EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

MARCH 1986 £1·10

STEREO HI-FI PREAMP

BBC MIDI INTERFACE

MAINS TESTER & FUSE FINDER

Newcomers Magazine for Electronic & Computer Projects

£1 BAKERS DOZEN PACKS

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

1. 5 – 13 amp ring main junction boxes
2. 5 – 13 amp ring main spur boxes
3. 25 – 13 amp fuses for ring mains
4. 5 – surface mounting switches suitably insulated for mains voltage
5. 3 – electrical switches intermediate type, will also replace 1 or 2 way switches, white flush mounting
7. 4 – in flex line switches with neons
9. 2 – mains transformers with 6V 1A secondaries
10. 2 – mains tranformers with 12V 1/2A secondaries
11. 1 – extension speaker cabinet for 6 1/2" speaker
13. 12 – glass reed switches
17. 2 – ultra sonic transmitters and 2 receivers with circuit
19. 2 – light dependent resistors
25. 4 – wafer switches – 6p 2 way, 4p 3 way, 2p 6 way, 2p 5 way, 1p 12 way small one hole fixing and good length 1/4 spindle your choice
27. 1 – 6 digit counter 12V
28. 1 – 6 digit counter mains voltage
30. 2 – Nicad battery chargers
31. 1 – key switch with key
33. 2 – aerosol cans of ICI Dry Lubricant
34. 96 – 1 mtre lengths colour-coded connecting wire
39. 1 – long and medium wave tuner kit
41. 8 – rocker switch 10 amp mains SPST
45. 1 – 24 hour time switch mains operated (s.h.)
46. 1 – hour clock work time switch
48. 2 – 6V operated reed switch relays
49. 10 – neon valves – make good night lights
50. 2 – 12V DC or 24V AC, 3 CO relays
51. 1 – 12V 2 CO miniature relay very sensitive
52. 1 – 12V 4 CO miniature relay
53. 2 – mains operated relays 3 × 8 amp changeover, (s.h.)
54. 10 – rows of 32 gold plated IC sockets (total 320 sockets)
55. 1 – locking mechanism with 2 keys
56. 1 – miniature uniselector with circuit for electric jigsaw puzzle
58. 2 – telephone hand sets with ear piece and mike, (s.h.)
60. 5 – ferrite rods 4" × 5/16" diameter aerials
61. 4 – ferrite slab aerials with L & M wave coils
63. 1 – Mullard thyistor trigger module
64. 10 – assorted knobs 1/4 spindles
65. 5 – different thermostats, mainly bi-metal types
66. 1 – magnetic brake – stops rotation instantly
67. 1 – low pressure 3 level switch can be mouth operated
69. 2 – 25 watt pots 8 ohm
70. 2 – 25 watt pots 1000 ohm
71. 4 – wire wound pots – 18, 33, 50 and 100 ohm your choice
72. 1 – 1250 watt dimmer Ultra ref SE20
77. 1 – time reminder adjustable 1-60 mins clockwork
80. 2 – 10A bridge rectifiers 30V
81. 2 – 30A panel mounting slyslok fuses
85. 1 – mains shaded pole motor 3/4" stack – 1/4 shaft
89. 1 – mains motor with gear box 1 rev per 24 hours
91. 2 – mains motors with gear box 16 rpm
96. 1 – thermostat for fridge
97. 1 – infra red fire element 1000 watts
98. 1 – motorised stud switch (s.h.)
101. 1 – 2 1/2 hours delay switch
102. 1 – mains power supply unit – 9V DC
103. 1 – mains power supply unit – 6V DC
104. 1 – mains power supply unit – 4 1/2V DC
105. 1 – 5 pin flex plug and panel socket
107. 1 – 5" speaker size radio cabinet with handle
110. 10 – slider type volume controls
111. 2 – musical boxes (less keys)
112. 1 – heating pad 200 watts mains
113. 1 – FM front end with tuning condenser and data
114. 1 – 1W amplifier Mullard 1172
115. 1 – wall mounting thermostat 24V
118. 1 – teack effect extension 5" speaker cabinet
120. 2 – p.c. boards with 2 amp full wave and 17 other recs
121. 4 – push push switches for table lamps etc.
122. 10 – mtrs twin screened flex white p.v.c. outer
124. 25 – clear plastic lenses 1 3/4 diameter
123. 100 – staples for thin flex
125. 4 – Items – rev per hour mains motor, counter, coin switch and srbp panel
127. 4 – pilot bulb lamp metal clip on type
128. 10 – very fine drills for pcbs etc.
129. 4 – extra thin screw drivers for Instruments
130. 2 – centre zero panel meters 100-0-100 UA
131. 1 – 100 UA edge wise balance meter
132. 2 – plastic boxes with windows, ideal for interrupted beam switch etc.
134. 10 – model aircraft motor – require no on/off switch, just spin to start
136. 2 – car radio speakers 5" round 4 ohm made for Radiomobile
137. 1 – 6 1/2" 4 ohm 10 watt speaker and 3" tweeter
142. 10 – 4 BA spanners 1 end open, other end closed
145. 2 – 4 reed relay kits 3V coil can be normally open or c/o if magnets added
146. 20 – pilot bulbs 6.5V .3A Philips
147. 1 – secret switch kit with data
148. 1 – printed circuit kit with 100 circuits
149. 4 – socket covers (protect inquisitive little fingers) for twin 13A
152. 1 – air or gas shut off valve – clockwork operated
153. 1 – air or gas shut off valve – thermostat operated
154. 1 – 12V drip proof relay – ideal for car jobs
155. 3 – varicap push button tuners with knobs
158. 5 – 12 way connector blocks 2A 250V
159. 3 – 12 way connector blocks 25A 250V
162. 1 – 13A fused and switched spur for surface mounting or can be removed from box for flush mounting
163. 3 – 13A sockets good British make but brown
169. 4 – short wave air spaced trimmers 2-30f
171. 1 – shocking coi kit with data – have fun with this
172. 10 – 12V 6W bulbs Philips m.e.s.
176. 4 – heavy duty push switches – ideal for foot operation 3A 250V
   5 – lilliput bulbs 12V
178. 3 – oblong amber Indicators with lilliputs 12V
180. 6 – round amber indicators with neons 240V
181. 100 – p.v.c. grommets 3/8 hole size
182. 1 – short wave tuning condenser 50 pf with 1/4" spindle
183. 1 – two gang 50 pf short wave tuning condenser with 1/4" spindle
184. 1 – three gang tuning condenser each section 500 pf with trimmers and good length 1/4" spindle
188. 1 – plastic box sloping metal front, size 16 × 95mm average depth 45mm
   2 – double pole 20 amp 250V flush mounting switch – white
191. 6 – B.C. lamp holder adaptors white
193. 6 – 5 amp 3 pin flush sockets brown
195. 5 – B.C. lampholders brown bakelite threaded entry
196. 1 – in flex simmerstat for electric blanket soldering iron etc.
197. 2 – thermostats, spindle setting – adjustable range for ovens etc.
198. 1 – rod thermostat for water heater etc. 11" rod
199. 1 – mains operated solenoid with plunger 1" travel
200. 1 – 10 digit switch pad for telephones etc.
201. 8 – computer keyboard switches with knobs, pcb or vero mounting
206. 20 – mtres 80 ohm, standard type co-ax off white
211. 1 – electric clock mains driven, always right time – not cased
216. 1 – stereo pre amp Mullard EP9001
230. 2 – stereo headphone leads, curly and terminating with stereo jack plugs
231. 2 – TV aerial outlet sockets, brown but easily painted to match skirting
232. 2 – 12V solenoids, small with plunger
236. 1 – mains transformer 9V 1 amp secondary C core construction
238. 3 – boxes with hinged lids size 2 1/4 × 1 3/4 × 7/8 made from clear plastic
241. 1 – car door speaker (very flat) 6 1/2" 15 ohm made for Radiomobile
241. 2 – speakers 6" × 4" 4 ohm 5 watt made for Radiomobile
243. 2 – speakers 6" × 4" 16 ohm 5 watt made for Radiomobile
244. 1 – mains motor with gear-box very small, toothed output gives 1 rpm
245. 4 – standard size pots, 1/2 meg with dp switch
249. 1 – 13A switched socket on double plate with fused spur for water heater
266. 2 – mains transformers 9V 1/2A secondary split primary so ok also for 115V
267. 1 – mains transformers 15V 1A secondary p.c.b. mounting

MULLARD UNILEX AMPLIFIERS

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

CAR STARTER/CHARGER KIT

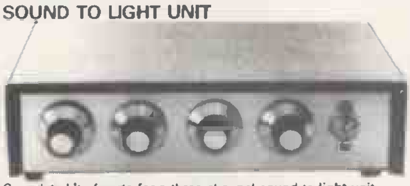
Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 or without case £15.00 post paid.

Ex-Electricity Board. Guaranteed 12 months.

VENNER TIME SWITCH

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

SOUND TO LIGHT UNIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 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 28p/metre or 15m for £3.95.

25A ELECTRICAL PROGRAMMER

Learn in your sleep. Have radio playing and kettle boiling as you wake – switch on lights to ward off intruders – have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 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 hastily written and technical information sheets are seldom available about the items we have to describe, also advertisements sometimes go to press without our having a chance to correct any mistakes, however, everything we sell is supplied on the understanding that if it is not suitable for your project you may return it within 7 days for credit. If there was a definite error of description in our copy then we will pay postage. If not, then you pay the postage. Note this offer applies to kits, but only if construction is not started.

TANGENTIAL BLOW HEATER

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

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

CORDLESS TELEPHONES

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

SOCKETS PLUGS ETC for BT phones

Master socket (has surge arrestor – ringing condenser etc) and takes B.T. plug	£3.95
Extension socket	£2.95
Dual adaptors (2 from one socket)	£3.95
Cord terminating with B.T. plug 3 metres	£2.95

Kit for converting old entry terminal box to new B.T. master socket, complete with 4 core cable, cable clips and 2 BT extension sockets £11.50

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

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

J & N BULL ELECTRICAL
128 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX.

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: phone for quote.

MORE £1 BAKERS DOZEN PACKS

289. 50 3.5v torch bulbs
290. 3 7" reel to reel tape spools
291. 1 ten turns 3 watt pot 1/4 spindle 100 ohm
292. 5 two plate brown bakelite ceiling roses
293. 50 silicon diodes mixed unmarked
294. 50 Germanium transistors mixed and unmarked
295. 10 round pointer knobs 1/4 spindle with grub screw
296. 3 car cigar lighter socket plugs
297. 1 cover for 24hr time switch ref BD45
298. 2 15 amp round pin plugs brown bakelite
299. 2 pull cord switch with cord and tassle
300. 1 mains solenoid with plunger compact type
301. 10 ceramic magnets Mullard 1" ×3/8×5/16
302. 1 13 amp flat pin socket and fused spur on double size plate, white
303. 1 12 pole 3 way ceramic wave charge switch
304. 1 stereo amp 1 watt per channel
305. 1 tubular dynamic microphone with desk rest
306. 1 module, speaker & battery to make musical card
307. 5 thermal fuses 15 amp woods metal
308. 1 T.V. turret tuner (black & white T.V.)
309. 12 adaptable legended knobs 1/4" spindle
310. 2 oven thermostats
311. 1 Clare Elliot sealed relay
312. 1 pressure pad switch 24×18 (Trigger Mat)
313. 5 sub miniature micro switches
314. 1 12" 8 watt min fluorescent tube white
315. 1 8" 6 watt min fluorescent tube white
316. 1 round pin kettle plug with moulded on lead

TWO POUNDERS

Following the popularity of our BAKERS DOZEN £1 PARCELS, we are now introducing some BAKERS DOZEN £2 PARCELS. We feel that you will agree that most are exceptional bargains but you can still get a bit extra, as with the £1 parcel, if you buy 12 you get another free!

- 2P1 – 24 hour time switch with 2 on/offs, an ideal heating programmer
- 2P2 – Wall mounting thermostat, high precision with mercury switch and thermometer
- 2P3 – Variable and reversible 8-12v psu for model control
- 2P4 – 24 volt psu with separate channels for stereo made for Mullard UNILEX Amplifiers.
- 2P6 – 100 watt mains to 115 volts auto-transformer with voltage tappings
- 2P7 – Mini key, 16 button membrane keyboard, list price over £12, as used on PRESTEL
- 2P8 – Mains motor with gear box and variable speed selector. Series wound so suitable for further speed control
- 2P9 – Time and set switch. Boxed, glass fronted and with knobs. Controls up to 15 amps. Ideal to program electric heaters
- 2P10 – 12 volt 5 amp mains transformer – low volt winding on separate bobbin and easy to remove to convert to lower voltages for higher currents
- 2P11 – Power amp module Mullard Unilex EP9000 (note stereo pre-amp module Unilex 9001 is BD216
- 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 emit piercing squawk
- 2P15 – Interupted Beam kit for burglar alarms, counters, etc
- 2P17 – 1 rev per minute mains driven motor with gear box, ideal to operate mirror ball
- 2P18 – Liquid/gas shut off valve mains solenoid operated
- 2P19 – Disco switch-motor drives 6 or more 10 amp change over micro switches supplied ready for mains operation sh
- 2P20 – 20 metres extension lead, 2 core – ideal most Black and Decker garden tools etc
- 2P21 – 10 watt amplifier, Mullard module reference 1173
- 2P22 – Motor driven switch 20 secs on or off after push
- 2P24 – Clockwork operated 12 hour switch 15A 250V with clutch
- 2P26 – Counter resettable mains operated 3 digit
- 2P27 – Goodmans Speaker 6 inch round 8ohm 12 watt
- 2P28 – Drill Pump – always useful couples to any make portable drill
- 2P29 – 24 position Yaxley switch contacts rated 5A – 1/4 spindle
- 2P30 – 15 metres 6 way telephone or interconnecting wire
- 2P31 – 4 metres 98 way interconnecting wire easy to strip
- 2P32 – Hot Wire amp meter – 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
- 2P37 – 0-100 micro amp meter, 2" square flush mounting good make
- 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, unused but slightly storage soiled, made by G.E.C. Perfect order (must be collected by appointment as 12ft long).
- 2P43 – Small type blower or extractor fan, motor inset so very compact, 230V.
- 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 and normal controls.
- 2P54 – 2 1/2kw. 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. Please collect or add £3 to cover packing and postage.
- 2P55 – Mains motor, extra powerful has 1 1/2" stack and good length of spindle both ends.
- 2P60 – 1 12" uv tube and tube holders.
- 2P61 – 1 control panel kit for Unilox.
- 2P62 – 1 pair Goodmans 15 ohm speakers for Unilox.
- 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 & 86.3v 5A mains transformer.
- 2P70 – 1 E.M.I. tape motor two speed and reversible.
- 2P71 – 1 PAPST 240 5 hz motor.
- 2P72 – 1 115v Muffin fan 4"×4" approx.
- 2P73 – 1 12v 15 watt soldering iron.
- 2P74 – 1 pocket audio component tester.
- 2P75 – 1 6 hour timer, plugs into 13A socket.
- 2P76 – 1 audax tweeter partner to 5P26 speaker.
- 2P77 – 1 instrument box with key size 12"×4 1/2" wide 6" deep.
- 2P78 – Metal clad switchbox with 4, 5 amp 250v switches G.E.C.
- 2P81 – ORACLE VB100 instrument panel, is a MODEM with extras, it is the heart of many viewdata systems including the Prestel unit we recently stocked. It uses 25 I.C's, 2 crystals, u.h.f. modifier Aztec UM1233 etc etc. You receive this, new, unused and complete except for 7 of the plug in I.Cs.

OVER 400 GIFTS YOU CAN CHOOSE FROM

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

VOL 15 No.3 MARCH '86

EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY

ISSN 0262–3617

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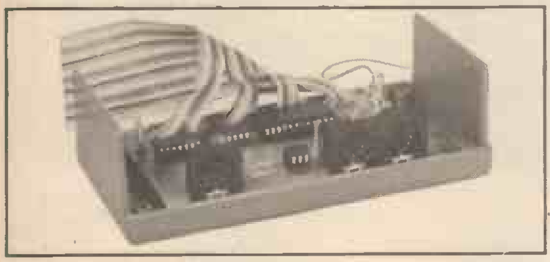
COMMENT . . . POPULAR FEATURES . . .



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High quality preamplifier for your power amplifier

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Our April 1986 issue will be published on Friday, 21 March.
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HOME LIGHTING KITS

These kits contain all necessary components and full instructions and are designed to replace 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**

DLZ1000K – 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**

MICROPROCESSOR TIMER KIT

Designed to control 4 outputs independently switching on and off at preset times over a 7-day cycle. LED display of time and day, easily programmed via 20-way keyboard. Ideal for central heating control (including different switching times for weekends). Battery back-up circuit. Includes box.
18 time settings.

CT6000K **£39.00**

XK114. Relay Kit for CT6000 includes PCB, connectors and one relay. Will accept up to 4 relays. 3A/240V c/o contacts **£3.90**

701115 Additional Relays **£1.65**

DVM/ULTRA SENSITIVE THERMOMETER KIT

Based on the ICL 7126 and a 3½ 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°C. 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**

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LONDON W7 3SJ

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MON-FRI 9-5pm
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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 o/p 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:
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- 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:-

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- ☐ CITY & GUILDS EXAMS

Other Subjects . . . .

British National Radio & Electronics School P.O. Box 7, Teignmouth, Devon, TQ14 0HS

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THIS MONTHS PROJECTS

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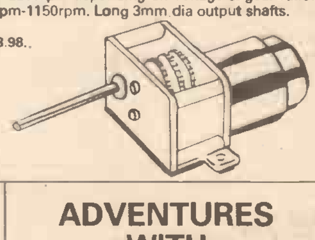

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DEVELOPMENTS

THINGS are certainly moving in the hobby electronics arena with renewed interest in constructional projects and a resurgence of courses in schools and colleges. Readership of EE has increased dramatically over the last few months and orders for p.c.b.s, books and our special offers are at an all time high; why?

It is our belief that many readers have recently become interested in the hobby as a result of their involvement in computing. That may sound a little odd but our most popular projects are those for a variety of computer add-ons and also for test gear. On the theory side *Teach-In '86* has been very well received and we know many hundreds of readers have bought kits and got down to teaching themselves how things work.

We are of course developing the magazine to meet your needs, items which will be apparent from this issue are the introduction of our free readers advertisement section where you can buy, sell or swap anything to do with electronics (but please read the rules regarding software and company advertisements, etc.) and, from next month, the introduction of a special page devoted to the BBC micro. This new Beeb page is a result of many requests from readers and schools, and we are sure will be just as popular as *On Spec.*

Our book service and the special offers are very popular. Next month we will include a special selection of sale books and hopefully another special offer. The oscilloscope special offer (repeated in this issue) is proving very popular.

While we know from your response all the above items go down well, we do not always know all your views on the magazine so please do not hesitate to drop us a line and let us know just what you like or dislike.

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Over recent months many readers have informed us that they have had problems with finding issues in the newsagents. Distribution of EE is now being handled by a new company and hopefully we can try to ensure better availability of the magazine. In case of problems please:

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2. Place a regular order with your newsagent.
3. Send us a cheque or postal order for a year's subscription. Issues will then be posted to you in time to arrive on or before the date of publication (overseas supplies take longer). Full subscription details are given at the bottom right of this page.

We will go on trying to improve the product to ensure good value for money.

Mike Kenward

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Certain back issues of EVERYDAY ELECTRONICS and ELECTRONICS MONTHLY are available world-wide price £1.25 inclusive of postage and packing per copy. Enquiries with remittance, made payable to Everyday Electronics, should be sent to Post Sales Department, Everyday Electronics, Westover House, West Quay Rd., Poole, Dorset BH15 1JG. In the event of non-availability remittances will be returned.

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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.**

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We advise readers to check that all parts are still available before commencing any project in a back-dated issue, as we cannot guarantee indefinite availability.

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

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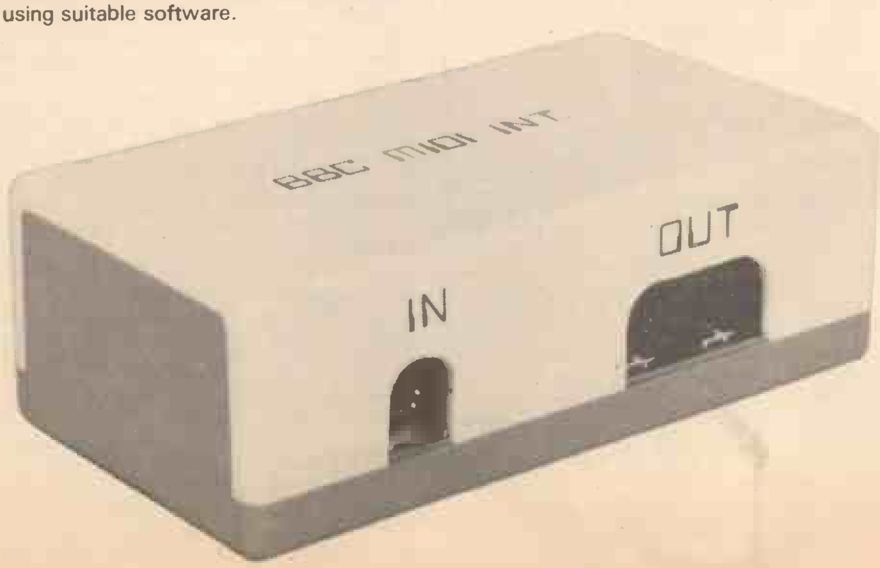
BBC MIDI INTERFACE

R.A.PENFOLD

This Musical Instruments Digital Interface will link a BBC Micro to a keyboard or synthesiser

MIDI is a term which will probably be familiar to any readers who have an interest in electronic music making, and it is a form of interface which is appearing on an increasing range of instruments from portable keyboards to expensive synthesisers. For the record, MIDI stands for "Musical Instruments Digital Interface", and it is a computer style serial interface. It enables two or more instruments to be connected together, and unlike the old CV/gate system, it enables complex systems to be put together using a minimum of connecting wires. One instrument acts as the controller for the system, or a special sequencer can be used to control the system.

An attractive feature of the MIDI system is that a home computer fitted with a suitable interface can act as the sequencer, and an extremely good one at that. Even with a long sequencer program loaded, the average home computer will still have sufficient memory left to accommodate several thousand notes. A home computer also gives great versatility since any desired feature (within reason) can be added using suitable software.



BBC

As yet there are few computers which have a built-in MIDI interface, and due to its rather specialised nature this could remain the case (although MIDI ports can also function as high speed serial interfaces for communication between two computers). As it is basically just a standard serial interface it is not difficult to add a MIDI port to most computers, and this article describes an add-on MIDI interface for the BBC model B computer.

The BBC machine is a good choice for an application of this type as it is easy to interface to add-ons, it has a fast BASIC which enables several channels to be sequenced with good synchronisation, and the built-in assembler is available for applications that require the extra operating speed of assembly language routines.

MIDI BASICS

MIDI is a two way asynchronous serial interface which is similar to the RS232C and RS423 serial systems often used with home computers. As we shall see shortly, the MIDI system is sufficiently different from these two forms of interface to prevent either of them from being used in a MIDI set-up. The MIDI word format is one start bit, eight data bits, one stop bit, and no parity, which is about the most common one these days. The baud rate is very high at 31·25k baud, but it is necessarily so as significant delays must be avoided when sequencing several channels. The highest standard RS232C and RS423 baud rate is 19·2k baud, which is one reason for the incompatibility between MIDI equipment and standard serial interfaces. Although 31·25k baud appears at first sight to be a rather odd choice, it is a practical one which enables a suitable clock signal to be derived from a 1MHz crystal oscillator (1MHz divided by 32 equals 31250).

With RS232C and RS423 serial systems the signal levels are around +3V to 12V and −3V to 12V. The MIDI system has an opto-isolator at each input to avoid problems with earth and hum loops, and consequently ordinary 0V to 5V output logic levels are all that is required. Alternatively, open collector outputs to drive the l.e.d.s in the opto-isolators can be used.

Most MIDI equipped musical instruments can have practically any parameter set via the MIDI interface, but the instruction codes for many facilities are non-standard and can be found in the instruction manual concerned. However, there is a standard format used for gating notes on and off so that there is compatibility between any two MIDI instruments at a fundamental level at least. Bytes are sent in groups of three, one group to switch a note on, and another to switch it off.

BYTES

Taking the triggering of a note first, the first byte breaks down into two four bit nibbles. The most significant of these contains the "trigger a note" header code which is 1001 in binary (144 in decimal). The least significant nibble contains the MIDI channel number, and this is in the range 0 to 15, but note that MIDI channels are normally numbered 1 to 16 and not 0 to 15. To select (say) MIDI channel 8, a channel value of 7 would therefore be used.

The second byte is the note value and must be in the range 1 to 127. Notes increment in semitones and a value of 60 gives middle C. This gives a very wide pitch range of well over ten octaves. Bear in mind though, that although the MIDI system accommodates this pitch range, not all MIDI equipped instruments can do so. The manual for each instrument should specify the pitch range available via the MIDI interface (which might actually be wider than can be achieved via the keyboard). Of course, with something like a percussion synthesiser only on/off gating is required, and the note value (which must always be sent) is ignored.

The third byte is the velocity value, and is again in the range 1 to 127. A value of 1 represents a key that is played as gently as possible, incrementing to a key struck as hard as possible at a value of 127. Not all instruments have touch sensitivity, and it is actually a feaure which is absent from the majority of instruments. However, in order to maintain compatibility between touch sensitive and non-touch sensitive instruments this byte must always be sent. Non-touch sensitive instruments normally send a dummy value of 127.

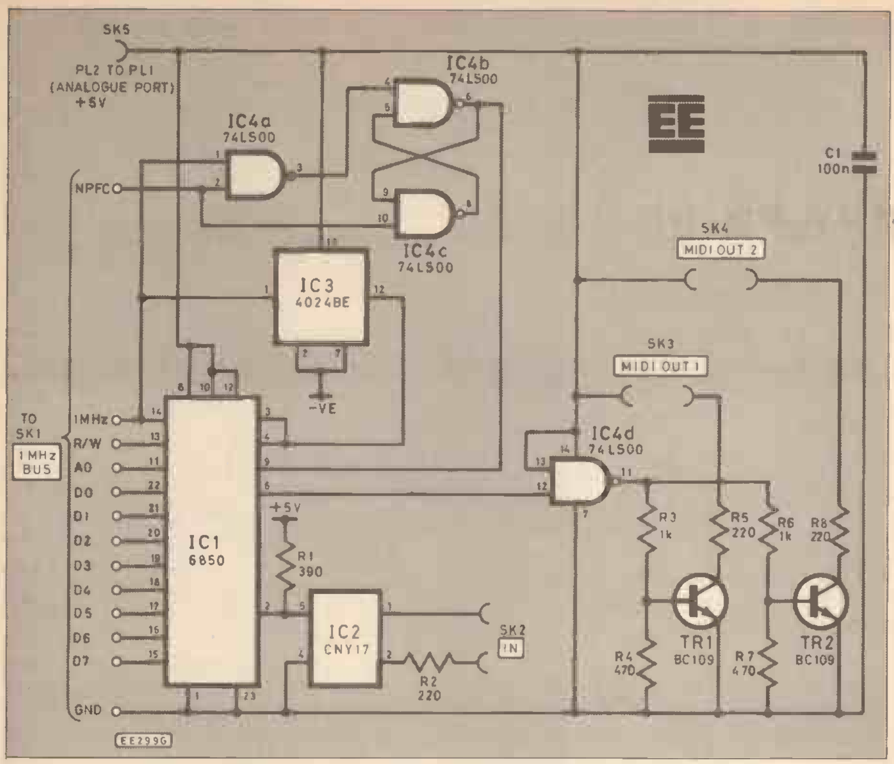


Fig. 1. Complete circuit diagram of the BBC MIDI Interface.

The system used to switch a note off again is virtually identical to the one used for triggering. In fact the second and third bytes perform the same function as before. On the face of it there is no point in including the note value, but in serial control systems things are usually arranged so that a certain number of bytes are transmitted in each control sequence, and the note value is transmitted merely to make up the three byte block. The least significant nibble of the first byte is also as before, and contains the channel value. The header code in the most significant nibble is different though, and is 1000 in binary (128 in decimal).

MODES

MIDI interfacing can be a little confusing at first as there are three operating modes, and the system will probably not perform as intended unless every component in it is set to the right mode. The most important mode is "Omni", which is one that every piece of MIDI equipment has, and the one which the equipment defaults to at switch-on. In this mode the receiving device will respond to all commands regardless of which channel they are directed to. This mode ensures a basic level of compatibility between all pieces of MIDI equipment, and it is adequate for monophonic sequencing of a single instrument, or where two or more instruments must play in unison. Polyphonic sequencing of a suitable synthesiser is possible, but exactly how the received notes are assigned to the channels of the instrument depends on the design of the instrument. Whatever the system of internal assignment, homophonic operation (all channels having the same voice) is all that is likely to be possible.

The "Poly" mode gives slightly greater versatility by enabling each instrument in the system to have its own channel number, and commands can therefore be directed to just one instrument in a multi-component set-up. However, this still effectively limits each instrument to homophonic operation. The "Mono" mode is the most sophisticated one, and it gives individual access to each channel of an instrument. With a suitable instrument this permits polyphonic sequencing with each channel having a different voice.

Only a few fundamentals of MIDI software have been covered here, but this is all that you need to know in order to understand how sequencing via a MIDI interface can be achieved. Other features can be controlled via the MIDI interface of most instruments, but the codes and system used are not universal in many cases, and it is a matter of consulting the handbook for each instrument to see just what can be achieved, and how.

CIRCUIT OPERATION

The full circuit diagram of the interface is provided in Fig. 1. Most simple BBC add-ons connect to the analogue and (or) user port, but in this case where 8 bit bidirectional operation is required the 1MHz Bus represents the best option.

Most normal serial interface devices can be used as the basis of a MIDI interface, and the only exceptions are the few devices which can not handle the fairly high baud rate involved. The obvious choice for a 6502 computer is the inexpensive and 6502 bus compatible 6850 ACIA (Asynchronous Communications Interface Adaptor), which is the device used here (IC1). The data bus of IC1, plus the clock and R/W lines simply connect to the corresponding lines of the 1MHz Bus. There is no reset terminal on IC1 as the 6850 uses a software reset. IC1 has two read registers and two write types, and it consequently occupies two addresses in the memory map. Address line A0 is used to drive the single register select input of IC1.

The 6850 can operate with the transmitter and receiver clocks at 1, 16 or 64 times the required baud rate. In practice this device is not normally operated in the mode where the clock frequency is identical to the baud rate, as the internal receiver synchronisation circuit will not function in this mode and an external synchronisation circuit would be required. In this case the 1MHz clock signal is divided by two in IC3, and the 500kHz output is connected to the receiver and transmitter clock inputs of IC1. With IC1 operated in the X16 mode this gives the required 31·25k baud rate.

There are two decoded address outputs on the 1MHz Bus; NPFC and NPFD. These pulse low when any address in page &FC or &FD respectively is accessed. In theory one of these lines could be connected direct to the negative chip select input of IC1, but in practice this might not give good results due to noise on the page select outputs. In this application a missed byte of information would almost certainly cause the system to crash, and good reliability in the interface is essential. The problem is due to the BBC computer having a 2MHz clock for normal operation, but a change to 1MHz when input/output circuits are accessed. A simple circuit is all that is needed to rectify the problem, and in this circuit three of the NAND gates in IC4 are used to provide a "clean" version of NPFC to IC1. This places the control and status registers at address &FC00, and the receive/transmit registers at address &FC01. Note though that only partial address decoding is used, and that the interface appears at "echoes" throughout page &FC. This page is therefore unavailable for other add-ons when the MIDI interface is connected.

IC2 is the opto-isolator at the MIDI input. R1 is the collector load resistor for the transistor at the output of IC2 while R2

COMPONENTS

See Shop Talk page 146

Resistors

R1	390
R2,5,8	220 (3 off)
R3,6	1k (2 off)
R4,7	470 (2 off)

All ¼W 5% carbon film

Capacitors

C1	100n ceramic

Semiconductors

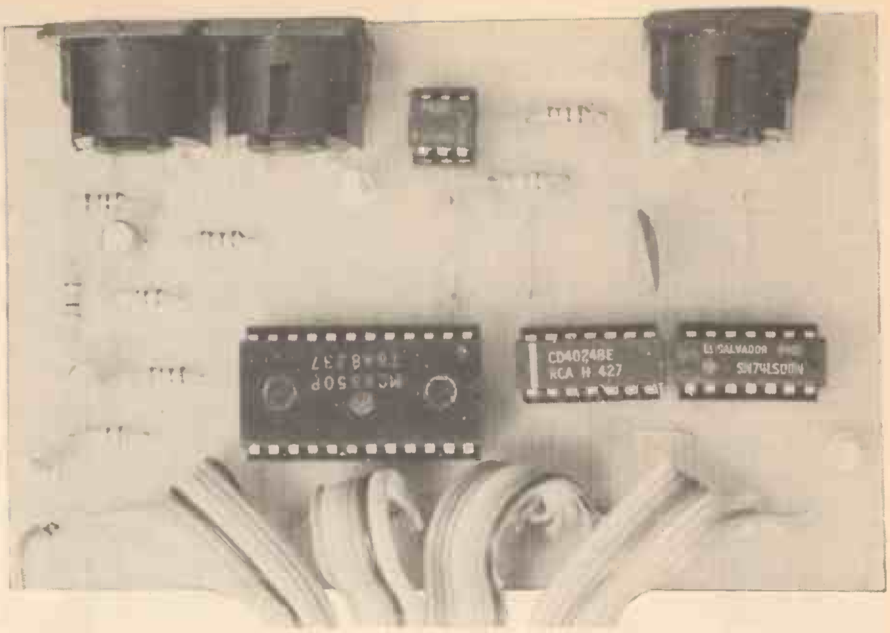
IC1	MC6850P ASCIA
IC2	CNY17 high efficiency opto-isolator
IC3	4024BE CMOS binary counter
IC4	74LS00 TTL quad 2 input NAND gate
TR1,2	BC109 silicon npn (2 off)

Miscellaneous

SK1	34 way IDC header socket and cable
SK2,3,4	5 way 180 degree DIN printed circuit mounting sockets (3 off)
SK5	1mm socket
PL1	15 way D plug
PL2	1mm plug

Printed circuit board, available from the *EE PCB Service*, order code 518; Plastic Verocase 150 × 80 × 50mm; two 14-pin DIL i.c. holders; 6-pin d.i.l. i.c. holder; 24-pin d.i.l. i.c. holder; wire; fixings; solder; etc.

Approx. cost Guidance only £15.40



provides current limiting at the input. IC4d is used to invert the output from IC1, and the inverted signal is then coupled to a couple of switching transistors which provide the unit with twin MIDI outputs.

Most MIDI instruments have three interface sockets, "IN", "OUT", and "THRU". The "THRU" socket merely provides a buffered version of the signal applied to the input. A MIDI system is normally "chained" together in the manner shown in Fig. 2(a), but if two of the instruments lack a "THRU" socket this is not possible. The method of connection shown in Fig. 2(b), with the second MIDI output of the interface being brought into operation, must then be utilized. If the second output is not required, simply omit R6, R7, R8, TR2, and SK4.

An unexpected omission from the BBC computer's 1MHz Bus is any form of power supply output. The +5V supply for the interface is therefore taken from the analogue port.

CONSTRUCTION

Refer to Fig. 3 for details of the printed circuit board. IC1 and IC3 are both MOS devices and accordingly require the standard antistatic handling precautions to be observed. The standard connector for MIDI interfaces is a 5 way (180 degree) DIN type, and here printed circuit mounting sockets are used. Make sure that these are pushed right down onto the board before soldering them into place, and use plenty of solder. There are four link wires on the board which should not be overlooked. Also, note that IC1 and IC2 have the opposite orientation to IC3 and IC4.

The board is connected to the 1MHz Bus of the computer via a piece of 34 ribbon cable up to about one metre long and fitted with a 34 way IDC header socket. Be careful to connect the free end of the cable to the board the right way around. Fig. 4 gives connection details for both the 1MHz Bus and the analogue port (note that the diagram on page 499 of the BBC computer's "User Guide" shows the 1MHz Bus connector incorrectly, and it is Fig. 4 rather than this which should be followed). An insulated lead about one metre long is used to connect PL1 to the board.

The unit can be left as an open board or, like the prototype, it can be fitted into a case having outside dimensions of about 150 by 80 by 50 millimetres. The board is mounted on the base panel of the case using 6BA fixings, including ¼ inch spacers. Cutouts to accommodate the sockets are then made in one side of the case, which then effectively becomes the front panel. An exit slot for the 34 way ribbon cable is filed in the rear panel of the case, and the +5V lead to the analogue port can also be taken through this. However, a neater solution is to connect the +5V terminal of the circuit board to a 1mm socket mounted on the rear panel of the case, and to terminate the lead from the analogue port in a 1mm plug which connects to this socket.

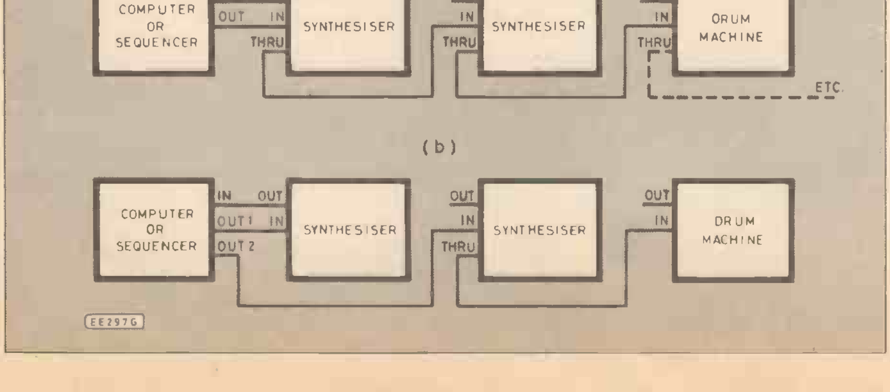
TESTING

As this project connects to the computer's buses, albeit via buffers in most cases, it is essential to connect it to the computer prior to switch-on. Once switched on the computer should give the normal "beep" and screen display, and you should switch off at once and recheck everything if there is any sign of abnormal operation. The interface is connected to the synthesiser (or whatever) using a standard five way DIN to five way DIN lead. If you are making up your own connecting leads bear in mind that only pins 4 and 5 actually carry connections; pin 2 at each output is earthed, and this connects to the outer braiding of the cable to provide screening and prevent radio frequency interference from being radiated.

SOFTWARE

The 6850 needs only very simple driving software. First the device must be reset by writing a value of three to the control register (i.e. ?&FC00 = 3), after which the word format and baud rate are selected by writing the correct value to the control register. In this case a value of 21 is required (i.e. ?&FC00 = 21). Data to be transmitted is then written to address

Fig. 2(a). The normal "chained" MIDI set-up. (b) A series-parallel combination can be used if there are inadequate "Thru" sockets for the "chained."



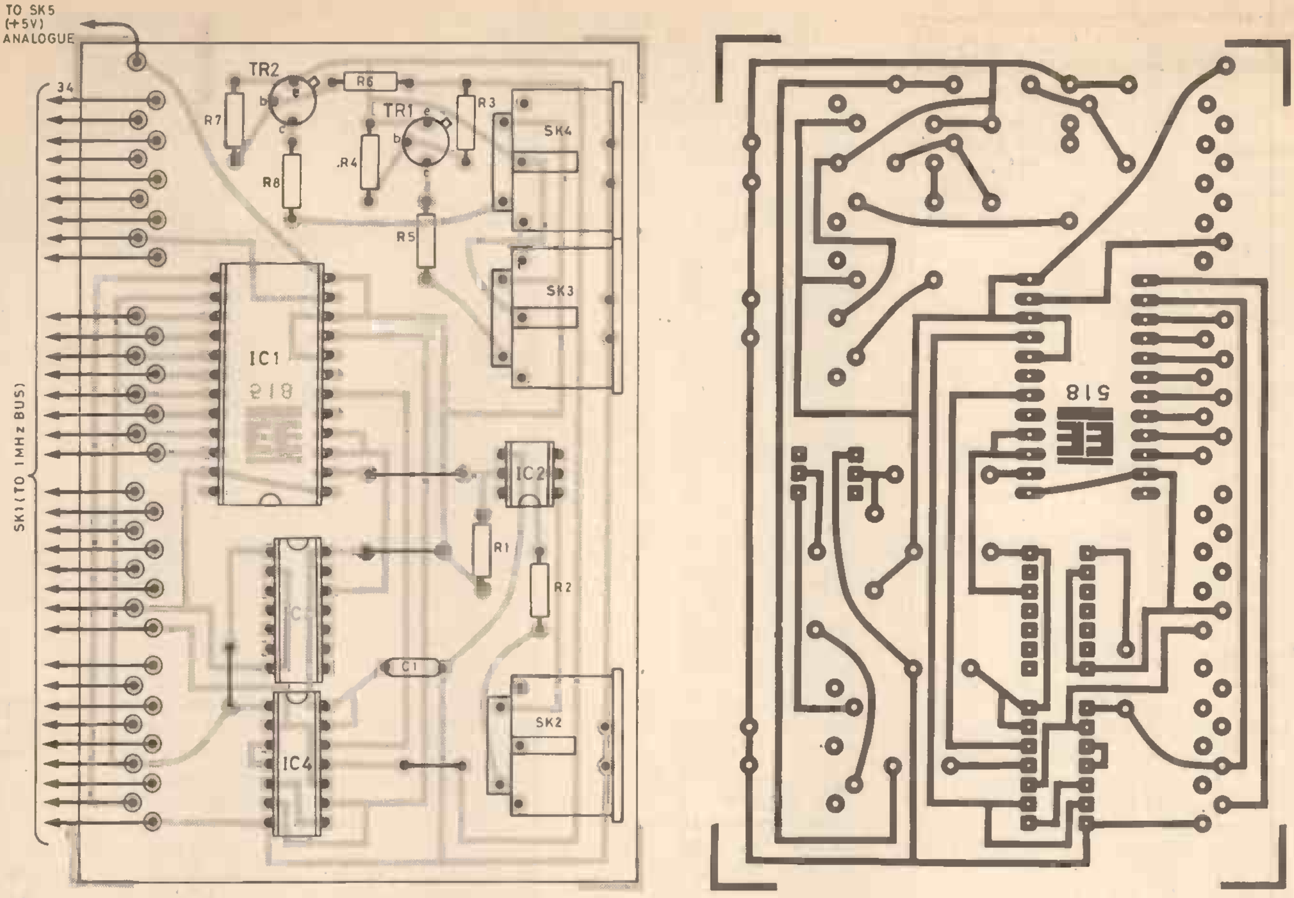


Fig. 3. Printed circuit board layout and construction.

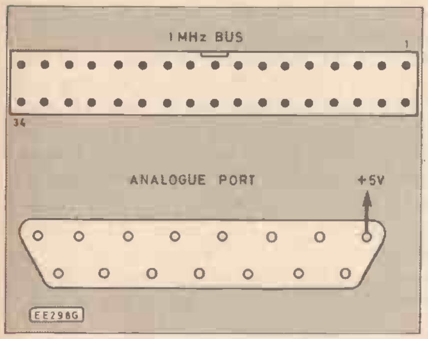


Fig. 4. Connections to the 1MHz Bus and Analogue Port.

&FC01. Using assembly language it is possible to write data to the interface faster than it can be transmitted. This must be avoided by reading the "transmitter register empty" bit at bit 1 of the status register and using a software loop to provide the necessary hold-off. This bit goes high when the register is empty and ready to receive fresh data.

Data is read from the receive register at address &FC01, but to avoid multiple readings of each byte data should only be read when the "receive data register full" bit of the status register (bit 0) is set to 1. The MIDI system does not include any handshake lines to control the rate at which data flows, and any device which receives data must be able to keep up with the very rapid rate at which it is transmitted at times. In practice this means that the interface can only be read properly using machine code or assembly language.

As a quick test of the unit you can try connecting one of the outputs direct to the input socket. After writing the two values to the status register, as described previously, you should find that any value written to ?&FC01 can be read back from that address, but only if the link from the output to the input is maintained.

USE

The accompanying listing is for a simple real-time sequencer that is suitable for recording and backing of up to four parts. The normal way of using a sequencer of this type is to record a backing, and to then have the computer play this while the user plays the melody line. Most MIDI instruments will accept input simultaneously from the keyboard and the MIDI interface.

In theory there is no limit to the number of notes that can be played simultaneously using this sequencer program, which records notes in five byte blocks of memory (three bytes from the synthesiser, plus two from the computer's timer). In practice though, using more than four part harmonies might produce data from the instrument at a faster rate than the computer can handle it, despite the extensive use of assembly language routines in the program. It might be possible to streamline the program to handle more than four notes at a time reliably, and it should be possible to add refinements such as rhythm correction and the ability to vary the playback speed. As it stands the program uses a 5k block of memory which gives a storage capacity of 512 notes, but this could obviously be boosted considerably if required. The program is largely self explanatory in use.

Step-time sequencing can be achieved relatively easily, and the high operating speed of BBC BASIC avoids the need to resort to assembly language unless a large number of channels are to be controlled. □

BBC MIDI SOFTWARE

```
10REM MIDI INTERFACE
20REM REAL TIME RECORD/
30REM PLAYBACK PROGRAM
40REM VERSION 2.1 JWP 8/85
50MODE 7
60
70
80DIM CODE 1023
90DIM STORE 5119
100DIM CLOCK 4
110
120
130?&72=STORE MOD 256
140?&73=STORE DIV 256
150notecountl=&74
160notecounth=&75
170pointer=&70
180pointerh=&71
190OSWORD=&FFF1
200OSBYTE=&FFF4
210midi=&FC01
220status=&FC00
230
240
250FOR I%=0 TO 2 STEP 2
260P%=CODE
270[
280OPT I%
290.firstnote
300LDA #0
310STA CLOCK
320STA CLOCK+1
330STA CLOCK+2
340STA CLOCK+3
350STA CLOCK+4
360STA notecountl
370STA notecounth
380LDA &72
390STA &70
400LDA &73
410STA &71
420.start
430LDA status
440AND #1
450BEQ start
460LDA #2
470LDX #CLOCK MOD 256
480LDY #CLOCK DIV 256
490JSR OSWORD
500
510
520.getnote
530LDX #0
540LDY #0
550LDA midi
560STA (pointer),Y
570JSR increment
580.note
590LDA status
600AND #1
610BEQ note
620LDA midi
630STA (pointer),Y
640JSR increment
650.tail
660LDA status
```

continued overleaf

BBC MIDI SOFTWARE continued

```
670AND #1
680BEQ tail
690LDA midi
700STA (pointer),Y
710JSR increment
720JSR addnote
730JSR timing
740.next
750LDA #255
760CMP &78
770BEQ tobasic
780LDA status
790AND #1
800BEQ next
810JMP getnote
820
830
840.increment
850INC &70
860BNE nocarry
870INC &71
880.nocarry
890RTS
900
910
920.key
930PHA
940LDA #255
950STA &78
960PLA
970RTS
980
990
1000.timing
1010LDA #1
1020LDX #CLOCK MOD 256
1030LDY #CLOCK DIV 256
1040JSR OSWORD
1050LDY #0
1060LDA CLOCK
1070STA (pointer),Y
1080JSR increment
1090LDA CLOCK+1
1100STA (pointer),Y
1110JSR increment
1120RTS
1130
1140
1150.addnote
1160INC notecountl
1170BNE nohi
1180INC notecounth
1190LDA notecounth
1200CMP #4
1210BNE nohi
1220BRK
1230EQUB 100
1240EQUS "Note store full "
1250BRK
1260.nohi
1270RTS
1280
1290
1300.tobasic
1310BRK
1320EQUB 102
1330EQUS"Key pressed"
1340BRK
1350
1360
1370.wait
1380LDA #&91
1390LDX #0
1400LDY #0
1410JSR OSBYTE
1420BCC tobasic
1430LDX #CLOCK MOD 256
1440LDY #CLOCK DIV 256
1450LDA #1
1460JSR OSWORD
1470LDY #4
1480LDA CLOCK+1
1490CMP (pointer),Y
1500BEQ lobyte
1510BCS outwait
1520BCC wait
1530.lobyte
1540DEY
1550LDA CLOCK
1560CMP (pointer),Y
1570BCC wait
1580.outwait
1590RTS
1600
1610
1620.firstplay
1630LDA #0
1640STA CLOCK
1650STA CLOCK+1
1660STA CLOCK+2
1670STA CLOCK+3
1680STA CLOCK+4
1690LDA &72
1700STA &70
1710LDA &73
1720STA &71
1730LDA &74
1740STA &76
1750LDA &75
1760STA &77
1770LDA #2
1780LDX #CLOCK MOD 256
1790LDY #CLOCK DIV 256
1800JSR OSWORD
1810JSR nextnote
1820.playnote
1830JSR wait
1840LDA status
1850AND #2
1860BEQ playnote
1870LDY #0
1880LDA (pointer),Y
1890STA midi
1900JSR increment
1910.noteval
1920LDA status
1930AND #2
1940BEQ noteval
1950LDA (pointer),Y
1960STA midi
1970JSR increment
1980.thirdval
1990LDA status
2000AND #2
2010BEQ thirdval
2020LDA (pointer),Y
2030STA midi
2040JSR increment
2050JSR increment
2060JSR increment
2070JSR nextnote
2080JMP playnote
2090
2100
2110.nextnote
2120DEC &76
2130LDA &76
2140CMP #255
2150BNE nextout
2160DEC &77
2170LDA &77
2180CMP #255
2190BNE nextout
2200BRK
2210EQUB 101
2220EQUS "All notes played"
2230BRK
2240.nextout
2250RTS
2260]
2270NEXT I%
2280
2290
2300ON ERROR GOTO 2510
2310
2320
2330CLS
2340?status=3
2350?status=21
2360?&220=key MOD 256:?&221=key DIV 256
2370PRINTTAB(5,5);"Press R to record"
2380PRINTTAB(5,7);"Press P to playback"
2390PRINTTAB(5,9);"Press any key to sto
p recording/"'TAB(5);"playing back, exce
pt ESCAPE."
2400PRINTTAB(5,12);"Press ESCAPE to qui
t program."
2410
2420
2430REPEAT
2440K=GET
2450K=K AND 223
2460IF K=82 THEN PROCrecord
2470IF K=80 THEN PROCplay
2480UNTIL FALSE
2490
2500
2510IF ERR=17 THEN STOP
2520*FX13,2
2530?&78=0
2540IF ERR=100 THEN PROCnotes:GOTO 2430
2550IF ERR=101 THEN PROCclearline:GOTO
2430
2560IF ERR=102 AND K=82 THEN PROCnotes:
GOTO 2430
2570IF ERR=102 AND K=80 THEN PROCclearl
ine:GOTO 2430
2580REPORT:PRINT " at line ";ERL
2590PRINT "PRESS ANY KEY"
2600REPEAT UNTIL GET
2610GOTO 2330
2620
2630
2640DEF PROCrecord
2650*FX14,2
2660PRINTTAB(5,20);"Recording..."
2670?status=3
2680?status=21
2690CALL firstnote
2700ENDPROC
2710
2720
2730DEF PROCplay
2740IF ?&75=0 AND ?&74=0 THEN PROCempty
:ENDPROC
2750PRINTTAB(5,20)"Playing..."
2760CALL firstplay
2770ENDPROC
2780
2790
2800DEF PROCnotes
2810notecount=(256*?&75+?&74)
2820PRINTTAB(5,20);notecount;" Events s
tored."
2830*FX21,0
2840PRINTTAB(5,21);"Press any key"
2850REPEAT UNTIL GET
2860PROCclearline
2870ENDPROC
2880
2890
2900DEF PROCclearline
2910PRINTTAB(5,20);SPC(20)
2920PRINTTAB(5,21);SPC(20)
2930VDU 31,5,20
2940ENDPROC
2950
2960
2970DEF PROCempty
2980PRINTTAB(5,20)"Nothing recorded."
2990PRINTTAB(5,21)"Press any key."
3000REPEAT UNTIL GET
3010PROCclearline
3020ENDPROC
>
```

TEACH-IN 86

PART 6 · Michael Tooley BA David Whitfield MA M Sc C Eng MIEE

IN this month's instalment of "Teach-In" we shall be discussing the principles of radio as well as taking a look at some simple receiver and Radio Frequency (RF) oscillator arrangements. Before we do, however, we shall introduce another important semiconductor device, the Field Effect Transistor (FET).

THE FIELD EFFECT TRANSISTOR

The field effect transistor operates on a different principle from that used by the conventional junction transistor. The fundamental difference being that the FET is a unipolar device (i.e. only one type of charge carrier is involved).

Field effect transistors exist in various forms; the two major sub-families being Junction Gate (JUGFET) and Insulated Gate (IGFET) types (see Fig. 6.1). At this stage we will only consider JUGFET devices and will go on to use one of these devices in a simple radio receiver.

Fig. 6.2 shows the simplified internal construction of an n-channel JUGFET. A thin slice of n-type silicon links the "source" and "drain" connections. A narrow p-type region is formed beneath a third electrode called a "gate".

With no bias applied to the gate and with a potential difference (of either polarity) applied between the source and drain, electrons will travel within the n-type material in a region called the "channel". We have illustrated this in Fig. 6.3(a) for the normal case in which the drain is made positive with respect to the source.

Now suppose that a negative bias voltage is applied to the gate. The p-n junction formed between the gate and the channel will become reverse biased. The increase in negative charge will repel the electrons away from the p-type region effectively reducing the width of the channel available for conduction, as shown in Fig. 6.3(b).

Increasing the reverse bias still further will further reduce the width of the channel until we eventually reach a condition (known as "pinch-off") in which the channel width has been reduced so much that electrons can no longer flow from source to drain. This condition is depicted in Fig. 6.3(c).

In terms of current flow, when no bias is applied to the gate (i.e. V_{GS} = 0V) current flowing into the drain and out of the source (remember that current and electron flows are opposite) will take a maximum value. Note that, since no current flows at the gate, the drain and source currents must be identical in magnitude.

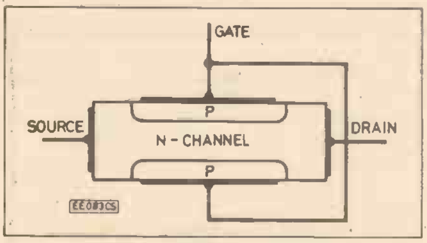


Fig. 6.1. JUGFET symbols.

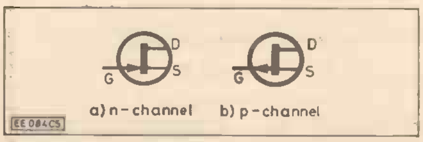


Fig. 6.2. Simplified internal arrangement of an n-channel JUGFET.

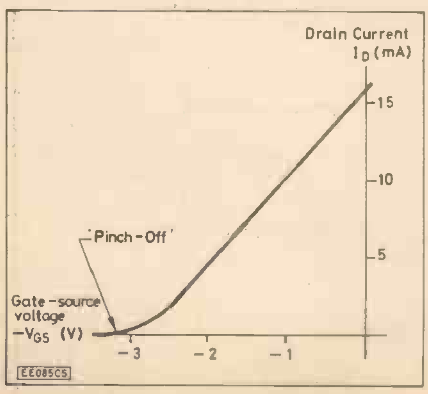


Fig. 6.4. Mutual characteristic for an n-channel JUGFET.

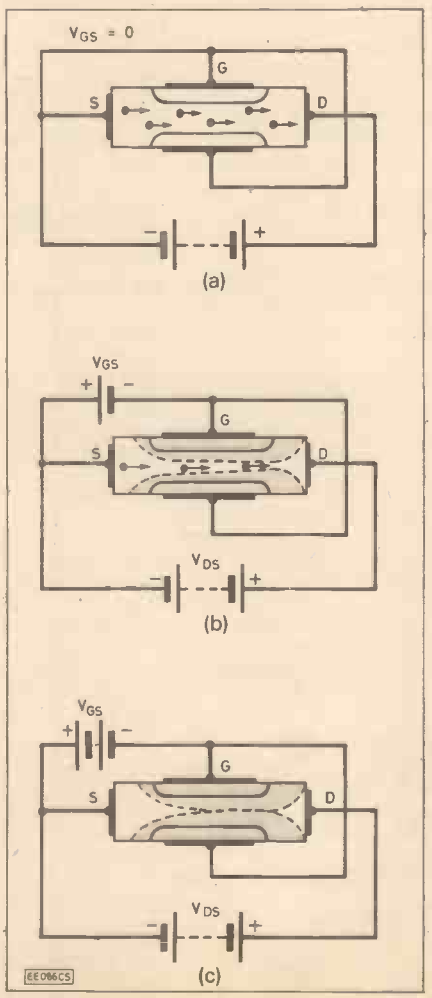


Fig. 6.3. JUGFET operation.

NEGATIVE BIAS

When negative bias is applied, and depending upon the magnitude of this bias, the source and drain currents will be reduced. Furthermore, no source and drain current will flow at all when the bias exceeds the pinch-off value.

We can illustrate this relationship with the aid of the "mutual" characteristic curve shown in Fig. 6.4. This shows drain current (I_D) plotted against gate-source voltage (V_{GS}). From Fig. 6.4, it should be noted that the drain current falls linearly with increasing negative gate-source bias. A typical family of output characteristics for a JUGFET are shown in Fig. 6.5. Readers may like to compare this with the corresponding characteristics for a bipolar transistor in Teach-In Part 3 (Fig. 3.29).

Readers should note that JUGFETs are not normally operated with the gate-source junction forward biased. (For an n-channel JUGFET this corresponds to a positive value of gate-source voltage). The danger, of course, is that the gate-channel junction will become forward biased and an appreciable value of gate current will be drawn. In this condition the device will no longer operate in a linear manner indeed, an appreciable gate current may destroy the devicel

One of the principal advantages of the FET (over conventional bipolar transistors) should now be becoming apparent. Since no current flows into the gate (it is operated by charge rather than current) the resistance looking into the gate of a FET is extremely high (in practice this can be tens of millions of ohms!) and thus the device presents very little loading upon the input circuit.

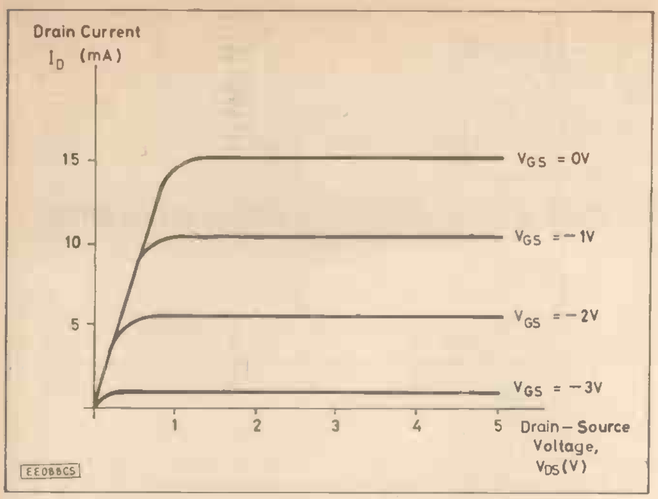


Fig. 6.5. Output characteristic for an n-channel JUGFET.

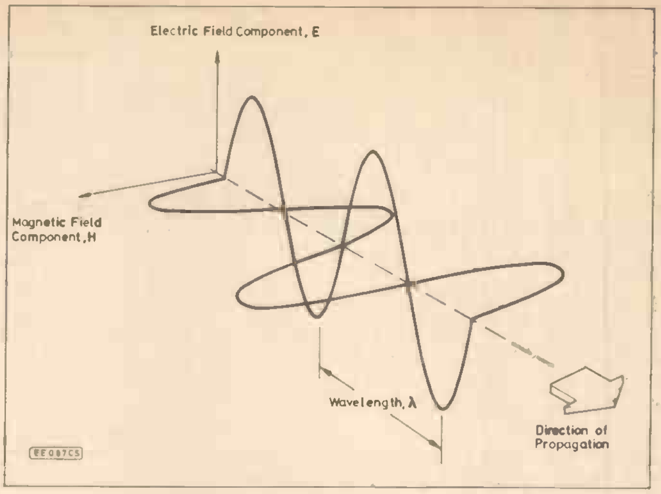


Fig. 6.8. An electro-magnetic wave.

A typical JUGFET amplifier is shown in Fig. 6.6. This should be compared with the equivalent arrangement for a bipolar transistor which was shown in Teach-In Part 4 (Fig. 4.8(c)). Readers will note that the only difference (apart from the symbol) is the absence of the base bias resistor, R_B.

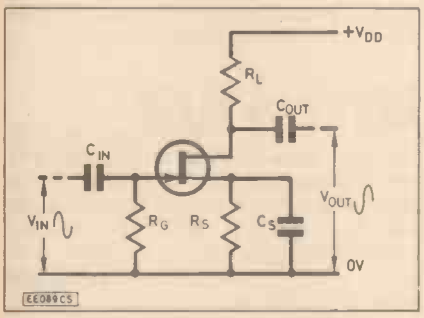


Fig. 6.6. Typical JUGFET amplifier stage.

RADIO

Speech and music can be conveyed over short distances using wires and cables along which an audio frequency electric current is sent. This system works well provided the distance is relatively short and a direct wire connection can be made between the two ends of the circuit.

An alternative method of communication is, however, desirable where information is to be "broadcast" generally or where the distances involved are so great that the losses inherent in cables and wires make their use impractical.

In such cases we must resort to the use of a high frequency carrier wave to convey our information from one end of the circuit to the other. When the high frequency carrier is radiated into space (as an electro-magnetic wave) the system is called "radio", the sending and receiving ends being respectively known as a "transmitter" and "receiver".

The modulated high frequency carrier may also be transmitted using a coaxial cable linking the sending and receiving ends of the circuit. By choosing appropriate carrier frequencies, systems of this type can permit a number of signals to be transmitted simultaneously down the same line. This "Frequency Domain Multiplexing" (FDM) is used in many long distance trunk telecommunication systems.

THE RADIO FREQUENCY SPECTRUM

Radio signals occupy a very wide frequency range which itself is part of the complete electro-magnetic spectrum, as shown in Fig. 6.7. The wavelength of a radio signal is simply the distance between corresponding points on consecutive cycles of the electro-magnetic wave, as depicted in Fig. 6.8. In air, or space, such a wave travels at a velocity equal to that of the speed of light (300 million metres per second or 3×10^8m/s).

Velocity of propagation, v, wavelength, λ, and frequency, f, of a radio wave are related by the following equation:

$$v = f\lambda$$

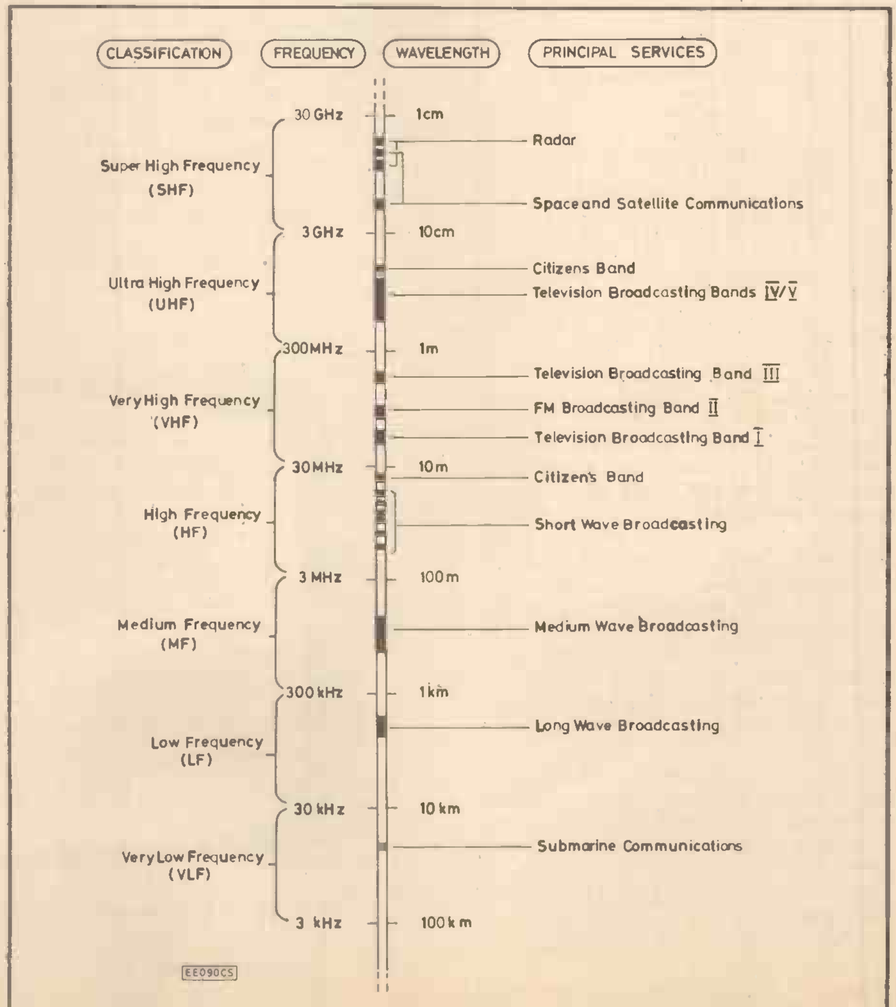


Fig. 6.7. The radio frequency spectrum.

Hence, when $v = 3 \times 10^8$m/s:

$$f = \frac{v}{\lambda} = \frac{3 \times 10^8}{\lambda}$$

and

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8}{f}$$

where λ is the wavelength expressed in metres and f is the frequency expressed in Hertz.

A radio wave with a frequency of 3MHz, for example, will have a wavelength given by:

$$\lambda = \frac{3 \times 10^8}{3 \times 10^6} = 100 \text{ metres}$$

Similarly, a radio wave having a wavelength of 1m will have a frequency given by:

$$f = \frac{3 \times 10^8}{1} = 300\text{MHz}$$

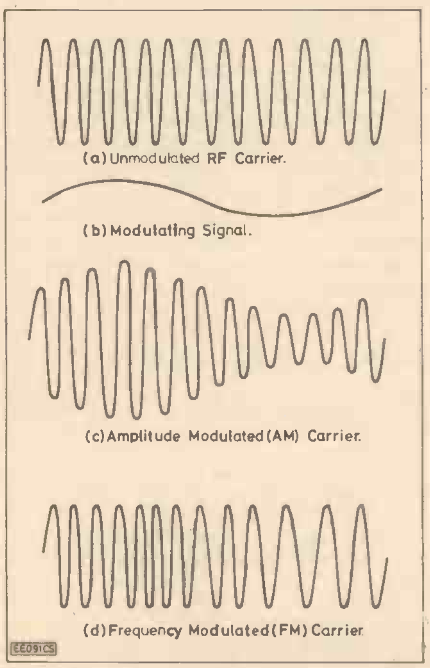


Fig. 6.9. Amplitude and frequency modulation.

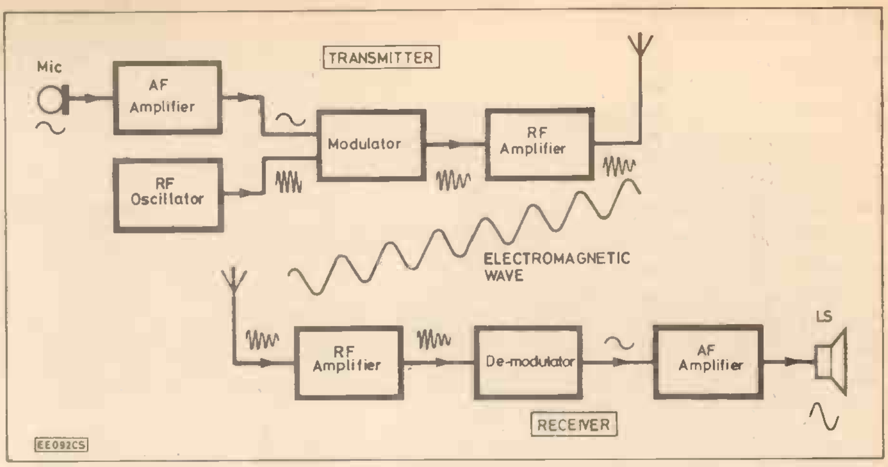


Fig. 6.10. Block schematic of a radio communication system.

The lowest frequencies used for practical radio communication are in the low tens of kHz. Very Low Frequency (VLF) waves travel close to the surface of the earth and rely on good earth conductivity. A typical application of VLF transmissions is, therefore, long distance telegraphic communication with submarines.

At the other end of the spectrum, frequencies of beyond 30GHz (i.e. 30,000,000,000 Hertz) travel only in straight lines over an unobstructed path. They are thus used for applications such as short range high resolution radar.

The use to which each frequency range is put depends upon a number of factors, paramount of which is the propagation characteristics within the range. Other factors that need to be taken into account include the efficiency of practical aerial systems in the range concerned and the bandwidth available.

Finally, though it may appear from Fig. 6.7 that a great deal of the frequency spectrum is unused, it should be stressed that competition for frequency space is fierce. Frequency allocations are, therefore, ratified by international agreement and the various radio services carefully safeguard their own areas of the spectrum.

MODULATION

In order to convey information from one end of a radio circuit to another, the signal information must be "modulated" onto the high frequency carrier. The process of modulation is simply that of changing a particular property of the carrier wave in accordance with the instantaneous voltage (or current) of the signal to be conveyed.

Several methods of modulation are in common use, two of the most common being Amplitude Modulation (AM) and Frequency Modulation (FM). In the former case the carrier amplitude (its peak voltage) varies according to the voltage, at any instant, of the modulating signal. In the latter case the carrier frequency is varied in accordance with the instantaneous modulating signal voltage.

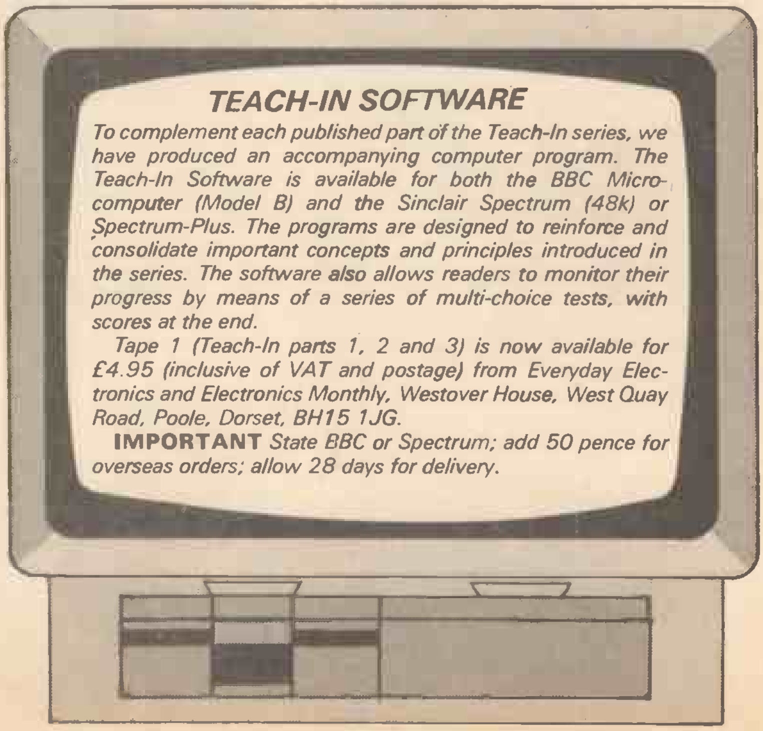
Typical waveforms showing a sinusoidal carrier modulated by a sinusoidal modulating signal are shown in Fig. 6.9. It should be noted that, in a practical case, far more cycles of the RF carrier would occur in the timespan of one cycle of the modulating signal than can actually be shown.

Consider, as an example, the case of a 1MHz carrier modulated by a 1kHz signal. One thousand cycles of RF carrier will occur during the time interval occupied by only one cycle of the modulating signal.

DEMODULATION

The process of recovering the signal from a modulated carrier is known as "demodulation". This process is carried out by a circuit known as a "demodulator" (sometimes also called a "detector").

The block schematic of a complete AM radio system is shown in Fig. 6.10. The carrier wave (of constant frequency) is generated by means of an RF oscillator. In order to ensure unconditional stability of such an oscillator the frequency determining element is generally a quartz crystal. The



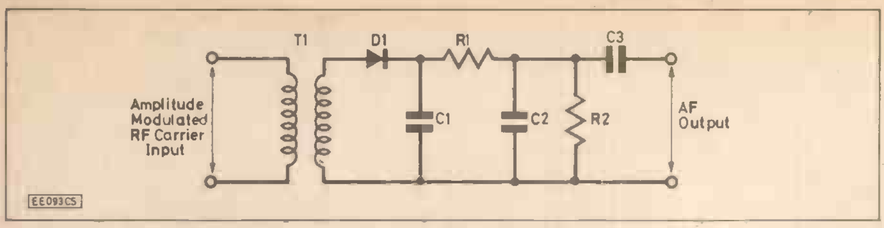


Fig. 6.11. A diode demodulator for AM signals.

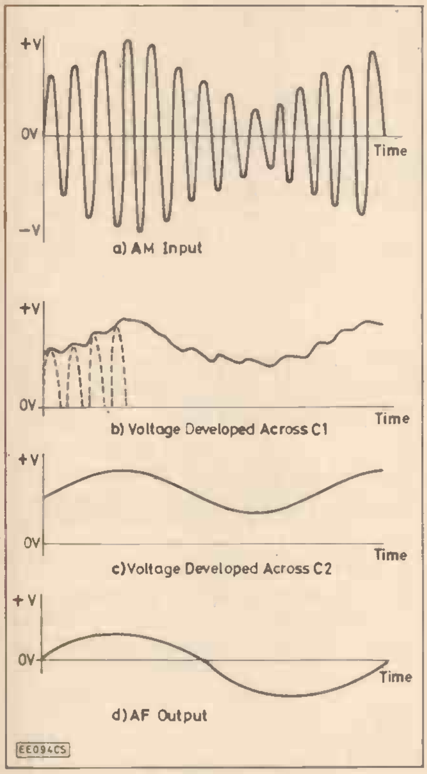


Fig. 6.12. Waveforms for the circuit of Fig. 6.11.

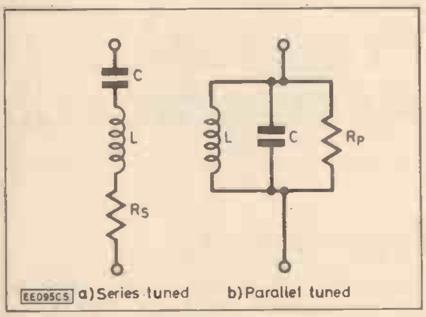


Fig. 6.13. Tuned circuits.

output of the modulator (a modulated RF carrier) is amplified before outputting to an aerial system. The output is usually also carefully filtered to remove any spurious signals (harmonics) that may be present.

At the receiver, the signal produced by the receiving aerial is a much weaker copy of the transmitted signal. Also present will be countless other signals at different frequencies. These must be rejected in the receiver's RF tuned circuits if they are not to cause interference at the demodulator.

Besides selectivity, the RF amplifier stage also provides voltage and power gain so that a larger signal is presented to the demodulator. This stage then recovers the modulated information.

The signal recovered by the demodulator normally has quite a small amplitude (500mV, or less) and thus further (audio frequency) amplification is subsequently required to bring the signal to a voltage and power level suitable for connection to a loudspeaker.

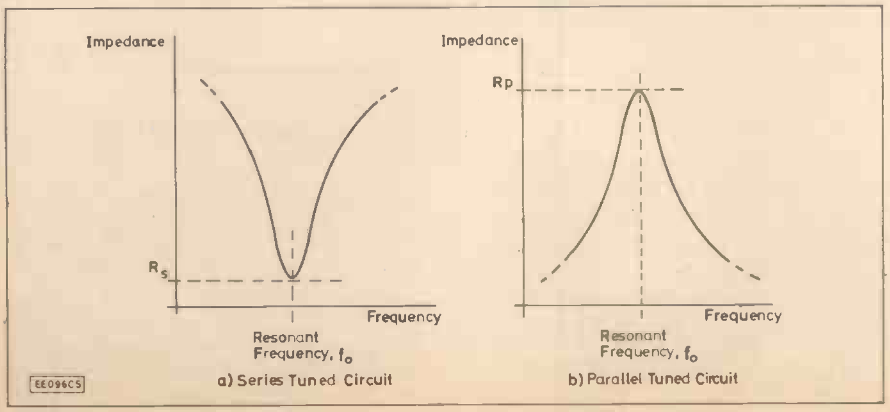
DIODE DEMODULATOR

A simple diode demodulator is shown in Fig. 6.11 together with representative voltage waveforms in Fig. 6.12. The modulated RF carrier is applied (usually via a radio frequency transformer) to the diode which conducts on positive going half cycles of the RF input voltage. The diode used, incidentally, should be a germanium (rather than silicon) type by virtue of the much smaller forward bias voltage required for conduction to take place. This helps to improve the sensitivity and linearity of the detector.

Capacitor, C1, charges to the peak voltage of each RF cycle and maintains a voltage which resembles the shape of the "envelope" of the amplitude modulated input waveform.

Series resistor, R1, and shunt capacitor, C2, then form a simple low-pass filter which removes any residual carrier frequency components present on the recovered audio frequency output voltage. Finally, R2 completes the d.c. path (required by the detector) whilst C3 acts as a d.c. blocking/a.c. coupling capacitor to pass the signal to the next stage.

Fig. 6.14. Impedance frequency characteristics for the tuned circuits of Fig. 6.13.



TUNED CIRCUITS

We have already mentioned the need for "selectivity" within the RF amplifier stage. Selectivity is achieved with the aid of a tuned circuit comprising inductance, L, and capacitance, C. Where the frequency of the tuned circuit is to be made adjustable, either of the components may be made variable. In practice, however, it is usually easier to make use of a variable capacitor rather than a variable inductor.

Two forms of series tuned circuit are possible; "series" and "parallel", as depicted in Fig. 6.13. We have included, in each case, an equivalent loss resistance which accounts for the imperfections of the circuit (i.e. the leakage resistance associated with the capacitor and the winding resistance of the inductor).

Fig. 6.14 shows the impedance/frequency characteristic of each type of tuned circuit. It should be noted that the series and parallel tuned circuits have opposite characteristics and, furthermore, the series tuned circuit has a *minimum* impedance of Rs whilst the parallel tuned circuit has a *maximum* impedance equal to Rp.

The resonant frequency of a tuned circuit is given by:

$$f_o = \frac{1}{2\pi\sqrt{LC}}\ \text{Hz}$$

where L is the inductance (in henries, H) and C is the capacitance (in farads, F).

The characteristics of the tuned circuit make it ideal for selecting or rejecting a range of frequencies. For this reason the series tuned circuit is often known as an "acceptor" circuit whilst the parallel tuned circuit is often called a "rejector" circuit.

A SIMPLE RADIO RECEIVER

A practical radio receiver can be produced by combining a tuned circuit with a diode demodulator, as shown in Fig. 6.15. The tuned circuit provides a degree of selectivity whilst the diode demodulator recovers the amplitude modulated signal. This arrangement is often called a "crystal set" since the first generation of such receivers employed a piece of galena crystal and a "cat's whisker" (a small piece of spring steel with a sharp point) to make a crude form of diode.

Provided that a reasonably efficient aerial and earth system can be realised, our simple radio receiver should be capable of providing acceptable reception of around half a dozen of the strongest broadcasting stations in the medium and long wave bands.

The selectivity and sensitivity of the receiver still leaves a geat deal to be desired and thus the simple "crystal set" must now be considered as something of an "antiquity"!

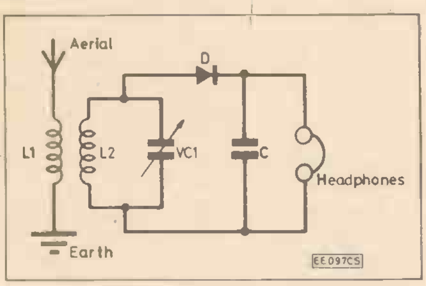


Fig. 6.15. A simple "crystal set".

TRF RECEIVER

A modern "tuned radio frequency" receiver using just one tuned circuit is shown in Fig. 6.16. This receiver uses a ferrite rod (the same as that employed for this month's practical assignment) and does not require any external aerial or earth connection. The integrated circuit provides all the functions of an RF amplifier, demodulator, automatic gain control (AGC) and audio amplifier all contained on the same 8-pin dual-in-line plastic packaged chip.

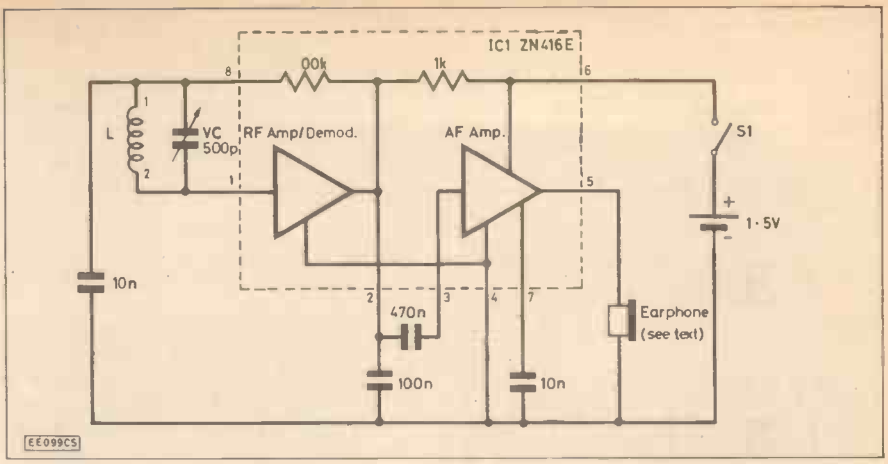
The circuit requires only six external components (excluding medium/high impedance headphones or small loudspeaker) and is capable of operation over the range 150kHz to 3MHz, depending upon the tuned circuit employed. The i.c. provides a typical power gain of 72dB and operates from a nominal 1·5V single dry cell.

Despite its simplicity, this little receiver is capable of quite astonishing performance producing reception of more than a dozen medium wave stations at reasonable volume. Hopefully, it should make an interesting constructional project for readers wishing to put the components used in this month's practical assignments to some good use!

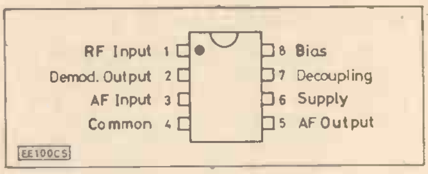
RF OSCILLATORS

We shall conclude this month's "Teach-In" with a brief look at an RF oscillator circuit. Readers will remember that we introduced a simple transformer coupled oscillator in Part Five of the series. Furthermore, we stated that the disadvantage of such an arrangement was the somewhat unpredictable frequency of operation. By tuning the transformer (i.e. placing a capacitor across the collector winding), as shown in Fig. 6.18, we can ensure that the circuit oscillates at a known frequency (approximately equal to the resonant frequency of the tuned circuit). This now becomes an extremely useful circuit!

NEXT MONTH
We shall be taking a look at operational amplifiers.



◀Fig. 6.16. A modern tuned radio frequency (TRF) receiver.



◀Fig. 6.17. Pin connections for the Ferranti ZN416E.

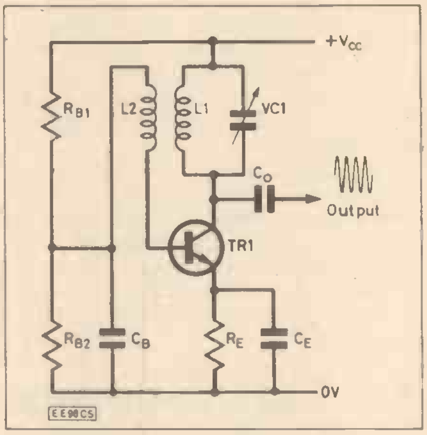


Fig. 6.18. A simple tuned RF oscillator.

PROBLEMS

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

6.1 An n-channel JUGFET operates with a variable gate-source bias voltage. When the gate-source bias is −2·5V the value of drain current is 2mA whereas when the gate source bias voltage is −3·5V the value of drain current is 0·5mA. Assuming a linear mutual characteristic, estimate the "pinch-off" voltage for the device. (m)

6.2 An AF amplifier uses an n-channel JUGFET in the arrangement shown in Fig. 6.6. If the device operates with a drain current of 2·5mA and gate-source bias of 0·5V, determine the value of source bias resistor, Rs. (e)

6.3 Calculate the wavelength of a radio frequency signal at 600kHz. (e)

6.4 Calculate the frequency of a radio frequency signal having a wavelength of 2m. (e)

6.5 A parallel tuned circuit comprises a fixed inductor of 100μH and a variable capacitor. If the resonant frequency of the circuit varies between 1MHz and 3MHz, determine the maximum and minimum values of capacitance. (d)

THE ANSWERS TO THESE PROBLEMS WILL APPEAR IN TEACH-IN PART 7

ANSWERS TO LAST MONTH'S PROBLEMS

5.1 50
5.2 45 degrees
5.3 23·3kHz (maximum), 1·49kHz (minimum)
5.4 The output voltage leads the input voltage by approximately 45 degrees
5.5 14.28
5.6 280

Practical Assignments

COMPONENTS

Besides the items used in earlier parts, you will need the following components in order to complete the practical assignments described in this part of Teach-In:

Resistors ($\frac{1}{4}$W, 5%): 3k3 (1 off); 2M2 (1 off).

Capacitors (160V polyester): 2n2 (1 off); (polystyrene): 100p (2 off); 1n (2 off).

Variable capacitor 500pF (solid dielectric) (1 off).

Transistor 2N3819 (1 off).

Miscellaneous Ferrite rod (see below) and approx. 1m of 30 s.w.g. enamelled copper wire.

Before commencing this month's practical assignments, readers will need to construct the RF transformer which is used in all three assignments.

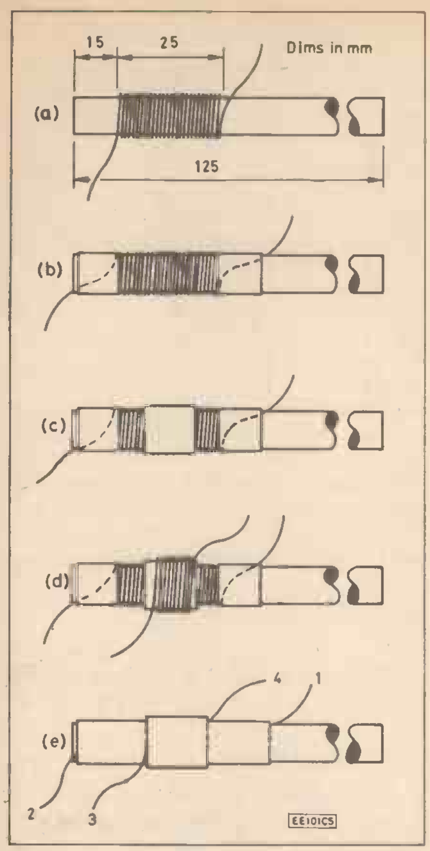


Fig. 6.19. Winding details for the ferrite rod RF transformer.

The RF transformer uses a ferrite rod having approximate dimensions 125mm × 10mm diameter. The actual size of the rod used is not critical and, in practice, a ferrite rod inductor removed from an old transistor radio should prove to be quite adequate.

The method of winding the transformer is shown in Fig. 6.19. Starting near one end of the rod, 55 turns of 30 s.w.g. enamelled copper wire are "closewound" (i.e. no gaps are left between adjacent turns) onto the rod. This winding should occupy a length of approximately 25mm, as shown in Fig. 6.19(a).

The ends of the winding should now be secured using PVC tape (or Sellotape) and then a single layer of tape should be wound over the centre of the winding, as shown in Fig. 6.19(b) and (c).

Now wind ten further turns (again closewound) over the centre of the first winding and again secure the ends using tape as shown in Fig. 6.19(d). Finally cover the entire transformer assembly with a layer of tape.

It is important to note that the direction of both windings must agree *exactly* with that shown in the figure (failure to do this may result in lack of oscillation in Assignments 6.2 and 6.3).

The ends of the enamelled copper wire should be trimmed to a length of approximately 80mm and the wire should be carefully scraped to remove the enamel from the last 5mm, or so, of the wire. The ends should now be tinned using a soldering iron. This step is essential in order to ensure a good electrical contact to the transformer windings.

The connections to the transformer are numbered 1 to 4, as shown in Fig. 6.19(e) and, if required, coloured sleeves may be fitted to aid identification of the individual leads.

For the curious, the electrical specification of the ferrite rod inductor is as follows:

Turns ratio: 1:5·5
Secondary inductance: 200uH (approx.)
Q factor (measured at 1·5MHz): 278
Q factor (measured at 500kHz): 292
Resonant frequency (with parallel C = 50pF): 1·5MHz (approx.)
Resonant frequency (with parallel C = 500pF): 500kHz (approx.)

ASSIGNMENT 6.1

Radio Receiver Demonstration

This assignment is designed to demonstrate the operation of a simple radio receiver. The assignment uses the circuit arrangement depicted in Fig. 6.20. This comprises the following elements:

(a) a tuned circuit to provide RF selectivity (L2/VC1).
(b) an RF amplifier using a junction gate FET (TR1). The very high gate-source input impedance of TR1 minimises the effect of loading upon the tuned circuit.
(c) a diode AM demodulator (D1 and associated components).

So that it is possible to monitor signals received, the output of the receiver should be connected to the "radio" or "auxilliary" input of an external amplifier or Hi-Fi system. Alternatively, where such equipment is not immediately available, Fig. 6.22 shows an optional audio amplifier stage capable of providing a modest signal from medium/high impedance headphones or a small loudspeaker having an impedance of between 40 and 80 ohms.

PROCEDURE

Connect the circuit shown in Fig. 6.20 on your breadboard using the wiring diagram shown in Fig. 6.21. If the optional audio amplifier stage shown in Fig. 6.22 is to be utilised, the wiring diagram of Fig. 6.23 should also be followed.

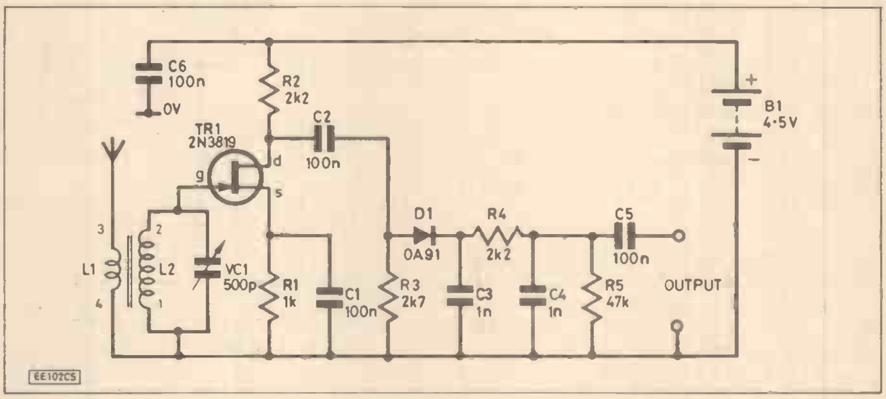
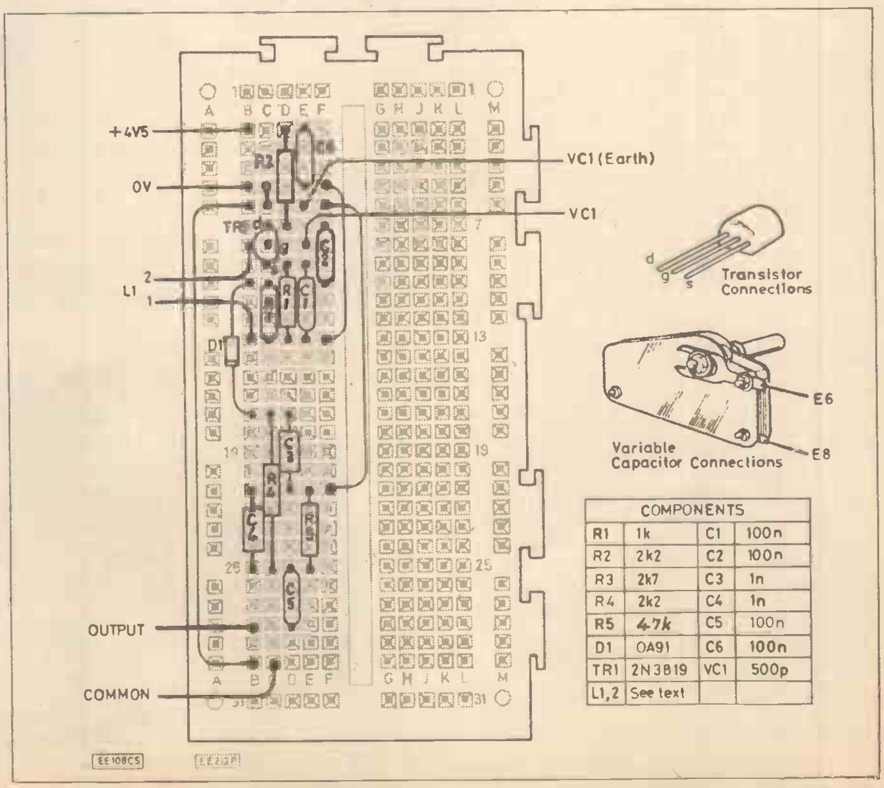


Fig. 6.20. Circuit diagram used in Assignment 6.1.



COMPONENTS			
R1	1k	C1	100n
R2	2k2	C2	100n
R3	2k7	C3	1n
R4	2k2	C4	1n
R5	47k	C5	100n
D1	OA91	C6	100n
TR1	2N3819	VC1	500p
L1,2	See text		

Fig. 6.21. Wiring diagram for Assignment 6.1.

In either case, it is important to ensure that the transistor(s) are correctly orientated and that the numbered connections to the ferrite rod are as shown.

When the wiring is complete, connect the 4·5V supply, set VC1 to mid-position, and ensure that the ferrite rod is supported clear of any metal objects. After adjusting the volume control of the external amplifier or listening carefully into the headphones, readers should hear some noise resulting from one, or more, received signals.

If VC1 is now carefully tuned, it should be possible to separate one signal from another and, although the tuning is rather "broad" (the single tuned circuit is not particularly selective), reasonable reception of up to half a dozen different broadcasting stations should result. (If this is not the case carefully check the breadboard wiring!)

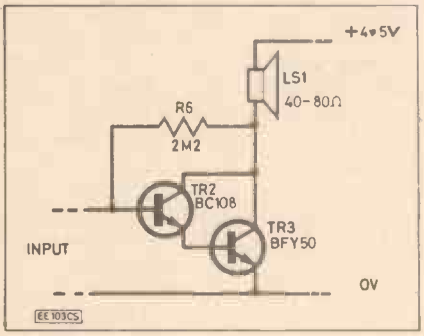
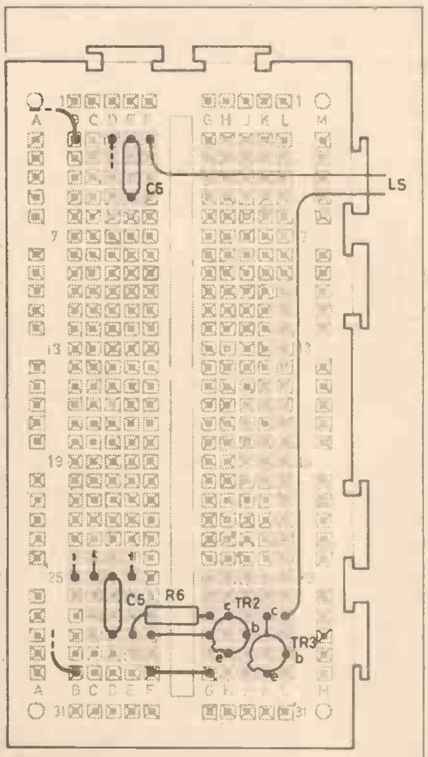


Fig. 6.22. Optional AF amplifier stage for use with Assignment 6.1.



COMPONENTS			
R6	2M2	TR2	BC108
LS	40-80Ω	TR3	BFY50

Fig. 6.23. Wiring diagram for the optional AF amplifier stage.

It should also be noted that the ferrite rod inductor is directional. Best reception occurs when the ferrite rod is aligned so that it is broadside on to the incoming signal. In this position it is able to intercept the maximum amount of magnetic field component.

ASSIGNMENT 6.2

This assignment demonstrates the operation of a simple tuned collector RF oscillator. In order to test the circuit readers should have access to a medium wave (AM) radio receiver.

PROCEDURE

Connect the circuit shown in Fig. 6.24 on your breadboard, using the wiring diagram shown in Fig. 6.25. As before, take care to ensure that the transistor is correctly connected.

Tune the radio receiver to around 650kHz, adjust the volume so that a moderate amount of background noise is heard, and then place the receiver so that it is close to the ferrite rod inductor. Now connect the 9V supply and tune the receiver until a strong unmodulated carrier is obtained. (The receiver will appear to be quiet since no modulation is present; the effect of the carrier is simply that of obliterating any background noise and signals that may have been present).

If you are uncertain as to whether or not the signal has been located, simply disconnect and then reconnect the supply. Provided the wiring diagram has been carefully followed and the inductor has been wound correctly, the circuit should oscillate!

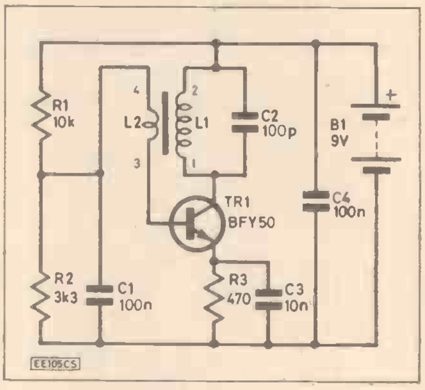


Fig. 6.24. Circuit diagram for Assignment 6.2.

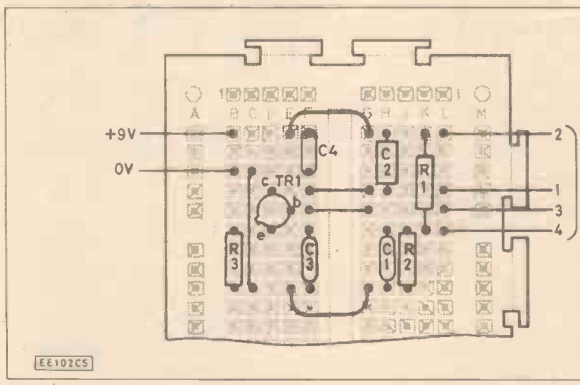
ASSIGNMENT 6.3

This assignment demonstrates the action of a simple modulated RF oscillator.

PROCEDURE

First connect the circuit of Fig. 6.26 using the wiring diagram shown in Fig. 6.27. (Readers should note that this oscillator configuration is different from the last). Then, using exactly the same procedure as described in

Fig. 6.25. Wiring diagram for Assignment 6.2.



COMPONENTS			
R1	10k	C1	100n
R2	3k3	C2	100p
R3	470	C3	10n
TR1	BFY50	C4	100n

THIS MONTH'S TEACH-IN PROJECT IS A RF SIGNAL GENERATOR—See Page 140

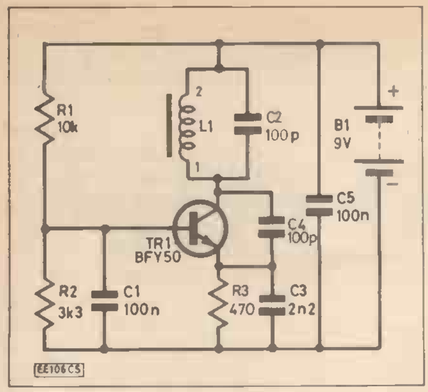


Fig. 6.26. Circuit diagram for Assignment 6.3.

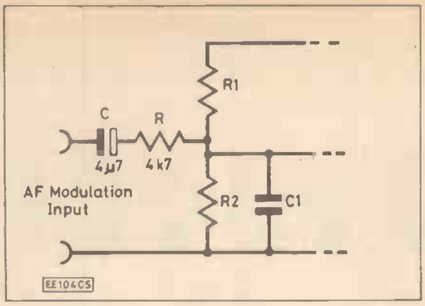


Fig. 6.28. Modification to the circuit of Fig. 6.26 in order to permit modulation.

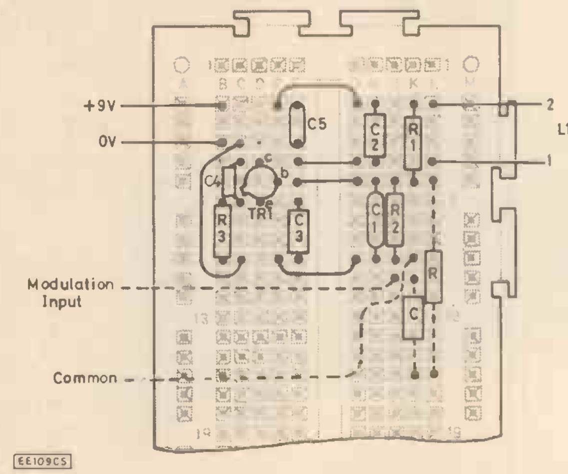


Fig. 6.27. Wiring diagram for Assignment 6.3.

COMPONENTS			
R1	10k	C1	100n
R2	3k3	C2	100p
R3	470	C3	2n2
TR1	BFY 50	C4	100p
		C5	100n

Assignment 6.2, check that the circuit oscillates. The frequency of oscillation will be somewhat higher than in the previous assignment and should be between 800kHz and 900kHz.

Having checked that the circuit oscillates, the modification in Fig. 6.28 should now be added. (The additional components have been shown dotted in Fig. 6.27). The modulating signal input can be derived from the "external loudspeaker" or "headphone" socket of a cassette recorder or Hi-Fi system and the effect of changing the depth of modulation (by altering the setting of the volume control of the cassette recorder/Hi-Fi system) should be noted.

Readers should not worry overmuch if the signal produced by the radio receiver sounds a little distorted. The reason for this is simply that the modulation employed is FM rather than AM. Furthermore, best results will be obtained if the receiver is slightly off-tuned.

NEXT MONTH
You will need the following additional components in order to carry out the practical assignments.

Semiconductors The only additional components for next month are (2 off) 741 Operational Amplifier i.c.s.

STEREO HI-FI PREAMP

ALAN BOWES

A high quality preamplifier that can drive a range of power amps

GIVEN the vast range of power amplifiers currently available, in kit or modular form, it is surprising to note the relative scarcity of suitable high quality pre-amplifiers with which they may be used. Our hi-fi pre-amp has been designed to meet this need while keeping construction relatively simple.

CIRCUIT DESCRIPTION

The circuit diagram for the Stereo Hi-Fi Pre-amp is shown in Fig. 1. Only one channel is shown, the other channel is identical.

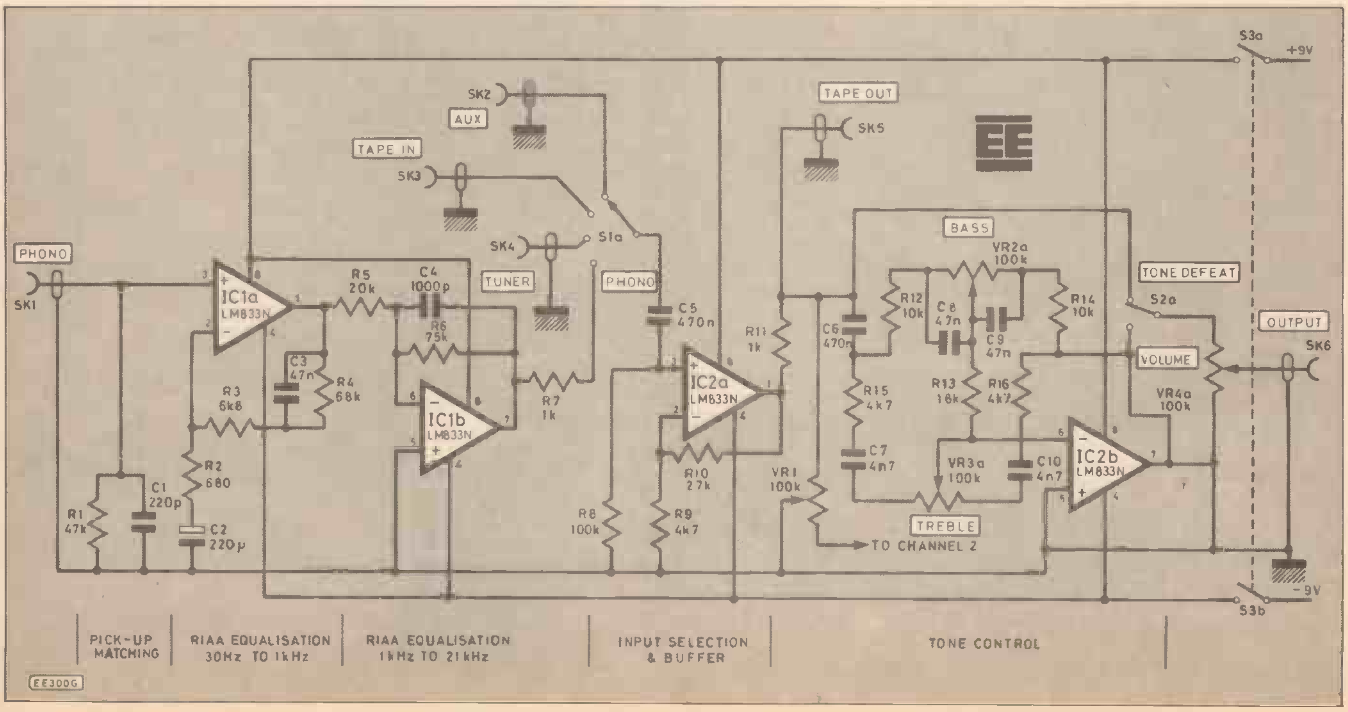
The first section of the circuit, shown in Fig. 1, is a two-stage RIAA equalisation network. This is used to compensate for the non-linear output of magnetic cartridges. Resistor R1 and capacitor C1 match the impedance/output capacitance of the cartridge. The values used will generally be suitable for most cartridges, but may be altered as required.

A very low noise, high quality dual op-amp integrated circuit is used for IC1. Together with selective feedback components, it provides the two-stage RIAA equalisation curve which boosts frequencies between 30Hz and 1kHz, whilst cutting frequencies between 1kHz and 21kHz. This is to match the characteristic of the recording on the record.

This stage has a gain of 32dB at a 1kHz reference. It therefore provides an 80mV output for a 2mV input. The stable characteristics of the design make it ideal for most applications, even where the cartridge output is particularly low. The unit may be driven by signals easily exceeding 2mV without significant distortion.

Components R3, R4 and C3 set the low-pass filter frequency for the first half of the

Fig. 1. Circuit diagram of one side of the stereo Hi-Fi Preamp.



RIAA equalisation, using half of IC1. R2 sets the gain to 24dB at 1kHz whilst C2 provides stability. Resistor R5 is used to couple the two RIAA stages. Components C4 and R6 set the feedback for the response of the second stage using the second half of IC1, and R6 sets the gain to 8dB at 1kHz.

The incoming signal is selected by S1 and C5 decouples the signal from any d.c. levels. R8 is used to set the input impedance, R9 and R10 set the gain of IC2a to 16dB across the range. At a nominal 100mV input, the output will be 630mV, which is sufficient to drive a power amplifer.

Resistor R11 couples the buffer stage to the tone control stage. VR1 provides balance control between the two identical channels. The tape output is taken from this point to ensure an adequate signal.

Capacitor C6 decouples the buffer stage from the Baxendall-type tone control stage, which offers useful bass and treble, boost and cut. A defeat switch is provided which bypasses the tone circuit, enabling comparisons between flat and "coloured" outputs and eliminating any noise generated in the tone control section. The volume control is VR4.

Positive and negative 9V supplies, as required by the LM833N i.c.s, are supplied

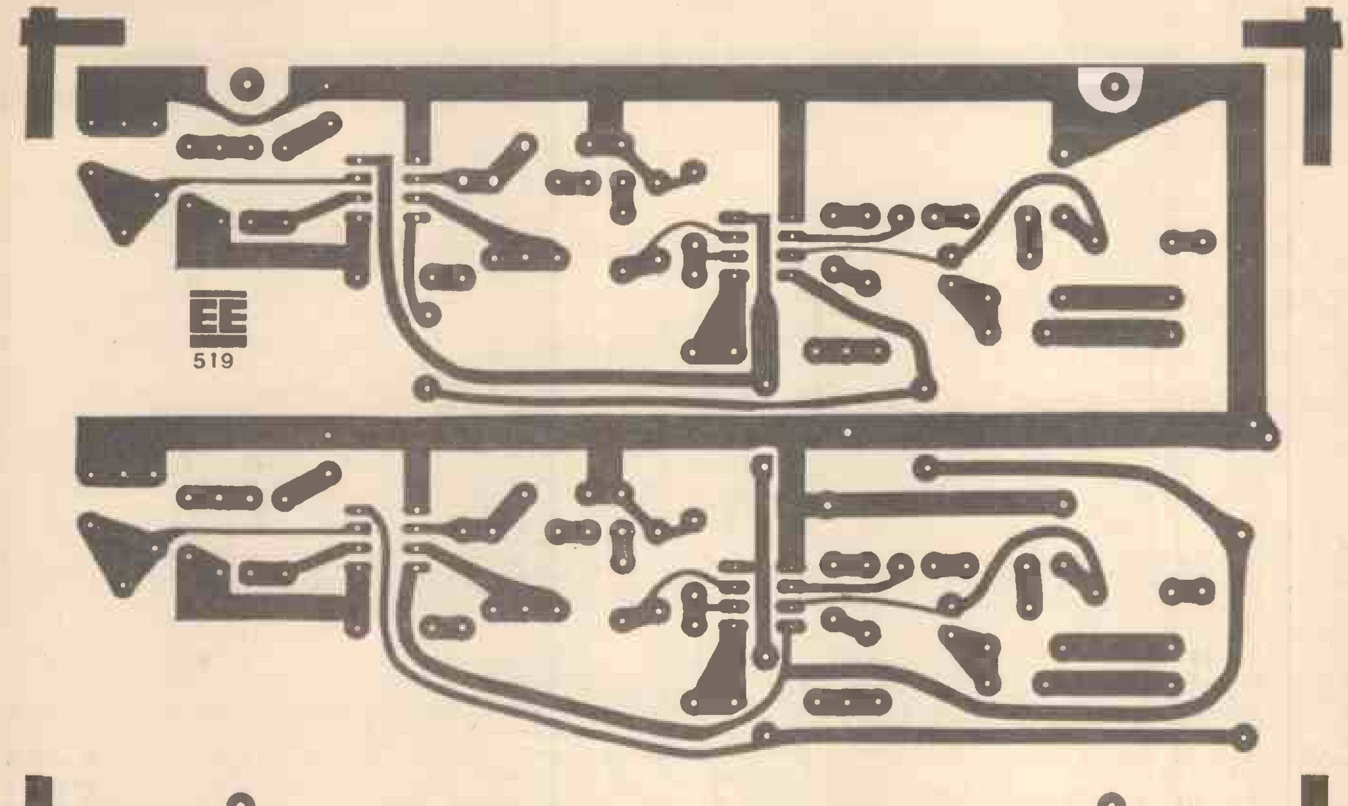
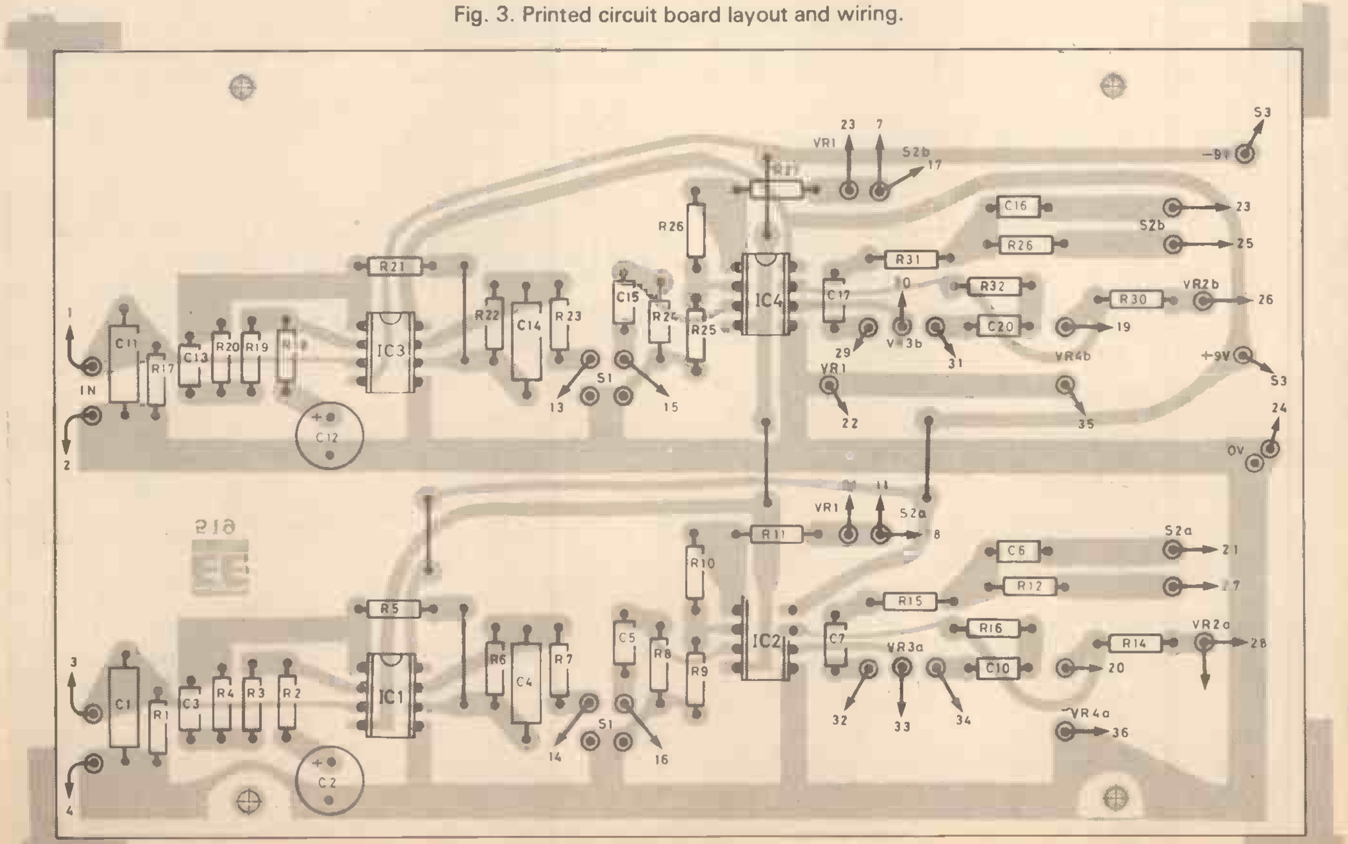


Fig. 2. Printed circuit board design.

Fig. 3. Printed circuit board layout and wiring.



COMPONENTS

Approx. cost
Guidance only **£38.50**

See **Shop Talk** page 146

Resistors

R1,17	47k (2 off)
R2,18	680 (2 off)
R3,19	6k8 (2 off)
R4,20	68k (2 off)
R5,21	20k (2 off)
R6,22	75k (2 off)
R7,11, 23,27	1k (4 off)
R8,24	100k (2 off)
R9,15,16, 25,31,32	4k7 (6 off)
R10,26	27k (2 off)
R12,14, 28,30	10k (4 off)
R13,29	18k (2 off)

All 0·4W ± 1% metal film

Potentiometers

VR1	100k lin pot. (Balance)
VR2,3	100k lin dual-gang pot. (2 off) (Bass & Treble)
VR4	100k log dual-gang pot. (Volume)

Capacitors

C1,11	220p 1% polystyrene (2 off)
C2,12	220µ 16V p.c.b. mounting elec. (2 off)
C3,8,9 13,18,19	47n polycarbonate (6 off)
C4,14	1000p 1% polystyrene (2 off)
C5,6, 15,16	470n polycarbonate (4 off)
C7,10, 17,20	4n7 polycarbonate (4 off)

Integrated Circuits

IC1,2,3,4 LM833N (4 off)

Switches

S1	2-pole 6-way rotary switch
S2	d.p. changeover push switch
S3	d.p. miniature toggle switch

Miscellaneous

SK1–12 Phono chassis socket metal (12 off); 22mm Black aluminium knob (3 required); 28mm Black aluminium knob (2 required); Suitable case measuring 205mm × 140mm × 75mm; Printed circuit board available from the *EE PCB Service*, order code EE519; Single core screened cable; twin core screened cable; strapping wire 20swg; bell wire; PP3 battery clip (2 off); Veropins: 1mm single-sided.

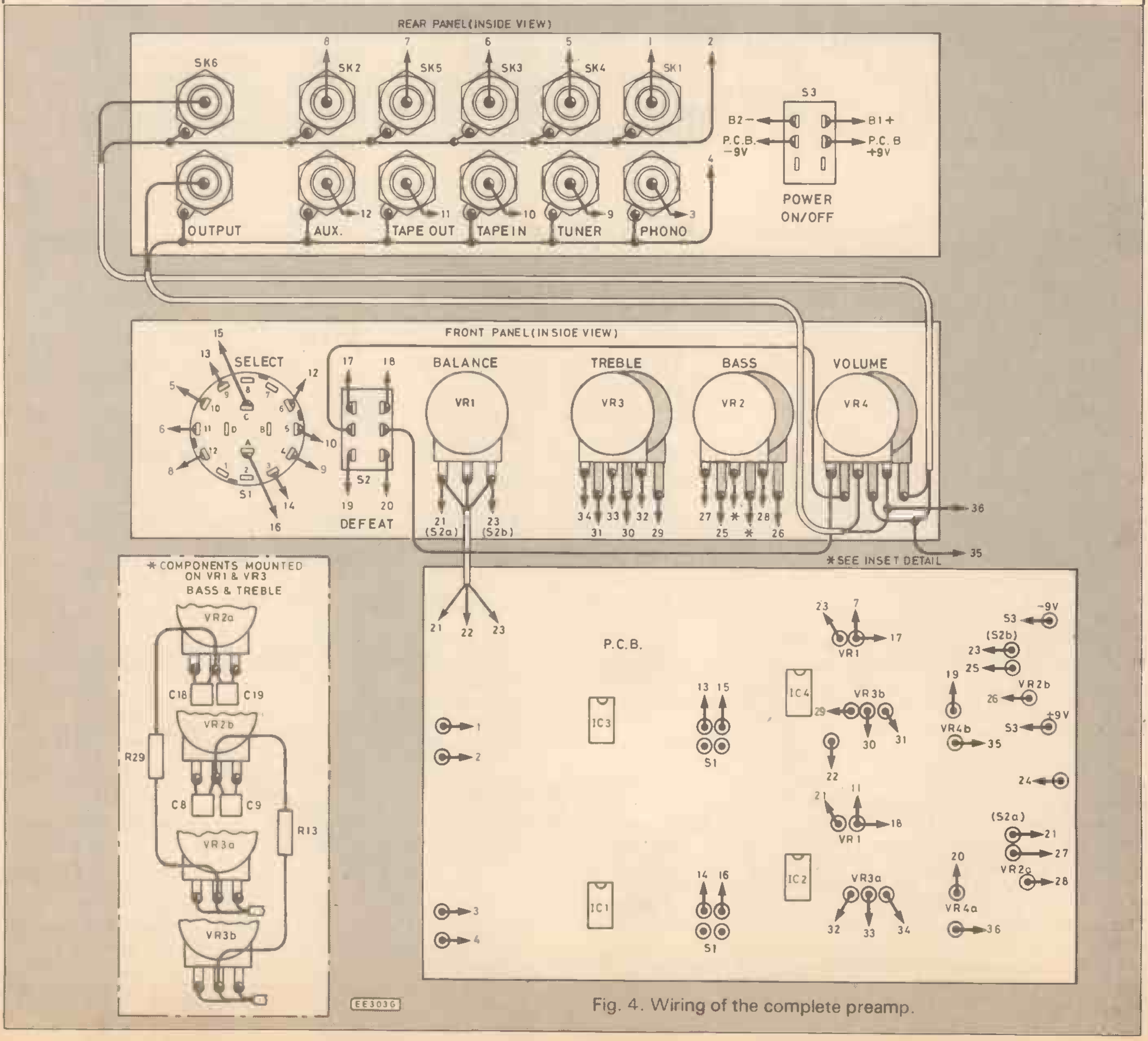
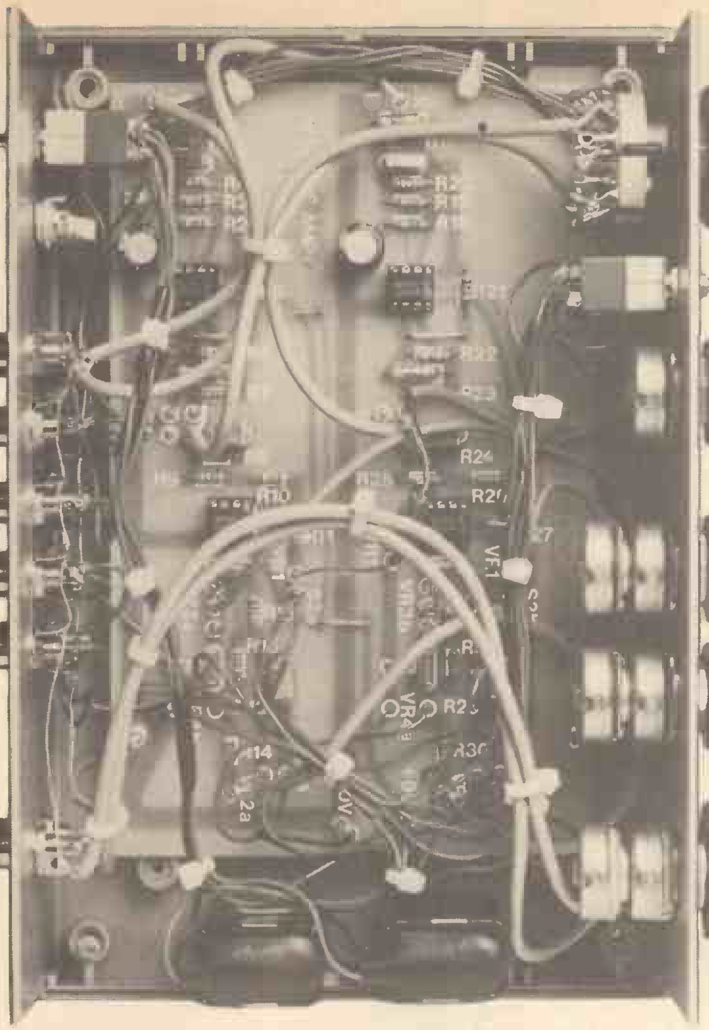
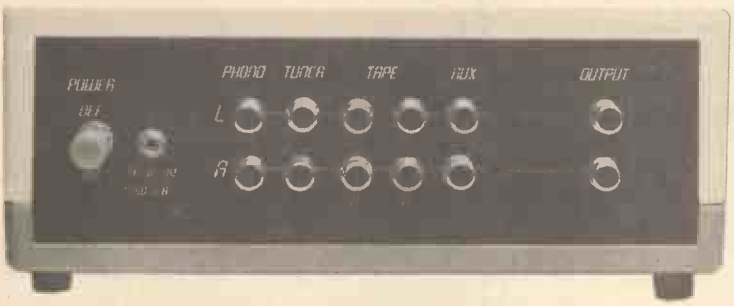


Fig. 4. Wiring of the complete preamp.





by two PP3 batteries. With the low current requirement of this design such batteries will last a long time and no problems with noise on supply lines will result. An external plus and minus 9V supply may be employed but it must be well smoothed and "clean" to ensure good noise performance from the unit. The supply is switched by S3 which is mounted on the rear panel; it could however be relocated in any convenient position.

CONSTRUCTION

The circuit is constructed on a single p.c.b. and the printed circuit master is shown in Fig. 2. The circuit board component layout is given in Fig. 3. The printed circuit board is available from the *EE PCB Service*, order code EE519.

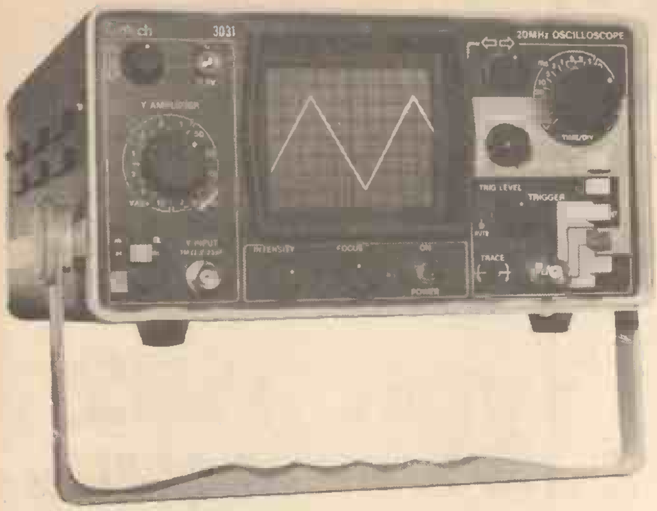
As with any project start construction by checking and identifying all components. Then continue by fitting the five link wires to the p.c.b. Next fit the resistors, capacitors and i.c. sockets, as shown in Fig. 3. Ensure that C2 and C12 are fitted the correct way round.

Fit and solder the Veropins (shown as small circles on the p.c.b.) and check the board for faults. When you are satisfied, fit the p.c.b. to the enclosure, using four screws and spacers. Mount the potentiometers and the switches to the front panel. Fit the phono sockets, power switch and power socket to the rear panel.

Connect the panel mounting components to the p.c.b., referring to the wiring diagram, Fig. 4. Use screened cable for all connections except the power switch. Fit the four capacitors to VR2, followed by the two resistors between VR2 and VR3.

Push the four i.c.s into the sockets. Make sure that they are correctly positioned; the correct orientation is shown on the p.c.b. layout. Fit the battery clips and batteries and test the completed unit. If all is well, assemble the box and secure.

Once the knobs have been fitted the unit is ready for use and should give many years of trouble free service in a variety of applications. It may be connected to any of the range of output amplifier modules available to the hobbyist through advertisers in *Everyday Electronics*. □

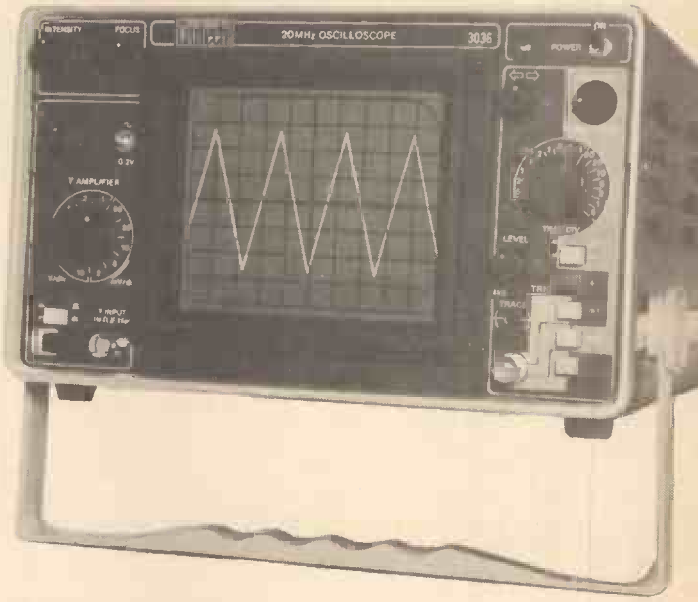


Type 3031
Single Trace 20MHz
£199

- ★ 2mV/division to 10V/division (12 steps) calibrated sensitivity (±3%)
- ★ DC–20MHz bandwidth (–3dB). Rise time 17ns
- ★ 400V (d.c. + pk a.c.) max i/p voltage
- ★ 95mm P31 cathode ray tube
- ★ 40ns/division to 0·2s/division (18 steps) timebase (±5%)
- ★ Various trigger functions
- ★ Triggering to 25MHz
- ★ 10 x 8 division display
- ★ Component tester
- ★ Probe test output
- ★ Measures 125H x 240W x 317D (mm), weight 6kg (approx)

Type 3036
Single Trace 20MHz
£219

- ★ 2mV/division to 10V/division (12 steps) calibrated sensitivity (±3%)
- ★ DC–20MHz bandwidth (–3dB). Rise time 18ns
- ★ X–Y operation
- ★ 130mm cathode ray tube
- ★ 40ns/division to 0·2s/division (18 steps) timebase (±5%)
- ★ Manual/automatic triggering
- ★ Triggering to 25MHz
- ★ 10 x 8 division display
- ★ Component tester
- ★ Calibrator output
- ★ Measures 160H x 265W x 317D (mm), weight 6kg (approx)



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TEACH-IN 86 PROJECT 6

RF SIGNAL GENERATOR

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

THIS MONTH'S project in the *Teach-In* projects series is an RF Signal Generator. This is an ideal complement to the Audio Signal Generator described last month, as it extends the possible frequency coverage to include signals in the range of 300kHz to 25MHz. The r.f. signal produced may also be modulated with an audio signal to allow it to be readily traced when troubleshooting r.f. circuits such as radio receivers.

CIRCUIT DESCRIPTION

A block diagram for the RF Signal Generator is shown in Fig. 1. The d.c. supply for the unit is stabilised and filtered by the power supply conditioning circuitry. This stabilised supply is then fed to the modulator and to the output buffer.

The modulator allows the r.f. signal produced by the oscillator to be amplitude and (to a lesser extent) frequency modulated. The r.f. signal thus carries the modulating signal, and is consequently often referred to as a *carrier*. The application of a suitable audio signal to the modulator input allows the signal to be readily identified, e.g. on a domestic LW/MW/SW radio receiver. A suitable signal is readily available from last month's audio signal generator project.

The oscillator section provides the basic signal source, which may or may not be modulated. Fig. 1 shows the typical waveform of an amplitude modulated signal; the carrier frequency is shown much lower than would actually be the case for reasons of clarity. The oscillator output is then fed to the f.e.t. output buffer, which serves to isolate the oscillator from the load, and provides a low output impedance. This stage also includes an output level control.

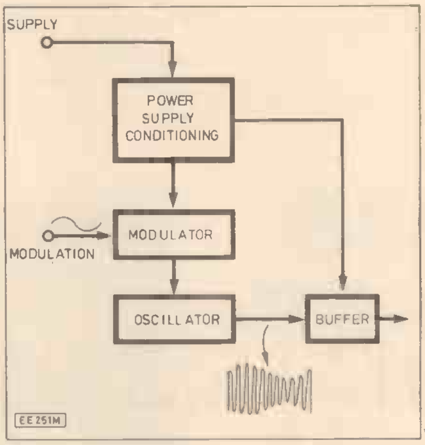


Fig. 1. Block diagram.

The complete circuit diagram for the RF Signal Generator is shown in Fig. 2. The incoming supply is shunt stabilised by the combination of Zener diode D1 and R7, with filtering provided by C8 and C6. The modulator is formed by TR2, which is biased into conduction by R6 and R5, and the modulating signal is a.c. coupled to the base by C7.

When there is no modulating signal present, the emitter of TR2 is held at approximately 5·6V. The modulating signal causes a variation in the emitter voltage, and hence to the supply voltage to the oscillator stage. This has the effect of imposing modulation onto the carrier.

A 1V peak-to-peak input on SK1 produces approximately 10 per cent amplitude modulation on the output, whereas 1V r.m.s. results in approximately 25 per cent amplitude modulation. These are useful amounts of modulation, corresponding to readily available audio signal levels.

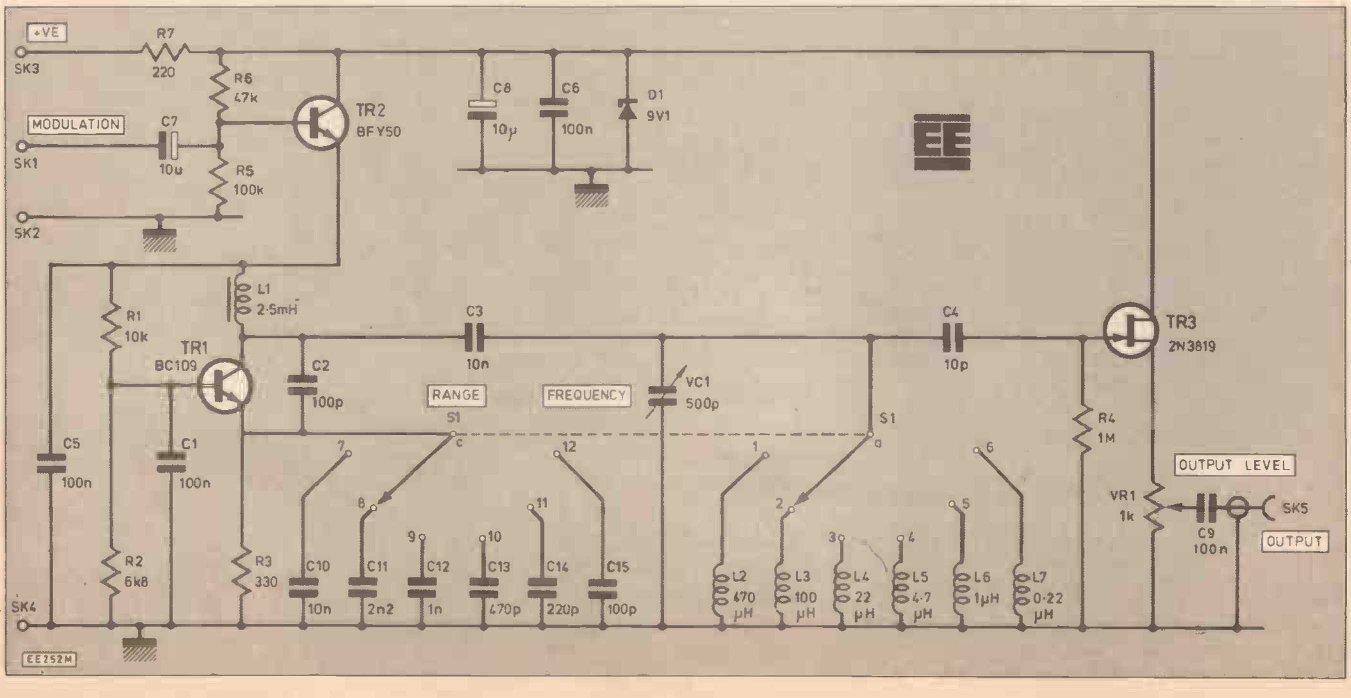
OSCILLATOR STAGE

The oscillator stage is built around TR1, whose operating point is set by R1 and R2. L1 forms the a.c. collector load, and the emitter bypass is selected by S1c to suit the operating frequency range. The frequency of oscillation is set by the tuned circuit combination of VC1 and the inductor (L2–L7) selected by S1a. The maximum frequency of each range is determined by the stray capacitance in the circuit, which includes that in the inductor itself.

The oscillator signal is a.c. coupled to the output buffer, TR3, by C4. This buffer is a j.f.e.t. unity gain source follower configuration, with the output tapped from the source load.

The typical maximum output level available depends on the range selected, but in general falls with increasing frequency. The prototype showed a mid-scale output level

Fig. 2. Circuit diagram for the RF Signal Generator.



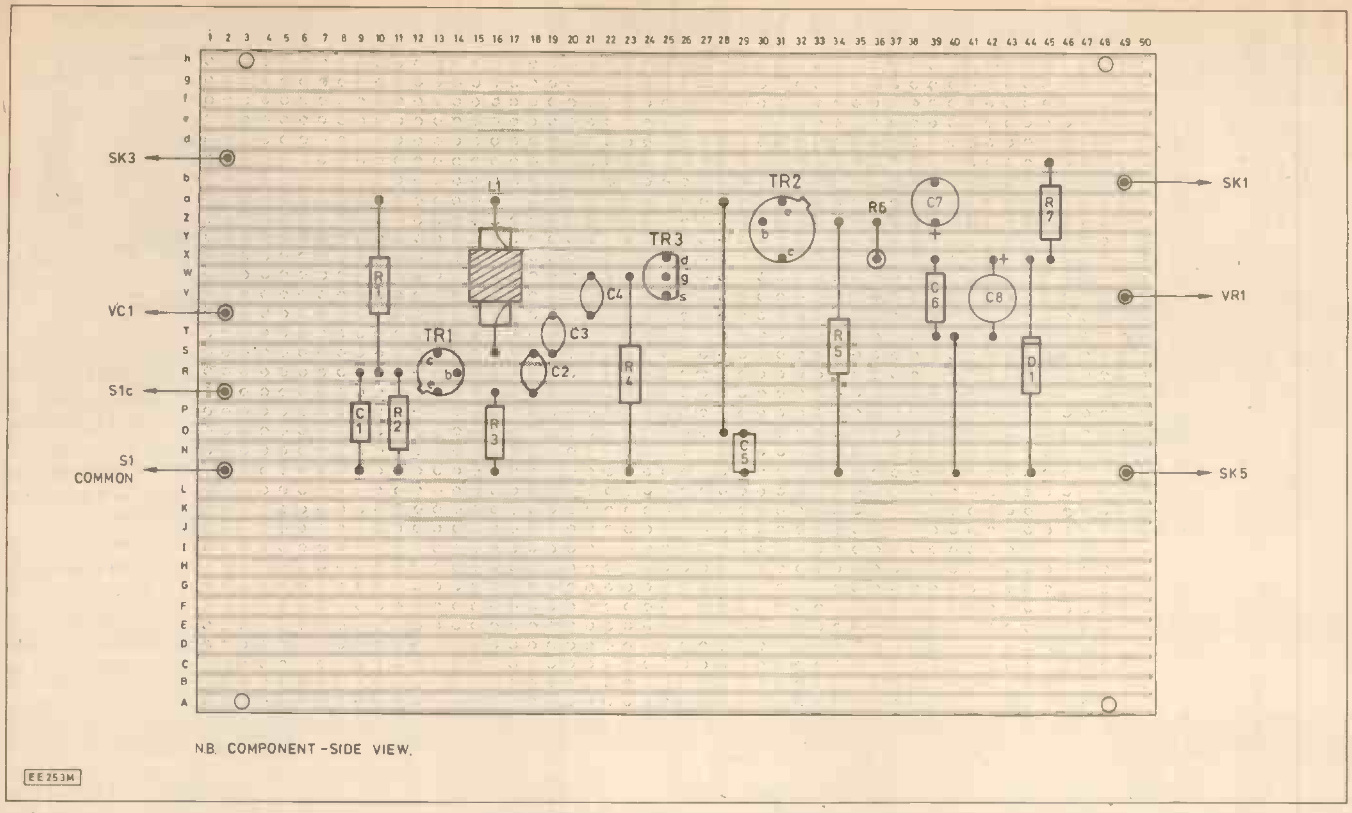


Fig. 3. Main circuit board component layout.

of 2·5V r.m.s. on the lowest frequency range, falling gradually to 0·6V r.m.s. on the highest range.

CONSTRUCTIONAL DETAILS

The unit is built in the standard project case, and uses a circuit board for mounting many of the small components. The layout for the main circuit board is shown in Fig. 3. However, before soldering any components in place on this board, four mounting holes of suitable diameter need to be drilled, although no track cuts are required.

When the board has been prepared, the components may be fitted in the positions shown. The order of assembly is not critical, but a methodical approach (e.g. left to right across the board) is to be recommended. Care should be taken to correctly orientate the polarised components (diode, transistors and electrolytic capacitors). Terminal pins are recommended for all off-board connections, since this will simplify the later installation of the interconnection wiring.

Before moving on, it is well worth spending a few moments at this point making a careful visual inspection of the completed board. Particular points to look for are: missing 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 trouble-shooting 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.

COMPONENTS

Approx. cost Guidance only £24

Resistors

R1	10k	R5	100k
R2	6k8	R6	47k
R3	330	R7	220
R4	1M		

All 0·25W 5%

See Shop Talk page 146

Potentiometer

VR1 1k lin.

Capacitors

C1,C5, C6,C9	100n polyester (4 off)
C2,C15	100p ceramic (2 off)
C3,C10	10n ceramic (2 off)
C4	10p ceramic
C7,C8	10μ elec. 16V (2 off)
C11	2n2 ceramic
C12	1n ceramic
C13	470p ceramic
C14	220p ceramic
VC1	500p solid dielectric variable capacitor

Semiconductors

D1	9V1 400mW Zener
TR1	BC109
TR2	BFY50 or 2N3053
TR3	2N3819

Inductors

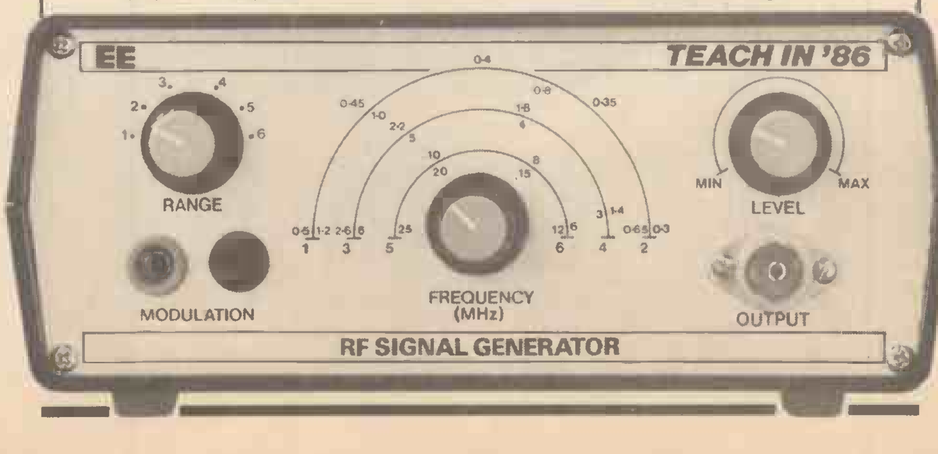
L1	2·5mH	L5	4·7μH
L2	470μH	L6	1μH
L3	100μH	L7	0·22μH
L4	22μH		

L1 is an open-wound r.f. choke on a ferrite core. Inductors L2 to L7 are r.f. chokes with a Q of at least 45.

Miscellaneous

S1	2-pole 6-way rotary
SK1,SK3	4mm socket, red (2 off)
SK2,SK4	4mm socket, black (2 off)
SK5	Co-ax socket (surface mount—see text)

3 knobs with pointers; 4 stick-on plastic feet; Veroboard 0·1in. pitch 5in × 3·75in, and mounting hardware; 7 Vero terminal pins; Case: West Hyde Developments type TEK A22, available in black, grey or lobster red at £6.18 + VAT, inclusive of carriage.



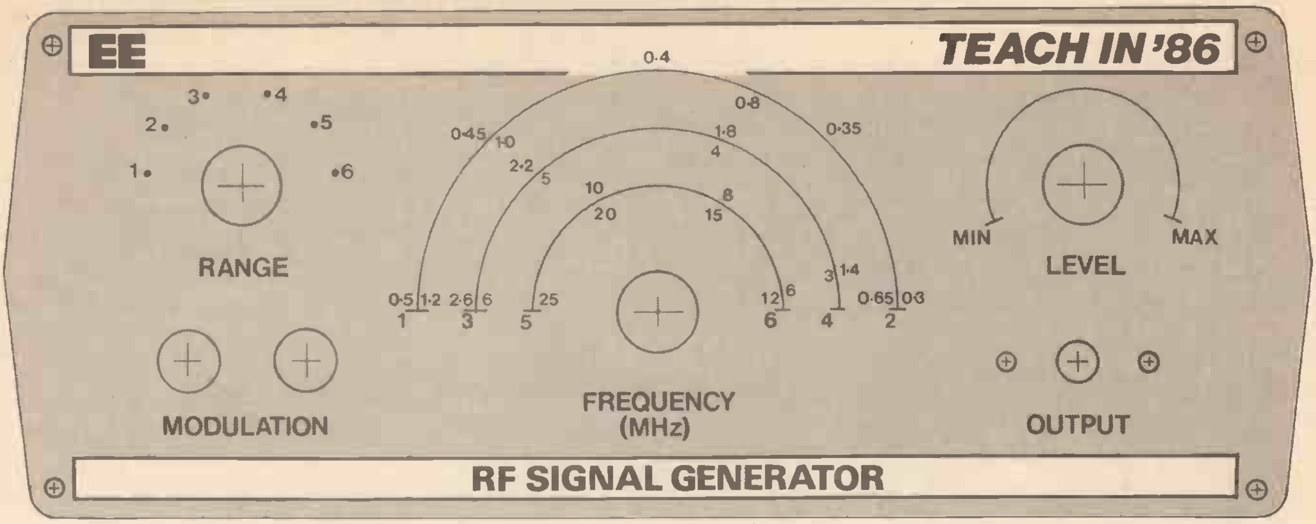


Fig. 4. Full size front panel layout. The calibration should only be taken as a guide.

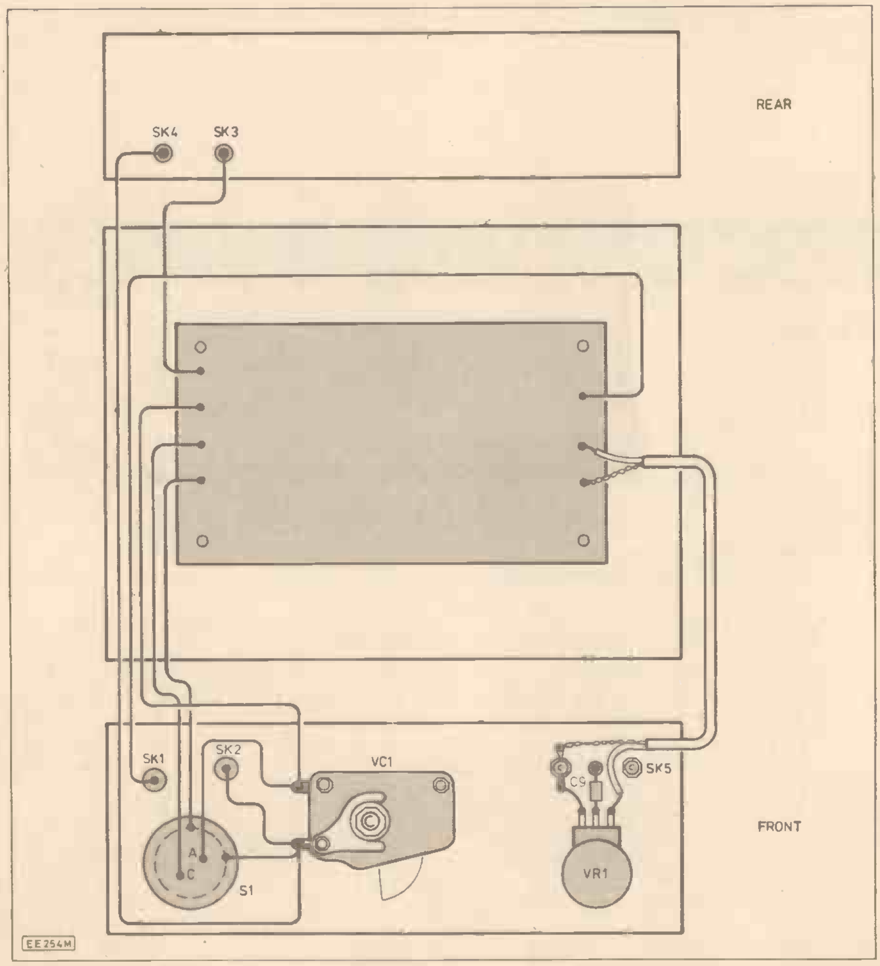
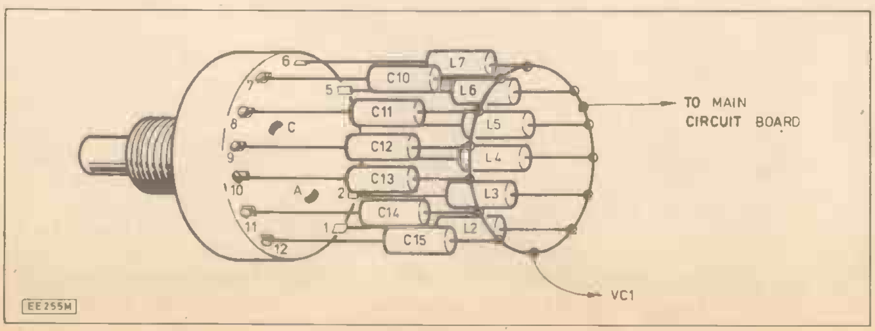


Fig. 5. Assembly and interconnection wiring.

Fig. 6. Range switch S1 detailed assembly.



FRONT PANEL DETAILS

The next step is to drill the front panel in accordance with the layout given in Fig. 4. The hole diameters required may vary a little from those shown, depending on the exact dimensions of the components used. In particular, the selection of an appropriate screened output connector for SK5 is a matter for personal preference. The prototype used the readily available TV type, but constructors may wish to use BNC, PL259, or other types to suit their own requirements.

Once the panel has been drilled, the overlay in Fig. 4 (or a photocopy) should be fixed to the panel; a layer of self-adhesive transparent library film can then be used for protection. The rear panel requires two holes in any convenient position to allow mounting of SK3 and SK4. The panel mounting components (i.e. the sockets, VC1, VR1 and S1) can then be fitted as shown in Fig. 5.

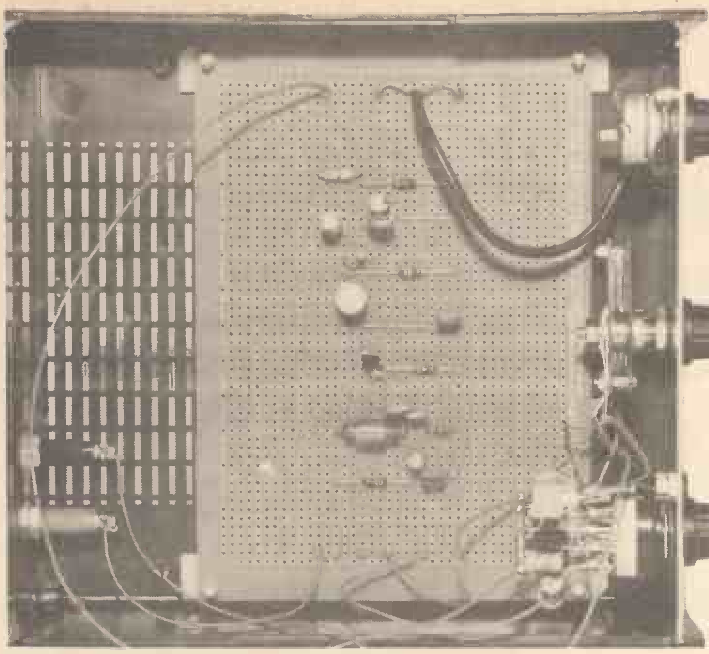
The remaining components (which should comprise C9 to C15, and L2 to L7) are fitted to the panel mounted controls as shown in Fig. 5. The inductors L2 to L7 and capacitors C10 to C15 are soldered directly to the tags of S1. The assembly of these components is shown in greater detail in Fig. 6.

One end of each component should be soldered (with only a short lead) to the appropriate switch tag. Each component should be aligned so that it lies parallel to the axis of the switch shaft, as shown. The free end of each component lead should then be soldered to a circular loop of heavy gauge tinned copper wire, approximately 2cm in diameter whose ends have been soldered together.

Capacitor C9 and the interconnection wiring should then be fitted as shown in Fig. 5. The front and rear panels may then be attached to the top and bottom of the case using the screws provided. The unit is now ready for testing and use.

TESTING

The first step to be undertaken when testing is to measure the supply current drawn by the unit. This should typically be in the range 10 to 25mA for supply voltages of 12 to 15V, although the unit will operate satisfactorily from any d.c. supply in the range 10 to 18V.



Positioning of the circuit board within the case and interwiring to the rear and front panel mounted components.

Any significant deviation from the supply figures given should be investigated before proceeding. Particular attention should be paid to the orientation of the Zener diode D1 and to the interconnection wiring.

The next step to verify that the generator is actually producing an output signal on the appropriate frequencies. The best way to do this is with a digital frequency meter connected to SK5, but in many cases such an instrument will not be available. A good alternative is to connect a short length of wire to the output socket, with the output level set to maximum, and tune a radio receiver until the carrier is detected. If an audio signal is available to drive the modulator, this will aid signal identification.

The scale calibrations given in Fig. 4 should only be taken as a guide. Different components (inductors in particular) and component tolerances will all cause possible deviations from these calibrations.

If a range is consistently too high, a small value capacitor in parallel with the appropriate inductor will compensate for the error. For situations requiring accurate calibration of the frequency ranges, however, a set of scales produced by using a digital frequency meter (or well calibrated radio receiver) are recommended.

NEXT MONTH: Project 7 will be a FET Voltmeter.

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

STUDENT BOARD

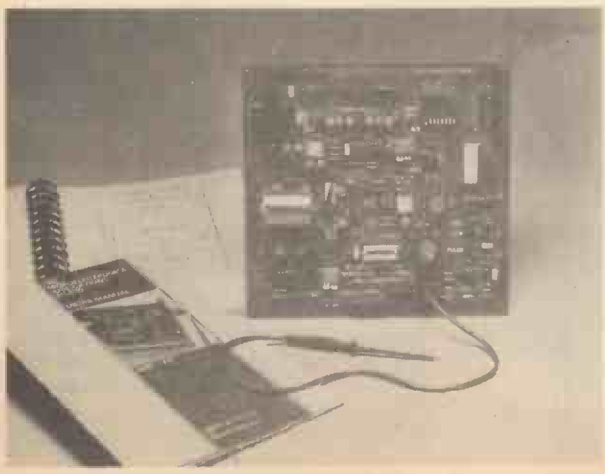
A NEW Microelectronics Applications board which, it is claimed, is a complete "control technology" laboratory on a single p.c.b. has just been launched by **Flight Electronics**. Complete with a comprehensive experiment manual and priced at £139, the experiments take the student from instructions on entering a simple program, through motor control, to temperature control programs.

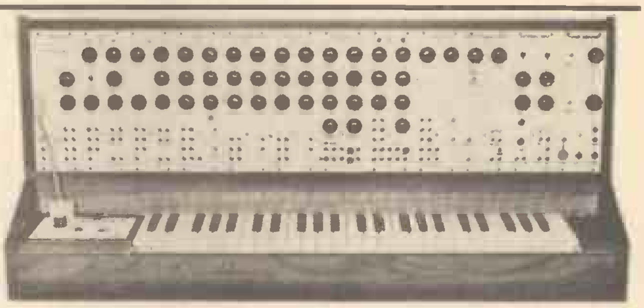
Designed by the Plymouth College of Further Education, and manufactured in England, the compact unit contains all that is needed to understand "real time" microprocessor based control systems. The extensive experiment manual, written by a lecturer at the college, contains 15 easy to use self-teach style experiments which show how to interface a computer to the outside world and control external devices such as motors, lights and heating systems. However, the manual assumes no prior knowledge of microprocessor systems.

Designed to teach closed-loop and open-loop systems the board can be used with Flight's range of microprocessor tutors and the BBC Microcomputer. The board comes complete with the experiment manual, a user's manual which provides full specifications, circuit diagrams and interface requirements, a 9V 1A mains adaptor, a 40-way ribbon cable connector and the interface required for the BBC computer.

The board is available direct from:

Flight Electronics Ltd., Dept EE, Flight House, Ascupart Street, Southampton, Hants, SO1 1LU.





MODULAR SYNTHESISER

OUR photograph above shows just one of the many possibilities available to the constructor from the range of synthesiser modules from **Digisound**. With so many variations to choose from, the kits or ready built "instruments" should appeal to the professional and amateur alike. Items of particular interest should be the Digisound 80 modular synthesiser, Specdrum sequencer and the Digisound Pitch Tracker.

The Specdrum drum sequencing package has been developed as a flexible method of generating complete rhythmic structure using the 48K Sinclair Spectrum and a simple hardware interface. The interface provides four accented and two unaccented triggers. External clock and joystick inputs are also provided.

However, as a first time constructor you may be puzzled by the increasing number of modules available. Don't be. Start with a "basic" synthesiser consisting: power supply (80-1); VCO (80-2); VCF (80-6L); VCA (80-9); and a ADSR envelope generator (80-18A). Add keyboard, low frequency oscillator and noise generator and you are away! *Digisound Ltd., Dept EE, 14/16 Queen Street, Blackpool, Lancs, FY1 1PQ.*

NEWS ...from the wo

SPACEWATCH

DESPITE the non-existence and complete shambles of the UK's efforts to launch its own Direct Broadcast Satellite (DBS) system, satellite television has been available for some time.

There is often confusion as to what precisely "satellite television" means. The press has been filled with stories concerning cable television, DBS and a variety of variations.

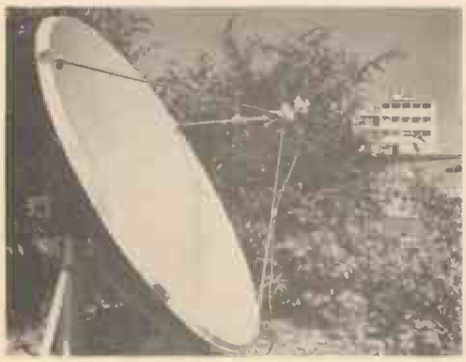
Essentially, satellite television covers all these areas, with a satellite functioning as a transmitter mast occupying the "high ground" of a geostationary earth orbit. By orbiting at the same speed as the Earth's rotational velocity, the satellite appears to hover over the same spot on the Earth's surface and this enables the antenna to be firmly locked in position. All those areas within the "footprint" or reception area should receive good quality sound and vision.

DBS satellites have powerful transmitters and consequently need only small dishes to receive programme signals. However, until DBS becomes well established, programme makers have turned to commercial communications satellites with "spare capacity" that can be employed for TV broadcasts. These transmitters are weaker than those employed in DBS satellites, but reception is just as good using a larger dish antenna.

NEC supplied some of the transmitters for Intelsat series of satellites.

At present, there are only two satellites carrying programmes receivable in the UK, namely *Intelsat V* and *Eutelsat F1*. These satellites are used primarily to route telephone calls across Europe and to the USA. It's their spare capacity which is used for TV broadcasts.

Two frequency bands are used on the satellite downlink and they cover the ranges from 10·95GHz to 11·20GHz and 11·45GHz to 11·70GHz. These are used for both X and Y polarisations.



(Left) The NEC dish antenna sited in the garden and (above) the stack-mounted low noise converters.

Transmitting from the Docklands Teleport site in London, the *Intelsat V* reception footprint spreads over the British Isles and much of Europe. The *Eutelsat F1* is claimed to cover the whole of Western Europe and transmits a wide range of programme material. Between them they broadcast about 17 TV channels throughout Europe, approximately 12 are English speaking, showing films, pop videos, children's programmes, sport and news.

Earth Terminal

The customers satellite receive only system, TVRO for short, consists of a dish antenna, low noise converter/amplifier and the satellite tuner/receiver.

The dish aerial is usually located in the garden, with the low noise converter, and a low loss screened cable is run to the receiver located beside the TV inside the house. To receive satellite signals the 1·2m to 2·3m dish antenna has to be accurately aimed at the selected satellite. If you wish to watch programmes from both *Intelsat V* and *Eutelsat F1*, the polar mount aerial should be readily adjustable or "steerable". For single reception a cheaper fixed type of antenna may be used.

Further Information

For those wishing further information on satellite equipment readers should write to the following companies:

NEC Business Systems (Europe) Ltd., Dept. EE, 35 Oval Road, London NW1 7EA.
Connexions Satellite Systems Ltd., Dept. EE, 125 East Barnet Road, New Barnet, Herts EN4 8RF.
*Space Communications (SAT-TEL) Ltd., Dept. EE, 9 Edgemead Close, Round Spinney, Northampton, NN3 4RG.
* (British designed, developed and manufactured in the UK.)

What's On

INTELSAT V

- **Premiere**—9 hours of recent box office movies every day.
- **The Children's Channel**—exclusively for young children and teenagers, 8 hours every day.
- **Screen Sport**—sports and leisure programming, 6 hours.
- **Cable News Network**—24 hour US and international news coverage.
- **Mirrorvision**—Films and general entertainment, 9 hours.

EUTELSAT F1

- **Music Box**—from the UK, 18 hours a day of rock videos, chat shows and concerts.
- **Sky Channel**—General entertainment (coded).
- **Teleclub**—German movie channel.
- **Filmnet**—Dutch movie channel —English spoken.
- **Worldnet**—Daily news and current affairs from the USA.

The SAT-TEL satellite receiver.

Connexions satellite receiver.

NEC NETSAT satellite receiver.

AMATEUR RADIO

The appointment of the Radio Society of Great Britain to take over the running of the amateur radio morse tests has just been announced by The Department of Trade and Industry. This follows the assessment of proposals from City and Guilds of London Institute and also British Telecom International as well as the RSGB. The new service will commence from 1 April 1986.

Radio amateurs who wish to operate on the high frequency (h.f.) bands with the potential for world wide communication must, in accordance with the requirements of the International Radio Regulations, have a knowledge of morse code. In the UK this means that they must have a *Class A Licence* as distinct from a *Class B Licence* which allows operation on the v.h.f. bands with, generally, much reduced range of contact.

The RSGB's successful proposal includes a test fee of £7, which will be held at this price for two years, and the establishment of at least 70 testing centres, one in each county, region or designated island. Tests will be held every two months in each centre.

The Department believes that the RSGB's proposals represent a significant improvement in the service offered to radio amateurs who wish to take the morse test.

DESIGN AWARDS

The 1986 Design Council Awards will be announced on February 26 and the winning products will be on display at the Design Centre, London, from 27 February to 1 April.

Exhibits on display will include items from the medical and automotive industries and, for the first time, computer software.

Marconi Instruments has appointed Electronic Brokers as an authorised distributor for the company's ranges of high-performance r.f. and microwave test and measuring instruments, including signal sources, digital voltmeters, power and modulation meters and spectrum analysers.

TECHNOLOGY AWARD

Philips, together with Sony, has received the Japanese Mainichi Technology Award for the development and commercialisation of the Compact Disc (CD). It is the first time that a non-Japanese company has received this award.

To date, this is the eighth international award which Philips have received for the development of the Compact Disc system.

ELECTREX '86

Working exhibits will form the main displays on the Photain Controls stand (No. 5M20) at the Electrex '86 exhibition at the National Exhibition Centre, Birmingham, from 24 to 28 February.

This year is Photain's "Silver Jubilee" and they will be celebrating this event by introducing a new range of sophisticated microprocessor based control panels for both fire sensing and control and for multiplex control and data communication systems.

HOUSE OF REPAIRS

An exclusive contract to provide a back-up service for in and out of warranty repairs on the Advance House of Instruments' ranges of electronic test and measuring instruments has been awarded to Beds. Industrial Calibration Centre, Beds.

The Calibration Centre undertakes repair, servicing and calibration of a wide range of instruments and also provides an emergency repair facility and a 7-day turnround as standard for calibration.

SATELLITES IN EDUCATION

An initiative is being launched to encourage the use of satellites in British schools. Satellites in orbit are transmitting data to low cost ground stations.

Already many enthusiasts, schools and colleges are receiving data directly from radio amateur satellites, University of Surrey satellites and weather stations. The use of this data in the secondary school curriculum will, it is hoped, provide the opportunity for technological projects such as constructing detecting apparatus and creating computer models to be carried out.

A number of interested organisations have joined forces to form The UK National Coordinating Committee for Satellites in Education. *The group will assist and liaise with: teachers who wish to become involved in using satellite data in education; individuals or institutions who wish to conduct research on their educational use; and also agencies that may fund projects.*

A strategy paper giving further information about this initiative is available, free of charge, from Dr John Gilbert, Dept of Educational Studies (AA), University of Surrey, Guildford, GU2 5XH.

Personality of the Year

Alan Sugar, Chairman of Amstrad Consumer Electronics plc, was named "Personality of the Year" at the RITA Awards at the recent Which Computer Show held at the NEC Birmingham.

Alan Sugar is founder and chairman of Amstrad. The company was formed in 1968 to market low cost audio equipment, videos and televisions. In 1980 the company went public and in 1984 he was named the Guardian Young Businessman of the Year.

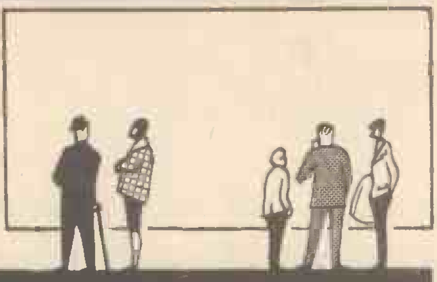
The year 1984 also marked Amstrad's entry into the computer market.

GLOBAL LINK-UP

Professor David Pye of Queen Mary College, London, explains the role of satellites to two young visitors to the Royal Institution's Christmas lectures on *Communication.*

A telephone call, especially set up by British Telecom International went right round the world involving BTI's satellite earth station at Madley in Hertfordshire, two satellite hops and a cable link touching down at Sydney, Australia, and Vancouver, Canada, before connecting back to London.

SHOP TALK



BY DAVID BARRINGTON

Home Security

Now that the annual deluge of holiday brochures has stopped flooding through letter boxes—plus, if we are to believe the holiday industry, the fact that most "packages" have been taken up—I wonder how many people have considered the potential for burglars during the holiday period and taken steps to protect their homes against this ever increasing threat?

If you haven't, then now is the time to start and there are numerous security systems to choose from on the market. These range from "hard-wired" systems to ultrasonic and infra red "wireless" systems.

Apart from a claimed saving of over £130, the Thandar Minder system from **BK Electronics** has been well tried and tested over the last few years. The system uses the "doppler" principle and comes in three units.

The control unit houses the radar transmitter/receiver with a range up to 15 metres, with an adjustable sensitivity control and a key-operated "arming" switch. The indoor unit is a swept frequency siren producing an 104dB output. The outdoor unit is housed in a heavy duty metal case and produces 98dB output. The system is expandable with door sensors and panic buttons.

For an infra red system the range from **Riscomp** looks appealing and should provide protection from would-be burglars. It is ideal for security, photographic and industrial applications.

For the sum of £25.61, plus VAT, the IR147 provides an invisible infra red beam which, when interrupted energises a built-in relay in order to operate external switches or equipment. It will operate over a distance of up to 50ft. uses l.e.d.s for easy alignment and is powered by 12V d.c.

A more conventional system is being marketed by **Smiths Security Systems** for the sum of £57.50, plus VAT.

Manufactured by Shorrock Systems and distributed by Smiths, the Model 75 provides security control in premises where a system with sounders only is required. Conforming to BS4737 Part 1, it controls a system of normally open or normally closed circuit detectors.

Exit and entry are controlled by preset time delays and the exit delay may be terminated by a push button. L.e.d.s indicate the circuit status.

Door entry phone and closed circuit TV surveillance systems are also available. For more details readers should contact **Smiths Security Systems, Dept EE, 43 Park Parade, Harlesden, London NW10.**

Audio Power

One of the projects published in this issue is a *Stereo Hi Fi Preamp* and together with a good power amplifier should form the basis of an excellent audio system.

There are some first class audio power amp modules on the market and any one of the ranges advertised in EE should give good results. Typical prices range from just over £15 to just under £85. Output powers range from 100W to 300W r.m.s.

The OMP power amplifier modules from **BK Electronics** feature Bi-Polar and MOS-FET stages and are supplied ready built and tested. The MF300 (£79.99 plus £4.50 p&p) has a claimed typical total harmonics distortion (THD) factor of 0·0008 per cent, frequency response of 1Hz to 100kHz and an output power of 300W r.m.s.

The rugged, top of the range module AL 12580 from **Riscomp** provides output powers up to 125W into 4 ohms. This module would be suitable for disco or PA systems and costs only £14.70 plus VAT.

A new range of audio amplifier, preamps, p.s.u.s and active crossover modules has been introduced by **R.A.K. Electronics**. New models include a series of MOS-FET power amplifiers and claim a THD of 0·002 per cent, full power 1kHz and output powers of 150W and 300W r.m.s. into 4 ohms. For further details write to **R.A.K. Electronics, Dept EE, Bridge Road, Downham Market, Norfolk PE38 0AE.**

Finally, there is the range of World renowned ILP Audio modules available through the UK distributor **Jaytee Electronic Services**. These excellent modules are available with outputs from 15W r.m.s. to 180W r.m.s., distortion less than 0·01 per cent. Completely encapsulated with integral heatsinks, they can be bolted directly onto the chassis.

For details of the complete range of ILP Audio Modules readers should write to: **Jaytee Electronic Services, Dept EE, 143 Reculver Road, Beltinge, Herne Bay, Kent, CT6 6PL.**

Book Service

Whilst *Everyday Electronics* provides lots of information about electronics and related technology, many readers like to read specialist books which concentrate on a particular area of the hobby.

Often these books are difficult to locate and in many cases potential readers are not even aware of their existence. To overcome some of these problems, *Everyday Electronics* have now started a Book Service which covers a variety of subjects. Books can be ordered direct from our editorial office, see opposite page.

CONSTRUCTIONAL PROJECTS

Mains Tester and Fuse Finder

Most of the components for the *Mains Tester and Fuse Finder* should be readily available from most of our advertisers.

The high brightness miniature mains neons are now fairly common and should be carried by most component suppliers. The same applies to the ceramic transducer WD1, this is certainly stocked by **Rapid, Cirkit, Magenta, Maplin and Marco Trading.**

Note that the on/off switch S1 is of the "push-fit" type with side flanges and the case will have to be cut very carefully to accept the switch. Of course, you can use the more common screw fixing types but bear in mind that *mains* voltage appears on some of the wiring within the unit.

A full kit of parts (£8.58, including p&p) for the Mains Tester and Fuse Finder is available from **Magenta Electronics Ltd., Dept EE, 135 Hunter Street, Burton-on-Trent, Staffs, DE14 2ST**. A printed circuit board is available through the *EE PCB Service*—see page 162.

BBC Midi Interface

At first glance, a number of components required for the *BBC Midi Interface* look to be special items.

The high efficiency opto-isolator device, type CNY17-3, would appear to be only listed by **Electrovalue and Cricklewood Electronics**. Other devices have been tested but *not* all the devices in batches of identical type numbers, such as TIL111, have worked. Therefore, we suggest you stick to the CNY17-3.

The ACIA or Asynchronous Communications Interface Adaptor chip, type MC6850, should be available from most component sources. However, in case of difficulty it is listed by **Rapid Electronics**.

The demand for IDC and DIN plugs and sockets for computer based projects is quite common and any good component stockist should be able to supply them.

Stereo Hi Fi Preamp

We cannot foresee any component buying problems for the *Stereo Hi Fi Preamp*. The one per cent resistors and capacitors are fairly readily available items and should be stocked by local suppliers.

Be sure to specify a dual-gang "log" potentiometer when purchasing the Volume control VR4. All other potentiometers are linear types.

The printed circuit board may be purchased through our *PCB Service*—see page 162.

RF Signal Generator—Teach In '86 Project

Component kits for the Teach In '86 Project Series—*RF Signal Generator*—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.

It may be possible that some advertisers may quote a "special" price for a complete set of inductors for this project.

Interval Timer

There should be no problems when purchasing parts for the *Interval Timer*.

All items appear to be "off-the-shelf" components, including the single tone buzzer.

BOOK SERVICE

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

DATA AND REFERENCE

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

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

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

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

RADIO

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

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

PROJECT CONSTRUCTION

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

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

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

CIRCUITS AND DESIGN

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

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

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

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

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

COMPUTING

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

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

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

TO ORDER

Add 50p per order postage (overseas readers add £1, surface mail postage) and send a PO, cheque or international money order payable to Everyday Electronics (quoting order code and quantities) to **EE & EM BOOK SERVICE, WESTOVER HOUSE, WEST QUAY RD., POOLE, DORSET BH15 1JG.**

PLEASE ALLOW 28 DAYS FOR DELIVERY

MAINS TESTER AND FUSE FINDER

MARK STUART

How safe is your mains wiring? Locate that blown fuse! You can do both with this audio/visual tester

THE IDEA for this project came about whilst trying to find which fuse in the fusebox was connected to which set of sockets in the house. There are two "traditional" ways of doing this. One way is to remove a fuse, and then search the house for "dead" sockets. The other way is to connect a lamp to one socket and remove fuses one at a time. An observer posted next to the lamp is asked to shout when it goes out.

Both methods work. The first method is tedious, especially if the fusebox is positioned (as usual) in the most inaccessible corner of the house. The second method is better, but needs two people and has been known to put considerable stress on marital harmony.

DESIGN CONSIDERATIONS

It was decided that the ideal "gadget" would be one that could be plugged into a mains socket and would emit a loud easily recognized sound when the supply was disconnected. In addition it would be helpful (and safer) to incorporate an indicator lamp to give visual confirmation that the supply was disconnected.

This could be done by fitting just one lamp between the live and neutral connections. By adding two further lamps, however, it is possible not only to indicate whether power is on or off, but also to check the connections of live, neutral, and earth wires to the socket.

The final design has proved to be a very useful tool for checking sockets and finding fuses, and has also been used as a mains failure indicator when trying to track down spurious tripping of an ELCB (now known as RCCB).

CIRCUIT DESCRIPTION

The complete circuit diagram is shown in Fig. 1. Three neon lamps LP 1-3 are fitted to indicate that power is connected and that the three leads to the sockets are correctly fitted. Normally there will be mains voltage between *L* and *N*, and between *L* and *E*, lighting LP2 and LP3. Lamp LP1 will not light because normally the neutral wire is earthed at the local distribution transformer.

If the wiring to the socket is faulty the correct combination of lamps will not light. By checking which lamps are on or off it is possible to determine the nature of the fault. The interpretation of the fault indications is dealt with later in the section headed 'IN USE'.

The audible signal is produced by a ceramic resonator, WD1, driven by IC1. IC1 is a quadruple two input NAND Schmitt trigger i.c. The first section, IC1a, is used as a gated low frequency oscillator. Power for the oscillator is provided from battery B1 via S1.

The positive side of the supply is connected to the mains neutral. When mains voltage is present a small amount of mains current passes through capacitor C1. On positive half cycles, the Zener diode D1 is forward biassed and acts like a normal diode, clamping the voltage at point *A* in Fig. 1 at +0·6V with respect to point *B*. On negative half cycles of the mains D1 is reverse biassed and will not conduct until point *A* is at −10V (the Zener diode breakdown voltage) with respect to point *B*.

Diode D2 conducts during the negative half cycles so that the smoothing capacitor C2 is charged to −10V. The voltage on point *C* of Fig. 1 is a steady −10V with respect to point *B*.

This voltage is passed via potential divider resistors R8 and R7 to one of the inputs of IC1a holding it low. As IC1 is a NAND gate a logic low on any of the inputs forces the output to a high state. IC1b is connected as an inverter so that its output is held low. This in turn holds down one of the inputs of IC1c so that its output is forced high. IC1d is connected as an inverter and so its output is held low. In this condition all of the sections of IC1 are held in steady status and there is no audio output.

When the mains voltage is disconnected C2 discharges via R7 and R8 and the voltage on the input of IC1a changes from low to high. The voltage on the other input of IC1a is also high because C3 has charged via R9. With both inputs high the output of IC1a is held low.

Capacitor C3 now discharges via R9 and the voltage on the associated input of IC1a begins to fall. After a time this voltage falls to the lower input threshold voltage of IC1a. At this point the output switches from low to high and C3 begins to charge via R9.

When the voltage across C3 rises to the upper input threshold of IC1a, the output switches from high back to low. C3 now begins to discharge through R9 again and the cycle repeats.

This simple oscillator action is only possible with Schmitt trigger type inverting gates, because it depends upon the output switching rapidly between low and high states. Normal gates will simply settle with their outputs at around half the supply voltage and not oscillate at all. The ease with which these simple oscillators can be put together makes the 4093 one of the author's favourite chips.

OUTPUT

The output of IC1a is a squarewave of about 2Hz which is inverted by IC1b and passed to one of the inputs of IC1c. IC1c is another oscillator circuit similar to IC1a but operating at about 2·5kHz. It is turned on during positive half cycles of the low frequency input from IC1b. IC1d inverts the input of IC1c and drives the ceramic resonator WD1.

The resulting output is a piercing beep-beep-beep sound whenever S1 is on and the mains off. The current consumption is very low, a single PP3 will probably last for a year or more of typical intermittent use.

CONSTRUCTION

As the whole circuit is connected to the mains it is **essential that it is housed in a totally insulated enclosure.** The plastic box specified is ideal and fits comfortably into a pocket. All of the components are fitted on a single printed circuit board. Fig. 2 shows the copper foil pattern and Fig. 3 the component layout. This board is available from the *EE PCB Service*: quote order code EE517.

Before mounting any components it is a good idea to use the board as a template to cut out the three holes in the bottom of the case through which the lamps are viewed. Figs. 4 and 5 show the layout of the components in the case and the method of assembly.

The holes for the neons should be about 8mm diameter. An additional hole or set of holes is needed for the ceramic resonator WD1. These holes should be drilled so that they do not line up with the hole in the resonator. A circle of 6 holes 3mm diameter is ideal. The metallised top plate of the resonator is connected to the mains so it is **important that the holes do not align.** Fig. 5b shows a suitable pattern.

The resonator WD1 is mounted on the bottom of the case by means of four strips of double sided adhesive sponge tape 1·6mm thick. These are first stuck to the case to form a square around the six holes and then WD1 is pressed into place. This arrangement ensures that there is sufficient air gap for the sound to travel efficiently.

A strip of 2 or 3mm thick clear or amber Perspex 12mm wide × 50mm long should be glued to the bottom of the case so that it covers the three holes through which the

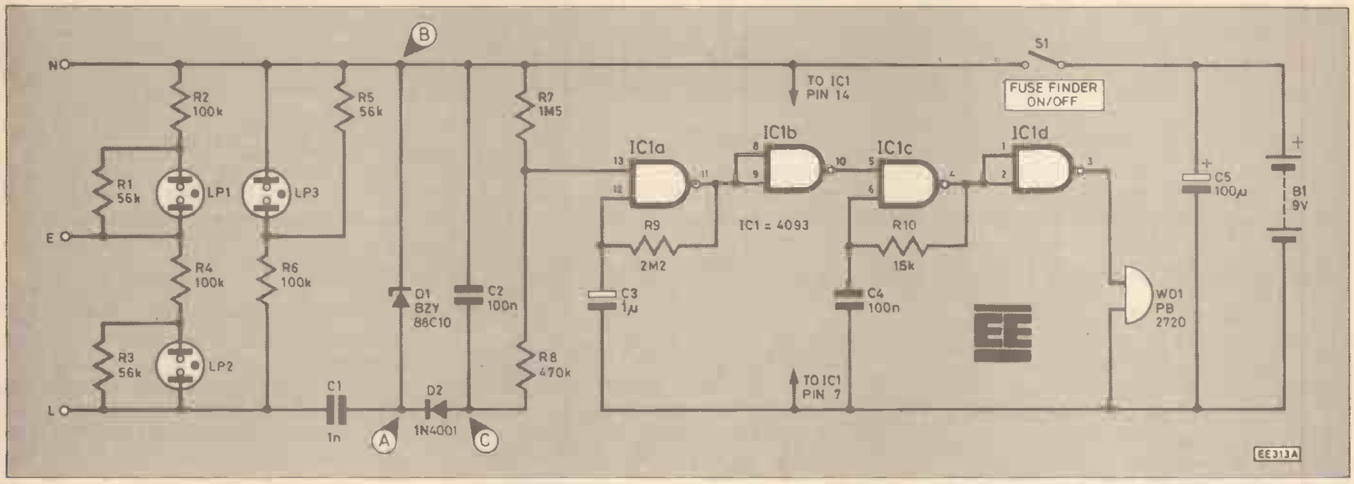


Fig. 1. Complete circuit diagram for the Mains Tester and Fuse Finder.

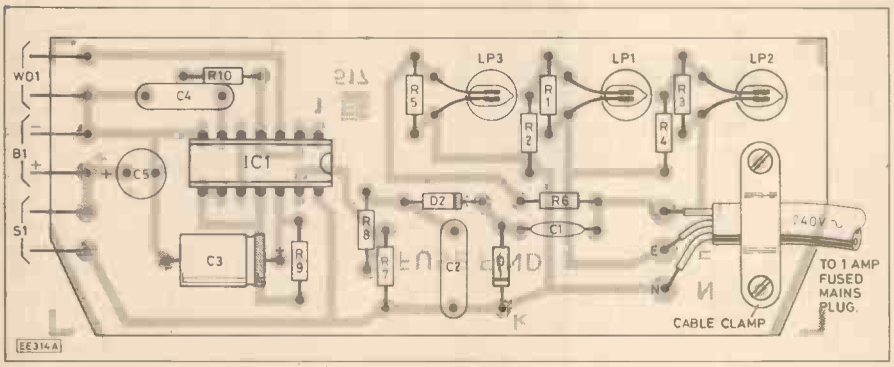


Fig. 2. Layout of components on the printed circuit board.

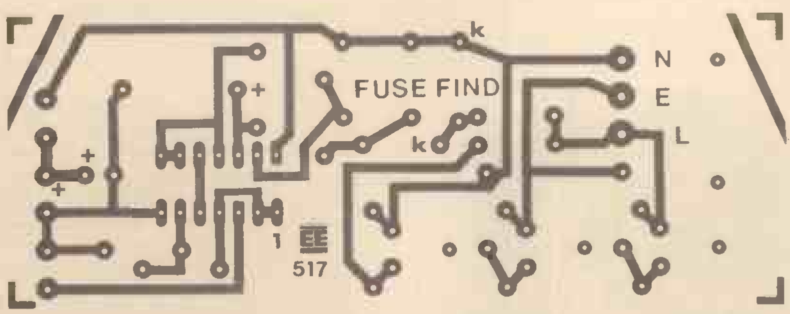


Fig. 3. Full size printed circuit master. This board is available from the *EE PCB Service:* code EE517.

COMPONENTS

See Shop Talk page 146

Resistors	
R1,3,5,	56k
R2,4,6	100 (3 off)
R7	1M5
R8	470k
R9	2M2
R10	15k
All ¼W ±5% carbon film	
Capacitors	
C1	1n disc ceramic 750V
C2,4	100n polyester (C368) (2 off)
C3	1µf axial elec. 16V
C5	100µf radial elec. 16V
Semiconductors	
IC1	4093 CMOS quad 2-input NAND Schmitt trigger
D1	BZY88C10 10V Zener
D2	1N4001 silicon
Miscellaneous	
WD1	PB2720 ceramic resonator
LP1-LP3	Miniature mains neons, 4mm high brightness type, 3 off
S1	SPST rocker switch

B1, 9V PP3; battery clip; connecting wire; Veropins; cable clamp and screws; 2A 3-core mains cable; printed circuit board, available from the *EE PCB Service* —order code EE 517; 14-pin i.c. socket; case; double-sided adhesive foam tape; clear or amber Perspex

Approx. cost Guidance only **£8**

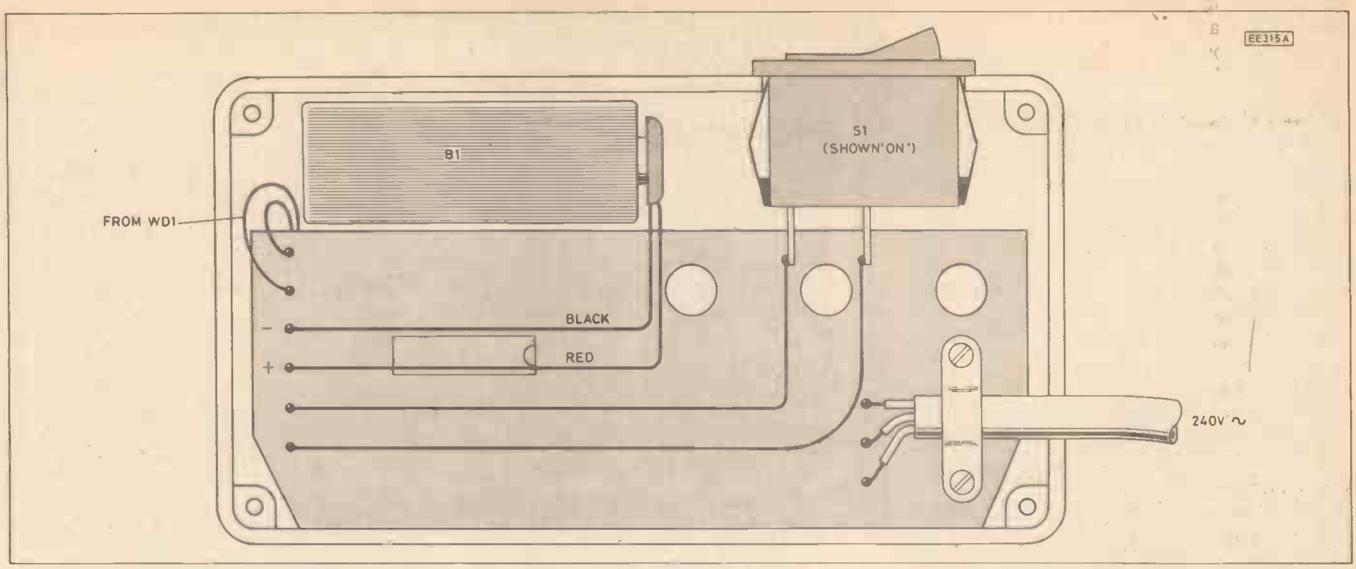


Fig. 4. Layout of components inside the case and interwiring details. Note the "wings" on S1 for holding the switch firmly in position.

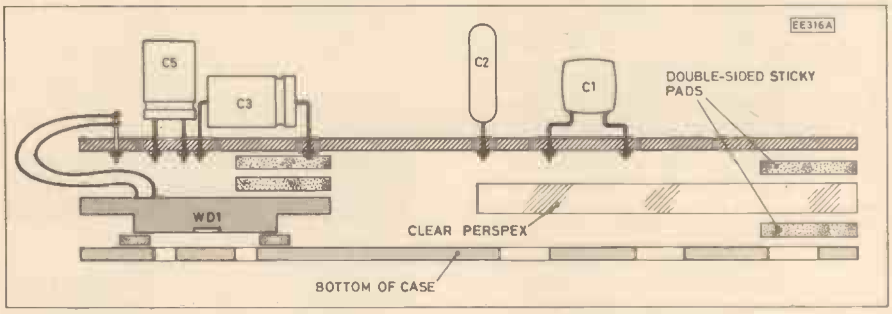


Fig. 5a. Arrangement for mounting the printed circuit board in the case.

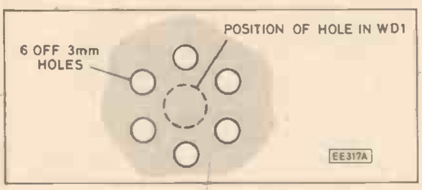
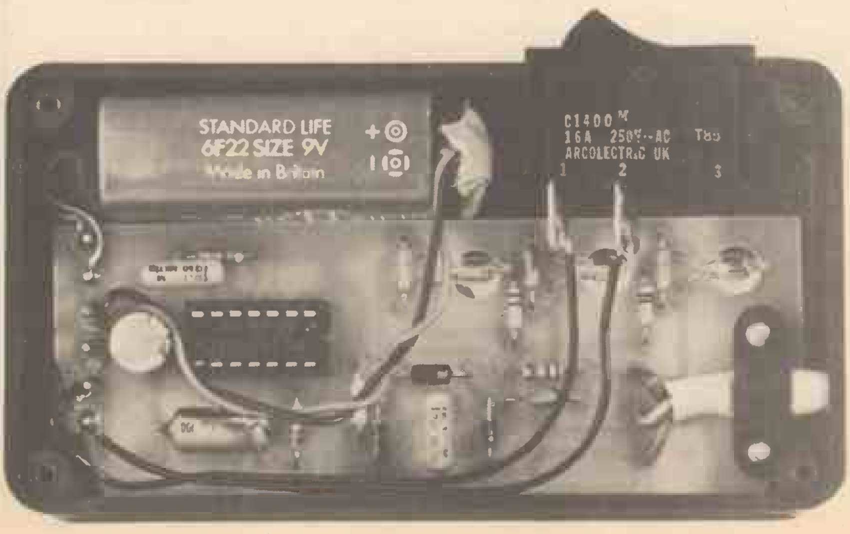


Fig. 5b. Suggested pattern of holes to be drilled in the case over the sound transducer.

The completed tester showing the cutouts in the board for the neon indicators. Note the "strain" clamp for the mains lead.



neons LP1-LP3 are viewed. The mains cable enters the case through a hole drilled in one end. This hole should be a close fit around the cable to prevent accidental access to the internal live parts.

The switch S1 requires a rectangular notch to be cut in the side of the case. Refer to Fig. 4 and position the switch as shown. The switch specified has a pair of "wings" which snap into position to hold it in place. Take care to cut the hole exactly the right size otherwise the switch will wobble.

CIRCUIT BOARD

When the case cutting is complete the printed circuit board should be assembled. Begin by fixing six single sided "solder pins" for the connections to B1, WD1 and S1.

These pins are inserted from the foil side of the board and must be pressed in so that their splined section passes into the board. This operation can require considerable force. Once the pins are fully home, solder them on the foil side in the usual way.

Continue by fitting all of the other board mounted components, starting with the smaller low profile ones such as diodes and resistors. A socket should be used for IC1. Note that D1, D2, C3, C5 and IC1 must all be fitted the right way round. The other components fit either way. The miniature neons must be positioned so that they lie centrally over the large holes in the board.

When all the components have been fixed, the mains lead should be connected to the board and fixed with a "saddle" type cable clamp. At this stage the board should be loosely fitted to the case, the connections made to WD1, B1 and S1, and tested for correct operation.

When all is well the board should be fixed in position using double sided adhesive foam pads. The battery can be fixed in the same way, as it will not require changing very often.

TESTING

The correct operation of the oscillator section can be tested, without connecting the mains, simply by fitting a battery and closing S1. A loud 2kHz tone interrupted at about 2Hz should be produced after a delay of around 2 seconds. The beep is produced by IC1 and its associated components so this is the area to check if problems arise. It should be possible to stop oscillation by linking pins 7 and 13 of IC1.

Take extreme care when carrying out the following tests. The remaining tests are performed with the mains connected so must be done with great care. With a battery connected and S1 closed, check that the circuit stops beeping when the mains is connected, and re-starts when the mains is disconnected. Problems here will probably be due to either D1 or D2 being fitted the wrong way round.

Finally, check the operation of the three neon lamps. With a normal supply connected LP2 and LP3 should be on and LP1 off. Reverse the live and neutral connections and then LP1 and LP3 should be on and LP2 off. These tests ensure that all of the neons are working. The next step is to simulate all of the mains fault conditions one by one and check for the correct indication.

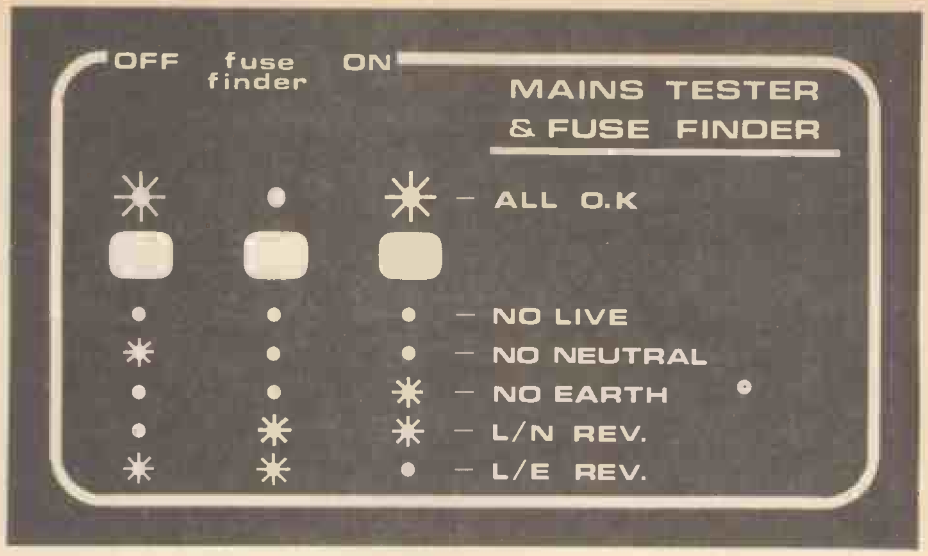


Fig. 6. Full size master of the front panel layout and lettering.

IN USE

The use of the fuse finder section of the circuit requires little explanation. The unit is switched on and plugged in to the circuit under test. As soon as the fuse feeding the circuit is removed, the beeping sound will be heard. It is surprising how far away interrupted high frequency sounds can be heard and recognised, even in the presence of considerable background noise.

The three neon lamps are able to indicate a wide range of fault conditions. In principle each neon indicates the voltage between each pair of the incoming wires. The series and parallel resistors R1-R6 are chosen so that above 200V the neons will light and below 150V they will not.

If the earth lead is disconnected LP3 will have 250V across it and will light. The other two neons are effectively in series between the live and neutral leads and so the supply is divided equally, giving 125V to each neon, which is not enough to light them.

The various other fault conditions and their associated indications are shown on the front panel label drawing in Fig. 6. The one condition that the unit does not indicate is reversed neutral and earth connections. Fortunately this is an unusual fault. □

...REPORTING AMATEUR RADIO...

TONY SMITH G4FAI

EMERGENCY CALL

IMMEDIATELY following the recent Mexico City earthquake, radio amateurs around the world rallied to establish emergency communications with Mexico, seeking information about families for worried relatives overseas.

In Britain, the Red Cross asked Raynet, the Radio Amateur Emergency Network, to act on its behalf on a national basis. Raynet teams, plus individual amateurs, throughout the UK, monitored the 20 metre international band for stations from Mexico, and elsewhere, carrying emergency traffic related to the disaster.

Over 500 enquiries were transmitted, and a good number of replies were received direct from Mexico, or via other countries, with reassuring news. The Foreign Office gave its approval to the operation, and the DTI agreed that it would take no action to hinder the passing of third party traffic arising from the disaster.

Considering the nature of the event, this last comment may seem rather strange, but the fact is, transmissions from British stations seeking or receiving information about families affected by the earthquake, were illegal!

The amateur radio licence conditions forbid the passing of messages on behalf of third parties, except at the request of named user organisations engaged in disaster relief operations, or exercises, *in the United Kingdom*. That is why the Red Cross could only ask Raynet to act on a national basis.

Obviously, in an emergency situation, officialdom may well give qualified approval to activities it would not normally permit—but what a ridiculous situation! Amateurs in the US and Canada have long been allowed to pass messages about friends and relatives on behalf of others, and have agreements with over 40 other countries for the international exchange of third party traffic.

Australia obtained similar privileges in 1980. It has international agreements with America and Canada, and is seeking agreements with the other 40 countries, plus a few more.

Where third party privileges exist, amateurs can pass messages individually at any time, or feed them into national or international networks of stations working on a more formal basis. When the need arises, these nets go into emergency operation. While organisations similar to Raynet provide emergency communications for the authorities, the third party stations and networks assist and supplement this work by providing health and welfare communication facilities for the general public.

Radio amateurs have a world-wide communication ability which they are more than willing to make available when the need arises. Their response to the Mexican disaster shows how they can help, even when the event is thousands of miles away. If every country, including Britain, permitted its amateurs to pass third party messages, as a normal everyday event, there would be a greater preparedness, and a greater ability, to provide assistance whenever required.

LASTING PROBLEM

Modern amateur radio equipment often uses specialised components, including integrated circuits and microprocessor chips. Some transceivers feature factory programmed RAM devices controlling basic functions, and these are powered by built-in lithium batteries having a life of up to seven years.

While all this adds up to a very high standard of performance, it also leads to the possibility of trouble in the years ahead. Amateurs traditionally keep their equipment going for years, but to do this with modern hi-tech equipment may not be so easy.

According to a recent note in *QRV*, journal of the RAF Amateur Radio Society, many specialised components have a potential life-span in excess of the time direct replacements are likely to remain available. By the time repair is necessary, quite extensive, and costly, modifications may be required to bring a rig back into use.

A similar problem may arise with battery powered memories. When any fault arises, or the battery expires, the equipment, or part of it, must be returned to the manufacturer, or agent, for battery replacement and re-programming of the RAM.

Equipment is up-dated or re-designed every few years. Manufacturers and dealers come and go. Lithium batteries are still in the development stage. How sure can one be that, when the time comes, the super-transceiver can be serviced, re-programmed, and put back on the air at reasonable cost?

Maybe all will be well after the first seven years, but what about the next? And the next? Perhaps the original owner won't want to keep it all that long, but what resale value will it have in these circumstances? Buyers of expensive equipment today should consider all these factors. If they must have the latest all-singing and dancing rig perhaps they should consider putting aside depreciation sums each year against inevitable obsolescence!

All this raises the question, "Is the availability of near-professional type equipment diminishing the hobby?". I don't really think so. There is still some basic type equipment available which communicates without frills. There is a large

Table 1:

Examples of the *Q*-code. Intended for Morse operation, some codes are used in speech communication.

	Original meaning	*Amateur usage*
QRM	Is my transmission being interfered with?	Interference from other stations
QRO	Shall I increase transmitter power?	High power
QRT	Shall I stop sending?	Closing down
QRZ	Who is calling me?	Who is calling me?
QSL	Can you acknowledge receipt?	Confirmation of information or QSL card (confirmation of contact)
QSO	Can you communicate with . . . direct?	Contact between stations
QTH	What is your position in latitude and longitude?	Location

Signal Reporting System

Readability

R1	Unreadable	**R4**	Readable with practically no difficulty
R2	Barely readable		
R3	Readable with considerable difficulty	**R5**	Perfectly readable

Signal Strength

S1	Faint, barely perceptible	**S6**	Good
S2	Very weak	**S7**	Moderately strong
S3	Weak	**S8**	Strong
S4	Fair	**S9**	Extemely strong
S5	Fairly good		

Tone

T1	Extremely rough	**T6**	Trace of modulation
T2	Very rough	**T7**	Near perfect tone, smooth ripple
T3	Rough	**T8**	Near perfect tone
T4	Rather rough	**T9**	Perfect tone
T5	Modulated		

secondhand market for older style units, and there are still a few who make their own transmitters and receivers.

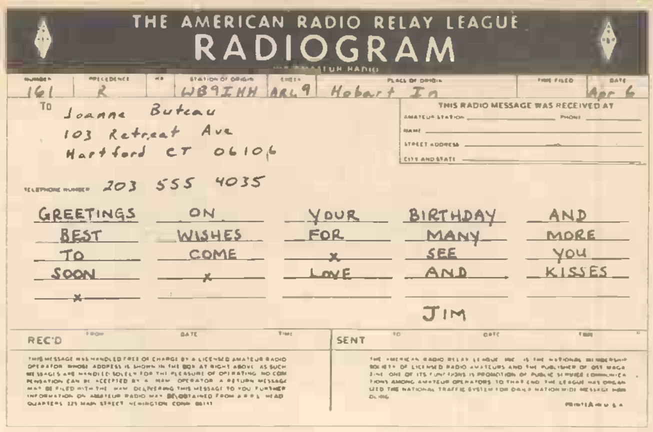
It's all a question of what you can afford. If money is no object, then the possible long-term disadvantages of sophistication probably don't matter. If you want to make a transmitter for just a few pounds, you can do that as well, and it will probably last a lifetime!

QUESTION CORNER

Q. Radio amateurs seem to speak a language of their own. Can you explain what some of it means?

A. Like any specialised activity, the hobby has developed its own jargon to express particular meanings. Much of it originated in Morse code communication to save spelling out whole words, phrases, or even sentences, and there is a tendency to use some of this in speech communication.

Basically, it is a series of internationally understood abbreviations, such as the *Q*-code. This comprises groups of three letters, beginning with a *Q*, each group having its own meaning. It is, however, a commercial code. Its full meanings are not entirely applicable to amateur radio, and amateurs have adapted some for their own purpose, while not departing entirely from the original meaning. A few examples are illustrated in Table 1.



Typical everyday amateur radio third party message, but not allowed in Britain!

Some words are reduced to two letters, comprising the first letter of the original word, plus the letter "x" to represent all other letters: Tx is transmitter, Rx—receiver, Wx—weather, and if used in speech they are pronounced by spelling out the letters.

During a contact, stations will exchange reports with each other, for example, 5–9 in speech, or 5–9–9 in Morse. These are based on a numerical reporting code with readability assessed 1 to 5, signal strength 1 to 9, and tone quality (of Morse signals) the same. 5–9–9 therefore means the other station is perfectly readable or understandable, with an extremely strong signal and perfect tone.

There's a lot more to it all than shown here. Most amateur radio manuals give the full lists, and advice on their use.

DON'T FORGET!

I will gladly answer general questions about amateur radio in this column. Just write to me c/o the Editor. 73, bcnu. (That's two more abbreviations. 73 means "best wishes". Work out for yourself what the second one means in a Morse transmission!).

Actually Doing it!!

THE STORY so far has our notional project to the stage where everything is mounted in the case (controls, circuit board, etc.), which one might think was the end of things. There is in fact still a little way to go to completion, and one of the outstanding tasks is the point-to-point wiring (also known as "hard" or "spaghetti" wiring).

In the days of valve projects the electronic side of construction consisted of a mass of hard wiring, but in modern designs there is not necessarily any interwiring at all, and with some projects all the controls and sockets are printed circuit mounting types. These tend to be in the minority though, and with most home constructor equipment all, or at least some, of the components are mounted off-board.

Printed circuit mounting types have the advantage of greatly reducing the risk of errors, but have the disadvantage of tying the user down to a specific type of component, and often give no option as to the front panel layout and case to be used either. It is worth noting though, that where printed circuit mounting controls and potentiometers are called for it is still usually possible to use ordinary types hard wired to the board if preferred.

WIRING-UP

Most constructional errors in projects are due to either accidental short circuits on the component board due to blobs of excess solder, or to wiring errors. It is therefore well worthwhile taking your time over this aspect of construction, rather than rushing things and taking pot-luck with any wiring where you are unclear as to the correct way of doing things, and taking little care over the soldered joints. Actually connecting the wires should not present too many problems, but there are a few pitfalls which must be avoided.

Most component suppliers stock at least one type of connecting or "hook-up" wire, and this is normally a fairly thin form of p.v.c. insulated multistrand wire. Most circuits these days operate with low current consumptions, and any connecting wire will do.

With something like a high current power supply or a power amplifier it might be necessary to resort to a heavier gauge of wire. Thin wire when used with high currents can become quite hot, and can introduce unacceptable voltage drops.

Multistrand wire is generally preferable to the single core variety since it is much more flexible, less likely to break, and easier to work with. The single core type is mainly used where leads are to be formed into specific shapes to give neat cable runs. This method of construction can look very impressive but is little used in home constructor designs where there is usually too little hard wiring to justify the effort involved.

RIBBON CABLE

Where a number of wires are to run side by side they can be tied together into a sort of pseudo multi-way cable once the wiring has been completed. A much easier way of doing things is to use ribbon cable for this type of wiring. I prefer the multicoloured ("rainbow") type to the single colour variety, since having each wire a different colour greatly reduces the likelihood of making errors due to muddling up the leads.

Ribbon cable is generally only available with ten or more ways, but it is easily separated up into two or three-way leads, and it is not usually necessary to resort to using a knife or scissors. Most ribbon cable can be easily pulled apart by hand.

Many beginners are tempted to strip p.v.c. insulation using a knife or scissors rather than obtaining proper wire strippers. The insulation can certainly be removed in this way, but the problem is nicking of the core or cores of wire.

Fig. 1. (a) Single-sided and (b) double-sided printed circuit pins. Both types are inserted from the underside of the board.

Fig. 2. Where two or more leads must connect to one tag or pin, hooking or binding the leads will hold them in place ready for soldering.

Cutting slightly into the surface of the wire may not seem to be important, and electrically it will not make much difference. Mechanically things are very different though, and the effect of even a slight nick is to make the wire prone to breaking at that point.

Proper wire cutters have two semicircular cutting blades which can be set so that they will only close down to a certain diameter. The idea is to set this diameter so that it is slighly wider than the inner conductor, making it impossible to nick the wire.

Obviously this also makes it impossible to fully cut through the p.v.c. sleeving, but pulling the wire and the strippers firmly in opposite directions breaks the insulation away. It may take a little practise and some experimentation with the aperture setting of the strippers before good results are obtained, but this is not exactly one of the more difficult aspects of electronic construction.

One type of insulated wire that should not be used for wiring up projects is enamelled copper wire. Apart from being difficult to use in this application, the enamel is relatively easily damaged and short circuits would be likely to occur.

The wires can be connected to the printed circuit board much like ordinary component leadout wire, but this normally requires the board to be temporarily dismounted from the case to give access to the underside of the board. Once some of the wires have been soldered into place it can become awkward to add the others.

SOLDER PINS

A much better way of doing things is to fit pins to the board at the points where off-board connections are to be made. Single-sided pins (Fig.1a) are the type normally used, and these enable the off-board connections to be made with the board still fixed to the case.

Double-sided pins (Fig.1b) are used where the board is mounted in such a way that the connections must be made to the copper side, or where connections are to be made to both sides. Both of these eventualities are rare.

A special pin insertion tool is available, and this resembles a screwdriver with a hole in the end into which a pin is placed. It is not essential to use one of these, and the pins can usually be pushed into place by hand, or with the aid of pliers in awkward cases.

With a little ingenuity it should not be difficult to make an insertion tool. There are two sizes of pin, 1mm and 1·3mm diameter. The 1mm size is the type most frequently required as this is the size for use with 0·1 inch pitch stripboard, and most printed circuits are designed for this size of pin as well. The 1·3mm type is mainly for use with 0·15 inch pitch stripboard.

SOLDERING

Most projects are designed in such a way that only one connection is made to each pin, or to each tag of off-board components. This makes the wiring very easy, and the basic technique is first to tin the end of the wire and the pin or tag with a generous amount of solder.

Next the bit of the iron is loaded with a small amount of solder, the wire is placed in position on the pin or tag, and the iron is briefly applied to them. Keep the lead still while the solder sets, and allow sufficient time for the solder to completely set (it can sometimes be two or three seconds).

This is not the standard textbook method of soldering, where the iron is placed onto the lead and the tag, and then the solder is applied. It is a more practical method for those who do not have three hands, and it works well provided the two surfaces to be joined are adequately tinned with solder. *Do not be tempted to try this method when fitting components onto circuit boards though, as it is likely to provide more problems than it solves.*

Where two or three leads are to connect to one tag things are a little less straightforward. The standard method is to hook all the leads around "Loop" type tags, or to bind them around pins, as shown in Fig. 2. The iron and the solder are then applied (in that order), and a generous blob of solder is run onto the leads.

With this method it is still a good idea to tin each lead and the pin or tag with solder prior to making the joint, although only a small amount of solder should be used. With no tinning there is a strong possibility of producing a dry joint, but with little or no outward sign of there being anything amiss.

Many constructors prefer not to use hooked or binding connections. Both systems give very strong and reliable connections – possibly too good in fact as it can be very difficult to undo connections if the equipment needs servicing at some future time.

An alternative that I have always found to be completely satisfactory is to first tin all surfaces to be joined with plenty of solder. Then carefully hold them all in position and apply a soldering iron bit which is well loaded with solder. This is easier said than done, but with a little practice you should soon be able to make a good job of it.

Robert Penfold

INTERVAL TIMER

C. J. BOWES

An inexpensive timer with many useful applications. Time intervals from 30sec. to 15 min. in 12 switched ranges. Features a variable tone burst function.

THERE are numerous occasions when it is useful to have some sort of timer which emits a signal at regular intervals. The circuit described in this article has been designed to fulfil this function in a versatile way, by providing a range of switched time intervals between 30 seconds and 15 minutes. The duration of the output tone can be varied so that a range of signals, between a short burst and a long tone can be obtained.

CIRCUIT DESCRIPTION

The circuit diagram of the unit is shown in Fig. 1. The heart of the circuit is a 555 timer (IC1) which is connected as an astable multivibrator.

In this configuration the output of the i.c. swings from V+ to ground for a period "T2" after a time interval "T1", as shown in Fig. 2. The duration of both T1 and T2 are determined by the values of the resistors RA and RB, as shown in Fig. 3.

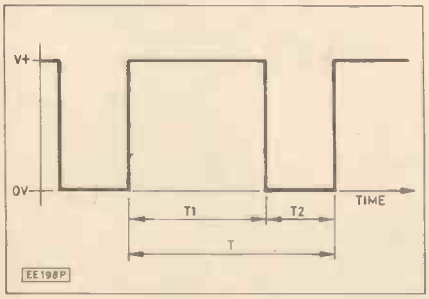


Fig. 2. Timing diagram for the circuit.

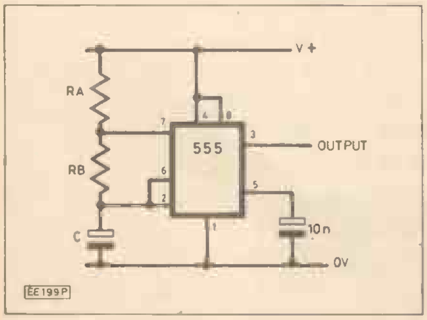


Fig. 3. The basis of the Timer circuit.

T1 is calculated using the formula:
$T1=0{\cdot}7 \times (RA + RB) \times C$
(Where T=time in seconds, RA=value of RA in ohms, RB=value of RB in ohms and C=value of the capacitor in Farads.)

T2 is obtained in the same manner from the formula:
$T2=0{\cdot}7 \times RB \times C$

By splitting the value of RA into several smaller values it is possible to produce a circuit in which a single switch can be used to select a series of different values for T1. This has been exploited in this circuit, so that RA is in fact made up of a series of fixed and variable resistors (VR1–VR12 and R1–R12) which are wired as a chain.

The proportion of the chain used as RA is selected by the position of the wiper of the time selector switch, S2. This determines T1, which is the interval between the output tones. The length of the tone corresponds to T2 and is calculated from the second formula given above. This is set by the total resistance of VR13 and R13. R13 is chosen to give a minimum duration of tone of about one second.

If the two timing formulae are combined we see that the total time for the sequence (shown as T in Fig. 2) is found from the formula:
$T=0{\cdot}7 \times (RA + (2 \times RB)) \times C$

RB is the value which is adjusted to increase or decrease the duration of the tone. It is therefore necessary to alter the value of RA by twice the alteration in the value of RB if adjustment of the duration of the tone burst is not to alter the duration between tones.

This is achieved by making VR13 a dual gang "stereo" potentiometer, connected as shown in Fig. 1. VR13 is connected so that its wiper forms the junction of RA and RB and is connected to pin 7 of IC1.

The second half of the stereo control is connected in series with the resistor string (RA) to double the changes in the value of RB. S3 is included so that the duration of the tone can be either included in or excluded from the time between tone bursts.

In the inclusive position the interval set by S2 runs from the start of one burst of tone until the beginning of the next tone burst. In the exclusive position the interval selected by S2 runs from the end of one burst of tone until the start of the next tone burst. The longer time period is achieved by placing the whole 5k of VR13a and R14 in series with the resistor chain.

CONSTRUCTION

Construction of the unit is reasonably straightforward as the great majority of the components are mounted on the printed circuit board as shown in Fig. 4. The remainder of the components are mounted on the removable lid of the case, with the exception of the buzzer. As this is rather large in comparison with the depth of the case, it is mounted inside the box and protrudes through the removable lid as shown in Fig. 5.

To facilitate correct location of this component the construction should be done in the order suggested.

The printed circuit board pattern shown in Fig. 4 should be transferred to a suitable board, etched and drilled in the normal way. The components should then be inserted in the appropriate positions and soldered, starting with the smallest components. After soldering has been completed, any excess wire can be trimmed off.

The Timer, showing the front-panel controls.

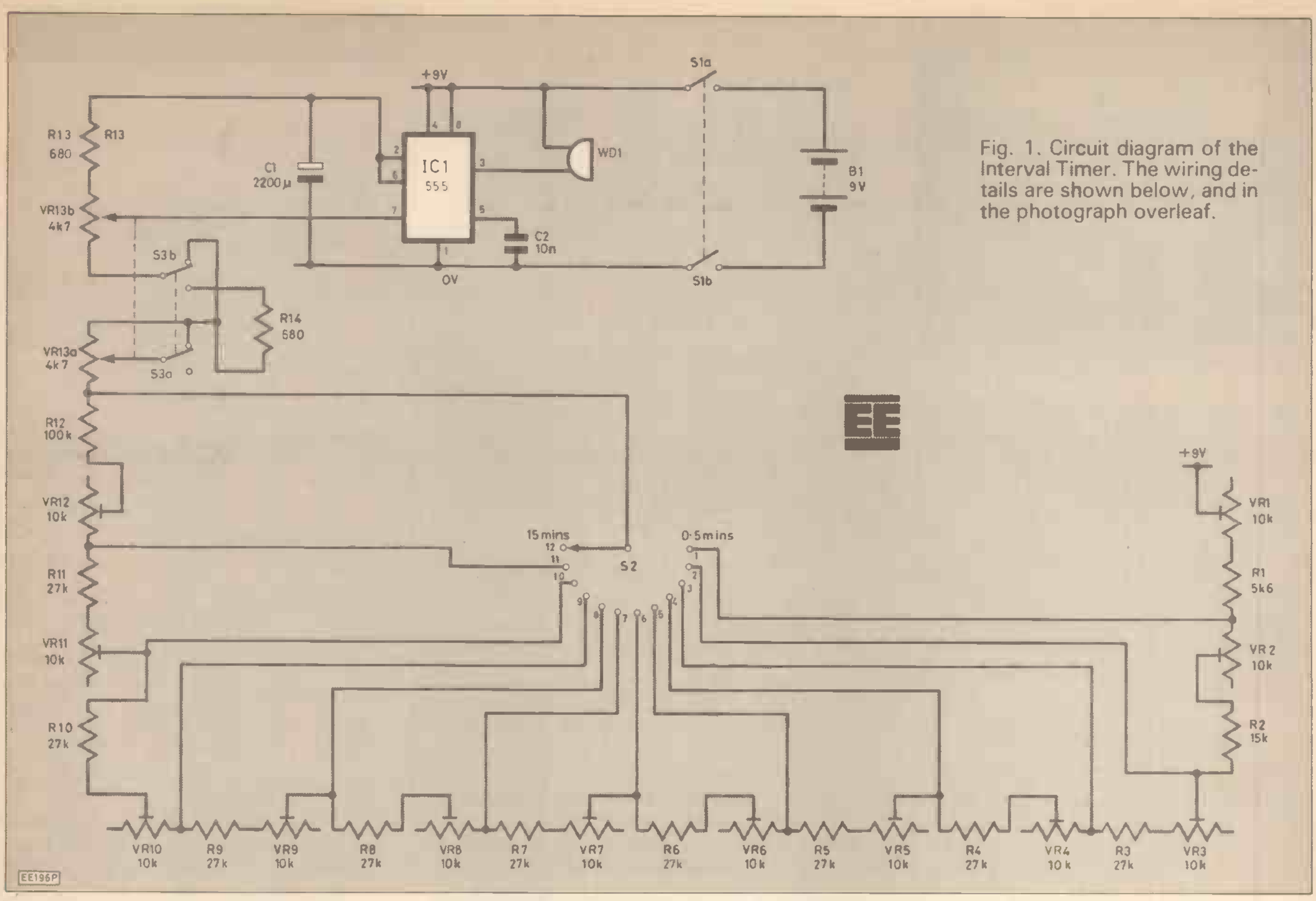
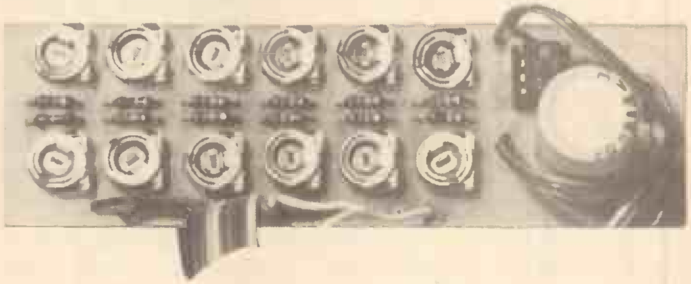


Fig. 1. Circuit diagram of the Interval Timer. The wiring details are shown below, and in the photograph overleaf.

COMPONENTS approximate cost £16.50



Completed printed circuit board showing the two banks of presets VR1–VR12.

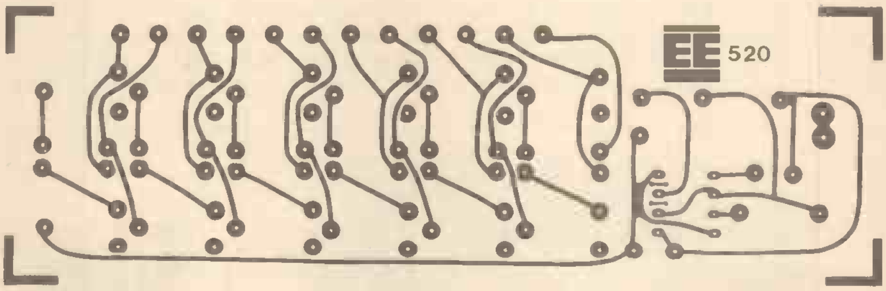
SWITCH WIRING

The wires required for making connections between the p.c.b. and the other components can then be soldered into place on the p.c.b. It is advisable to use ribbon cable for the connections between S2 and the p.c.b. The board should then be thoroughly inspected for solder bridges between tracks.

Once the p.c.b. has been completed and checked it should be inserted into the case and a suitable position found for the piezo-electric buzzer. This component is mounted inside the case and protrudes through the lid.

When a suitable position has been found, the position of the component should be marked on the case lid and an appropriately-sized hole cut out, preferably using a circular-hole cutter. The positions of the remaining components can be marked on the case lid and suitable holes cut out or drilled, including that required to mount the buzzer on the case body.

Rub-down lettering should be applied to the exterior of the case. The only component requiring careful positioning of the lettering is S2, which is the interval time selector switch. A convenient method to locate the lettering for this component is to mount the switch temporarily in its correct position and rotate the spindle to its farthest anti-clockwise position.



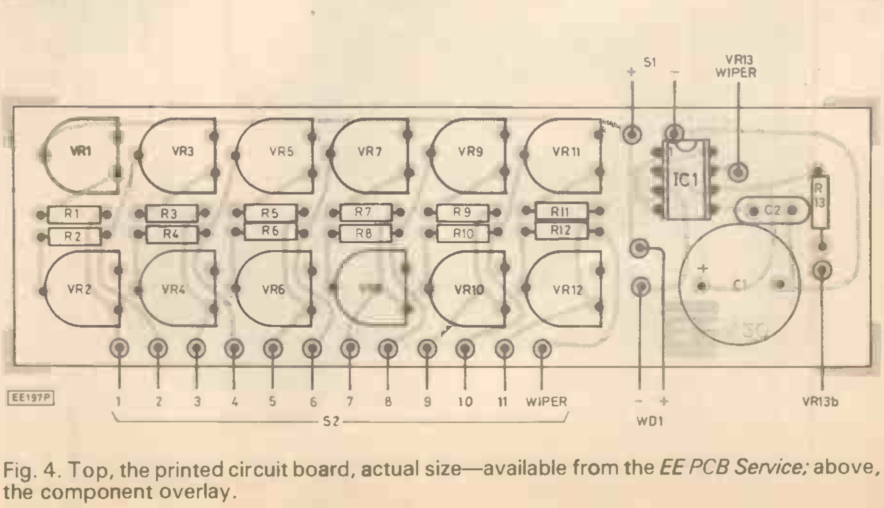


Fig. 4. Top, the printed circuit board, actual size—available from the *EE PCB Service;* above, the component overlay.

Front panel legend.

The knob is then fitted, with its line in the appropriate position. A fine pencil spot should be marked on the case directly below the line engraved on the knob. This marks the location of the first legend.

The switch is then rotated to its next position and the process repeated until all twelve positions have been marked. A small rub-down spot can then be applied to cover the pencil spot and the appropriate lettering applied to complete the legend. With the components specified the intervals will be as shown in Table 1:

Table 1: Timing intervals.

Switch Position	Interval
1	30 sec
2	1 min
3	2 min
4	3 min
5	4 min
6	5 min
7	6 min
8	7 min
9	8 min
10	9 min
11	10 min
12	15 min

Once applied, the lettering should be protected by several layers of spray-on clear lacquer.

When the case is dry the components can be mounted onto the lid, cutting down the spindles of the rotary components as required. Both S1 and VR1 should be rotated to their fully anti-clockwise position so that the knobs can be placed in position and correctly lined up before tightening the securing screws.

The wiring between the panel-mounted components and the printed circuit boards should be completed, as should the connection between the battery connector and S1. All solder-joints should then be thoroughly inspected before connecting the battery and testing the circuit.

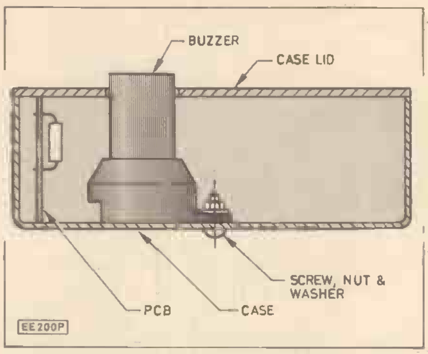


Fig. 5. Buzzer and p.c.b. mounting details.

TESTING AND CALIBRATION

To test the unit the controls should be set as follows:

S1	On
S2	Position 1. (Fully anti-clockwise)
S3	Inclusive
VR1	Minimum (Fully anti-clockwise)

After a short period to stabilise the circuit, the unit should start emitting a short tone burst at about 30 second intervals. The intervals between the output tones should be identical but will not necessarily be accurate, since the system will not have been calibrated.

VR13 should then be rotated to check that the duration of the tone is increased but that the interval between the start of one tone and the start of the next remains the same, irrespective of the setting of VR13. When S3 is placed in the exclusive position the interval between the end of one tone and the start of the next should remain constant irrespective of the setting of VR13.

Calibration of the unit is, unfortunately, a little tedious but, if done carefully and methodically, worth the effort involved.

COMPONENTS

Resistors

R1	5k6
R2	15k
R3 to R11	27k (9 off)
R12	100k
R13, R14	680 (2 off)
All $\frac{1}{4}$W ±5% carbon	

Potentiometers

VR1 to VR12	10k skeleton preset, horiz. mounting (12 off)
VR13	Dual ganged 4k7 linear rotary

Capacitors

C1	2200μ, 16V elect., radial leads
C2	10n disc ceramic

Semiconductor

IC1	555 timer

Miscellaneous

B1	PP3 9V battery
S1	d.p.s.t. min. rocker
S2	single-pole, 12-way rotary wafer switch
S3	d.p.d.t. min. rocker
WD1	piezoelectric transducer, single tone.

Printed circuit board, available from the *EE PCB Service*, order code EE520; knobs for rotary controls; case, about 115 × 95 × 37mm internal dimensions —e.g. MB3; rub-down lettering; battery clip; interconnecting wire.

The unit should be switched on with S2 at position 1, S3 at the inclusive setting and VR13 set to give minimum tone duration. A stop-watch should be used to time the interval from the end of one tone to the end of the next tone. VR1 is then adjusted until this interval is correct.

Once the first time interval is correctly set, S2 can be rotated to the next position and VR2 adjusted until the correct interval is obtained. This process is repeated until all the presets have been correctly adjusted. If the correct time interval cannot be obtained by adjusting the appropriate preset, then the associated fixed-value resistor should be substituted by one with a different value.

To increase the time period, the value of the fixed resistor should be increased and to decrease the time period the value of the fixed resistor should be decreased. Once the unit has been calibrated, the buzzer can be mounted in position, the printed circuit board placed in the correct location and the lid screwed down. Care should be taken to ensure that the preset potentiometers are not disturbed during this process.

USING THE UNIT

Operation of the unit is simple and straightforward but it must be remembered that there will be a longer delay than that selected between switching on the unit and the production of the first tone.

This is caused by the need for the circuit to settle down and can be overcome by switching to the lowest time interval and waiting for the first tone to be produced before commencing to use the timer as part of an activity. □

See Shop Talk page 146

Completed timer showing ribbon cable wiring from S2 to the p.c.b.

a regular feature for the Spectrum Owner...

by Mike Tooley BA

SINCE *Everyday Electronics* joined forces with *Electronics Monthly*, there has been an absolute mountain of mail from readers. Many of you have raised topics worthy of a wider audience so we start this month with some of these.

Square Wave Generator

First, Bruce Phipps from Hatfield has taken me to task over a rather obvious error in the machine code square wave generator routine given in Oct 85's *On Spec*. Readers who have used this will have found that it is not possible to break out of the routine.

The problem, quite simply, is that having disabled interrupts at the start of the program I had forgotten to enable them again at the end!

Bruce has kindly provided a corrected listing together with the corresponding BASIC data values. This corrected listing has been included in our latest "Update" so there is no longer any need to suffer in silence; just drop me a line and enclose a large stamped addressed envelope.

Input Interface

S. Lewis writes from Cheltenham and says that he has been experiencing some difficulties with the Four Channel Input Interface described in last April's *On Spec*. He is using an Issue 3B Spectrum and the Interface works normally about 66 per cent of the time but occasionally some false readings are returned.

Mr Lewis says that the problem can, at least partially, be cured by the use of the following small machine code routine:

```
LD BC,0
IN A, (191)
LD C,A
RET
```

Have other readers suffered from the same problem, I wonder? If anyone can throw some more light on this please drop me a line.

Power Supply

David Corder from Kirkby Stephen, Cumbria, writes to ask for circuit information on the Issue 2 Spectrum power supply. David says that the −5V rail is missing. The power supply is, without any doubt, the worst engineered part of the Spectrum and this particular complaint is extremely common with early issues of the Spectrum.

For the uninitiated, the Spectrum requires its −5V and +12V rails for the lower 16k of RAM (the eight 4116 chips on the front left-hand side of the p.c.b.). More modern RAM devices (and those used for the upper 32k RAM fitted in Issue 3 and later) only require a single +5V supply rail.

Incidentally, failure of the d.c.-to-d.c. converter transistor (TR4) will affect both supply rails, though, in the case of Issues 1, 2 and 3, the +12V supply rail will actually take on a slightly reduced voltage (typically 10·5V) and will not, like the −5V rail, disappear altogether.

The reason for this somewhat anomalous behaviour is that the a.c. voltage at the collector of TR4 is rectified to produce the +12V supply. If the oscillator fails for some reason or other the rectifier diode still conducts, placing the unregulated d.c. input voltage on the +12V RAM supply rail. (This effect does not appear on Issue 4 and 6 Spectrums as they use a capacitor to couple TR4 collector to the rectifier.)

When delving into the Spectrum a copy of the "official" service manual will be invaluable. This document is, unfortunately, not generally available (it would appear that most of the service agencies have been sworn to secrecy!). However, Video Vault Ltd. at 140 High Street West, Glossop, Derbyshire, can supply a service manual (at £20 plus £1.50 postage and packing) and also carry a good range of Spectrum spares.

Servicing

While on the subject of servicing, perhaps I can take this opportunity to sound a cautionary note. The Spectrum, like any other personal computer, can be very easily damaged by inexpert servicing (having spent some time training computer service engineers I can speak from experience on this).

A simple fault can become a total disaster when "investigated" by an inexperienced person. So, if you are not absolutely confident that you know what you are doing, don't attempt to service the innards of your Spectrum. In the long run it is usually far cheaper (and quicker!) to send the computer away for repair and have it professionally repaired.

While on the subject, readers will probably be aware that around a dozen companies now offer service facilities for the Spectrum. The cost is usually around the £20 mark and must be considered a real bargain when compared with the cost of removing a similar fault on a "business computer" which can be up to ten times that amount.

Fortunately, the competition amongst service agents has been instrumental in bringing the costs down to a rock bottom level. This can only be good news for the end user.

Using The Programmable Interface

Last month we described a programmable I/O interface for the Spectrum. This month we shall provide some guidance for programming the interface together with a few sample routines. First, however, a few general points concerning the PIO.

Reset: the Z80 PIO automatically enters a reset state whenever power is applied. Once in this state the PIO remains inactive until a control word is received from the CPU (achieved by means of an OUT instruction followed by the relevant port address and control data).

Modes of Operation: port A of the PIO may be operated in any of four distinct modes: Mode 0 (output mode), Mode 1 (input mode), Mode 2 (bi-directional mode), and Mode 3 (control mode). Port B can operate in modes 0, 1 and 3 but not in mode 2 (we shall see why later).

The Control Word: the mode of operation can be established by writing a control word to the PIO in the following format:

D7	D6	D5	D4	D3	D2	D1	D0
		X	X	1	1	1	1
Mode select		X = don't care		Signifies that a mode word is being sent			

The two most significant bits, bits 7 and 6, select the desired mode according to the following truth table:

D7	D6	Mode	Function
0	0	0	Output
0	1	1	Input
1	0	2	Bi-directional
1	1	3	Individual control

Bits 4 and 5 of the control word are ignored and bits 0 to 3 must all be set to logic 1 to indicate that a control word is being sent.

In case this is beginning to sound rather complex, let's consider a simple example which uses BASIC to initialise the PIO so that all eight lines of Port A are configured as outputs while all eight lines of Port B are configured as inputs.

Table 1 last month gave the register assignment for the PIO and shows that the control register for Ports A and B are allocated decimal addresses of 93 and 127 respectively. We can conveniently make use of the BIN function provided in Sinclair BASIC, stating the control word in binary rather than decimal, as follows:

```
10 OUT 93, BIN 00001111
20 OUT 127, BIN 01001111
```

Line 10 sends the binary control word 00001111 to the Port A control register (decimal address 93) and sets Mode 0 operation (bits 7 and 6 both reset).

Line 20 sends the binary control word 01001111 to the Port B control register (decimal address 127) and sets Mode 1 operation (bit 7 reset, bit 6 set).

Modes 2 and 3: while Modes 0 and 1 are fairly obvious in their operation (byte output and input respectively) Modes 2 and 3 require some further comment. Since Mode 2 makes use of all four handshake lines it is only available for Port A. Furthermore, the bi-directional buffer (IC2) used in conjunction with Port A is hardware, rather than software, controlled and thus Mode 2 operation is not possible with our interface.

Readers requiring bi-directional operation in conjunction with Port A will have to add the necessary handshake lines to the Z80 PIO and use one from Port B (for example, PB0) as a direction input to IC2.

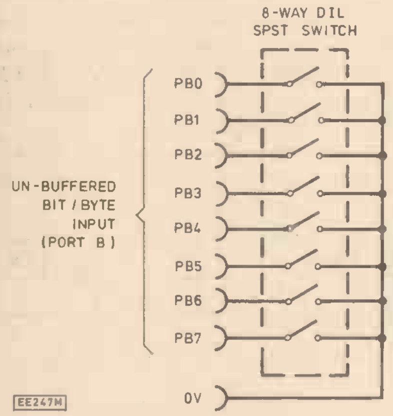


Fig. 1. Switch input arrangement for testing the I/O interface. Switch open = logic 1 input, switch closed = logic 0 input.

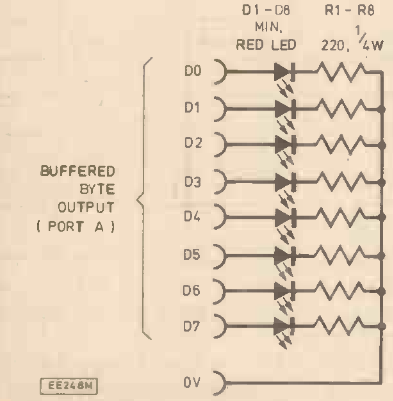


Fig. 2. L.e.d. output indicator for testing the I/O interface. L.e.d. illuminated = logic 1 output, l.e.d. extinguished = logic 0 output.

Mode 3 operation is intended for status and control applications and does not utilise the handshake lines. When Mode 3 is selected a second control word must be sent to the PIO in order to define which of the port data lines are to be configured as inputs and which are to be configured as outputs.

Each bit position within the second Mode 3 control word corresponds to a particular I/O line. If a bit is set (1) then the corresponding data bus line will be configured as an input. Conversely, if the bit is reset (0) the line will be configured as an output. The following example shows how Mode 3 operation is selected and Port B lines PB0 to PB3 configured as inputs whilst PB4 to PB7 are configured as outputs:

```
10 OUT 127, BIN 11111111
20 OUT 127, BIN 00001111
```

Line 10 sends the control word which selects Mode 3 operation. Line 20 configures the individual lines as outputs or inputs.

Again, since we have buffered Port A, it is not possible to configure the individual lines of Port A as inputs or outputs. They can all be inputs or all be outputs but not mixed! Mode 3 operation, therefore, must be confined to Port B.

Demonstration Routines

In order to test the PIO and gain some familiarity with its operation, readers may like to construct either, or both, of the circuits shown in Fig. 1 and Fig. 2. These provide a means of inputting data to Port B and displaying the logical state of Port A.

Now for some complete demonstration routines! The first BASIC routine repeatedly outputs a binary count using the eight lines of Port A (before use it is necessary to ensure that the Port A direction switch is set to the "Out" position):

```
10 OUT 93, BIN 00001111
20 FOR X=0 to 255 STEP 1
30 PRINT AT 0,0; X
40 OUT 31,X
50 PAUSE 20
60 NEXT X
70 CLS
80 GO TO 20
```

The next routine inputs data from Port B, displays the value (in decimal) and then outputs this value to Port A (the Port A direction switch should be in the "Out" position):

```
10 OUT 127, BIN 01001111
20 OUT 93, BIN 00001111
30 LET X=IN (63)
40 CLS
50 PRINT AT 0,0; X
60 OUT 31, X
70 PAUSE 20
80 GO TO 10
```

The last BASIC example prints the value of a data byte input to Port A (before use it is necessary to ensure that the Port A direction switch is set to the "In" position):

```
10 OUT 93, BIN 01001111
20 LET X=IN (31)
30 PAUSE 20
40 CLS
50 PRINT AT 0,0; X
60 GO TO 20
```

Finally, for all you machine code buffs, Listing 1 shows a machine code routine that uses PB0 to turn "on" or "off" all Port A lines simultaneously. Note that a bit mask is used so that the state of lines PB1 to PB7 is made unimportant.

Listing 1: Machine Code Routine

```
8000                ORG   8000H
8000 3E0F     INIT  LD    A,15
8002 D35D           OUT   (93),A
8004 3E4F           LD    A,79
8006 D37F           OUT   (127),A
8008 DB3F     START IN    A,(63)
800A E601           AND   1
800C FE01           CP    1
800E 2006           JR    NZ,ALLON
8010 3E00     ALLOF LD    A,0
8012 D31F           OUT   (31),A
8014 18F2           JR    START
8016 3EFF     ALLON LD    A,255
8018 D31F           OUT   (31),A
801A 18EC           JR    START
                    END
```

The program can be entered using our hexloader (see December *EE* or send for the latest "Update"). Simply set RAMTOP to 32767 and then key in the hexadecimal values given in the second column (28 bytes total). After first saving and then protecting the code, readers can call the routine by simply typing:

```
RANDOMIZE USR 32768
```

If you have any ideas for inclusion in *On Spec*, please send them to:

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

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

NEXT MONTH: We shall be taking a look at FORTH and describing a stepper motor interface for the Spectrum.

PLEASE TAKE NOTE

DIGITAL CAPACITANCE METER ***(Dec '85)***

Page 641, Fig. 2, IC6 is a 4534. The supply leads from JK1 (Fig. 4, page 643) to the printed circuit board should be transposed.

Also with reference to Fig. 4, the three pairs of resistors R1 (R1), R2 (R2) and R3 (R3) should read the other way. From top to bottom: R3 (R3), R2 (R2), R1 (R1). R1 should be 5k15 (this is made up from two resistors in series, i.e. 5k1 plus 47Ω).

Check IC6 should be the Mullard version type HEF 4534. The Motorola version should work, but "failed" devices have been reported.

If complete kits have been purchased from Magenta, they will replace any faulty IC6.

COMPUTER OUTPUT PORT ***(Feb '86—Building Blocks)***

Page 98, Fig. 5 (circuit), lead from pin 1, IC1a, should go to pin 11, IC2. The lead from pin 13, IC1d, should go to pin 1, IC2.

Fig. 8, termination of lead from TB1a to board should read 7 not 8 as shown on the board. The p.c.b. layout and wiring is correct.

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, Westover House, West Quay Road, Poole, Dorset BH15 1JG. 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 *M.I.T. Part 1*	8307-01	£4.82
User Port Control *M.I.T. Part 1*	8307-02	£5.17
— AUGUST '83 —		
Storage 'Scope Interface, BBC Micro	8308-01	£3.20
Car Intruder Alarm	8308-02	£5.15
High Power Interface *M.I.T. Part 2*	8308-03	£5.08
Pedestrian Crossing Simulation *M.I.T. Pt 2*	8308-04	£3.56
— SEPTEMBER '83 —		
High Speed A-to-D Converter *M.I.T. Pt 3*	8309-01	£4.53
Signal Conditioning Amplifier *M.I.T. Pt 3*	8309-02	£4.48
Stylus Organ	8309-03	£6.84
— OCTOBER '83 —		
D-to-A Converter *M.I.T. Part 4*	8310-01	£5.77
High Power DAC Driver *M.I.T. Part 4*	8310-02	£5.13
— NOVEMBER '83 —		
TTL/Power Interface for Stepper Motor *M.I.T. Part 5*	8311-01	£5.46
Stepper Motor Manual Controller *M.I.T. Part 5*	8311-02	£5.70
Speech Synthesiser for BBC Micro	8311-04	£3.93
— DECEMBER '83 —		
4-Channel High Speed ADC (Analogue) *M.I.T. Part 6*	8312-01	£5.72
4-Channel High Speed ADC (Digital) *M.I.T. Part 6*	8312-02	£5.29
Environmental Data Recorder	8312-04	£7.24
Continuity Tester	8312-08	£3.41
— JANUARY '84 —		
Biological Amplifier *M.I.T. Part 7*	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 *M.I.T. Part 8*	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 *M.I.T. Part 9*	8403-01	£5.30
Buffered Input Port *M.I.T. Part 9*	8403-02	£4.80
VIC-20 Extension Port Con. *M.I.T. Part 9*	8403-03	£4.42
CBM 64 Extension Port Con. *M.I.T. Part 9*	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" *M.I.T. Part 10*	8404-02	£5.20
Data Acquisition "Output" *M.I.T. Part 10*	8404-03	£5.20
Data Acquisition "PSU" *M.I.T. Part 10*	8404-04	£3.09
A.F. Sweep Generator	8404-06	£3.55
Quasi Stereo Adaptor	8404-07	£3.56
— MAY '84 —		
Simple Loop Burglar Alarm	8405-01	£3.07
Computer Controlled Buggy *M.I.T. Part 11*		
Interface/Motor Drive	8405-02	£5.17
Collision Sensing	8405-03	£3.20
Power Supply	8405-04	£4.93
— JUNE '84 —		
Infra-Red Alarm System	8406-01	£2.55
Spectrum Bench PSU	8406-02	£3.99
Speech Synthesiser *M.I.T. Part 12*	8406-03	£4.85
Train Wait	8406-04	£3.42
— JULY '84 —		
Ultrasonic Alarm System	8407-01	£4.72
Electronic Code Lock		
Main Board	8407-03	£2.70
Keyboard	8407-04	£3.24
— 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		
Mains Unit	8505-02	£2.56
Micro Unit	8505-03	£2.56
Voltage Probe	8505-04	£2.67
— 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.
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†Four separate circuits.

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FOR YOUR ENTERTAINMENT

BY BARRY FOX

Just The Ticket

There is some clever electronic technology and automation in the very modern underground railway which serves Hong Kong. London Transport could learn a lot from the Chinese system.

The route maps tell what price ticket is needed for each destination. When you put the money into a ticket machine, out pops a plastic card with a magnetic strip —like a bank cash card. This lets you through a turnstile and onto the trains.

At the other end of the journey you put the same card into an "out" turnstile. If the ticket is valid, the turnstile opens and the ticket remains inside for recycling and eventual re-use by someone else. The clever part is what happens if the ticket is of the wrong value for the journey.

The magnetic strip carries a coding which was recorded by the issuing ticket machine at the start of the journey. If the recorded fare does not match the journey length, the turnstile refuses to open and a message lights up: "Go to excess fare booth".

The ticket card is returned for the passenger to take it to the booth. Here a (human) worker takes the card, and puts it into another machine. This reads out on a digital display the excess fare due.

When the passenger pays over the extra the booth operator keys a command into the display unit which re-codes the magnetic card to signify that the full fare has been paid. When the card is now put into the turnstile, it opens and keeps the card.

One neat non-electronic touch keeps the Hong Kong trains looking clean, even though they are very heavily used. All the seats are made from polished and contoured stainless steel. They feel surprisingly comfortable and just wipe clean. Compare this with the grotty upholstery on British tubes.

Piece of Cake

Hong Kong goes back to Mainland China in 1997. No-one is too sure what will happen. "Don't worry, we'll still love you" promise tee-shirts on sale from Chinese street hawkers.

The People's Republic may get more than it bargains for. Hong Kong is the most capitalist society in the world. Recently a lady baker hit on a bright idea; cake vouchers. Instead of sending cakes through the post you buy and send a voucher bought from one of Madame Wu's shops. The voucher is then redeemed at another of Madame Wu's establishments.

It all sounds a wonderful idea, rather like paper money and its promise to pay the bearer gold. Obviously the similarity dawned on the Chinese. After tens of thousands of cake vouchers had been sold someone started thinking. What happens if Madame Wu cannot supply the goods?

Within hours of the rumour starting there were crowds outside the cake shops, demanding either a cash refund or cakes to the full value of the vouchers bought. Needless to say Madame Wu could not bake enough cakes in time. She was also handicapped by having invested the takings in gold.

Danger was averted by a bank loan and all-night baking under sub-contract. Now a large number of Chinese people in Hong Kong have cakes that were intended for someone else.

Vintage Planning

I learned long ago that if you don't understand something there is no point in pretending you do. I have been to press conferences where manufacturers have talked grandly in jargon about some new product they are launching, often bought in from abroad and simply labelled with a British name tag.

When asked what they mean by a technical term, they frequently collapse into embarrassed silence. This is worth bearing in mind when a shop salesman tries to bamboozle you with high tech talk. There is a good chance that it's bluff. Two examples recently came up.

The Government has promised to relax the rules on planning permission, and make it easier for people to erect dish aerials and receive satellite broadcasts. Unfortunately the Government departments don't talk to each other. The Department of Environment is allowing people to erect dishes of up to 0·9 metres in diameter, without planning permission. This size of dish is matched to high power Direct Broadcast Satellite transmissions.

Presumably the DoE doesn't know that Britain's plans for DBS crumbled. This is why the Home Office has relaxed its rules on satellite reception and said people can buy a licence to receive programmes from communications satellites. These programmes are intended primarily for distribution between cable stations. The transmitters are low power (under 20W compared to 200W for DBS), so larger dishes, around 1·6m in dia., are needed.

When I asked the Department of Environment to explain the situation, a spokesman kept talking about "the need for primary legislation". I owned up that I was ignorant about planning laws and did not know what was meant by "primary legislation". After a lot of fudging and fumbling he had to admit that he didn't know either and would have to go away and find out.

Not long before that, I had the good fortune to visit a vineyard in California. A charming French girl was showing visitors around. We went down into the cellars where there were rows and rows of champagne bottles, maturing in racks. They have to be turned round every few days as part of the champagne fermentation process. "We used to turn all the bottles by hand" she explained "but now we use a specially designed VBM". Most people in the crowd of tourists nodded sagely, obviously well familiar with VBMs. From a corner, a brave voice piped up "What exactly is a VBM?"

"It's this Very Big Machine in the corner" she explained pointing to a rusty, dusty old wheel on which racks of champagne bottles were crudely secured.

Power of the Press?

In a previous column I told how the Home Office had set such strict technical standards for community radio that they effectively barred stereo and made reception by hi-fi roof aerials impossible. Quietly, ever so quietly, the Home Office has now backed down. It has published some guidance notes on products and services which may not be advertised on community radio. Clipped to the annexe is a short technical note. It overturns the previous nonsensical restrictions.

The Home Office originally said that the sidebands of community f.m. radio must be at least 40dB below the carrier power, at 100kHz away from the carrier. This is what made stereo impossible. The new rules say the vital 40dB measurement can be made at 200kHz away from the carrier.

The previous Home Office rules said that community radio could broadcast in f.m. only with vertical polarization. This meant that the signals could be received only by vertical rod aerials.

As many roof aerials in Britain are horizontal, because until recently the BBC used horizontal polarisation, this meant that many hi-fi radio receivers in Britain would reject community radio. After all the whole point of using vertical or horizontal polarisation is to exclude unwanted signals of opposite polarisation.

Now the Home Office says that community radio stations may use horizontal polarisation or a mixture of vertical and horizontal, if they make a special request. It really is very worrying to see Government departments with as much power as the Home Office and Department of Trade and Industry, make gross technical errors and then have to cover up quietly when someone in the press looks closely enough to spot them.

Song Bird

When Sony introduced *Walkman*, and brought a new pidgin word into the English language, it came in the nick of time. The super-powerful portable stereo, known unaffectionately as the "Ghetto Blaster" was just starting to catch on. Now that at least half the population seems to be walking around in a cocoon of personal stereo sound, and sales have predictably dropped off, the electronics firms are again trying to sell portable nuisance machines.

Philips has cooked up a portable radio recorder with built-in CD player for under £400. The latest brute from Akai has "detachable 3-dimensional speakers", a power output of 30W—which is as much as many home systems—and "a novel energiser button to enliven the sound reproduction". When these hit the streets, people who have been bitching about the scratchy sound which escapes from personal headphones may start counting their blessings instead.

Meanwhile, I am happy to report that these portable sound machines do have a use. A builder who likes birds (the feathery kind) tells us how he hates having to disturb them when they nest in a loft.

So as soon as there is any sign of nest-building, he puts a portable radio alongside the unwelcome guests, tunes to *Radio 1* and leaves it running until the batteries go flat. Without fail, the birds find somewhere else to nest.

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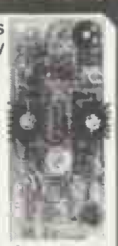

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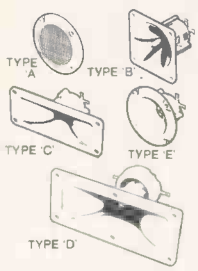

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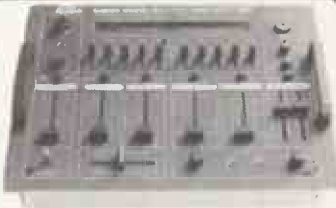

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