driver i.c. (SAA1027) and uses only a handful of other components.

The stepper motor should be a 12V 4-phase (47ohm/400mH per phase) two stator type providing 7.5 degrees rotation per step. Such motors are readily available at reasonable cost from a number of suppliers and are capable of producing a maximum working torque in excess of 50mNm.

Due to the relatively large power consumption of the stepper motor, a separate power supply of 12V \pm 5% at 500mA (max) will be required. Under no circumstances should the stepper motor power be derived from the Spectrum's own power unit!

Construction

The stepper motor driver may be assembled on a piece of Veroboard measuring approximately 100mm \times 80mm. The precise dimensions of the board are uncritical and those quoted leave plenty of room for the necessary input, output, and power connectors. The use of a low-profile 16-way d.i.l. socket is recommended.

Component layout is uncritical though care should be taken to ensure that the decoupling capacitors, C1 to C3, are distributed around the p.c.b. Links can be made, as necessary, between the components using short lengths of tinned copper wire on the upper surface of the matrix board.

Readers should give some careful consideration to the choice of connectors used. The input connector should be a four-way type whilst the output should have at least five, and preferably six, ways. This latter connector should be rated at currents of at least 1A.

Connections to the stepper motor are depicted in Fig. 3. The power connector should be a polarised two-way type and this again should be rated for currents of up to 1A. If desired, this latter connection can be replaced with suitably coloured flying leads.

NEXT MONTH: Some routines for driving the Stepper Motor Interface will be described and we shall be taking a further look at FORTH.

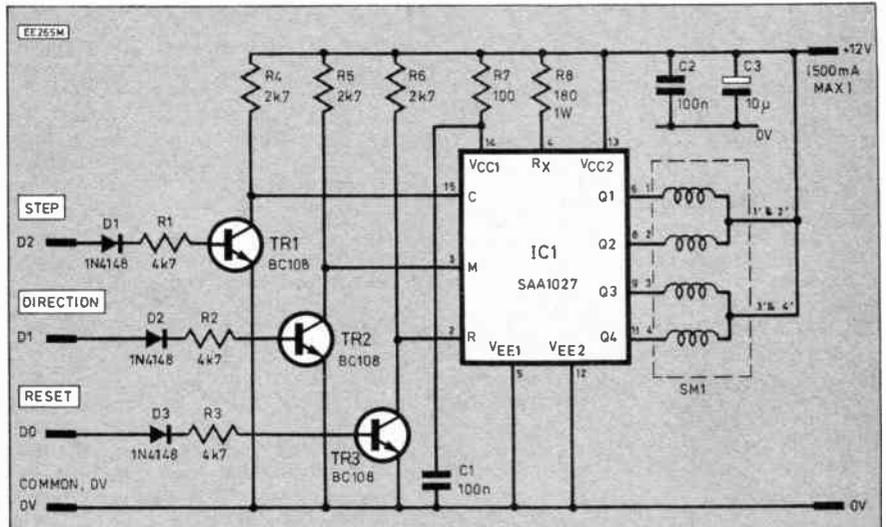


Fig. 1. Complete circuit diagram for the Stepper Motor Driver.

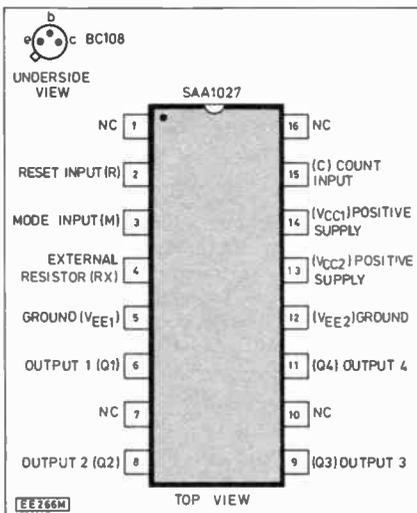


Fig. 2. Pinning details for the BC108 and SAA1027.

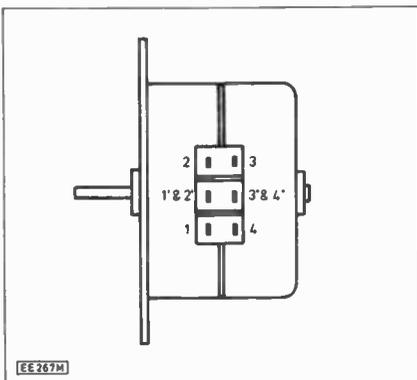


Fig. 3. Stepper motor connection details.

COMPONENTS

Resistors

R1 to R3	4k7 (3 off)
R4 to R6	2k7 (3 off)
R7	100
R8	180 1W

Unless otherwise stated all resistors are 0.25W 5% carbon

See
**Shop
Talk**
page 208

Capacitors

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

Semiconductors

D1 to D3	1N4148 (3 off)
TR1 to TR3	BC108 (3 off)
IC1	SAA1027

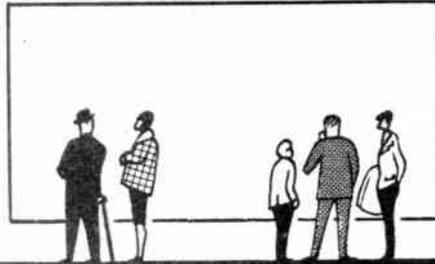
Miscellaneous

Stepper motor SM1 (see text), 16-pin d.i.l. socket, connectors (see text), 0.1in. matrix Veroboard (or similar) measuring approximately 100mm \times 80mm.

Approx. cost
Guidance only

£16

SHOP TALK



BY DAVID BARRINGTON

CATALOGUES RECEIVED

This month we have received two first class catalogues from Marco Trading and Cirkit.

Containing over 130 pages, with most containing illustrations, the Marco 1986 Catalogue list is very impressive and carries items ranging from a musical buzzer to high speed pen recorders and test equipment to telecom equipment, including the latest press-button phones.

Also there are 30 pages devoted to popular, and not so popular, i.c.s, semiconductor and opto devices. I like the idea of the inclusion of two pages devoted to Sony equipment spares, as finding a source of replacement parts for Japanese equipment can be very difficult in the UK.

Our copy of the catalogue was accompanied by a 15-page inset of "bargain buys". Items listed included dynamic mics, component packs, portable gas soldering iron and a range of low voltage miniature d.c. motors.

The catalogue costs £1, but includes a 50p credit note. They claim that orders received by 4 p.m.—post, phone or telex—will be despatched same day (subject to availability). Copies of the Marco 1986 catalogue may be obtained from: Marco Trading, Dept EE, The Maltings, High Street, Wem, Shropshire SY4 5EN.

Every year when the new edition of the Cirkit Components Catalogue is released, they usually augment the event with an announcement of a new "exclusive" franchise or component range. This year they have gone one better and announced a new "first" and a special educational phone-in desk.

Coinciding with the latest Spring '86 edition, they have just launched, what they claim, is the first 6m transverter kit to be offered by a UK company. The kit, designed by G3 WPO, is just one of the many new items listed in the 144-page catalogue which should now be arriving on the bookstalls. The catalogue can also be purchased at the cover price of £1.15 direct from Cirkit at their Broxbourne headquarters. The catalogue contains redeemable £1 vouchers for use with each single order of £15 and over, excluding VAT.

For the first time the new issue features a special section containing pinouts for linear i.c.s plus an enlarged section on computer communication peripherals for the Amstrad, including modems, text dumps, RS232 interface, parallel/cen-tronics interface and ROM card. Additions to the kit range are low power h.f. amps and h.f. pre amps, plus a car windscreen wiper delay.

By contacting the Cirkit "hot line" on 0992 445736, educational Science and Technology departments can receive a complimentary copy of the catalogue and regular updates.

Service with a smile from Sonia, Marco's Internal sales rep.

Please mention
**EVERYDAY
ELECTRONICS**
when replying
to products
mentioned on
this page and to
Classified Ads



CONSTRUCTIONAL PROJECTS

Stereo Reverb

The dimensions of the case for the *Stereo Reverb* will be determined by the size of springline module used. The one in our prototype was obtained from Maplin and is their "short" version. This should be ordered as: XL08J (Short Spring Line).

If the reverb is to receive fairly rough treatment, it may be a good idea to mount the springline on "rubber couplers". These are also available from Maplin (code FB98G) and are claimed to reduce transmission of acoustic shocks and vibrations to the springs.

Freeloader

The case used in the *Freeloader* project is entirely optional and, in view of the tight density of components, readers may prefer to use a larger case.

If constructors do follow the circuit board layout and use a case of the type listed, the choice of relay may cause problems. Also, if the "universal" modification is built the extra relay and battery will not fit in the case.

The relay used in the author's model was a low-profile, sub-miniature printed circuit mounting type. The relay used must be able to operate down to 5V.

The sub-miniature relay is listed by *Electrovalue*. An alternative would be one of the microminiature range from *Rapid Electronics*. These have two sets of contacts and only one set need be used.

FET Voltmeter—Teach In '86 Project

Components for the *FET Voltmeter*, this month's Teach In '86 Project 7, seem to be readily available and no purchasing problems should be encountered.

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

Versatile Power Supply

When ordering components for the *Versatile Power Supply* it is important to quote the L when specifying the transistor type BC184L. The BC184 has a different pinning arrangement and will cause confusion when mounting on the stripboard.

Stepper Motor Driver

Readers contemplating building this month's suggested *On Spec* project may encounter a couple of component purchasing problems.

We can only find the 16-pin stepper motor i.c. type SAA1027 listed in the Maplin catalogue at £3.75.

Suitable stepper motors for the *Stepper Motor Driver* should be available from Greenweld, or Maplin Electronics Supplies. Maplin can supply a stepper motor kit consisting of motor and motor driver i.c. (SAA1027) for the sum of £12.95: code LK76H (Stppr Mtr + Drvr Kit).

Circle Chaser

We do not expect any component buying problems when ordering parts for the *Circle Chaser*.

The mains transformer used in the prototype was one of the miniature types rated at 100mA. These have a C-clamp type construction with flying leads and are listed by *Rapid*, *Dziubas*, *TK Electronics* and *Marco Trading*.

EE SPECIAL OFFER

Riscomp Alarm Systems

SECURITY SYSTEM CS 1370

**SPECIAL OFFER PRICE
INCLUDING VAT P & P**

£39.95



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

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

STAND ALONE ALARM...CK 5063

**SPECIAL OFFER PRICE
INCLUDING VAT P & P**

£37.95

A self-contained Alarm Unit Kit with built-in siren. Kit contains: Digital Ultrasonic Detector US5063, Siren and Power Supply Module PSL1865, Internal Speaker SS3515, Key Switch KS3901, Enclosure and Hardware Kit HW5063. Using built and tested modules, it requires only the minimum of mechanical assembly together with the inter-

connection of the modules in order to provide an effective and convenient alarm system. The housing is similar to that shown above. The alarm can be wall-mounted or simply placed on a shelf or table to protect the surrounding area. It has false alarm protection with entry and exit delays.

Post to: Riscomp Ltd., 51 Poppy Road, Princes Risborough, Bucks HP17 9DB. Tel: (084 44) 6326

Please complete both parts of the coupon in BLOCK CAPITALS

Please send me Kit/s (CS1370)

Please send me Kit/s (CK5063)

Please allow 28 days for delivery OFFER CLOSES FRIDAY MAY 30, 1986

I enclose PO/Cheque No..... Value £.....

Name.....

Name.....

Address.....

Address.....

Post to: Riscomp Ltd, 51 Poppy Road, Princes Risborough, Bucks HP17 9DB

VERSATILE PSU

M.P. HORSEY

Cheap constant current for charging cells and boosting batteries—a useful PSU to boot

THE RATHER high cost of a power unit is due mainly to the transformer and the need for mains safety in the form of fuses, switches, neon indicator, and a substantial case. It is helpful, therefore, to make any power unit as versatile as possible. The unit to be described provides: a regulated variable voltage output from 1.2V to 15V and a constant current output, suitable for charging a wide range of nickel-cadmium cells.

CONTROL

The voltage is controlled with a variable resistor linked with an integrated circuit, and regulation is sufficiently accurate to allow a scale to be marked, without the need for a built-in voltmeter.

The constant current required is set via a rotary switch. The settings are as follows:

- Setting 1. Regulated voltage output.
- Setting 2. Constant current 8mA (for charging PP3 batteries & AAA cells).
- Setting 3. Constant current 45mA (for charging AA cells).
- Setting 4. Constant current 80mA (for charging PP9 batteries).
- Setting 5. Constant current 150mA (for charging C cells).
- Setting 6. Constant current 320mA (for charging D cells).

AUTOMATIC VOLTAGE REGULATION

Regulator circuits can be designed which automatically compensate for a changing current, and thus provide a true regulated voltage. Such circuits can now be obtained in the form of miniature integrated circuits, such as the chip which forms the heart of this project, the LM317T.

This i.c. provides a possible regulated voltage range from 1.2V to 37V, at up to 1.2A. It is fully protected from short circuits, and includes thermal shutdown—which automatically reduces the current if the i.c. becomes too hot. The basic regulated voltage circuit is shown in Fig. 1.

AUTOMATIC CURRENT REGULATION

The same i.c. may also be wired to produce a constant current which is deter-

mined by a single resistor. The following formula may be used to calculate the size of the resistor required:

$$\text{Output current} = \frac{1.25}{R}$$

(where R is the value of the resistor)

Thus, if a current of 45mA is required, the resistor needed will have a value of 27Ω as shown in Fig. 2.

The figures quoted for voltage and current regulation assume ideal conditions but actual values will depend on the type of heat sink used, and the voltage drop across the i.c.

CIRCUIT DESCRIPTION

In this project a conventional transformer circuit is employed, with transformer T1 stepping down the mains 240V a.c. to 12V a.c. Four silicon diodes (contained in a bridge rectifier), are used to rectify the a.c. into d.c., and capacitors C1 and C2 provide smoothing of the supply. The positive supply is fed into the i.c., the output of which is fed via switch S2, either into one of the current control resistors, or to the regulated voltage output. This allows VR1 to control the voltage when S2 is in position 1.

Voltage regulation is sufficiently accurate to allow calibration of VR1, which removes the need for a built-in voltmeter. However, without a voltmeter, there is no indication if a short circuit is connected across the output. An l.e.d. indicator is therefore included, with components R3, R4, TR1 and R1.

Under normal conditions, enough current will flow into the base of transistor TR1 to turn it on, and hence the l.e.d. will light, as current flows through limiting resistor R1 to ground via the transistor. If a short circuit occurs the voltage at the junction between R3 and R4 will fall, causing the l.e.d. to switch off.

Such a short circuit will not harm the i.c., or any other part of the power unit. However, it is essential to know of this condition, in case damage is caused to whatever is connected to the power unit. Note that the l.e.d. does not function when the unit is set to constant current, since a virtual short circuit is normal in this application.

If switch S2 is set to position 2, the adjust pin is connected directly to the constant current output. The i.c. output is also connected to the constant current output, but via resistor R5. Thus a circuit similar to that shown in Fig. 2 is created, the 150Ω

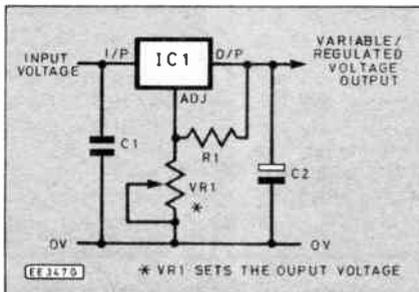


Fig. 1. Basic regulated voltage circuit.

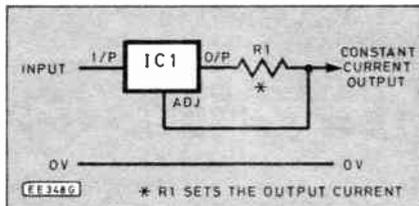


Fig. 2. Constant current regulation is determined by resistor R1.



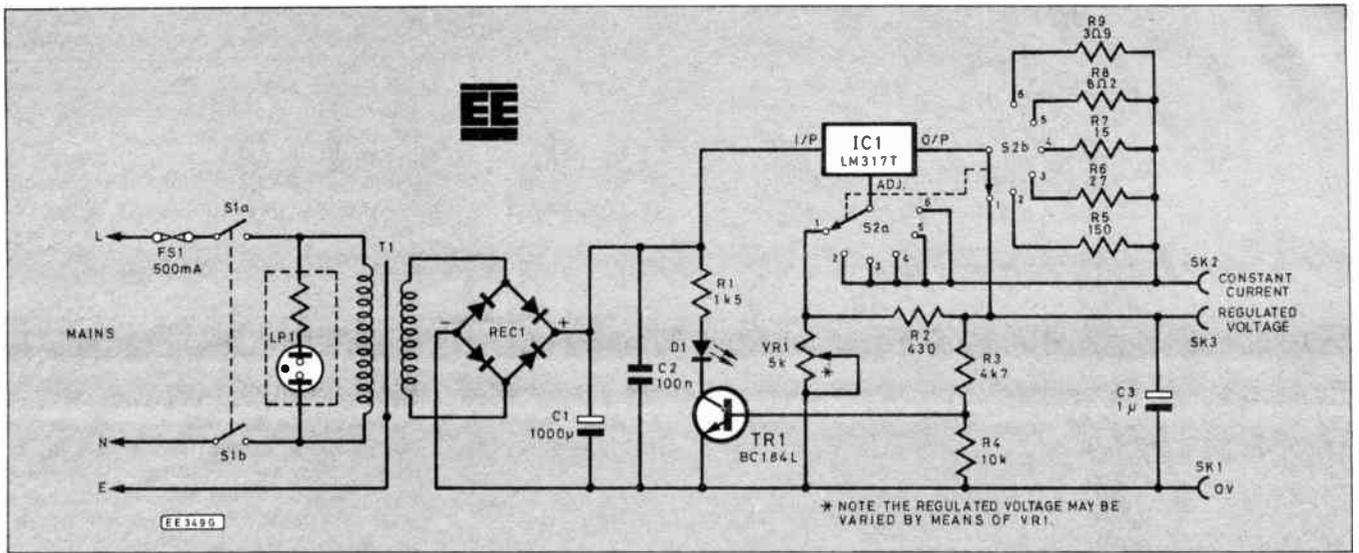


Fig. 3. Complete circuit diagram for the Versatile Power Supply Unit.

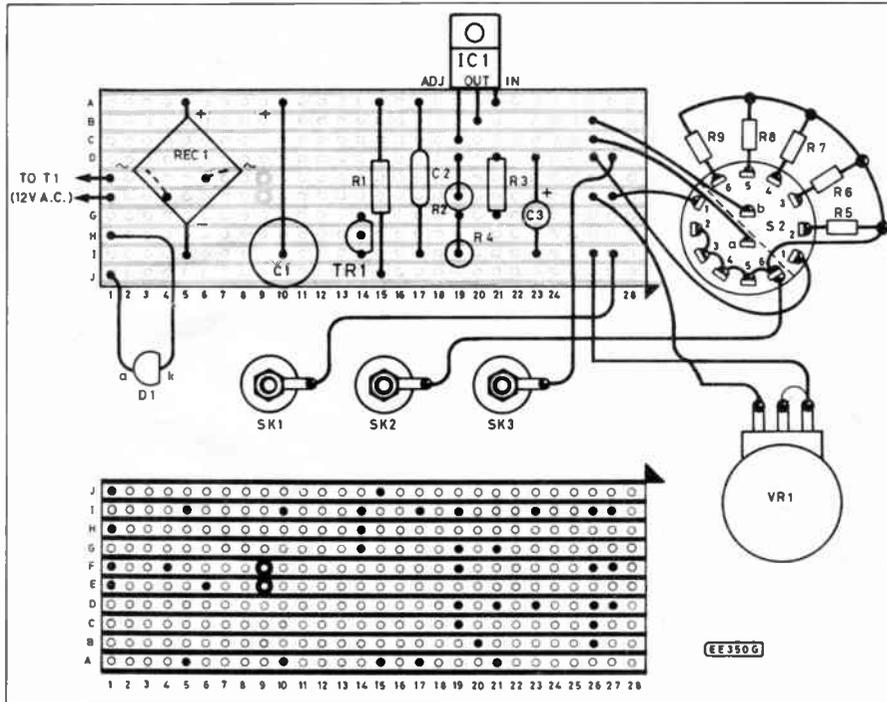


Fig. 4. Component layout, details of breaks in copper strips (2 off) and interwiring to the front panel mounted components. The wires from S2 to the stripboard should be kept as short as possible and reasonably thick.

value of R5 fixing the output current to 8.3 mA.

The other positions of switch S2 work in a similar manner thus providing a variety of output current options.

CONSTRUCTION

The majority of components are housed on a piece of stripboard measuring 70mm by 40mm. This is large enough to allow four holes to be drilled for mounting purposes.

Begin by marking out the stripboard, shown in Fig. 4, including the positions of the breaks. Strictly speaking, only one break is necessary on track F. It was considered prudent, however, to isolate the a.c. supply as much as possible; hence the other break. If the stripboard is to be mounted with metal screws, make additional breaks to isolate them from the circuit.

Assemble the components, starting with the smallest. Note carefully the polarity of the bridge rectifier, and place transistor

TR1 the correct way round, noting it is a BC184L (not a BC184, which has different connections). Note also the polarity of the electrolytic capacitors.

The regulator i.c. (IC1) is positioned in order to allow a heatsink to be fitted. The heatsink may be made from aluminium, copper or steel. The prototype used a strip of aluminium measuring 19 cm by 5cm, and shaped in order to avoid other components. Alternatively, IC1 may be bolted to the case of the power unit, if made of metal. Note, however, that the metal tag on the i.c. is connected internally to the output pin. It is essential to electrically isolate the tag, if it is bolted to the power unit case.

The i.e.d. is connected via flexible wires. Be sure to use wires capable of carrying up to 2A for the a.c. input. The wires linking the rotary switch with the stripboard must have the lowest possible resistance, if good load regulation is to be achieved. Therefore, keep the wires as short as possible, and reasonably thick.

COMPONENTS

Resistors

R1	1k5
R2	430
R3	4k7k
R4	10k
R5	150
R6	27
R7	15
R8	8.2 (0.5 watt)
R9	3.9 (0.5 watt)

All resistors 5% 1/4W unless stated otherwise

Potentiometers

VR1	5k linear
-----	-----------

Capacitors

C1	1000µ 25V electrolytic
C2	100n polyester
C3	1µ 50V electrolytic

Semiconductors

REC1	bridge rectifier 2A 50V (or more)
TR1	BC184L npn silicon
IC1	LM317T variable regulator i.c.
D1	0.2" i.e.d.

Miscellaneous

LP1 mains neon with integral resistor; T1 mains transformer (20VA) with 12V, 1.6A output; S1 toggle switch d.p.s.t.; S2 rotary switch 2 pole, 6 way; FS1 fuse holder and 500mA fuse; push-on knobs (2 off); terminals (2 red, 1 black); case (see text); heatsink (see text); 13A plug; stripboard (0.1 inch) 70mm x 40mm; mains cable; screws, etc.

Approx. cost
Guidance only

£14

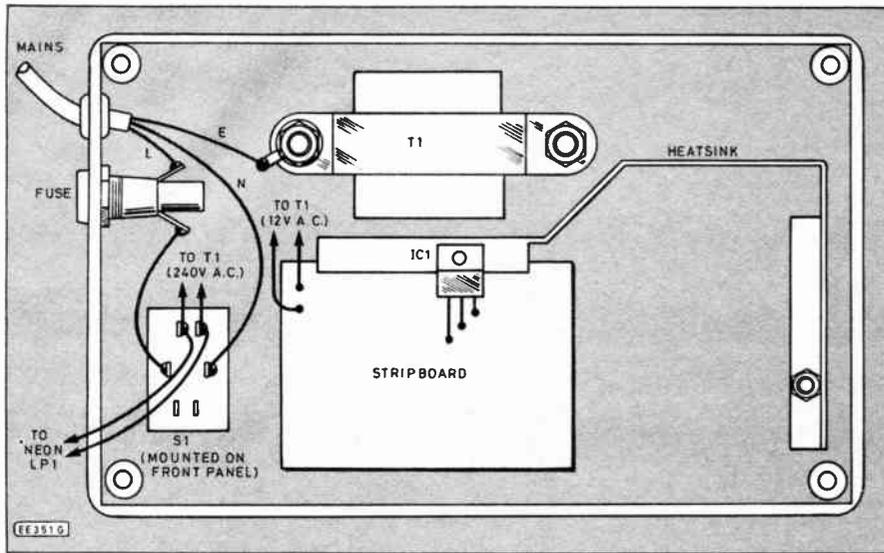


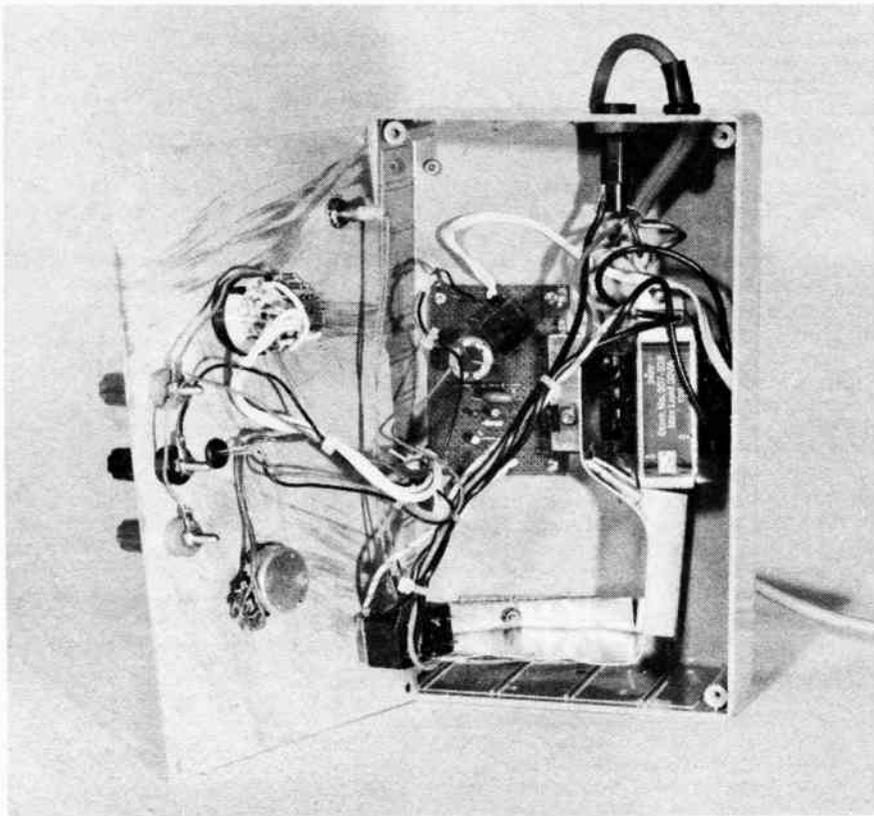
Fig. 5. Layout of components inside the case and wiring to the power supply section.

Resistors R5 and R9 are soldered to the rotary switch contacts. A piece of flexible wire is used to join their opposite ends together with the other tags of the switch as shown. The constant current output is also taken from this connection. Finally, link variable resistor VR1 with the stripboard, and solder in the regulated voltage output, and zero output wires. Carefully check the stripboard for bridged tracks, dry joints, etc. Check also that the a.c. supply is fully isolated from the d.c. side of the circuit.

It may be easier to test the circuit before the stripboard is mounted in the case. (See "Testing").

Almost any sturdy case may be used. Ensure that there is sufficient space for the transformer, and allow enough clearance for

The completed Versatile Power Supply Unit showing shaping of the heatsink for IC1. This heatsink must NOT touch any of the other components or wires. The mains input cable should be fixed by a strain relief clamp.



the potentiometer, switches, etc. The prototype unit was housed in a case with sloping front.

If ventilation holes are not provided, begin by drilling some, especially near the heatsink. However, ensure that small children are not able to make contact with mains connections inside. Any metal parts of the case must be properly earthed (i.e. connected to the mains earth), as must the transformer.

HEAT SINK

A fairly substantial heat sink is required, especially if the unit is expected to supply 1A at low voltages. At lower currents, or higher voltages, less heat is produced. The strip of aluminium (described earlier), must

be shaped and positioned to avoid touching other components or wires. One end is fixed to the i.c., and the other end bolted to the plastic case. A small piece of stripboard may be fixed between the aluminium and plastic, to prevent heat damage.

A smaller heatsink may be used, but the output current may be automatically reduced to below 1A (especially at low output voltages), as the i.c. becomes hot. If a metal case is used, the i.c. may be bolted to it, ensuring that it is electrically isolated with a suitable washer.

When the internal arrangement is finalised, drill the necessary holes, and secure the components. Take special care with the mains connections, ensuring that they cannot make contact with the low voltage connections. Fit a 1A or 3A fuse in the mains plug, and a 500mA fuse in the power unit. The power unit should give many years of service, and will almost certainly earn its keep, many times over.

TESTING

The circuit may be tested at this stage, if a suitable a.c. or d.c. supply is available (a 9V battery will suffice). Alternatively testing may be carried out when the transformer and associated circuitry is installed and working.

Connect the a.c. (on the stripboard) to the supply (either way round, whether an a.c. or d.c. supply is used). Set the rotary switch S2 to position 1 (fully counter-clockwise—if wired correctly).

The l.e.d. should light. If it does not, use a voltmeter to find out if there is a voltage across it. If a reading of several volts is obtained, the l.e.d. is probably connected the wrong way round.

Use the voltmeter to test the regulated output voltage. It should be possible to vary this voltage, using VR1, from 1.2V to a little less than the input voltage. If no reading is obtained, connect the voltmeter across tracks A and I, and establish that the rectifier is working properly. Check the voltage on the output (centre) pin of IC1. If this is satisfactory, there may be a wiring fault at switch S2. Note that for a regulated voltage output, the rotary switch should connect track B to track D, and track C to track F.

FINAL CHECKS

WARNING: These checks will quickly run down a battery, if in use as a temporary power supply.

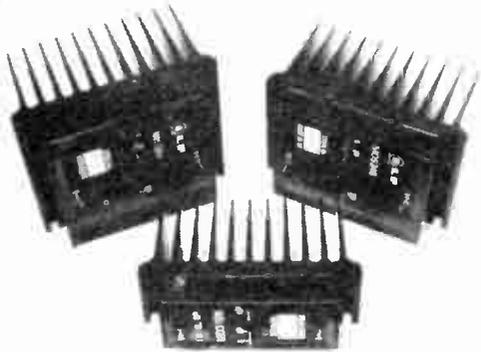
If all is well, short circuit the regulated voltage output. The l.e.d. should go out. The short circuit current should range from 2A to 3A, quickly falling to about 1A. This may be tested if an ammeter with a f.s.d. of about 5A is available.

Finally, connect an ammeter set to 1A f.s.d. to the constant current output. Turn the rotary switch to position 2. The l.e.d. should turn off, and the ammeter should show a small reading, which when set to a smaller scale, indicates about 8mA. Check that the other positions of S2 produce the correct current readings.

CALIBRATION

Calibration of VR1 must be accomplished with the aid of a voltmeter. The scale must be marked by hand, at 1V or 5V intervals. Switch S2 may be marked with the current options outlined earlier, not forgetting that setting 1 is reserved for regulated voltage operation. □

FROM JAYTEE



THE SPECIAL DISTRIBUTOR FOR SPECIAL AMPLIFIERS

ILP have long been recognised as manufacturers of top quality amplifiers.

All ILP products are built to extremely high specification for the ultimate in hi-fi performance. They're unique in being completely encapsulated with integral heatsinks, and can bolt straight onto the chassis. They're also extremely robust, ensuring high levels of reliability as well as performance.

ILP Amplifiers are now available through Jaytee. The UK Distributor with the availability and service to match the quality of the amplifiers.

POWER BOOSTER AMPLIFIERS

The C15 and C1515 are power booster amplifiers designed to increase the output of your existing car radio or cassette player to 15 watt rms.

C15 15 watts **£10.65**
C1515..... 15 + 15 watts..... **£19.78**

ILP LOUDSPEAKER

power..... 350 watt rms
size..... 12 inches
impedance..... 8 ohms
range..... 20 Hz to 5 KHz

NEW £78.61

FOR FREE DATA PACK PLEASE
WRITE TO OUR SALES DEPT.

PREAMPLIFIER MODULES

All modules are supplied with in line connectors but require potentiometers, switches, etc. If used with our power amps they are powered from the appropriate Power Supply.

Type	Application	Functions	Price
HY6	Mono Pre-Amp	Full Hi-Fi facilities	£8.45
HY66	Stereo Pre-Amp	Full Hi-Fi facilities	£13.95
HY73	Guitar Pre-Amp	Two Guitars plus Microphone	£14.45
HY78	Stereo Pre-Amp	As HY66 less tone controls	£13.45
NEW! HY83 Guitar and Special Effects Pre-Amp as HY 73 Plus Overdrive and Reverb £18.95			
MOUNTING BOARDS: For ease of construction we recommend the B6 for HY6 £0.95. B66 for HY66-83 £1.45.			

MOSFET MODULES

Ideal for Disco's, public address and applications with complex loads (line transformers etc.) Integral Heatsink
slew rate 20v/μs distortion less than 0.01%

Type	Output Power Watts (rms)	Load Impedance Ω	Price
MOS128	60	4 8	£34.45
MOS248	120	4 8	£39.45
MOS364	180	4	£64.45

BIPOLAR MODULES

Ideal for Hi Fi, Full load protection integral Heatsink, slew rate 15v/μs

Type	Output Power Watts (rms)	Load Impedance Ω	Price
HY30	15	4 8	£10.45
HY60	30	4 8	£10.45
HY6060	30 + 30	4 8	£21.95
HY124	60	4	£17.45
HY128	60	8	£17.45
HY244	120	4	£22.45
HY248	120	8	£22.45
HY364	180	4	£33.45
HY368	180	8	£34.95
Distortion less than 0.01%			

POWER SUPPLY UNIT

Type	For Use With	Price
PSU30	PRE AMP	£6.45
PSU12	1 or 2 HY30	£16.45
PSU412	1 or 2 HY60, 1 HY6060, 1 HY124	£18.45
PSU422	1 HY128	£20.45
PSU432	1 MOS128	£21.45
PSU512	2 HY128, 1 HY244	£22.45
PSU522	2 HY124	£22.45
PSU532	2 MOS128	£22.95
PSU542	1 HY248	£22.95
PSU552	1 MOS248	£24.95
PSU712	2 HY244	£26.45
PSU722	2 HY248	£27.45
PSU732	1 HY364	£27.45
PSU742	1 HY368	£29.45
PSU752	2 MOS248, MOS364	£29.45
All the above are for 240v operation		



Jaytee Electronic Services, 143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL Telephone: (0227) 375254
All Prices include VAT, Post & Packing

SAME DAY DESPATCH

COMPONENT PACKS

Ref	Qty	Description	Price
EP1	300	Assorted Resistors Mixed Types	£0.95
EP2	350	Carbon Resistors Pre-Formed 1/4 W - 1/2 W	£0.95
EP3	200	Assorted Capacitors	£0.95
EP4	75	C280 Capacitors Metal Foil Type	£0.95
EP6	4	1000mfd 16V Axial Electrolytic Capacitors	£0.40
EP7	20	Zener Diodes Mixed	£0.30
EP8	20	Assorted LEDs	£0.95
EP9	50	Assorted Electrolytics	£0.95
EP10	5	LEDS Red 3mm	£0.30
EP11	5	LEDS Yellow 3mm	£0.30
EP12	5	LEDS Amber Triangle 3mm	£0.30
EP30	50	BC177/8 Transistors Uncoded	£0.95
EP14	1	Wire Cutters (worth £7)	£1.95
EP15	1	Pliers (worth £7)	£1.95
EP16	5	Small Screwdrivers plastic handles	£0.40
EP17	20	Tantalum Capacitors 330mfd 63V 5%	£1.25
EP19	20	33mfd 16V Radial Electrolytics Caps	£0.35
EP20	1	Solder Pack, 3 Metres 18 swg Solder	£0.40
EP21	40	Metres PVC Multi-Strand Wire Mixed Colours	£0.90
EP22	40	Metres PVC Single Strand Wire Mixed Colours	£0.90
EP23	30	Fuses Mixed Types & Values	£0.70
EP24	15	Assorted Rotary Potentiometers	£1.15
EP25		Electronic Components, a package containing a vast selection of Resistors, Capacitors, Pots, Switches, Knobs, Diodes, etc. . . We estimate the total package to be worth more than £25. only £4.45	
EP26	1	Pack of Copper Clad Boards	£2.00
EP27	1	Stylus Balance (Bib) for measurement of Stylus Pressure, Precision made	£0.50

★ LOWEST PRICES

★ SAME DAY DELIVERY IF YOU ARE WITHIN 20 MILES OF HERTFORD (MIN ORDER £50)

★ NEW PRICE LIST NOW AVAILABLE

★ TELEPHONE ORDERS WELCOME

★ OFFICIAL ORDERS WELCOME

ADD 75p P&P plus 15% VAT (No Min Order)

AC128 27p. AC188 23p. BC107/8/9 10p.
2N3055 48p. Zeners 400mW 6p. 1N4148 3p.
NE555 19p. 741 16p. 1N4001 5p. LM311 30p.
MC1496 50p. 74LS03 18p. LM/UA733 50p.

ALL COMPONENTS ARE BRAND NEW AND FULLY GUARANTEED

PRESETS 7p. ROTARY POTENTIOMETERS 38p. 8-pin DIL Sockets 5p. PHONO PLUGS 10p.

ELECTRICAL GOODS AT WHOLESALE PRICES

DESOLDERING PUMP £4.25

MINI ELECTRIC DRILL 12V £5.25

Elmwood
Components

3 WARREN PLACE, RAILWAY STREET, HERTFORD, HERTS
TEL HERTFORD 0992 54319

DOWN TO EARTH

BY GEORGE HYLTON

CREATING trick audio effects is a well-known use for the ring modulator. In communications, however, it has other uses and a long history.

TRADITIONAL RING MODULATORS

In its traditional form (Fig. 1), a ring modulator comprises two transformers with centre-tapped windings and four diodes. Its function is to generate amplitude-modulation sidebands.

Although it isn't very obvious from Fig. 1 that the diodes are connected in a ring, nose to tail, they are (compare Figs. 1 and 2) and this is the origin of its name.

Long ago, before silicon and germanium diodes were invented, the ring modulator used copper-oxide diodes and was sometimes referred to as a copper-oxide modulator.

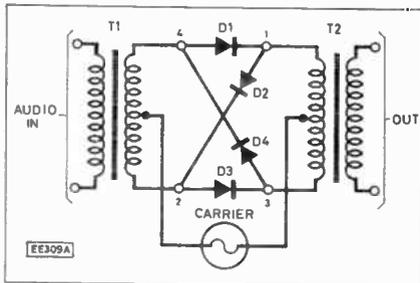


Fig. 1. Traditional ring modulator.

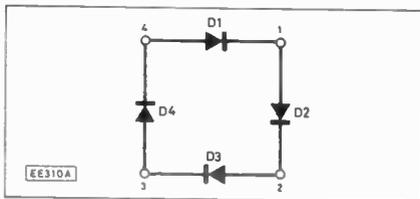


Fig. 2. The "ring" arrangement of the diodes in Fig. 1.

SWITCHING

The diodes are used as switches. They are switched on and off by the carrier, that is by a steady oscillation which normally runs at a much higher frequency than the audio signal.

The carrier is much stronger than the audio: this means that the state of any diode at a particular moment is governed by the carrier, not the audio. The carrier either makes the diode conduct strongly or reverse biases it so that it doesn't conduct at all.

All the audio can do is to flow through whichever diodes are conducting, adding a little more or a little less to the current created by the carrier, but not changing the state of a diode. The job done by the carrier is in effect to steer the audio through whatever diodes are required at any instant.

The diodes conduct in pairs. One half-cycle (Fig. 3) of the carrier makes D1 and D3 conduct while reverse-biasing D2 and D4. On the next half-cycle (Fig. 4) D2 and D4 conduct while D1 and D3 are off. The single arrows indicate the direction of the carrier current.

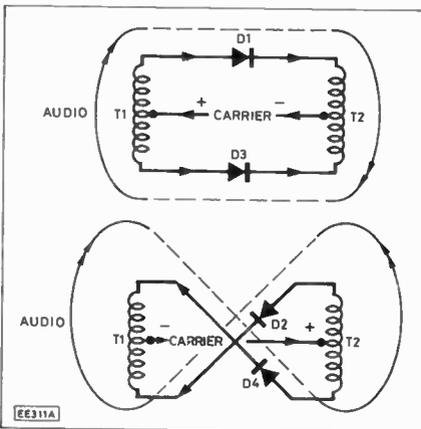


Fig. 3 (top). The diodes conduct in pairs. One half cycle of the carrier makes D1 and D3 conduct. On the other half cycle (Fig. 4 above) D2 and D4 conduct.

A conducting diode behaves like a low resistance. Audio signals (double arrows) at the secondary of transformer T1 flow through the diodes and the primary of T2. Because the audio is feeble compared with the carrier, audio currents can in effect flow in any direction through the low resistance of a conducting diode, mixed up with the much stronger carrier current.

If an audio half-cycle drives currents as shown then on one carrier half cycle (Fig. 3) the audio current goes downward through T2 (double arrow) and on the next, upward. Thus the direction of the audio current is reversed every time the carrier's polarity reverses.

The audio, as shown in Fig. 4, is steered first one way then the other at a rate governed by the carrier. This converts the audio to a high frequency whose amplitude is governed by the audio wave, but whose frequency is governed by the carrier.

SIDEBANDS

This converted "audio" wave in fact contains no audio, only high frequencies. It contains no carrier, either. Equal and opposite carrier currents flow through the two halves of T2's primary. The result is that they create equal and opposite magnetic fields which cancel, producing no carrier voltage in T2's secondary.

Because neither audio nor carrier appears at the output a ring modulator is said to be double-balanced. That is, both carrier and audio are "balanced out". This leaves only the sideband frequencies, plus

harmonics. If the carrier is at 100kHz and the audio 2kHz then the output contains 98kHz (lower sideband) and 102kHz (upper sideband) and some harmonics of no practical importance.

APPLICATIONS

Ring modulators were first widely used in carrier telephone systems. In these, a number of different telephone channels were created and sent over the same line, on different frequencies. One sideband of each channel was filtered out. This halved the bandwidth, enabling more channels to be carried by the same line.

Nowadays, ring modulators are also used in high-performance radio receivers, where they act as frequency changers. For example, an incoming signal on 4MHz might be mixed, in a ring modulator, with a local oscillation of 5MHz to give an intermediate frequency (i.f.) of 1MHz. The other sideband, on 9MHz would be eliminated by the i.f. filters.

The big attraction of the ring modulator, in its diode form, is that it produces less intermodulation of unwanted signals hence less spurious signals and noise. (This may not always be true of i.c. versions incorporating transistors.)

TRICK EFFECTS

It's quite possible (in Fig. 1) to replace the carrier with a second audio signal. If the first signal is a musical instrument and the second a human voice, then the instrument emerges controlled by the voice.

But because the ring modulator is balanced, the voice as such does not emerge. The result is an output consisting of the instrument modulated by a ghostly voice. This is how effects like the "talking piano" are made.

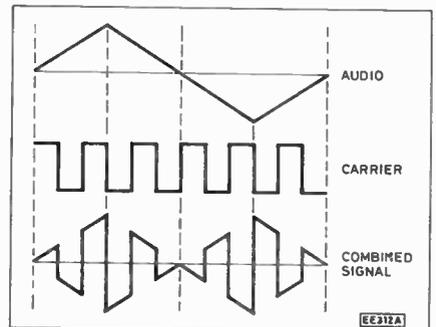


Fig. 4. The effect of combining the audio and carrier waves.

I.C. MODULATORS

It's possible to use transistors instead of diodes and to use transistor phase-splitters instead of centre-tapped transformers.

The way is then clear to making a sort of ring modulator on a chip. These are now finding their way into consumer equipment (often as parts of more complex i.c.s). Because of the mathematics of their operation they are sometimes called multipliers or product modulators.

The classic diode-ring modulator, with transformers, is now available as a miniature encapsulated assembly. It is likely to use Schottky diodes and windings on ferrite toroids but in all essentials is a direct descendant of the copper-oxide modulator of fifty years ago.

CIRCUIT EXCHANGE

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

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

We are looking for original ideas which may be simple or complex, but most importantly are useful and practical. Areas of particular interest are ideas for car electronics, test gear designs, home projects and computer interfacing.

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

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

STEPPER MOTOR CONTROLLER

This circuit is designed for use with any computer with an eight line TTL compatible output port, e.g. VIC20, BBC, Commodore 64. It is ideal for controlling a turtle as it operates two stepper motors.

Some recommended dimensions for this turtle are 61.1mm diameter wheels and 229mm between the wheels. These dimensions mean that with both motors running in the same direction, the turtle will move 2mm forwards/step. (The motor's step is 7.5 degrees). If the motors are stepped in opposite directions, the turtle will turn through 1 degree/step.

To make motor ME 1 step forwards, the output port should be poked with 255-(1,5,4,6,2,10,8,9). To make the other motor step forwards, the port should be poked with 255-16(1,5,4,6,2,10,8,9).

The 255- compensates for the inverters in the circuit. The inverters are NOR gates with one input grounded. They are present to ensure that the ULN 2803A, which is a Darlington amplifier, receives 5V whatever the inverter's input voltage.

The power supply must be 10-15V and capable of supplying 2A.

S. A. Baker,
Hampstead,
Glos.

SIMPLE PUSHBUTTON CODELOCK

IT HAS come to my notice there are two kinds of codelock systems. They are either the sort where you may push each button one at a time to release the lock, but require complicated logic; or they are the simple type that are just several switches in an "AND" type form where you have to press all the coded buttons at once. The circuit presented here is a code lock of both simple use and construction.

The circuit below operates around just one chip, a 4017 counter. When power is first supplied, the first output of IC1 goes high.

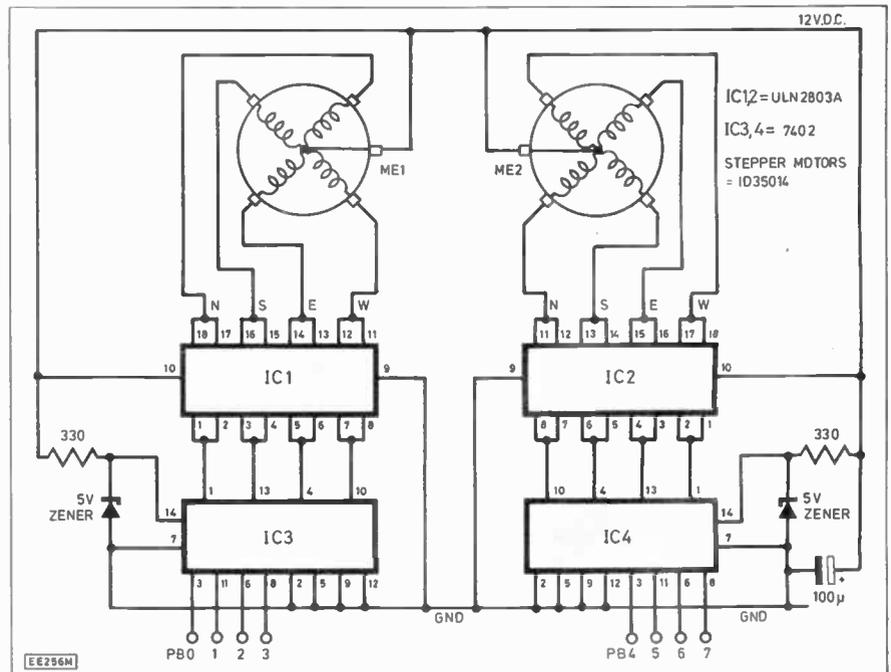
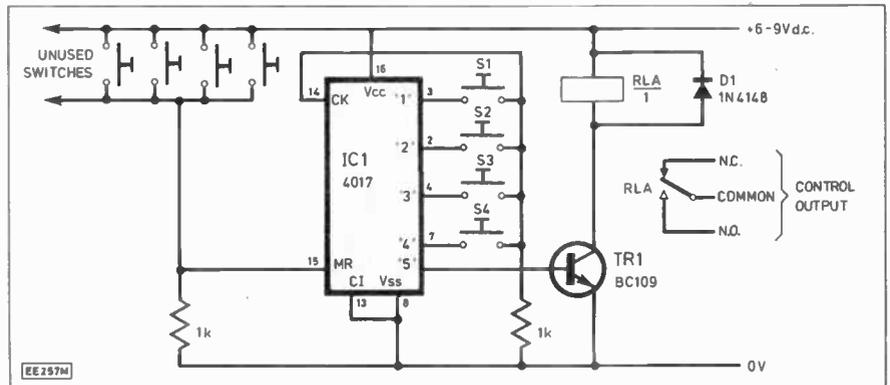
If the first coded switch S1 is pressed, the counter would be allowed to clock on one count. If any other switch is pressed, nothing would happen. Now that the i.c.'s second

output is high, the second button may be pressed, allowing the counter to clock one again.

Now if one of the unused switches is pressed, the counter will be reset. This goes on until the counter reaches the fifth output. At this point, the output is carried to the base of TR1, allowing the relay to operate. The resistance of the relay coil should be greater than 100 ohms in order to avoid damage to the transistor.

Up to nine switches may be used in the code. If more than the four shown here are required, simply connect the extra switches between the next output and the clock input pin. The base of TR1 should be connected to the output after the last switch. Any extra "unused" switches should be wired in parallel with those already shown.

David Cox,
Cardiff.



WATCH OUT FOR

PROTEUS

No.5

**A Complete Fantasy
Adventure Game Magazine**

Plus a FREE poster



More

PROTEUS

**PERILS
TO BRAVE**

On sale NOW — Only 80p

PCB SERVICE

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

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

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

NOTE: Please allow 28 days for delivery. We can only supply boards listed in the latest issue.

PROJECT TITLE	Order Code	Cost
— JULY '83 —		
User Port Input/Output <i>M.I.T. Part 1</i>	8307-01	£4.82
User Port Control <i>M.I.T. Part 1</i>	8307-02	£5.17
— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
Car Intruder Alarm	8308-02	£5.15
High Power Interface <i>M.I.T. Part 2</i>	8308-03	£5.08
Pedestrian Crossing Simulation <i>M.I.T. Pt 2</i>	8308-04	£3.56
— SEPTEMBER '83 —		
High Speed A-to-D Converter <i>M.I.T. Pt 3</i>	8309-01	£4.53
Signal Conditioning Amplifier <i>M.I.T. Pt 3</i>	8309-02	£4.48
Stylus Organ	8309-03	£6.84
— OCTOBER '83 —		
D-to-A Converter <i>M.I.T. Part 4</i>	8310-01	£5.77
High Power DAC Driver <i>M.I.T. Part 4</i>	8310-02	£5.13
— NOVEMBER '83 —		
TTL/Power Interface for Stepper Motor <i>M.I.T. Part 5</i>	8311-01	£5.46
Stepper Motor Manual Controller <i>M.I.T. Part 5</i>	8311-02	£5.70
Speech Synthesiser for BBC Micro	8311-04	£3.93
— DECEMBER '83 —		
4-Channel High Speed ADC (Analogue) <i>M.I.T. Part 6</i>	8312-01	£5.72
4-Channel High Speed ADC (Digital) <i>M.I.T. Part 6</i>	8312-02	£5.29
Environmental Data Recorder	8312-04	£7.24
Continuity Tester	8312-08	£3.41
— JANUARY '84 —		
Biological Amplifier <i>M.I.T. Part 7</i>	8401-02	£6.27
Temp. Measure & Control for ZX Comprs Analogue Thermometer Unit	8401-03	£2.35
Analogue-to-Digital Unit	8401-04	£2.56
Games Scoreboard	8401-06/07	£9.60
— FEBRUARY '84 —		
Oric Port Board <i>M.I.T. Part 8</i>	8402-02	£9.56
Negative Ion Generator	8402-03*	£8.95
Temp. Measure & Control for ZX Comprs Relay Driver	8402-04	£3.52
— MARCH '84 —		
Latched Output Port <i>M.I.T. Part 9</i>	8403-01	£5.30
Buffered Input Port <i>M.I.T. Part 9</i>	8403-02	£4.80
VIC-20 Extension Port Con. <i>M.I.T. Part 9</i>	8403-03	£4.42
CBM 64 Extension Port Con. <i>M.I.T. Part 9</i>	8403-04	£4.71
Digital Multimeter Add-On for BBC Micro	8403-05	£4.63
— APRIL '84 —		
Multipurpose Interface for Computers	8404-01	£5.72
Data Acquisition "Input" <i>M.I.T. Part 10</i>	8404-02	£5.20
Data Acquisition "Output" <i>M.I.T. Part 10</i>	8404-03	£5.20
Data Acquisition "PSU" <i>M.I.T. Part 10</i>	8404-04	£3.09
A.F. Sweep Generator	8404-06	£3.55
Quasi Stereo Adaptor	8404-07	£3.56

Simple Loop Burglar Alarm	8405-01	£3.07
Computer Controlled Buggy <i>M.I.T. Part 11</i>	8405-02	£5.17
Interface/Motor Drive	8405-03	£3.20
Collision Sensing — MAY '84 —	8405-04	£4.93
Power Supply		
— JUNE '84 —		
Infra-Red Alarm System	8406-01	£2.55
Spectrum Bench PSU	8406-02	£3.99
Speech Synthesiser <i>M.I.T. Part 12</i>	8406-03	£4.85
Train Wait	8406-04	£3.42
— JULY '84 —		
Ultrasonic Alarm System	8407-01	£4.72
Electronic Code Lock	8407-03	£2.70
Main Board	8407-04	£3.24
Keyboard		
— AUGUST '84 —		
Microwave Alarm System	8408-01	£4.36
Temperature Interface—BBC Micro	8408-02	£2.24
— SEPTEMBER '84 —		
Op-Amp Power Supply	8409-01	£3.45
— OCT '84 —		
Micro Memory Synthesiser	8410-01*	£8.20
Drill Speed Controller	8410-04	£1.60
— NOVEMBER '84 —		
BBC Audio Storage Scope Interface	8411-01	£2.90
Proximity Alarm	8411-02	£2.65
— DEC '84 —		
TV Aerial Pre-Amp	8412-01*	£1.60
Digital Multimeter	8412-02/03*	£5.20
Mini Workshop Power Supply	8412-04	£2.78
— JAN '85 —		
Power Lighting Interface	8501-01	£8.23
Games Timer	8501-02	£1.86
Spectrum Amplifier	8501-03	£1.70
— FEB '85 —		
Solid State Reverb	8502-01	£3.68
Computerised Train Controller	8502-02	£3.38
— MARCH '85 —		
Model Railway Points Controller	8503-01	£2.78
— APRIL '85 —		
Insulation Tester	8504-02	£2.53
Fibrelarm	8504-03	£3.89
— MAY '85 —		
Auto Phase	8505-01	£3.02
Amstrad CPC464 Amplifier	8505-02	£2.56
Mains Unit	8505-03	£2.56
Micro Unit	8505-04	£2.67
Voltage Probe		
— JUNE '85 —		
Graphic Equaliser	8506-01	£3.21
Computerised Shutter Timer	8506-02	£2.09
Mono-Bi-Astables (Experimenters Test Bed)	8506-03	£2.45
Across The River	8506-04	£2.63
— JULY '85 —		
Amstrad User Port	8507-01	£3.17
Nascom Printer Handshake	8507-02	£1.90
— AUGUST '85 —		
Electronic Building Blocks—1 to 4†	8508-01	£2.98
Tremolo/Vibrato	8508-02	£4.03
Stepper Motor Interface	8508-03	£2.40
Drill Control Unit	8508-04	£2.90
— SEPTEMBER '85 —		
RIAA Preamplifier Input Selector	8509-01	£2.36
Transducers Resistance Thermometer	8509-03	£2.64
Transducers Semiconductor Temp. Sensor	8509-04	£2.72
— OCT '85 —		
Transducers Strain Gauge	501	£2.87
Soldering Iron Power Controller	504	£2.09
— NOV '85 —		
Transducers— Magnetic Flux Density Amplifier	505	£3.93
Hallowe'en Projects (single board price)	506	£2.68
— DEC '85 —		
Electronic Building Block — 5 to 8†	508	£3.07
Opto Intensity Transducer	509	£2.70
Digital Capacitance Meter	512	£5.22
— JAN '86 —		
Mains Delay	503	£2.13
Musical Doorbell	507	£2.91
Tachometer—Transducers	513	£2.52
— FEB '86 —		
Touch Controller	510	£2.65
Function Generator	514	£3.10
Function Generator PSU Board	515	£2.09
pH Transducer	516	£2.75

*Complete set of boards.

M.I.T.—Microcomputer Interfacing Techniques, 12-Part Series.

†Four separate circuits.

PROJECT TITLE	Order Code	Cost
Mains Tester & Fuse Finder	517	£2.27
BBC Midi Interface	518	£3.26
Stereo Hi Fi Preamp	519	£5.70
Interval Timer	520	£2.36
— MAR '86 —		
Stereo Reverb	521	£2.89
— APRIL '86 —		

Prices for *ELECTRONICS MONTHLY* PCBs are shown below.

PROJECT TITLE	Order Code	Cost
Cymbal Synth	EM/8412/2	£4.86
The Thing	EM/8412/4	£3.18
— DEC '84 —		
Speak Board	EM/8501/2	£3.97
— JAN '85 —		
Headphone Amp	EM/8502/1	£2.08
Intelligent Nicad Charger	EM/8502/2	£3.50
Anti Phaser	EM/8502/3	£4.56
Logical Lock	EM/8502/4	£3.58
Touch Dimmer	EM/8502/5	£3.29
— FEB '85 —		
Courtesy Light Extender	EM/8503/4	£3.29
Disco Light Chaser	EM/8503/5	£8.11
— MAR '85 —		
Sound to Light Unit	EM/8504/1	£4.02
Car Audio Booster	EM/8504/2	£3.12
Short Wave Converter	EM/8504/3	£4.15
— APRIL '85 —		
Car Burglar Alarm	EM/8505/3	£2.88
— MAY '85 —		
Metal Detector	EM/8506/1	£4.24
Power Supply Module	EM/8506/3	£3.20
Flanger	EM/8506/4	£4.29
— JUNE '85 —		
EI Tom/EI Tom+	EM/8507/1	£4.10
EI Cymb	EM/8507/2	£4.10
Heartbeat Monitor	EM/8507/3	£3.98
Real Time Clock	EM/8507/4	£4.62
— JULY '85 —		

PCB SERVICE

EE PRINTED CIRCUIT BOARD SERVICE

Please send me the following p.c.b.s.

Make cheques/PO payable to: **Everyday Electronics**

Order Code	Quantity	Price
.....
.....
.....
.....
.....

BLOCK CAPITALS PLEASE

I enclose cheque/PO for £

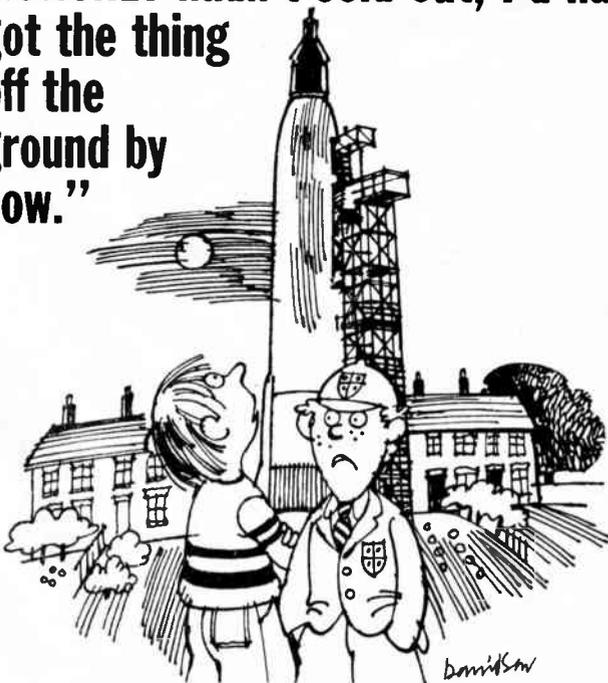
Name

Address

Please make cheques/PO payable to:
Everyday Electronics

Intelligent Windscreen Wiper (incl. Terminal Board)	EM/8508/1/2	£4.12
HiFi Intercom (2 boards)	EM/8508/3	£2.92
Plug Power Supply	EM/8508/4	£2.28
Hot Water Alarm	EM/8508/5	£1.93
— AUG '85 —		
Sinewave Generator	EM/8509/1	£2.76
Household Battery Checker	EM/8509/2	£1.97
Audio Signal Generator	EM/8509/3	£3.65
— SEPT '85 —		
Compressor Pedal	EM/8510/1	£2.87
Computer Cont Filter	EM/8510/2	£2.94
Spectrum MIDI Interface	EM/8510/3	£3.20
— OCT '85 —		

“If last month’s issue of EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY hadn’t sold out, I’d have got the thing off the ground by now.”



Sell-out disappointment can upset even the less ambitious reader! So why not take out a year’s subscription and make sure of every issue, straight from the Publisher? Complete the order form below and post to: **EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY**, Subscription Dept., 6 Church Street, Wimborne, Dorset BH21 1JH. Tel. 0202 881749.

Annual subscription rates:
UK £13. Overseas £15

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

Annual subscription rates: **SUBSCRIPTION ORDER FORM**
UK £13. Overseas £15

To: Everyday Electronics and Electronics Monthly, Subscription Dept., 6 Church Street, Wimborne, Dorset BH21 1JH.

Name

Address

I enclose payment of £..... (cheque/PO payable to Everyday Electronics)

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Computer Problems

The computer industry continues to decline. This can only be good news for the people who try to use computers as a working tool, rather than a hobby toy.

For too long the computer companies have been in such a mad rush to beat their rivals onto the market with new equipment, that they have sold it long before it is ready. In this, and a string of other respects, the computer industry has shown surprisingly little interest in lessons learned over the last twenty years by other consumer electronics industries.

I went to the press conference held by Apricot to explain the company's financial problems and tell how they will be tackling the future. Roger Foster, Group Chief Executive, kicked off with the disarmingly frank admission that his company "got it wrong".

Apricot has written off £6 million against lower priced and unsuccessful products, like the mains-powered Portable and peg-legged F1. They are now dumping these machines at very low prices, around £500 for the Portable which originally cost three times as much. After that, says Foster, Apricot will sell only higher priced hardware from selected dealers.

On the face of things the Apricot floppies (mainly through Dixons) look like a very good bargain. But what happens, I asked, if they go wrong and need repair?

If only one thing in life is certain it is that everything goes wrong in the end. And there is plenty to go wrong in a computer. A monitor is a modified TV set, and thus as likely to develop a fault as a TV.

Magnetic disc storage drives rely on precision mechanical technology and magnetic record and replay heads which can clog or wear. There is already a bandwagon industry of cleaning gadgets which can do more harm than good. The video industry learned ten years ago about the problems of head cleaners.

Hot Spot

The large number of chips in a computer body draw heavy power and give off a considerable amount of waste heat. This can damage other components.

The latest Apricot computer, the Xen, has its transformers and rectifiers in a separate metal cage which sits on the floor by the computer and doubles as a foot-warmer. Previous machines had the power supply on board.

Apricot PCs can overheat and loosen components on the printed circuit board which in turn causes distortion of the picture on screen. Until today I thought the cure was a cheap kitchen fan at the back of the machine to create some turbulence and help the internal fan do a better job. It's not! My Apricot PC picture is distorting again!

The hifi industry learned years ago about the value of separate power supplies and the problems of overheating. Japanese audio and video factories put all products

on soak test for long enough to find out if there is any overheating. They do this *before* launching a product for sale.

In a Spin

The video industry has been through a nightmare of battles on standardisation. The public has been the main casualty, often left with cassettes which can't be played and recorders for which blank tapes are hard to find.

Spare a thought for why the Amstrad PCW 8256 is so cheap, at £458.85 inc VAT (not £399 as the large print suggests—that's plus VAT). One reason is that the package uses a 3 inch floppy disc drive, not 3.5 inch.

The 3in. compact floppy disc system (CFD) was first announced in 1981 by Matsushita, Maxell and Hitachi. CFD came a year after Sony's 3.5in. MFD or micro floppy disc.

In both types of disc, the spinning flimsy magnetic sheet is protected by a hard case with a window shutter which opens only when the disc is being read. The large style older floppies are protected by only a flimsy sleeve with open window.

In 1984 ANSI (American National Standards Institute), ECMA (the European Computer Manufacturers' Association) and ISO (the International Standards Organisation) blessed Sony's MFD format. Hewlett Packard, Apple, Apricot, Atari and the MSX group started to use MFD drives and IBM is expected soon to follow with a second generation PC.

In February 1984 Matsushita proudly announced that it had begun making 30,000 CFD drives a month. This can only have produced one heck of a stockpile. Amstrad struck a hard bargain and took 450,000 at a price which helped make the budget 8256 possible.

Amstrad admits that blank discs are in short supply. The comment came after I found that Dixons' store in London's Oxford Street was selling the Amstrad computer but telling customers that they had no discs and could not get any from Amstrad.

Dixons was telling people to try rival specialist computer shops. Amstrad says plenty of blank discs are coming in from the Far East and 8256 users should "phone round stores looking for stocks". Users, says Amstrad, are buying so many discs that there is a shortage.

It follows then that 8256 owners are storing data. Read on to find out why this is important.

After-Sales Service

Amstrad was previously best known in the consumer electronics industry for budget audio systems. The company then moved into Citizens Band radio, car cassette players, video recorders and TV sets. These are seldom now seen in the shops. They are now moving into compact disc digital audio.

The company says it has been in computers for two years and they are a "long

term product". The company also says it has a commitment to spares even if it quits the wordprocessor business. Only time will tell how easy it is to get blank CFDs in five years' time and how easy current users find it to access the disc libraries of data which they are now building up.

The audio and video industries found long ago that "after-sales service" does not mean fixing equipment free under guarantee. That's the easy part. At worst you just give the customer another new one. The hard part is offering service-for-a fee years after guarantees have run out.

I fear many people who are building up libraries of data on systems which go to the wall are going to find it as inaccessible as the Crown Jewels in just a few years. The firms which survive in the computer business will be those who get their long term service right, and thus don't attract bad publicity from disgruntled customers who go public with their complaints.

I hope Apricot get it right for two reasons. Apricot is the only serious rival to IBM which is true-blue British; and I'm a user who already needs repairs.

I asked Roger Foster about this. Anyone buying the £500 portable from Dixons can buy a service contract from Apricot. But it costs £405 plus VAT for four years—which is almost the machine cost.

Foster says the Birmingham-based company has "many times" thought about opening a repair depot in London, where people can take equipment if their dealer is unhelpful. But Apricot is still only thinking about this.

Rental

The biggest lesson the computer firms could learn from the consumer electronics industry is on rental. Britain has the highest penetration of video recorders in Europe, with over a third of UK homes now using one.

This is the direct result of Britain's unique rental system. It began with colour TV. Ten years ago three-quarters of all colour TVs in Britain were rented, because people were scared of the high price of repairs.

When the rental companies switched to video, customers jumped at the chance of hiring rather than buying. They feared expensive repairs.

In the early 80s well over half the video recorders in Britain were rented. Even now, when colour TV and video recorders are cheap, very easy to use and proven to be reliable, one out of three colour sets and four out of ten video recorders are on hire.

Although personal computers cost more than video recorders or colour TV sets, are more difficult to set up and more likely to go wrong, there has been no serious attempt at renting out computers.—*Why not?*

EE BOOK SERVICE

SALE

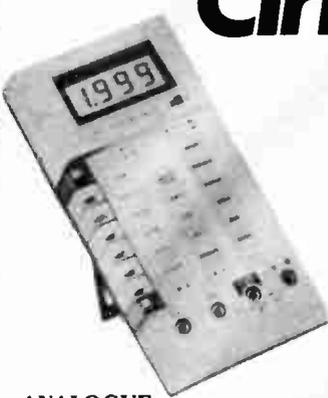
See Page 191

AFFORDABLE ACCURACY

Quality Multimeters from

Cirkit

A comprehensive range of Analogue and (Pushbutton or Rotary Switched) Digital Models



ANALOGUE

HM-102BZ — 10ADC Range, 20kΩ/VDC, Buzzer, Battery Test Scale £12.50
 19 measuring ranges
 HM-102R — Low end voltage & current ranges, Jack for Audio o/p voltages ... £11.00
 20 measuring ranges
 HM-1015 — Rugged, Pocket sized meter, for general purpose use £7.50
 16 measuring ranges

Battery, Test Leads and Manual included with each model.

Please add 15% for VAT and 60p for p&p

DIGITAL

HC-7030 0.1% Accuracy, Standard Model £39.50
 HC-6010 0.25% Accuracy, Standard Model £33.50
 HC-5010 0.25% Accuracy, TR Test Facility £39.50
 DM-105 0.5% Accuracy, Pocketable £21.50

All models have full functions and ranges and feature 3 1/2 digit 0.5" LCD display — low battery indication — auto zero & auto polarity — ABS plastic casing — DC AC 10amp range (not DM-105) — Overload protection on all ranges — battery, spare fuse, test leads and manual

Full details and specification from:

Cirkit Distribution Ltd

Park Lane, Broxbourne, Herts, EN10 7NQ
 Telephone (0992) 444111 Telex 22478

TRADE ENQUIRIES WELCOME

JOIN UP WITH LITESOLD

Professional Soldering Equipment at Special Mail-Order Prices.

EC50 Mains Electronic Iron. £31.64

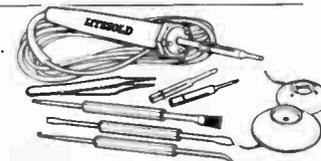


Features spike-free, solid state

proportional electronic temperature control inside the handle. Adjustable 280° to 400°C. Burn-proof 3-wire mains lead. Fitted 3.2mm Long-Life bit. 1.6, 2.4 and 4.7mm available. 240v a.c.

SK18 Soldering Kit. £16.36

Build or repair any electronic project. LC18 240v 18w iron with 3.2, 2.4, and 1.6mm bits. Pack of 18 swg flux-cored 60/40 solder. Tweezers. 3 soldering aids. Reel of De-Solder Braid. In PVC presentation wallet.



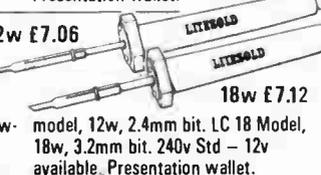
ADAMIN Miniature Iron £7.08

Possibly smallest mains iron in the world. Ideal for fine work. Slim

nylon handle with finger grip. Interchangeable bits available 1.2, 1.6, 2.4, 3.4 and 4.7mm. Fitted with 2.4mm. 240v 12w (12v available). Presentation wallet.

'L' Series Lightweight Irons. 12w £7.06

High efficiency irons for all electronic hobby work. Non-roll handles with finger guards. Stainless steel element shafts. Screw-connected elements. Slip-on bits available from 1.6 to 4.7mm. LA12



Soldering Iron Stands 3&4 £5.66

No.5 £5.88



Designed specially for LITESOLD irons. Heavy, solid-plastic base with non-slip pads. Won't tip over, holds iron safely. With wiping sponge and location for spare (hot) bits. No 5 stand for EC50 iron No 4 stand for ADAMIN miniature iron No 3 stand for LA12 and LC18 Irons.

Replacement Bits

For all above irons. Non-stick designs, machined from special copper alloy, with Inconel retaining rings. Two types — Chromium plated with copper face (for economy and ease of use) and iron plated with

Pre-tinned face (Long Life). State tip size, iron and type.

	Copper	L/L
EC50	—	£1.64
Adam 12 and	—	—
LA12	91p	£1.62
LC18	£1.01	£1.79

BRADWICK De-Solder Braid.



£1.04 per Reel

For simple, safe and effective de-soldering of all types of joint, using a standard soldering iron. Handy colour-coded packs of 1.5 metres in 3 widths: Yellow — 1.5mm, Green — 2mm, Blue — 3mm.

De-Solder Pumps £6.26

High Quality version of increasingly popular type of tool. Precision made anodised aluminium body, plunger guard and high-seal piston. Easy



thumb operation. Automatic solder ejection. Conductive PTFE nozzle — no static problems.

Tool Sets



Top quality Japanese metric hardened and tempered tools. Swivel-top chrome plated brass handles. Fitted plastic cases. 113 set — 6 miniature screwdrivers 0.9 to 3.5mm £3.71

227 set 5 socket spanners 3 to 5mm £2.82

305 set 2 crosspoint and 3 hex wrenches 1.5 to 2.5mm £2.70

228 set 20 piece combination: 5 open, 5 skt spanners, 2 crosspoint, 3 hex and 3 plain drivers, scriber, handle/holder £6.10

Microcutters. £4.82 Light weight hardened and precision ground. Flush cutting. Screw joint, return spring, cushion-grip handles. Safety wire-retaining clip.



Soldering Aids.



Set of 3 £4.22

Scraper/Knife, Hook/Probe, Brush/Fork. 3 useful double-ended aids to soldering/desoldering/assembly. In plastic wallet.



ADAMIN Electric Stylus. £16.24

Writes like a ballpoint in Gold, Silver, Copper or 6 colours, on card, plastics, leather etc. Personalise wallets, bags, albums, books, models... Operates at 4.5v from its own plug/transformer — totally safe. Supplied with coloured foils.



SEND FOR OUR ORDER FORM TODAY AND JOIN UP WITH THE PROFESSIONALS

Prices include p&p and VAT. Send order with Cheque/P.O. Ring for Access/Visa sales, or ask for order forms. LIGHT SOLDERING DEVELOPMENTS LTD. DEPT. EE. 97-99 GLOUCESTER ROAD, CROYDON CR0 2DN. 01 689 0574

1986 MAIL ORDER CATALOGUE

SEND BY POST TO: SEND BY MAIL TO: SEND BY AIR TO: (UK OVERSEAS) FOR YOUR COPY, ORDER FROM ANY OF OUR BRANCHES & COLLECTORS

APRIL SPECIAL

SWITCH CLEANING LUBRICANT WITH ANY ORDER OF £5 OR OVER — 1 @ 65p (ONLY 1 PER CUSTOMER) WITH ANY ORDER OF £10 OR OVER — 2 FOR £1 (ONLY 2 PER CUSTOMER)

DIFFERENT OFFER EACH MONTH

RESISTORS: 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75

OTHER ITEMS: SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £4.85, MIN PRESETS 100p, TRANSFORMERS, LED'S, SWITCHES, WIRE, HEADPHONES, IC'S, DIODES, ZENERS, POTS, TRANSISTORS, CO-AX PLUG METAL 200, CARBON FILM RESISTORS 2P, BUZZER £1.40, 240318 40p, 3.5 JACK PLUG 12P, ETCHING PEN £1.10, PLASTIC BONES, WIROBOND, ROTARY SWITCHES 50P, 3 CHANNEL CHART RECORDER £40, 1/4W RESISTOR KIT 10 OFF EACH VALUE £5.75, 1/2W RESISTOR KIT 8 OFF EACH VALUE £4.75, SOLDER SIZE 12 £

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

Reach effectively and economically today's enthusiasts anxious to know of your products and services through our semi-display and classified pages. The prepaid rate for semi-display spaces is £8.00 per single column centimetre (minimum 2.5cm). The prepaid rate for classified advertisements is 30 pence per word (minimum 12 words), box number 60p extra. VAT must be added. All cheques, postal orders, etc., to be made payable to Everyday Electronics. Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Dept., Everyday Electronics, 6 Church Street, Wimborne, Dorset BH21 1JH. Tel.: 0202 881749.

Service Sheets

SOLE SUPPLIERS TV/Video repair manuals/circuits. 1000s s/manuals supplied by return. S/sheets £2.50 except CTV/M. centres/stereos £3.50 LSAE with every order/query please brings free pricelist/magazine inc s/sheet - or phone 0698 884585 (883334 outwith business hours) TIS(EE) 76 Church Street Larkhall Lanarkshire.

SERVICE MANUALS. Any make, model, age. Televisions, audio, video, test, amateur, vintage, etc. Thousands stocked. SAE enquiries. MAURITRON (EE), 8 Cherrytree Road, Chinnor, Oxfordshire OX9 4QY.

Receivers & Components

TURN YOUR SURPLUS capacitors, transistors etc., into cash. Contact COLES HARDING & CO., 103 South Brink, Wisbech, Cambs. 0945-584188. Immediate settlement.

ESR ELECTRONIC COMPONENTS

● Full range of Components ● Speakers & Accessories ● Audio Connectors & Switches ● Amplifier Modules & Cases

FREE PRICE LIST AVAILABLE

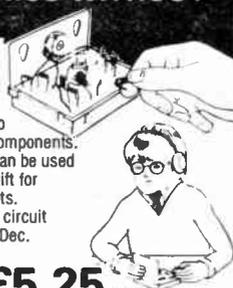
13A STATION ROAD, CULLERCOATS,
NORTH SHIELDS, TYNE & WEAR NE30 4PQ.
TEL: 091 251 4363.

LEARN
**ELECTRONICS WITHOUT
SOLDER**

Build electronic circuits without solder on a Roden S-Dec. This has built-in contacts and holes into which you plug your components. Suitable for all ages. Can be used time after time. Ideal gift for students or experiments. Full instructions and 2 circuit diagrams with each S-Dec.

Send Cheque or P.O. to:
Roden Products, Dep EE
High March, Daventry,
Northants, NN11 4QE.

£5.25 including p & p



Miscellaneous

THE SCIENTIFIC WIRE COMPANY
811 Forest Road, London E17. Telephone 01-531 1588

ENAMELLED COPPER WIRE				
SWG	1 lb	8 oz	4 oz	2 oz
8 to 34	3.63	2.09	1.10	0.88
35 to 39	3.82	2.31	1.27	0.93
40 to 43	6.00	3.20	2.25	1.61
44 to 47	8.67	5.80	3.49	2.75
48	15.96	9.58	6.38	3.69
SILVER PLATED COPPER WIRE				
14 to 30	9.09	5.20	2.93	1.97
TINNED COPPER WIRE				
14 to 30	3.97	2.41	1.39	0.94
Fluxcore				
Solder	5.90	3.25	1.82	0.94

Prices include P&P VAT. Orders under £2 add 20p. SAE for list of copper and resistance wire. Dealer enquiries welcome.

OFFERS Complete set of Everyday Electronics. Nov. 1971 to date. Phone 0253 854459.

Please mention
EVERYDAY ELECTRONICS
when replying to
Classified Ads

ORDER FORM PLEASE WRITE IN BLOCK CAPITALS

Please insert the advertisement below in the next available issue of **Everyday Electronics** for Insertions. I enclose Cheque/P.O. for £ (Cheques and Postal Orders should be made payable to Everyday Electronics)

HEADING REQUIRED:

NAME

ADDRESS

.....

.....

**EVERYDAY ELECTRONICS
and ELECTRONICS MONTHLY**
Classified Advertisement Dept.,
6 Church Street,
Wimborne,
Dorset BH21 1JH.
Telephone 0202 881749

EDUCATION AND CAREER

MAKE YOUR INTERESTS PAY!

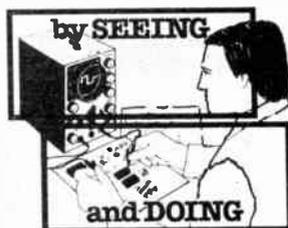
More than 8 million students throughout the world have found it worth their while! An ICS home-study course can help you get a better job, make more money and have more fun out of life! ICS has over 90 years experience in home-study courses and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert 'personal' tutors. Find out how we can help YOU. Post or phone today for your FREE INFORMATION PACK on the course of your choice. (Tick one box only!)

Electronics <input type="checkbox"/>	Radio, Audio and TV Servicing <input type="checkbox"/>
Basic Electronic Engineering (City & Guilds) <input type="checkbox"/>	Radio Amateur Licence Exam (City & Guilds) <input type="checkbox"/>
Electrical Engineering <input type="checkbox"/>	Car Mechanics <input type="checkbox"/>
Electrical Contracting/Installation <input type="checkbox"/>	Computer Programming <input type="checkbox"/>
GCE over 40 'O' and 'A' level subjects <input type="checkbox"/>	

ICS Name _____ P-Code _____
Address _____
International Correspondence Schools, Dept ECS46, 312/314 High St.,
Sutton, Surrey SM1 1PR. Tel: 01-843 9568 or 041-221 2928 (24 hrs).

Master Electronics - Microprocessors - Now! The Practical Way!

- Electronics - Microprocessors - Computer Technology is the career and hobby of the future. We can train you at home in a simple, practical and interesting way.
- Recognise and handle all current electronic components and 'chips'.
- Carry out full programme of experimental work on electronic computer circuits including modern digital technology.
- Build an oscilloscope and master circuit diagram.
- Testing and servicing radio - T.V. - hi-fi and all types of electronic/computer/industrial equipment.



New Job? New Career? New Hobby?

SEND THIS COUPON NOW.

FREE! COLOUR BROCHURE

Please send your brochure without any obligation to

OR TELEPHONE US 062 67 6114
OR TELEX 22758 (24 HR SERVICE)



NAME _____ I am interested in
ADDRESS _____ ELECTRONICS
 MICROPROCESSORS
 RADIO AMATEUR LICENCE
 CITY & GUILDS EXAMS
Other Subjects _____

British National Radio & Electronics School PO Box 7 Teignmouth, Devon, TQ14 0HS

TELEVISION/COMPUTER FULL-TIME TRAINING

(FULL TIME COURSES APPROVED BY THE BUSINESS & TECHNICIAN EDUCATION COUNCIL)

2 YEAR

BTEC National Diploma (OND) ELECTRONIC & COMMUNICATIONS ENGINEERING

(Electronics, Computing, Television, Video, Testing & Fault Diagnosis)

15 MONTHS

BTEC National Certificate (ONC) ELECTRONIC EQUIPMENT SERVICING

(Electronics, Television, Video Cassette Recorders, CCTV, Testing & Fault Diagnosis)

15 MONTHS

BTEC National Certificate (ONC) COMPUTING TECHNOLOGY

(Electronics, Computing Software/Hardware, Microelectronic Testing Methods)

9 MONTHS

BTEC Higher National Certificate (HNC) COMPUTING TECHNOLOGY & ROBOTICS

(Microprocessor Based Systems, Fault Diagnosis, ATE, Robotics)

THESE COURSES INCLUDE A HIGH PERCENTAGE OF COLLEGE BASED PRACTICAL WORK TO ENHANCE FUTURE EMPLOYMENT PROSPECTS

SHORTENED COURSES OF FROM 3 TO 6 MONTHS CAN BE ARRANGED FOR APPLICANTS WITH PREVIOUS ELECTRONICS KNOWLEDGE

NEXT SESSION TO COMMENCE
ON APRIL 21st

H.N.C. SEPTEMBER 1986
FULL PROSPECTUS FROM

LONDON ELECTRONICS COLLEGE (Dept EE)
20 PENYWERN ROAD, EARLS COURT,
LONDON SW5 9SU. Tel: 01-373 8721.

GWENT COLLEGE OF HIGHER EDUCATION

Faculty of Information Science & Technology

HIGH TECHNOLOGY COURSES IN GWENT

Are you looking for a career with a secure future?
Apply to Gwent College for:

B.Eng. Electronic and Instrumentation Systems

Reflecting the convergence of the modern disciplines of Electronics and Instrumentation, together with Communications and Computing, this is a systems-orientated course. It has been designed expressly to meet industrial needs, with emphasis placed on the applications of modern technologies such as Microelectronics, Information Technology, Robotics and Computer Control.

(Entry requirements: 'A' level maths and Physics or BTEC equivalent)

HND (BTEC) Microelectronic Engineering

Combining modern electronic and computer engineering with optimal studies in one of the following:

*I.C. Technology
Robotics and Manufacturing Systems
Communications
Electrical Power Systems*

(Entry requirements: 1 'A' level preferably maths or science having studied both or BTEC equivalent)

For further details and application form apply to:

The Admissions Officer,
Gwent College of Higher Education,
Allt-yr-yn Avenue, Newport,
Gwent NP9 5AX. Tel: (0633) 51525

Intruder Alarms and Accessories

A COMPLETE SECURITY SYSTEM FOR ONLY £39.95 + V.A.T.

contains
Control Unit
Enclosure & mechanical fixings
Key Switch & 2 keys
LED's
5" Horn Speaker
4 high quality surface mounting Magnetic Switches

With only a few hours of your time it is possible to assemble and install an effective security system to protect your family and property, at the amazingly low cost of £39.95 + V.A.T. No compromises have been made and no corners have been cut. The outstanding value results from volume production and direct supply. Assembly is straightforward with the detailed instructions provided. When installed you can enjoy the peace of mind that results from a secure home. Should you wish to increase the level of security, the system may be extended at any time with additional magnetic switches, pressure pads or ultrasonic sensors. Don't wait until it's too late - order today.
Order Code: CS 1370

EXTENDED SYSTEM CS 1480 Price £62.50 + V.A.T.

This system contains in addition to the CS 1370 an ultrasonic detector type US 5063 - its enclosure, an additional horn speaker and a further 2 magnetic switches. This system represents outstanding value for money for the high level of security provided.
Order Code: CS 1480

SELF-CONTAINED ULTRASONIC ALARM UNIT CK 5063

only £37.00 + V.A.T.

Requires no installation. Easily assembled using our professionally built and tested modules.
• Adjustable range up to 25ft
• Built in entrance and exit delay
• Built in timed alarm
• Key operated switch Off, Test and Operate
• Provision for an extension speaker
• Fully self contained
• Uses US 5063 PSL 1865 Key Switch 3901
• Speaker 3515

Now you can assemble a really effective intruder alarm at this low price using tried and tested Riscomp modules. Supplied with full instructions, the kit contains everything necessary to provide an effective warning system for your house or flat. With a built in LED indicator and test position the unit is easily set up requiring no installation. It may simply be placed on a cupboard or desk. Movement within its range will then cause the built in siren to produce a penetrating 90db of sound or even 110db's with an additional speaker. All parts included and supplied with full instructions for ease of assembly. Size 200 x 180 x 70mm. Order as CK 5063.

RISCOMP LIMITED

Dept EE31,
51 Poppy Road,
Princes Risborough,
Bucks, HP17 9DB,
Princes Risborough (084 44) 6326

ALARM CONTROL UNIT CA 1250

Price £19.95+V.A.T.

The heart of any alarm system is the control unit. The CA 1250 offers every possible feature that is likely to be required when constructing a system - whether a highly sophisticated installation or simply controlling a single magnetic switch on the front door.

- Built in electronic siren drives 2 loud speakers
- Provides exit and entrance delays together with fixed alarm time
- Battery back up with trickle charge facility
- Operates with magnetic switches, pressure pads, ultrasonic or I.R. units
- Anti tamper and panic facility
- Stabilised output voltage
- 2 operating modes full alarm anti tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for external loads
- Test loop facility

HARDWARE KIT HW 1250

only £9.50 + V.A.T.

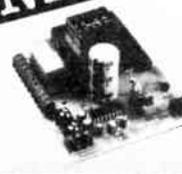
This attractive case is designed to house the control unit CA 1250 together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 x 180 x 70mm

SIREN & POWER SUPPLY MODULE PSL 1865

only £9.95 + V.A.T.

A complete siren and power supply module which is capable of providing sound levels of 110db's at 2 metres when used with a horn speaker. In addition the unit provides a stabilised 12V output up to 100mA. A switching relay is also included so that the unit may be used in conjunction with the US 5063 to form a complete alarm.

NEW



TIMER SWITCH & POWER SUPPLY MODULE OP 3570 Price £13.95 + V.A.T.

The OP 3570 consists of an adjustable timer switch and stabilised 12V power supply for use in a wide range of applications including security lighting control and automatic switching. The timer section of the module provides switching of loads up to 3A for pre set times, the duration of which may be set by the user to between 10 secs and 5 mins. The timed period may be triggered by the opening of a loop or the closing of external contacts with the timed period commencing instantaneously or delayed to provide a form of entrance delay. The power supply section of the module provides a 12V output of up to 250mA which is sufficient for most applications. The module operates from either 240V a.c. supply or a 12V battery for which trickle charge facilities are included. Connections to the module are by means of screw terminal connectors with no soldering needed.

For mounting the unit an attractive moulded enclosure is available.

ME 357 only £2.85 + V.A.T.

INFRA-RED SYSTEM IR 1470 only £25.61+V.A.T.

Consisting of separate transmitter and receiver both of which are housed in attractive moulded cases, the system provides an invisible modulated beam over distances of up to 50ft operating a relay when the beam is broken. Intended for use in security systems, but also ideal for photographic and measurement applications. Size 80 x 50 x 35mm

DIGITAL ULTRASONIC DETECTOR US 5063

only £13.95 + V.A.T.

This advanced module uses digital signal processing to provide the highest level of sensitivity whilst discriminating against potential false alarm conditions.

- 3 levels of discrimination against false alarms
- Crystal control for greater stability
- Adjustable range up to 25ft
- Built in relays
- +12V operation

ULTRASONIC MODULE ENCLOSURE

only £2.95 + V.A.T.

Suitable metal enclosure for housing an individual ultrasonic module type US 5063 or US 4012. Supplied with the necessary mounting pillars and screws etc. For US 5063 order SC 5063 for US 4012 order SC 4012.

RISCOMP THE SECURITY SPECIALISTS!

Add 15% to all prices
Add 25p post and packing to all orders. Saturday 9.00 to 1.00 p.m.
Units on demonstration. SAE with all enquiries.
Shop hours 9.00 to 5.30 pm. Order by telephone or post.
Closed Wednesdays. using your credit card.

FULL RANGE OF ACCESSORIES STOCKED SEND SAE FOR DETAILS

MAKE IT A GIFT EVERY MONTH . . .

Make sure of getting your copy every month by placing a regular order with your Newsagent NOW!
(Distributed by Seymour)



BACK ISSUES & BINDERS

Certain back issues of EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY are available price £1.25 (£1.75 overseas) inclusive of postage and packing per copy. Enquiries with remittance 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.

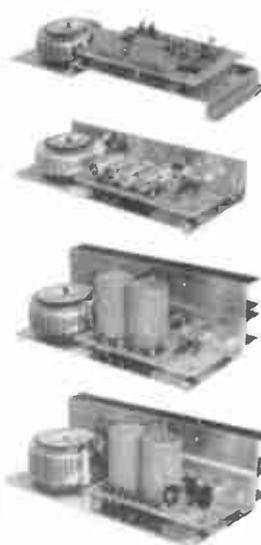
Binders to hold one volume (12 issues) are available from the above address for £5.50 inclusive of p&p world-wide.

INDEX TO ADVERTISERS

AES	195
ARMON PRODUCTS	170
BI PAK	172
B.K. ELECTRONICS	Cover III
B.N.R.E.S.	223
BULL, J.	Cover II
CAMBRIDGE LEARNING	195
CIRKIT HOLDING	221
C.P.L. ELECTRONICS	172
CRICKLEWOOD ELECTRONICS	171
ELECTROVALUE	172
ELMWOOD COMPONENTS	213
GREENWELD ELECTRONICS	171
I.C.S. INTERTEXT	223
JAYTEE ELECTRONICS	213
LIGHT SOLDERING DEVELOPMENTS	221
LONDON ELECTRONICS COLLEGE	223
MAGENTA ELECTRONICS	174
MAPLIN ELECTRONICS	Cover IV
MARCO TRADING	221
PHONOSONICS	171
RADIO COMPONENTS SPECIALISTS	205
RAPID ELECTRONICS	173
RISCOMP LTD	224
RODEN PRODUCTS	222
SCIENTIFIC WIRE COMPANY	222
SMITHS SECURITY	205
T.K. ELECTRONICS	170
UNIVERSAL SEMICONDUCTORS	170

OMP POWER AMPLIFIER MODULES

OMP POWER AMPLIFIER MODULES Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B. and Drive circuits to power compatible Vu meter. Open and short circuit proof



OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz -3dB, T.H.D. 0.01%, S.N.R. -118dB, Sens. for Max. output 500mV at 10K, Price 355 x 115 x 65mm. PRICE £33.99 + £3.00 P&P.

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

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

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

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



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

LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S. Cabinet Fixing in stock. Huge selection of McKenzie Loudspeakers available including Cabinet Plans. Large S.A.E. (28p) for free details.

POWFR RANGE
 8" 50 WATT R.M.S. Hi-Fi/Disco.
 20 oz magnet 1 1/2" ally voice coil. Ground ally fixing escutcheon Res. Freq 40Hz Freq Resp to 6KHz Sens 92dB PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea
 12" 100 WATT R.M.S. Hi-Fi/Disco
 50 oz magnet 2" ally voice coil. Ground ally fixing escutcheon Die-cast chassis. White cone Res. Freq 25Hz Freq Resp to 4KHz Sens 95dB PRICE £28.60 + £3.00 P&P ea

McKENZIE
 12" 85 WATT R.M.S. C1285GP Lead guitar keyboard/Disco.
 2" ally voice coil Ally centre dome Res. Freq 45Hz Freq Resp to 6.5KHz Sens 98dB PRICE £28.76 + £3.00 P&P ea
 12" 85 WATT R.M.S. C1285TC P.A./Disco 2" ally voice coil. Twin cone.
 Res. Freq 45Hz Freq Resp to 14KHz PRICE £29.80 + £3.00 P&P ea
 15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
 3" ally voice coil Die-cast chassis Res. Freq 40Hz Freq Resp to 4KHz PRICE £54.99 + £4.00 P&P ea
 10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.
 2" voice coil Res. Freq 75Hz Freq Resp to 7.5KHz Sens 99dB PRICE £19.15 + £2.00 P&P.
 10" 200 WATT R.M.S. C10200GP Guitar, Keyboard, Disco.
 2" voice coil Res. Freq 45Hz Freq Resp to 7KHz Sens 101dB PRICE £51.00 + £3.00 P&P.
 15" 200 WATT R.M.S. C15200 High Power Bass.
 Res. Freq 40Hz Freq Resp to 5KHz Sens 101dB PRICE £59.45 + £4.00 P&P
 15" 400 WATT R.M.S. C15400 High Power Bass.
 Res. Freq 40Hz Freq Resp to 4KHz Sens 102dB PRICE £85.00 + £4.00 P&P

WEM
 5" 70 WATT R.M.S. Multiple Array Disco etc.
 1" voice coil Res. Freq 52Hz Freq Resp to 5KHz Sens 89dB PRICE £19.99 + £1.50 P&P ea
 8" 150 WATT R.M.S. Multiple Array Disco etc.
 1" voice coil Res. Freq 48Hz Freq Resp to 5KHz Sens 92dB PRICE £29.49 + £1.50 P&P ea
 10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
 1 1/2" voice coil Res. Freq 35Hz Freq Resp to 4KHz Sens 92dB PRICE £33.49 + £2.00 P&P ea
 12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
 1 1/2" voice coil Res. Freq 35Hz Freq Resp to 4KHz Sens 94dB PRICE £41.49 + £3.00 P&P ea

SOUNDLAB (Full Range Twin Cone)
 5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
 1" voice coil Res. Freq 63Hz Freq Resp to 20KHz Sens 86dB PRICE £9.99 + £1.00 P&P ea
 6" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
 1" voice coil Res. Freq 56Hz Freq Resp to 20KHz Sens 89dB PRICE £10.99 + £1.50 P&P ea
 8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
 1" voice coil Res. Freq 38Hz Freq Resp to 20KHz Sens 89dB PRICE £12.99 + £1.50 P&P ea
 10" 60 WATT R.M.S. Hi-Fi/Disco etc.
 1 1/2" voice coil Res. Freq 35Hz Freq Resp to 15KHz Sens 89dB PRICE £16.49 + £2.00 P&P

AMTEC HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 x 46 x 14mm (9 volt) Price: £8.62 + 75p P&P.
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 x 84 x 12mm (12 volt) Price: £14.49 + 75p P&P.
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22mm (9/12 volt). Price: £17.82 Transmitter 80 x 50 x 15mm (9/12 volt). Price: £11.29 P&P + 75p each. S.A.E. for complete list.



POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME. SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUDE V.A.T. SALES COUNTER VISA/ACCESS/C.O.D. ACCEPTED.



* PRICES INCLUDE V.A.T. * PROMPT DELIVERIES * FRIENDLY SERVICE * LARGE S.A.E. 28p STAMP FOR CURRENT LIST

BURGLAR ALARM

Better to be 'Alarmed' than terrified. Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable FULLY GUARANTEED.

Control Unit - Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated fascia switch - off - test - armed 30 second exit and entry delay.
Indoor alarm - Electronic swept freq. siren. 104dB output.
Outdoor Alarm - Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.



Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.
SAVE £138.00 Usual Price £228.85
BKE's Price £89.99 + £4.00 P&P
 Why buy a collection of self-assembly boards!

OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit today's need for compactness with high sound output levels. Finished in hard wearing black vinyl with protective corners, grille and carry handle. All models 8 ohms Full range 45Hz - 20KHz Size 20" x 15" x 12". Watts R.M.S. per cabinet. Sensitivity 1W 1mtr. dB.

OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair.
 Delivery Securicor £8.00 per pair

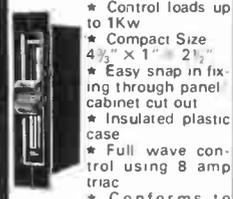


OMP 19" STEREO RACK AMPS



Professional 19" cased Mos-Fet stereo amps. Used the World over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. Three models (Ratings R.M.S. into 4ohms), Input Sensitivity 775mV
MF200 (100 + 100)W. £169.00 Securicor
MF400 (200 + 200)W. £228.85 Delivery
MF600 (300 + 300)W. £274.85 £10.00

1 K-WATT SLIDE DIMMER



- * Control loads up to 1Kw
- * Compact Size 4 1/2" x 1" x 2 1/2"
- * Easy snap in fixing through panel/cabinet cut out
- * Insulated plastic case
- * Full wave control using 8 amp triac
- * Conforms to BS800

* Suitable for both resistive and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.
PRICE £13.99 + 75p P&P

BSR P295 ELECTRONIC TURNTABLE

* Electronic speed control 45 & 33 1/3 r.p.m. Plus Minus variable pitch control * Belt driven * Aluminium platter with strobed rim * Cue lever * Anti-skate (bias device) * Adjustable counter balance * Manual arm * Standard 1/2" cartridge fixings * Supplied complete with cut out template * D.C. Operation 9-14v D.C. 65mA
 Price £36.99 - £3.00 P&P.

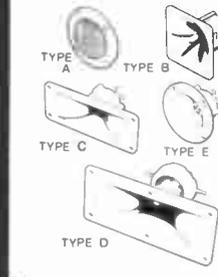


ADC Q4 mag. cartridge for above Price £4.99 ea. P&P 50p

PIEZO ELECTRIC TWEETERS MOTOROLA

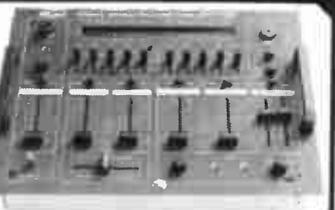
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series) FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.

TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-Fi speakers. Price £4.90 each + 40p P&P
TYPE 'B' (KSN1005A) 3 1/2" super horn. For general purpose speakers, disco and P.A. systems etc. Price £5.99 each - 40p P&P
TYPE 'C' (KSN6016A) 2" x 5" wide dispersion horn. For quality Hi-Fi systems and quality discos etc. Price £6.99 each + 40p P&P
TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Under frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. Price £9.99 each - 40p P&P
TYPE 'E' (KSN1038A) 3 3/4" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £5.99 each + 40p P&P
LEVEL CONTROL Combines on a recessed mounting plate. Level control and cabinet input jack socket. 85 x 85 mm. Price £3.99 + 40p P&P



STEREO DISCO MIXER

STEREO DISCO MIXER with 2 x 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 - 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot L. & R. Master Output controls. Output 775mV. Size 360 x 280 x 90mm.
 Price £134.99 - £3.00 P&P



B. K. ELECTRONICS
 UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX, SS2 6TR TEL: 0702-527572

**Lowest possible prices?
Top quality components?
Fast reliable service?
Large range?**



Maplin We've got it taped.

Pick up a copy of our new 1986 catalogue from any branch of W.H. Smith for just £1.45.

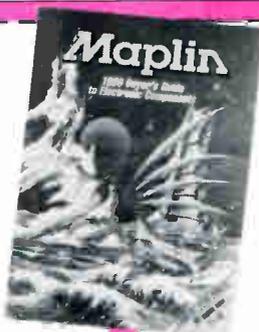
Or post this coupon now, to receive your copy by post for just £1.45 + 40p p & p. If you live outside the U.K. send £2.50 or 11 International Reply Coupons. I enclose £1.85.

Name

Address

.....

.....



MAPLIN ELECTRONIC SUPPLIES LTD.

Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 552911

SHOPS

- BIRMINGHAM Lynton Square, Perry Barr, Tel: 021-356 7292.
- LONDON 159-161 King Street, Hammersmith, W6.
Telephone: 01-748 0926.
- MANCHESTER 8 Oxford Road, Tel: 061-236 0281.
- SOUTHAMPTON 46-48 Bevois Valley Road, Tel: 0703 225831.
- SOUTHEND 282-284 London Rd, Westcliff-on-Sea, Essex.
Telephone: 0702-554000

Shops closed all day Monday

EE