JULY 1978

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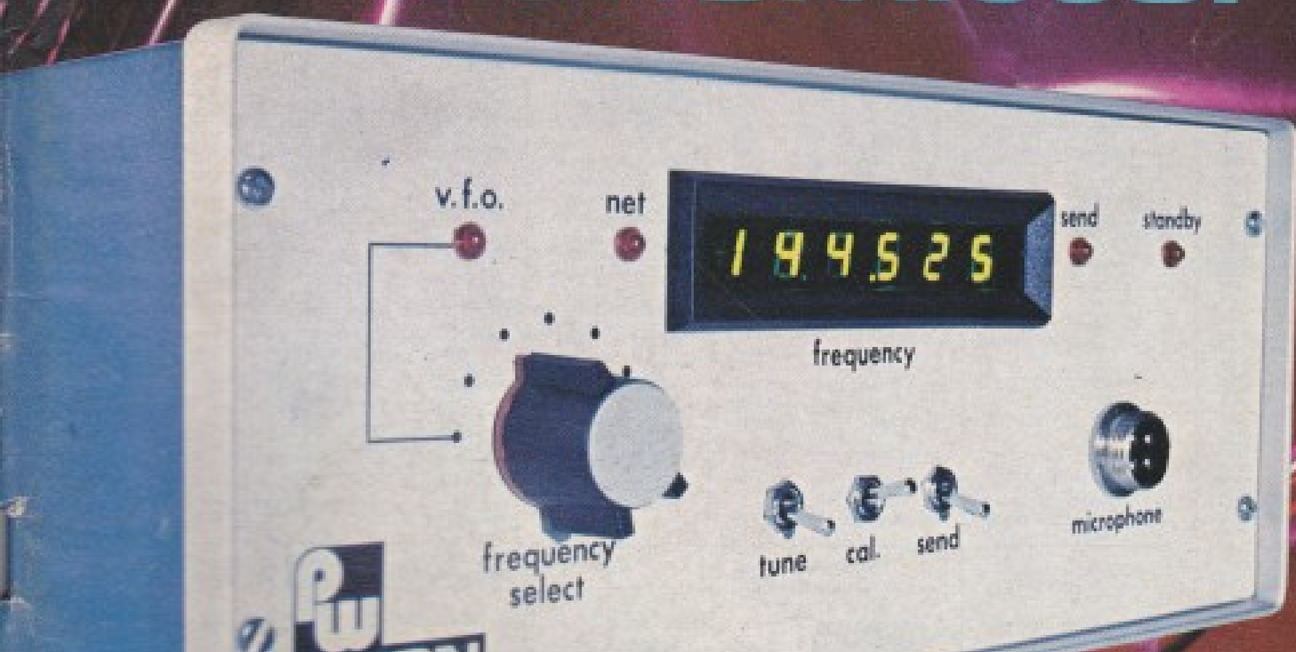

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ISSUE 857

JULY 1978 · VOLUME 54 · NUMBER 3

BRITAIN'S LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

Published by IPC Magazines Ltd., Westover House, West Quay Rd., POOLE, Dorset BH15 1JG

News and Views

For our Constructors

General Interest

RECEIVER UNIT small personnel type made for use by Army covers 500Kc to 18Mc/s by means of a 4 way plug in coil unit, uses 5 min valves inc BFO in superhet circ reqs 67·5v HT & 1·5 L.T. as o/p for 4K phones supplied tested with circ **£13.** HT batteries if req **£1·30** ea or 2 or more **£1** ea.

AERIAL DRIVE UNIT suitable 2mt beam & up, 24v DC motors max speed 6 RPM supplied with remote 360′ Ind again 24v DC & connections, ex aircraft radio compass two items **£13.**

HANDSETS rubber covered m.c. type nom 100 ohm with press to talke swt suit 19 or 62 sets store soiled elec okay **£2·50.**

VALVE TESTER ADAPTOR type MX849 for use with American I-177 valve tester extends range, in case with data **£5·40.**

V.H.F. TEST SET type 210 contains sig gen covering 20 to 88Mc/s in 4 bands good second harmonic o/p, int 2Mc/s xtal check, int pulse mod or CW o/p, noise generator with 50 Ma meter, all in case with cal charts & circ, note these req 200v DC & 6·3v **£13.**

DYNAMOTOR UNIT 27·5v DC I/P o/p 200 or 400v DC 280 Ma int rating, these can be used as motor only by removing ext fan ass, will run on 6 to 24v DC very powerful as 1 × ¼″ shaft approx motor size 6½ × 3½ dia new American surplus **£6·50.**

CRYSTAL OVEN small type takes 2x Hc18 size 2 × 1¼ × ¾″ 12/24v new **£1·20.**

CABLE min 25 core non scr colour coded new 10 mts for **£3.**

METERS panel mt type 1 Ma fed special scale 2″ **£1·30** also 100 Ua FSD scale 0 to 100 2″ **£3** both new.

CRYSTAL UNIT dual 100Kc & 1 Mc/s in 10X case with suggested circ **£2·80.**

TRANSISTOR VHF pwr type 2N3375 stud mt 7·5w at 100Mc/s 3w at 400Mc/s new **£1·80** ea.

BATTERIES sealed lead acid type 6v rechargeable 1·8 A/Hr size 2¾ ×2 × 2″ new **£5·40.**

RECEIVER UNIT single channel crystal controlled for use in range 225 to 400Mc/s double superhet 21 min valves 230v 50c/s I/P 19″ rack mt with circ **£30.**

FREQ METERS type BC221 125Kc to 20Mc/s req 135v HT & 6·3v with handbook & charts few only **£27.**

DIODES power types 100 PIV 10 amps 4 for **£1·60.** 1000 PIV 10 amps 4 for **£2·50** both new full spec. C.R.T.s

CV1746 6½″ P.I trace CRDF tube **£6,** 5CP1 5″ P.I trace **£7.** 5ADP1 5″ P.I trace **£8·50** all electrostatic types new.

C.R.T. VISOR complete with magnifier & padded eye piece approx size 5 × 4 × 7″ okay for colour slide viewer new **£3.**

TRANSFORMERS HT type Pria 230v sec 1125-0-1125v at 565Ma new **£12·50,** Isolating type pria 240 sec 120v at 60 watts enclosed new **£3.** Auto type 230/115v at 1 Kva **£13.**

RECTIFIER UNIT general purpose unit made for operation of Army telephone & teleprinter units I/P 200/250v o/p dual 12v DC at 3 amps ea circ. connected for 24v ct complete in case very conservative rating will do 8 amps okay for battery charger with circ **£8·50.**

TEST SET special purpose complete in case size 14 × 16 × 10″ contains large number of good quality parts as follows, HD rotary swts, plugs & sks, trips, power filters, relays, Ind lamps, pots, small 400c/s variac etc **£16.**

TEST SET special purpose contains 4 panel meters as follows, 0 to 500Ma x2, 0 to 1 amp DC mirror scale, 0 to 40v DC, plus lamps, tog swts, fuse holders etc in case size 17 × 12 × 7″. **£9.**

TEST SET M.7C used for testing telephone circs contains mains p.u. meter 200 Ua 3½″, 3x AF atten swt 10, 40 & 60Db, valve amp, filters etc in neat case with front cover & circ size 19 × 9 × 9″ **£10·80.**

TEST SET I.F. used to check 30Mc/s head amps, contains mains p.u. with trans 225-0-225v at 70 Ma 6·3v etc, also high grade 100 Ua meter scale 0 to 100 4″ dia, 30 Mc/s amp, misc coax fittings etc in case size 19 × 7 × 10″ **£10·80.**

CRYSTALS mixed type 10X & 10XJ in range 5 to 8Mc/s 20 for **£2·20.**

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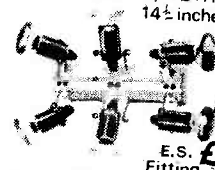
(less lamps) LENGTH 14½ inches



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600 WATTS PER CHANNEL

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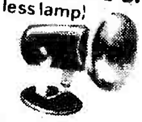

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(Less Lamps)

B.C. Fitting **£7·99** EACH | E.S. Fitting **£7·99** EACH

TWIN BANK 12 LIGHT UNIT

Length 31¾″

(less lamps)

B.C. Fitting **£18·50** EACH | E.S. Fitting **£18·50** EACH

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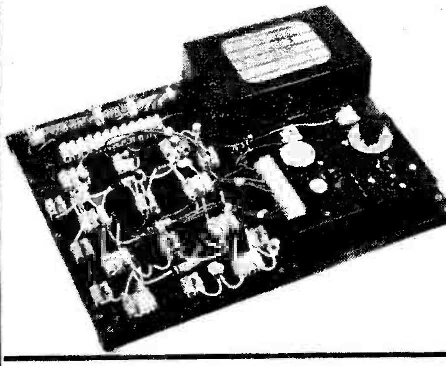


NEW ELECTRONIC MASTER KIT

WITH SPECIAL V.H.F. TUNER MODULE TO CONSTRUCT. A completely Solderless Electronic Construction Kit, with ready drilled Bakelite Panels, Nuts, Bolts, Wood Screws etc. Also in the kit: Transistors, Capacitors, Resistors, Pots, Switches, Wire, Sleeving, Knobs, Dials, 5" × 3" Loudspeaker and Speaker Case, Crystal Earpiece, etc. Also ready wound Coils and Ferrite Rod Aerial. These are the Projects you can build with the components supplied with the kit, together with comprehensive Instruction Manual Pictorial and Circuit Diagrams.

PROJECTS: V.H.F. Tuner Module ★ A.M. Tuner Module ★ M.W. L.W. Diode Radio ★ Six Transistor V.H.F. Earpiece Radio ★ One Transistor M.W. L.W. Radio ★ Two Transistor Metronome with variable beat control ★ Three Transistor and Diode Radio M.W. L.W. ★ Four Transistor Push Pull Amplifier ★ Eight Transistor V.H.F. Loudspeaker Receiver ★ Variable A.F. Oscillator ★ Jiffy MultiTester ★ Four Transistor and Diode M.W. L.W. Radio ★ A.F. R.F. Signal Injector ★ Five Transistor Push Pull Amplifier ★ Sensitive Hearing Aid Amplifier ★ Three Transistor and Diode Short Wave Radio ★ Signal Tracer ★ Three Transistor Push Pull Amplifier ★ One Transistor Class A Output Stage to drive Loudspeaker ★ Sensitive Transistor Pre-Amp ★ Transistor Tester ★ Sensitive Three Transistor Regenerative Radio ★ Four Transistor M.W. L.W. and Diode Tuner ★ Five Transistor M.W. L.W. Trawler Band Regenerative Radio ★ Five Transistor V.H.F. Tuner ★ Three Transistor Code Practice Oscillator ★ Five Transistor Regenerative Short Wave Radio ★ Four Transistor and two Diodes M.W. L.W. Loudspeaker Radio ★ Seven Transistor M.W. L.W. Radio with Loudspeaker Push Pull output ★ One Transistor Home Broadcaster.

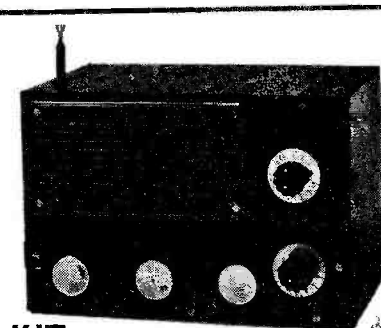
£14·99 + P & P £1·10

NEW ROAMER TEN MODEL R.K.3

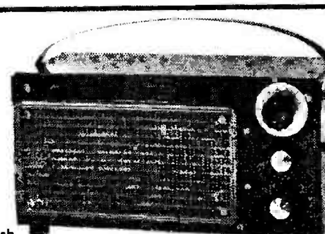
MULTIBAND V.H.F. AND A.M. RECEIVER.
13 TRANSISTORS AND SIX DIODES. QUALITY 4" ROUND LOUDSPEAKER.

WITH Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multiband A.M. section with Airspaced Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands S.W.1, S.W.2, S.W.3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc., Chrome Plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push-Pull output using 600mW Transistors. Gain, Wave-Change and Tone Controls. Plus two Slider Switches. Powered by P.P.9—9 volt Battery.

Complete kit of parts including carrying strap. Building Instructions and operating Manuals. **£14·79** + P & P £1·10



NEW MODEL R.K.1



MultiBand A.M. Receiver. M. W. L. W. Trawler Band and Three Short Wave Bands. Seven Transistors and Four Diodes. Push Pull Output stage. 5" × 3" Loudspeaker. Internal Ferrite Rod Aerial. Kit includes all parts to build it up including Carrying Strap, Rubber Feet and ready-drilled Panels. Comprehensive Instruction Manual for stage by stage construction. Uses P.P.9 Nine Volt Battery.

£8·99 + P & P 90p

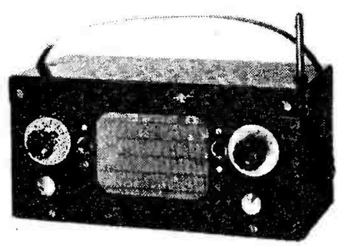
ELECTRONIC CONSTRUCTION KIT

E.C.K. 2 **Self Contained Multi-Band V.H.F. Receiver Kit.**

8 transistors and 3 diodes. Push pull output. 3in. loudspeaker, gain control, 7 section chrome plated telescopic aerial V.H.F. tuning capacitor, resistors, capacitors, transistors, etc. Will receive T.V. sound, public service band, aircraft, V.H.F. local stations, etc. Operates from a 9 volt P.P. 7 battery (not supplied with kit)

Complete kit of parts **£7·95** + P & P and Ins. 90p

NEW MODEL R.K.2



MW, LW and Air Band Receiver. Eight Transistors and Four Diodes. 3" Loudspeaker, Telescopic Aerial, Internal Ferrite Rod Aerial. Complete with Carrying Strap, and ready-drilled Panels and all components necessary for construction. A sensitive Receiver with the additional luxury of an Air Band section to pick up Aircraft from many miles away. Full Instruction Manual enables stage by stage construction. Uses P.P.9 and P.P.3 Nine Volt Batteries.

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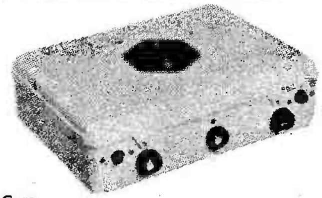
COMPLETELY SOLDERLESS ELECTRONIC CONSTRUCTION KIT
BUILD THESE PROJECTS WITHOUT SOLDERING IRON OR SOLDER



Complete kit of parts including construction plans. Total building costs **£9·99** + P & P and Ins. £1·10

- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN—PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker. Radio MW/LW.
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal Radio
- One Transistor Radio
- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier

● 24 Resistors ● 21 Capacitors ● 10 Transistors ● 5" × 3" Loudspeaker ● Earpiece ● Mica Baseboard ● 3 12-way Connectors ● 2 Volume Controls ● 2 Slider Switches ● 1 Tuning Condenser ● 3 Knobs ● Ready Wound MW/LW/SW Coils ● Ferrite Rod ● 6½ yards of wire ● 1 yard of sleeving, etc.

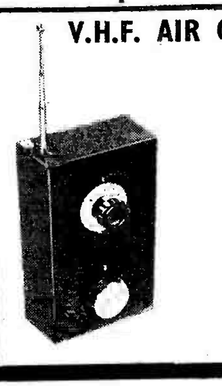
E.V.6. PLUS ONE

Build this exciting new design. Now with 7 Transistors and 4 diodes. MW/LW. Powered by 9V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in. loudspeaker. Attractive case with red speaker grille. Size 9in. × 5¼in. × 2¾in. approx. All parts including Case and Plans.

Total Building Costs **£6·95** + P & P and ins. 90p

ALL PRICES INCLUDE VAT

V.H.F. AIR CONVERTER KIT



Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to medium wave or the VHF band and operating as shown in the instructions supplied free with all parts. Uses a retractable chrome plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc. All parts including case and plans

£4·95 + P & P and Ins. 60p

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4v	7 amp	TM 32	£2·70
6v	¾ amp	TM 3	85
6·5v	¾ amp	TM 37	85
6·5v	200 ma	TM 21	£1·62
6·5v–0–6·5v	100mA	TM 21	£1·62
6·5v–0–6·5v	750mA	TM 7	£2·16
6·3v–0–6·3v	100mA	TM 33	£1·62
6·3v	2 amp	TM 4	£1·89
8·5v	1 amp	TM 12	£1·62
8·5v + 8·5v sep winding	½ amp	TM 12	£1·62
9v	1 amp	TM 5	£1·62
9v	1 amp 'c' core	TM 6	£1·80
9v	3½ amp	TM 11	£2·70
9v	5 amp	TM 38	£3·24
10v	25 amp	TM 15	£4·86
10v–0–10v	12½ amp	TM 15	£4·86
12v–0–12v	4 amp	TM 27	£4·32
12v	½ amp	TM 9	£1·05
13v	¾ amp	TM 7	£2·16
12v	1 amp	TM 10	£1·89
12v–0–12v	50mA	TM 19	£1·62
12v–0–12v	1 amp	TM 41	£3·24
15v tapped 9v	2 amp	TM 11	£2·70
15v	7 amp	TM 27	£4·32
15v–0–15v	3½ amp	TM 27	£4·32
15v–0–15v	3½ amp	TM 35	£4·86
17v	½ amp	TM 12	£1·62
18v	¾ amp	TM 13	£1·90
20v	½ amp	TM 14	£1·62
20v	5 amp	TM 27	£4·32
20v	12½ amp	TM 15	£4·86
20v–0–20v	6 amp	TM 15	£4·86
13v	100mA	TM 21	£1·62
24v	1½ amp	TM 16	£2·12
24v	2 amp	TM 17	£2·70
24v + 2v 7 amp	2 amp	TM 39	£2·97
24v	4 amp	TM 40	£3·78
25v	1½ amp	TM 18	£2·43
26v	2 amp	TM 39	£2·98
30v tapped 24, 20, 15 & 12	3½ amp	TM 27	£4·32
30v	8 amp	TM 15	£4·86
37v	37 amp	TM 34	£31·86
40v tapped at 30v, 20v & 10v	6 amp	TM 15	£4·86
50v-2 amp with 6·3v shrouded		TM 22	£4·86
50v	8 amp	TM 29	£11·65
60v	5 amp	TM 24	£7·02
75v–3 amp with 6·3v shrouded		TM 23	£8·10
75v	4½ amp	TM 24	£7·02
80v tapped 60v & 75v	4 amp	TM 24	£7·02
100v	1 amp	TM 25	£7·02
100v–0–100v	½ amp	TM 25	£7·02
130v tapped 120v	½ amp	TM 28	£3·78
200v	½ amp	TM 25	£7·02
250v–0–250v with 6·3v 2A	50mA	TM 36	£3·78
250v	100mA	TM 36	£3·78
500v	50mA	TM 36	£3·78
260v	60mA	TM 26	£3·24
1Kv		TM 44	P.O.A.
2Kv		TM 44	P.O.A.
5Kv	5mA	TM 30	£7·02
8·5Kv	10mA	TM 31	£10·26

Quality prices available. Please, unless you are calling, add 25% to your order to cover the cost of carriage, Also if you want to collect, telephone the day before.

Quick Cuppa. Mini immersion heater, ideal for taking on holiday, for making a "quick cuppa" tea, or for having by the bedside for baby's feed etc. 250w heater @ 230 volts or approximately 90 watts @ 110 volts. Price **£2·95.**

Neon Screwdrivers. Two useful models:– 7½" price **70p** and 5½" price **55p.**

240° 1mA Moving Coil Panel Meter. A large instrument, size approximately 4½" square at the front and 4½" deep. Intended for panel mounting, its scale is calibrated 0–7 and it was intended to be used as rev. counter. **£14** each.

Pressure Switch. Adjustable through a range of pressures from where it can be operated by sucking or lowing to approx. 50 psi–10 amp changeover microswitch, metal body with threaded inlet. Price **£2·90.**

Push-Push Switch. Fixed through panel this is a ratchet action, double pole changeover switch, the contacts we understand are hard gold plated. Spindle is ¼" diameter so that a standard radio knob can be fitted. Price **30p** + 3p. Good quantity available at usual discounts.

C.R.T. Display Unit. We feel this would be easy to convert to an oscilloscope, it has all the necessary ingredients. It is in a case size 15" × 10" × 11" approx. with a carrying handle and a front protection flap. Plenty of controls and is mains operated through step down transformer. Size of the tube is 3". Price **£16·75.**

VU Meter Edgewise mounting, through hole size 1½" × ½" approx: these are 100 micro amp fsd and fitted with internal 6 volt bulb for scale illumination, also have zero reset. The scale is not calibrated but has very modern appearance. Price **£1·85.**

Cassette Mechanism. Jap. made to rigid specification. These will fit many music centres and cassette players. Chassis size approx. 4½" wide by 5½" deep, 6v motor and tape position counter at the rear. The six levers for "play", "fast forward", "rewind", "stop", record and eject are all at the front, as is the auto mechanism to stop the motor when tape end is reached. These are new and unused and have record playback and erase heads. Limited quantity. Price **£15·50.**

Shortened 3kw Tangential Heater. This is in fact near enough the same size as the normal 2kw tangential. Motor runs a bit faster to compensate for the increased heating and the fan impellers are metal to save any possibility of extra heat distorting them. The heater element is tapped so that 1, 2 or 3kw's of heating can be used or of course this will blow cold. Price **£8·95,** post £1·50p + 12p.

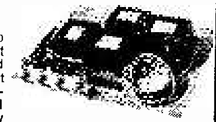
Omron 410 Relay. Built like a contactor, this has a clear plastic cover over the working parts but the terminals are all brought out of the front so that connection may be made without removing the cover also the relay may be fitted into position and the wires brought to it afterwards, generously rated at 10 amps the contacts are really more like 15 amps, they are changeover and there are 4 sets of them. A really robust relay which looks as though it will give a lifetime of service. Size 3½" × 3" × 3½" high. Price **£4·50.**

8 Track Cartridge Players. In car units with amplifiers but this amplifier may need attention, mechanism guaranteed O.K. **£9·00** + 19p.

Low rpm Crouzet Meters. Two more types have just come in; these are 2 rpm and 15 rpm, both 115v motors but as these consume only two to three watts it is a simple matter to divide the mains voltage using a mains working condenser, resistor auto transformer or of course use them in pairs. Price **£2·25, £2·00** + 16p each.

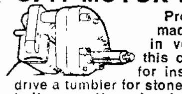
12 volt Miniature Relay. Gold plated contacts with plastic dust covers 4 sets of changeover contacts, **90p,** bases **15p.**

MULLARD UNILEX



A mains operated 4+4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of Plessey speakers this should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£15** including VAT and postage.

SPIT MOTOR WITH CARTER G/BOX

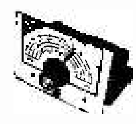


Probably one of the best spit motors made. Originally intended to be used in very high priced cookers, however this can be put to plenty of other uses, for instance your garden barbeque or to drive a tumbler for stone polishing; in fact there are no ends to its uses. Normal mains operation. **£4·32.**

PP3/PP9 REPLACEMENT MAINS UNIT

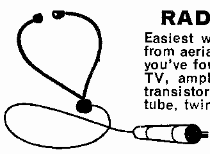
Japanese made in plastic container with leads size 2" × 1½" × 1½", this is ideal to power a calculator or radio, it has a full wave rectified and smoothed output of 9 volts suitable for a loading of up to 100mA. **£2·53.**

SHORTWAVE CRYSTAL SET



Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94**—crystal earphone **55p** including VAT and postage.

RADIO STETHOSCOPE



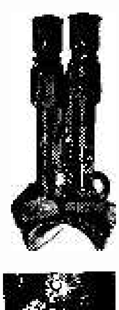
Easiest way to fault find, traces signal from aerial to speaker when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube, twin stetho-set. **£3·95.**

BREAKDOWN PARCEL

Four unused, made for computer units containing most useful components, and these components unlike those from most computer panels, have wire ends of usable length. The transistors for instance have leads over 1" long—the diodes have approx. ½" leads.

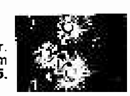
List of the major components is as follows:—17 assorted transistors—38 assorted diodes—60 assorted resistors and condensers—4 gold plated plugs in units which can serve as multipin plugs or as hook up boards for experimental or quickly changed circuits (note we can supply the socket boards which were made to receive these units). The price of this four unit parcel is **£1** including VAT and post (considerably less than value of the transistors or diodes alone). DON'T MISS THIS SPLENDID OFFER.

INFRA RED BINOCULARS



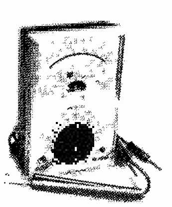
Made for military purposes during and immediately after the last war to enable snipers, vehicle drivers, etc. to see in the dark. The binoculars have to be fed from a high voltage source (5KV approx.) and providing the objects are in the rays of an infra red beam then the binoculars will enable these objects to be seen. Each binocular eye tube contains a complete optical lens system as well as the infra red cell, technical data on which is available. The binoculars are unused, believed to be in good order. Sold without guarantee.
Price **£17·50** per set. Post & VAT £2·50.

SOUND TO LIGHT UNIT



Add colour or white light to your amplifier. Will operate 1, 2 or 3 lamps (maximum 450W). Unit in box all ready to work. **£9·95.**

MINI-MULTI TESTER



Amazing, deluxe pocket size precision moving coil instrument—jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000
AC volts 10, 50, 250, 1000
DC amps 0–1 mA and 0–100 mA
Continuity and resistance 0–150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.

Unbelievable value only **£5·50p + 50p** post and insurance.

FREE Amps ranges kit enable you to read AC current from 0–10 amps, directly on the 0–10 scale. It's free if you purchase quickly, but if you already own a mini tester and would like one send £1·50p.

Terms: Prices include Post & VAT. But orders under £6·00 please add 50p to offset packing. Bulk enquiries—Please Phone for Generous Discounts 688 1833.

J. BULL (ELECTRICAL) LTD

(Dept. P. W.), 103 TAMWORTH RD., CROYDON CR8 1SG

IT'S FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains sell out before our advertisement can appear—It's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lists.

Mains Transformer. Small 2 secondaries, 115 volts at 10 mA and 6·3 volt @ ½A, a useful transformer for many instruments. **£2·70.**

25 Watt Audio Systems in Cabinets. Comprising 8" woofer and 3" tweeter with crossover and terminal connection panel, mounted in simulated teak finish cabinet with fabric front. These are extremely good quality units comparable with those selling at twice the price. Cabinet size approx. 20" high 10½" wide and 8½" deep, heavy cabinet made of thick blockboard. Price **£25·00** the pair, well worth your coming in to collect them but if you cannot collect them, then still worth adding £5·00 the pair for carriage.

Another Special Item, for callers this month is a pen recorder. Mains operated this is biggish instrument which probably cost originally several hundreds of pounds. We are having a reverse auction on this. The starting price is £50 but the price will come down £5·00 per week until it is sold.

Opto Electronics. Two special bargains in this field, the OPCP 70, price **75p** and the ORP 12, price **85p.**

Tilt Switch 15 amp. Meant to switch off heater should it be knocked over; this pendulum operated switch is on only when it is in the upright position. It could be incorporated in burglar alarm, car alarms etc. Contacts look quite able to cope with 15 amp loads at mains voltage. Price **50p** + 4p.

Neon Indicator Lamp. Two features about this particular one are—it has screw down terminal connectors for wiring and is fixed by a single threaded screw. The lens is clear so you could colour to suit your needs. Price **35p.**

Indicator Lamp Holders. For low voltage lamps (Liliput) type, we have these in five different colours—red, yellow, blue, green and white. Price **35p.**

Twin Padded Flex. 5 amp ideal for some electric irons and appliances which require very flexible lead, 10 metre lengths. Price **£1·50.**

Heating Pads. These measure 11" long × 8½" wide and are flat. Look rather like pieces of thick blotting paper. Wire ended 250 watt or joined in series they would be approximately 60 watt each. Dozens of uses. Price **80p** or two for **£1·50.**

Rod Thermostat. For high temperatures up to 550°F. This is adjustable either at the head or remotely by a length of flexible drive. Price **£2·95.**

Interval Timer. As used in schools and similar establishments to trigger off the bell which sounds the end of lessons, lunch breaks etc. This is another one off item we feel for callers only. It is in polish hardwood case, glass fronted, comprises a 24 hour switch, a large brass disc and other smaller discs on which the time is set out in relatively small intervals and a pair of contacts to switch a bell or something similar at precise times during the week. Price **£55·00.**

Two More Mullard Modules. Pre amp module ref. 1181/1183, stereo or mono. It is on a printed circuit board with wire connections. Supplied complete with connection diagram. Price **99p.**

Mullard IF Module Type 1181. In a metal case 2¾" long × 1½" wide × ¾" thick. Can be mounted on a printed circuit board connection to wire lead outs. Price **£1·25.**

Silicon Diodes. Two special bargains this month. 400 volt 1 amp, 10 for **£1·25.** 50 volt 1 amp, 20 for **£1·25.** Large quantities available at very much discounted prices.

Flex Cable Bargains. Core size 5mm 2 white pvc outer, pvc covered cores. Coloured coded with the usual blue, brown and green/yellow. Price 100 metre coil for **£10·25.**

Electrical Installation Work. We have good stocks of all the mains items required for ring mains and light installations, for example we have 2·5mm twin and earth pvc covered at **£12·50** + £1·00. Carriage £2·00 + 16p. We hope to make a complete list of the installation items we have in time for our next newsletter but if there is anything you are wanting by all means give us a ring.

Plastic Case Sections. Small very tough plastic cases at very reasonable prices, always repeatable. The case is 2–11/16" long. Section A is ½" deep and section B 1" deep, use 2AA's 2BB's or an A and a B to get different depths, i.e. 1½", 1½" or 2"–note these are external dimensions, the wall thickness of the case of 15" thick. Price, section A **25p,** B **30p.**

Computor Capacitors. Made by famous American companies for working under very exacting conditions. These are large condensers in Alicans for upright mounting. Ideal if you want to make a large storage bank 15,500 uf 10 volts working, 15 volts surge, 10 for **£8.**

Alarm Bells. Holiday time can often be a heyday for house breakers; why not fit a really loud alarm as good a method as any is to use trigger mats under carpets, at windows and doorways. Join them all in series through a latching circuit to sound off a really loud bell or hooter, prices of these various parts are as follows:

Loud Ringing Bell, industrial type with 6" gong, 24v, DC operated, price **£7·50.**

Switch Trigger Mat, size 24" × 18" for going under carpet etc. Price **£2·50.**

24v Relay with latching contacts. Price **95p.**

Secret Switch with key, Price **85p.**

24v 1 amp DC Power Supply Price **£5·50.**

Circuit Diagram. No charge, just request.

Mouth Operated Switch. Probably not made with this use in mind, more likely made for washing machines to control water level etc. this is a **sensitive low pressure** device which operates three 1 pole changeover switches at different levels of pressure but all within a normal persons blowing capacity—blow gently into it and No. 1 switch operates, blow a little stronger and No. 2 operates, blow harder still and No. 3 operates. The switch is airtight so weight of water or other fluid substance could operate it. Undoubtedly a switch with very many applications. Disc type construction, this is approximately 3½" dia. × 1¾" thick—the air entry is a pipe approximately 3/16" diameter—electrical contacts we estimate a 10 amp c/o a 230 volt connection by push on tags. Order ref. PS.4. Price **£1·95.** Large quantity available.

Powerful Induction Motor. 1½" stack, double ended, would drive a small lathe, drill or grinder or would power a blowing or extracting fan. Fit suitable pulleys and it would drive a pebble polisher or similar, being double ended it will drive in either direction. Can also be fixed from either end, fixing bolts are fitted and these are 1¾" apart. Spindles ½" diameter, extend 1¾" beyond each end plate. A motor like this would cost at least £3 from makes but we have a large quantity to offer at **£2·50,** Order Ref. MM.10.

Can any reader help! We urgently need some reasonably priced decoders to go with the F.M. tuner we have. If you can help us to find a supply we will be very much obliged and will try to do you a good turn some day—thank you.

TRANSISTOR/IC PRICE LIST. RETAIL

AC107	60
125	30
126	35
127	40
128	40
176	45
187	45
188	45
ACY19	50
20	45
44	75
AD140	70
141	70
161	95
162	95
AF115	60
116	60
117	60
118	60
124	60
139	65
172	65
239	65
279	75
AFZ12	1·30
ASZ21	1·50
BA100	16
102	16
110	30
112	28
114	10
115	15
156	14
167	10
202	10
BAV75	
BAX17	12
BAY38	25
72	20
BC107	13
108	13
109	14
113	18
114	18
115	18
116	18
117	18
118	18
119	26
126	22
132	26
134	18
135	18
136	18
137	18
143	26
147	12
148	12
149	14
153	25
157	13
158	13
159	14
160	34
167	12
168	12
169	12
171	14
172	14
177	20
178	20
182	12
183	12
184	12
186	22
187	25
204	15
205	15
207	15
208	15
209	15
212	15
213	12
214	15
237	12
238	12
239	15
257	16
259	16
261	22
263	26
287	25
300	40
301	40
303	45
308	14
318	12
328	18
337	18
348	12
349	12
486	
BCY30	1·00

BC 31	1·00
32	1·00
33	1·00
34	1·00
38	2·00
39	2·00
55	3·00
Y70	19
71	23
72	16
BD115	80
116	1·20
121	2·00
123	2·00
127	
131	50
132	65
135	35
136	35
139	40
140	40
153	90
156	90
165	45
183	2·10
259	48
436	80
561	95
562	95
BDY10	2·00
11	1·35
19	1·60
20	1·60
BF123	55
125	35
152	24
163	20
164	25
167	34
180	34
185	34
194	14
195	14
196	14
197	16
198	16
200	34
224	20
240	20
244	34
245	40
259	32
263	68
271	24
273	50
274	50
337	45
394	30
BFR39	27
40	26
41	27
79	27
BFS21	2·50
28	1·35
BFW58	
BFX29	30
30	30
34	60
43	
82	
84	30
85	30
86	30
87	30
88	30
BFY10	1·00
30	24
44	
50	24
51	24
52	24
53	34
72	90
90	1·20
BR101	50
BRY39	50
BSW63	
68	
BSX19	32
21	32
81	
BSY38	30
39	30
52	30
95	34
BY101	25
114	30
127	34
238	80
BYX10	
22	
GET16	

20	
672	
883	
KSP1174	70
1175	70
1176	70
2373	1·80
MBC337	15
MD2369	1·40
ME0210	20
0401	20
0402	20
0411	20
0413	15
4001	14
4002	14
4010	12
6101	20
6102	20
MJ340	
481	1·50
2801	1·40
2901	1·90
MJE340	55
520	45
521	64
2955	1·20
3055	95
NKT135	
212	
222	
273	
OA5	60
10	50
47	13
70	20
73	25
79	28
81	16
85	16
90	8
91	8
200	10
202	12
210	80
211	64
OC16	
16	
19	
22	3·00
23	
25	2·74
26	1·40
28	2·00
29	2·00
35	1·50
36	1·50
40	75
45	75
71	40
72	40
75	45
76	45
81	70
83	50
84	
139	1·40
170	70
171	60
200	90
201	70
202	2·40
203	2·40
205	2·50
SDT1062	
1064	
1152	
1159	
5503	
5553	
7603	
7604	
9200	
9801	
9803	
TIC44	30
TIP29A	45
29B	50
29C	60
30A	60
30B	65
30C	65
31A	50
31B	65
31C	65
32A	55
32B	65
32C	75
33A	80
33B	1·08
33C	1·08
34A	90
34B	95

TIP34C	1·20
35A	2·50
35B	2·70
35C	3·00
36A	2·75
36B	3·00
36C	3·20
41A	65
41B	75
41C	90
42A	80
42B	85
42C	1·00
2955	1·05
3055	1·00
TIS43	40
-46	50
50	50
52	70
90	20
92	30
UT2020	
UZ5111	
5839	
5856	
ZTX107	14
300	14
301	14
302	22
311	16
313	18
500	14
501	14
502	16
503	14
504	25
505	35
550	35
IN60	
483	
641	
645	
649	
659	7
780	
785	
914	6
916	6
4001	6
4002	7
4003	8
4004	8
4005	10
4006	10
4007	11
4148	6
4193	
4816	
5256	
5400	13
5407	25
IS44	7
85	
100	
103	
132	20
1555	
2472	
990	
2N457	
458	
498	
696	34
697	28
698	42
699	50
706	25
708	25
929	34
930	34
1050	
1132	30
1302	70
1303	70
1304	70
1305	70
1306	90
1307	90
1308	1·00
1309	1·00
1479	
1596	
1602	
1613	25
1711	25
1890	25
1893	25
2060	6·30
2147	1·40
2160	1·40
2217	50
2218	30
2219	33

2N2222	22
2368	23
2369	23
2398	
2411	72
2412	72
2477	1·00
2498	1·80
2646	72
2696	1·20
2697	
2698	
2846	70
2869	
2876	
2904	27
2905	27
2906	22
2907	22
2924	14
2926	14
2946	
3014	
3053	22
3054	65
3055	70
3252	
3792	2·10
3794	18
3819	33
3820	33
3823	76
3824	72
3830	
3866	1·80
3903	17
3904	15
3905	15
3906	15
3926	
4014	
4036	65
4037	55
4050	
4058	20
4059	15
4061	15
4062	18
4126	16
4230	1·00
4236	1·50
4239	1·40
4240	1·50
4259	
4286	18
4287	18
4288	18
4289	18
4290	18
4291	18
4292	23
4302	27
4340	
4348	2·30
4402	17
4416	80
4430	
4444	1·90
4861	
4871	45
4903	2·50
4904	1·65
4919	60
4922	54
4923	68
5060	30
5069	95
5191	68
5192	72
5194	72
5195	86
5245	33
5276	
5296	40
5297	70
5298	40
5320	50
5447	14
5467	
5485	35
5490	57
5555	60
5717	
5777	45
6027	57
6343	
3N38	90
76	1·32
81	3·10
83	2·00
84	
128	1·20
140	1·00

3N141	85
143	80
153	80
154	90
187	1·60
201	1·20
RCA40347	55
40360	50
40361	50
40362	50
40374	1·50
40407	50
40408	75
40412	60
40430	85
40432	90
40467	95
40468	60
40486	85
40543	1·35
40594	80
40595	90
40600	75
40603	60
40636	1·20
40669	1·10
40673	
40842	1·10
16083	1·20
16795	1·40
Diodes	
·6A 1500V	35
2A 100V	16
2A 600V	20
2A 800V	24
3A 50V	18
3A 200V	22
3A 600V	30
Bridges	
·75A 100V	
1A 40V	30
1A 100V	40
2A 100V	40
3A 200V	50
4A 50V	60
4A 100V	70
Logic CMOS	
4000	20
4001	20
4002	20
4006	1·25
4007	20
4008	1·00
4011	22
4012	22
4013	50
4014	1·00
4015	1·05
4016	50
4017	1·00
4018	1·05
4020	1·10
4021	1·05
4022	1·00
4023	22
4024	75
4025	22
4027	55
4028	90
4029	1·10
4032	1·34
4034	
4043	1·05
4044	1·00
4046	1·50
4049	55
4050	55
4051	85
4052	85
4053	85
4066	75
4068	28
4069	25
4070	65
4071	24
4072	27
4073	24
4075	24
4076	1·00
4077	70
4078	25
4081	24
4082	28
4093	1·60
4160	
4510	1·20
4511	1·75
4512	
4516	2·10
4518	1·20
4528	

Logic TTL	
7400	17
7401	17
7402	17
7403	17
7404	17
7405	22
7406	52
7407	52
7408	22
7409	22
7410	20
7411	25
7412	20
7413	35
7414	60
7416	35
7417	35
7419	25
7420	20
7422	20
7423	30
7425	30
7426	30
7428	30
7430	20
7432	30
7433	30
7437	40
7438	30
7440	20
7441	85
7442	65
7443	95
7445	1·10
7446	90
7447	85
7448	85
7450	20
7451	20
7453	20
7460	20
7470	30
7472	25
7473	30
7474	35
7475	48
7476	30
7480	50
7481	95
7482	76
7483	85
7485	1·10
7486	33
7489	2·60
7490	45
7491	75
7492	45
7493	45
7494	80
7495	70
7496	80
7497	2·10
74100	1·30
74104	50
74105	50
74107	34
74110	40
74118	90
74119	1·40
74121	40
74122	50
74123	60
74125	50
74132	60
74136	
74141	70
74145	80
74150	1·40
74151	70
74153	80
74154	1·20
74155	70
74156	72
74157	75
74160	1·00
74161	1·00
74162	1·00
74163	1·00
74164	1·20
74165	1·20
74166	1·20
74167	2·60
74170	2·00
74174	1·12
74175	80
74176	1·00
74177	90
741080	95
74181	2·30
74182	75
74184	1·45
74185	1·30

Logic TTL (cont)	
74188	3·20
74190	1·20
74192	1·20
74193	1·20
74194	1·00
74195	75
74196	1·00
74197	1·00
74198	2·00
74199	2·00
74283	
75450	
75451	
75452	
75453	
75454	
74H00	50
74H11	60
74H40	55
74L10	32
74LS253	
74S04	
74S08	
74S10	
74S20	
72710	
76630	
6601	
8281	
8836	
CA3005	2·20
3014	2·00
3018	65
3020	2·00
3028	80
3036	1·00
3046	65
3048	2·15
3075	1·50
3089	2·60
3090	3·90
MC724	1·85
1216	1·46
1303	1·80
1307	1·50
1310	2·20
1327	1·50
1350	1·80
1352	1·00
1458	
1463	3·45
1469	2·75
MFC6050	90
9601	
Lin. I/Cs	
511	
560	4·00
570	
706	
709	58
723	68
724	
733	
741	25
747	85
748	45
930	60
L129	75
130	75
131	75
LM304	2·35
309	1·70
340	75
380	85
3900	60
L005	1·45
036	1·45
NE555	35
556	60
TAA640	
700	4·30
861	
TBA480	2·60
510	2·35
520	2·60
530	2·35
550	3·50
800	1·15
810	1·10
820	1·05
TDA1200	
7805 1·50	1A 1·50
7812 1·50	100 mA
7824 1·50	·75
DL707	
747	
96439	
TIL 209	
R15/G20/Y25	

Prices missing P.O.A.

HARDWARE, KNOBS, CHASSIS RADIOS/AMPLIFIERS, WIRE AND CABLES, TEST METERS, PANEL METERS, PLUGS, SOCKETS, CONNECTORS, SLEEVING, ALUMINIUM BOXES, PCB, VERO PRODUCTS, GROMMETS, STABILISED POWER SUPPLIES, SMALL SPEAKERS.

IN OTHER WORDS ALMOST EVERYTHING FOR THE ENTERPRISING CONSTRUCTOR.

★ SPECIAL OFFER ★

BIGITRON stereo cassette deck complete mechanism, inc, heads, motor keys etc. Brand new in manufacturer's packing, £7·50 each + 12½ VAT.

SWITCHES

PTM, PTB	25p
PUSH BANKS	40-60p
TOGGLE STD.	40p
TOGGLE MIN	85p
SLIDE	15-20p
ROTARY	35p

ALUMINIUM BOXES

AB7	2 × 5¼ × 1½	66p
AB8	4 × 4 × 1½	66p
AB9	4 × 2½ × 1½	66p
AB10	4 × 5¼ × 1½	66p
AB11	4 × 2 × 2	77p
AB12	3 × 2 × 1	66p
AB13	6 × 4 × 2	93p
AB14	7 × 5 × 2½	£1·10
AB15	8 × 6 × 3	£1·40
AB16	10 × 7 × 3	£1·60
AB17	10 × 4½ × 3	£1·32
AB18	12 × 5 × 3	£1·60
AB19	12 × 8 × 3	£2·20

Prices subject to change + 8% VAT.

TRANSFORMERS

V	I	£
6v	250Ma	0·95
6-0-6v	1·5A	2·10
6·3v	1·5A	2·10
7v	250Ma	1·20
9v	2A	1·60
9-0-9v	100Ma	1·00
12v	100Ma	80p
12v	1 AMP	1·60
12V	2 AMP	1·80
12-0-12v	100Ma	1·20
15v	2A	2·20
15-0-15v	2·5A	2·60
18v	250Ma	1·20
18v	2·5A	1·80
20-0-20v	2A	3·30
24v	100Ma	1·20
24v	2A	2·30
25-0-25v	2A	5·00
0-28-0-6v	1A	1·20
30V	250Ma	1·35
30-0-30	1A	3·20

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BACK NUMBERS

We are very glad to announce the re-establishment of a PW Back Numbers Service for our readers. In future back numbers dated from June 1977 only will be available from our Post Sales Department for 65p, which includes postage and packing. Cheques and Postal Orders should be made payable to IPC Magazines Ltd.

Send your orders to:- Post Sales Department, IPC Magazines Ltd., Lavington House, Lavington Street, London SE1 0PF.

Standards

FROM time to time, *Practical Wireless* receives letters decrying the fact that we continue to publish circuit diagrams in which symbols other than those laid down in BS:3939 are used. We are by no means the only "offender", and in fact a letter published in the latest issue of *Electronic Technology*, the journal of the Society of Radio and Electronic Technicians, slates the whole of the UK technical press, with the exception of the text-book publishers.

The writer of that letter, a lecturer in Radio and TV studies at a south coast technical college, complains that his students have to learn not only the BS:3939 symbols for their examinations, but also a variety of other symbols in order to understand circuits published in technical journals. He sees this as a waste of time, and exhorts those responsible to get into line.

While I am, in general, in favour of standardisation, it is as well to realise that we live in a real world. Even if all UK technical journals and magazines used BS:3939 symbols exclusively from now on, there is a wealth of material, both existing and still coming in from abroad, which uses other symbols. If we are not to dismiss that material completely, we must accept that there is this variety and learn to interpret the various forms encountered.

It is, in any case, arguable whether some of the BS:3939 symbols are the best. Taking the humble resistor as an example, while the rectangular box may be simple for a computer or other mechanical draughting machine to draw, the zigzag is much easier to draw freehand with a little practice. Since many draughtsmen now use rub-down transfers to produce finished drawings, it makes little difference to them anyway, so why not make life a little easier for the student and development engineer trying to produce a neat sketch, by sticking with the zigzag? Again, with logic symbols, it has always struck me that the familiar shapes of MIL-STD-806B make a diagram much easier to understand than do the featureless outlines of their BS:3939 counterparts.

It has been said that the prime reason for the adoption of some of the BS:3939 symbols was that they were easier for machines to draw. Since the vast majority of circuit diagrams must surely still be produced by human means, the justification for those symbols is therefore highly questionable. It makes one wonder whether, at some time in the future, the standard which will replace BS:3939 will consist merely of rectangular boxes containing numbers from *1* to *n*, each indicating a different type of circuit element!

Geoffrey C. Arnold

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We do not operate a Technical Query Service except on matters concerning constructional articles published in PW. We do not supply service sheets or information on commercial radios, TV's or electronic equipment.

All queries must be accompanied by a stamped self-addressed envelope otherwise a reply cannot be guaranteed.

NEWS... NEWS... NEWS...

Aid for R & D

The Dept. of Industry has set up an Electrical Technology Requirements Board (ETRB) to fund research and development in the electrical engineering industry. The Board will be composed of eminent British engineers and chaired by Mr. T. W. B. Sallitt, Director, Hawker Sidderly Group Ltd.

The Board will cover such products as motors and generators, transformers, switchgear, cables and accessories, domestic appliances, and miscellaneous electrical equipment including lamps and batteries.

Major objectives of The Board will be to identify those areas which will most benefit from additional research and development, so as to promote technological innovation and to increase the application of known technology.

The Board welcomes applications from private companies as well as research organisations, for financial support on research and development projects, usually on a co-operative basis, in any of the fields mentioned above.

Enquiries should be addressed to: *Dr. L. Goldstone, Executive Officer/ Secretary ETRB, Abell House, John Islip Street, London SW1. Tel: 01-211 3450.*

Look in

Five new promotional films, to be shown by Independent Television programme companies, have been made by the IBA to promote 'better viewing'.

The five films are:

(1) The importance of the receiving aerial (30 seconds).
(2) The importance of correct receiver adjustment (60 seconds).
(3) The expanding coverage of the IBA transmitter networks (60 seconds).
(4) New technical developments in television broadcasting (60 seconds).
(5) Controlling the day-to-day quality of ITV broadcasts (30 seconds).

Film (2) on receiver adjustment is to be backed by a special leaflet which dealers and rental companies will be encouraged to distribute to viewers.

The films include shots of many IBA engineering installations and developments, including the unique Emley Moor concrete aerial tower, low-power solid-state transmitters for local relay stations, the special SABRE adaptive receiving aerial that brings ITV colour to the Channel Islands, DICE—the IBA's pioneering digital standards converter used for intercontinental relays, optional subtitling for the deaf which may become possible by using ORACLE teletext techniques, etc.

New source

Amtest Radio and Electronic Equipment, is a new company set up to specialise in equipment and aerials for s.w. listeners.

They hope in the near future to provide a similar service for long, medium and v.h.f. listeners with the emphasis on DXing.

The company will answer any enquiry, provided it is accompanied by a SAE.

Amtest Radio and Electronic Equipment, 55 Vauxhall Hill, Worcester WR3 8PA. Tel: 0905 22704.

The Wireless?

A foreign spy, an astronaut in deep space, a man in the street . . . what have they in common? A radio receiver!

The cost and sophistication varies enormously over the range of available equipment, from a few pounds for the portable 'transistor' to thousands for radar and satellite communications. No matter what the application the advances since the days of the cat's whisker crystal detector have been considerable and it is proposed to survey the subject at a conference on 'Radio Receivers and Associated Systems' organised by the I.E.R.E. to be held at the University of Southampton from 11-14 July, 1978.

Thirty-seven papers will be delivered formally and a further twenty will be presented in poster-booth sessions. An exhibition of relevant equipment is to be organised by the Electrical Research Association. Further details from:

Conference Secretariat, I.E.R.E., 99 Gower Street, London WC1E 6AZ. Tel: 01-388 3071.

Mobile Rally

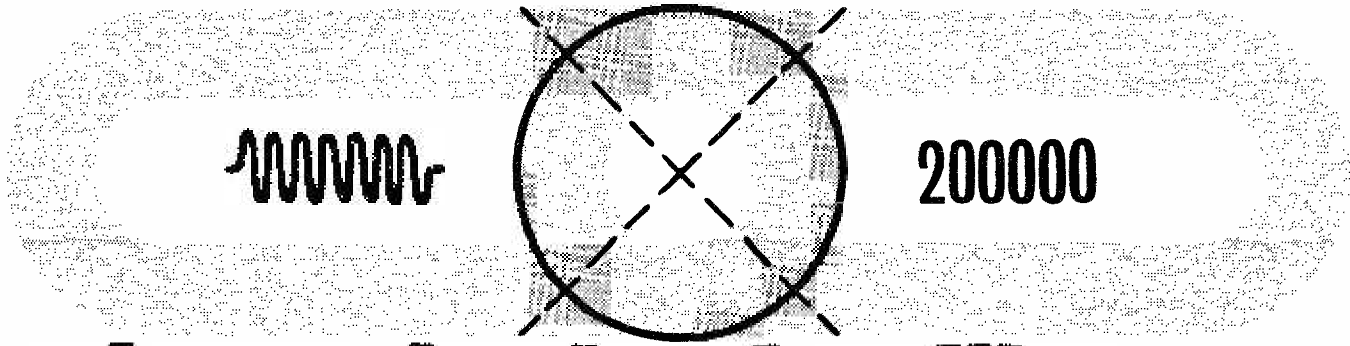
The Nunsfield House Community Association Amateur Radio Group are holding a mobile radio rally on Sunday 11 June 1978 at Elvaston Castle Country Park, which is located 5 miles south-east of Derby on the B5010.

Talk-in stations will be available from 10.00am; G3EEO/P on 160m, G3ZBI/P on 2m f.m. ch. S22, and on 70cm G8KGC/P on f.m. chs. SU8 and SU20. All the usual rally attractions will be present; over 40 trade stands housed in two marquees, bring and buy sale, RSGB bookstall, childrens rides and entertainments, sideshows and a full catering service at competitive prices. The I.B.A. will also be present demonstrating their ORACLE teletext service. The rally will be open from 11.00am and should provide an ideal day out for all the family. Further details are available from: *Ian Cage G4CTZ, 25 Petersham Drive, Alvaston, Derby DE2 0JU.*

Summer School

The Dept. of Electrical Engineering Science at the University of Essex will be holding its annual electronics summer school for teachers during the week 10–14th July, 1978. This year, as well as running two established courses in linear and digital circuit design, a third course in Electronics Systems is being introduced. The object of the course being to cover some of the more difficult material of the AEB Electronics Systems syllabus as well as discussing the teaching aspects of the 'A' level.

The linear design course is concerned with the use of transistors and operational amplifiers in analogue applications; particular emphasis being placed upon design related to basic circuits in a hi-fi amplifier. The digital design course concentrates on the use of the transistor as a switch and develops design using integrated logic circuits. A programme of laboratory work is included on each course. Teachers who require further information contact: *R. J. Mack, Dept. of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester. Tel: 0206 44144 Ext. 2408/ 2299.*



phase-locked calibrator

C.H. LUCK

The purpose of this project is to provide an accurate calibration source for digital frequency meters. The 200kHz Long Wave BBC signal is the standard frequency employed, and by regeneration is formed into a 4 volt peak to peak square wave output. It is emphasised that the calibrator requires moderate signal strength for reliable operation, but should function in most areas of the British Isles.

Circuit Description

The aerial coil is tuned by a trimmer in addition to a fixed capacitor. The signal is fed direct to the gate of Tr1, an f.e.t., which is used purely as a high impedance buffer and works in the source follower mode. This feeds its output through C2 to the base of Tr2 which forms a direct coupled amplifier with Tr3. Tr4 is another buffer used to feed the digital frequency meter without influencing circuit performance.

Regeneration is effected principally by capacitive coupling between the can of Tr3 and the aerial circuit. The overall gain of Tr2-Tr3 is sufficient to clip what would otherwise be a sine wave into a sloping square wave at the collector of Tr3. Transistors 2-4 are not run at the full 9 volt supply but are fed via a decoupled resistor, R7, at about 4·5 volts. This, in conjunction with aerial damping resistor R1, serves to restrict the degree of feedback. This technique was adopted when trying to lock on to a French transmission at 180kHz, a rather weaker signal than the 200kHz transmission.

Phase Locking

The circuit as a whole constitutes a free-running multivibrator which happens to use a tuned aerial as part of its feedback loop. Now, as with any multivibrator, it can be triggered by a suitably strong impulse, and the closer the triggering frequency is to that of the multivibrator, the more readily will phase locking occur. By adjusting the aerial close to 200kHz we allow the received signal to trigger the circuit.

However, we have a problem with triggering in that the received signal strength will vary by vast amounts, depending mainly on the distance from the transmitter. One way to overcome this problem is to devise a multivibrator with minimal feedback level, thereby reducing the trigger level required: hence the technique described here.

Construction

The m.w. winding supplied with the ferrite rod is discarded. Only leads 3 and 5 on the l.w. winding are used; lead 4 may be cut short, the ends carefully cleaned, and the two wires resoldered. If "P" clips are not available for mounting the rod it can be glued with Araldite direct to the top of the board.

The board is drilled to take four 4 BA mounting bolts, two of which secure the "P" clips, and also, as appropriate, for the type of trimmer used. These bolts may also be used to mount the unit in a suitable case if desired.

The components are back-wired on 0·15in matrix plain Veroboard and the layout shown should be adhered to, as spurious feedback plays such an important role.

The leads of R8 are formed into loops close to the resistor body before they pass through the board; these loops form the earth and output terminals. A PP3 type connector is fitted enabling either a PP3 or PP6 to be used.

★ components

Resistors
All ¼W 5% carbon

R1 470kΩ	R2 4·7kΩ
R3 47kΩ	R4 47kΩ
R5 3·3kΩ	R6 1kΩ
R7 1·8kΩ	R8 1kΩ

Capacitors
C1 200pF silvered mica
C2 1nF ceramic
C3 22nF ceramic
C4 10µF electrolytic 6V
TC1 40pF compression trimmer

Semiconductors
Tr1 2N3819
Tr2, 3, and 4 BC109

Miscellaneous
L1 Denco 5FR m.w./l.w. with ferrite rod, or similar, "P" clips, 4BA bolts—4 off, plain Veroboard 64mm × 95mm 0·15in. matrix, suitable case (optional), PP3 connector

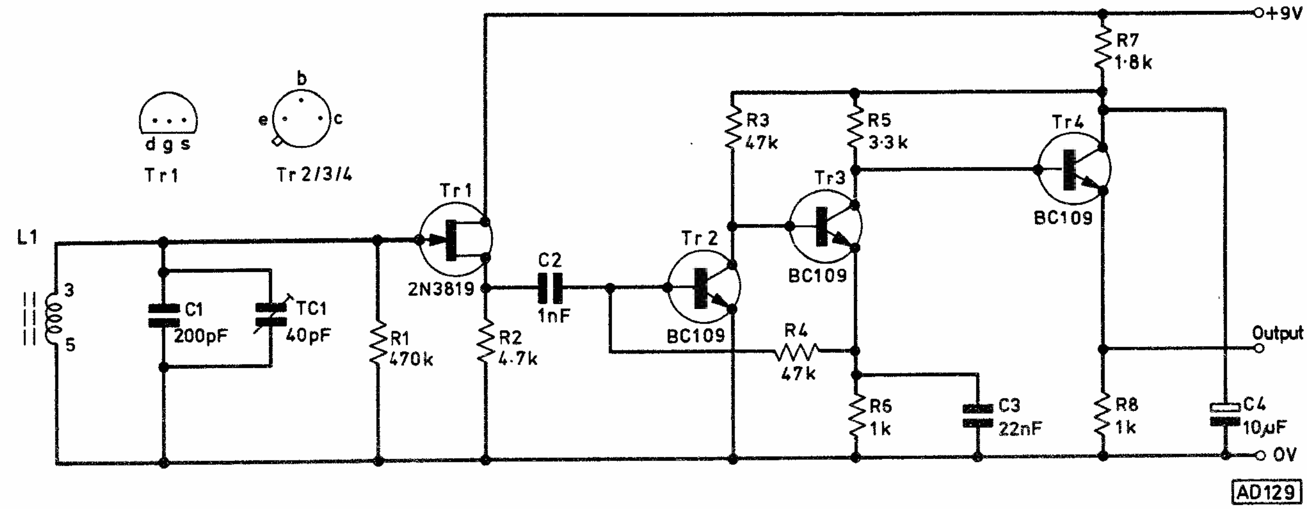
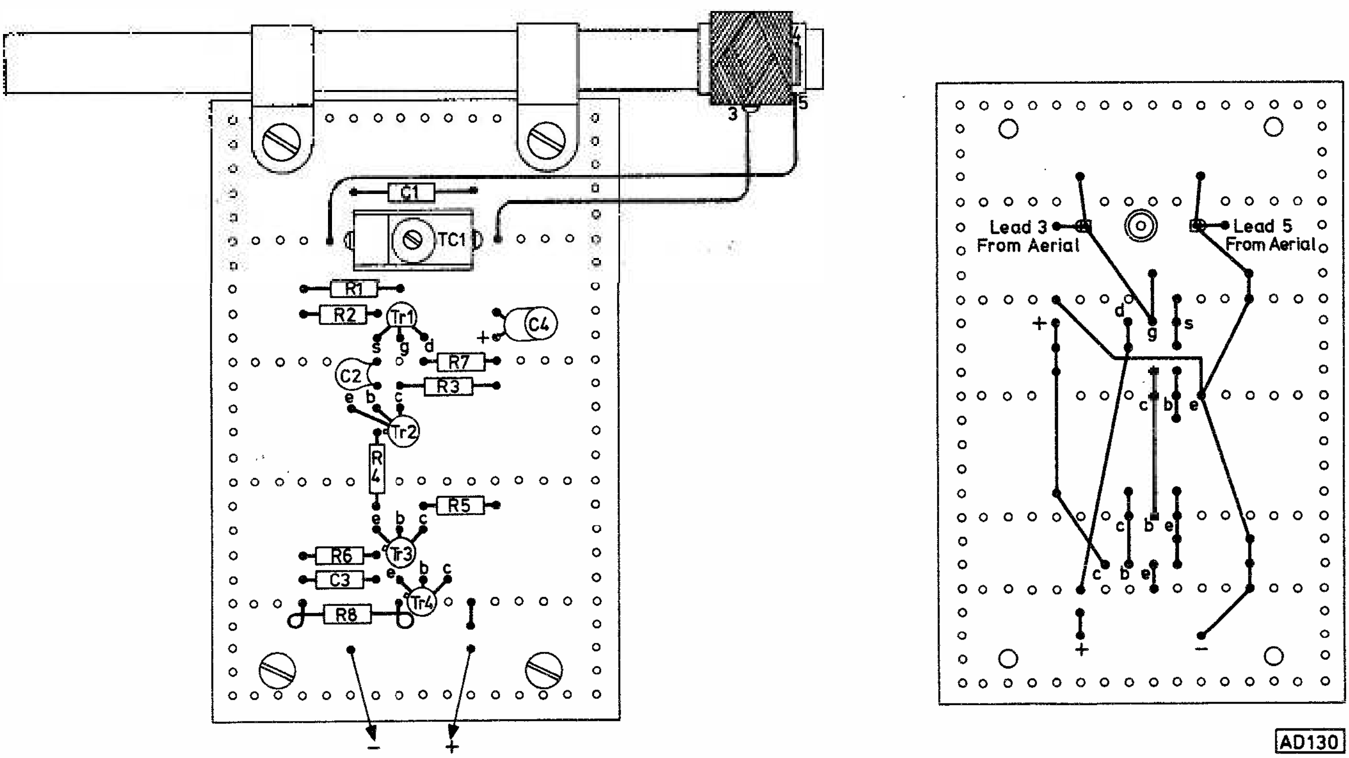


Fig. 1: (above) The complete circuit diagram of the Phase-Locked Calibrator

Fig. 2: (below) Component layout and wiring of the perforated board



Alignment

The equipment required for setting up is no more than a Long Wave receiver and an insulated trimming tool (a plastic knitting needle filed to shape will serve). Proceed as follows.

1. Screw down TC1, then unscrew $\frac{1}{2}$ to $\frac{3}{4}$ of a turn.
2. Connect the frequency meter earth to the 0V side of R8 and the probe to the output loop. Ensure that the unshielded section of the probe runs directly away from the aerial.
3. Connect a battery to the calibrator and then tune in 200kHz on the receiver which is placed nearby with both aligned for best reception.
4. Adjust the coil former on the ferrite rod until a heterodyne whistle is heard from the receiver; continue until the note is fairly low.
5. Using the trimming tool adjust TC1 until the beat disappears altogether. At this point the calibrator is phase locked to 200kHz.
6. Switch on the frequency meter, and after a suitable warming-up period make any adjustment necessary.

The coil former may be fixed in place with a few drops of candle wax melted with a soldering iron.

Final Notes

Remember that any digital frequency meter will have a last digit error of plus or minus one, so don't expect the readout to be rock steady. Static or man-made interference, including radiations from the meter itself, if too close, can cause a momentary spurious reading. The circuit, which consumes about 4mA, is quite tolerant of falling battery voltage.

The prototype was used some 90 miles from the transmitter at which range locking occurs without difficulty, but at appreciably greater ranges it could be more of a problem. ●

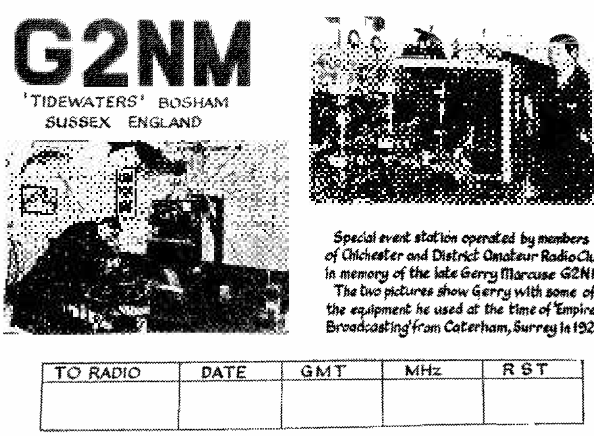
Receiver with Screened-grid H.F. Amplification" covering 20-48 metres. The circuit consisted of a screened grid h.f. stage followed by a leaky grid detector with reaction and two l.f. stages; the price, £25, exclusive of royalty, valves and batteries.

Receiver Designs

Somewhat different to the Short-Wave 2 described by H. B. Dent, *Wireless World* (4.11.32) covering from 15 to 80 metres with 5 plug-in coils. The blueprint was obtainable from *WW* for 1s.6d, post free, the receiver was available for inspection at their Editorial Offices in Fleet Street and the approximate cost of the parts, excluding valves, was £4.12s.0d.

For some years, up until the end of 1924, *Wireless World* was the official organ of the Radio Society of Great Britain, and in July 1925 the first issue of the *T and R Bulletin*, forerunner of today's *Radio Communication*, was published at the instigation of Henry Bevan Swift, G2TI, and Gerald Marcuse.

In later years the Marcuse family moved to the picturesque seaside village of Bosham, Sussex, where today, outside the church stands a teak seat on which is a bronze plaque inscribed:—"In Memory of Gerald Marcuse, G2NM, Pioneer of Empire Broadcasting, President RSGB 1929-30", accompanied by the badges of both the RSGB and RAOTA. This memorial seat was handed over to the Chairman of Bosham Parish Council (Mr Frank Parham) by representatives of the Radio Amateur Old Timers' Association at a short ceremony outside the church on July 21st, 1962. In the same year RAOTA also arranged for a commemoration plaque to be installed at Gerry's former home in Caterham which reads:—"From this house Gerald Marcuse, G2NM, inaugurated Empire Broadcasting in September 1927".



The QSL card of special event station G2NM, operating from Bosham, West Sussex, on 24/25th June, 1978

To commemorate the 50 years of Empire Broadcasting, the Chichester and District Amateur Radio Club are operating a station from Bosham on June 24th and 25th, and have a special QSL card to mark the occasion. Although they will be active on 2m, G8NMF, they intend to concentrate their efforts on the DX bands, as Gerry did. Owing to the limited space available, people wishing to visit the station must first contact Terry Allen, G4ETU, QTHR, to make arrangements. ●

Introduction to LOGIC ~ 1

S.A.MONEY

During the past few years something of a revolution has taken place in the field of amateur electronics. The valves and transistors of the past have been overtaken by a wide range of integrated circuits (i.c.s) or "chips" as they are often called. These new devices make possible amateur electronic projects which, only a few years ago, would have been just science fiction dreams. The integrated circuits available range from simple two- or three-stage audio amplifiers up to microprocessors with some 20,000 or more transistors packed on to a tiny chip of silicon.

Some integrated circuits, such as those for audio, radio or television applications, are linear types and they work in much the same way as their discrete component counterparts. It will be noticed however, that the great majority of i.c.s advertised have type numbers in the 74 and 4000 series. These are logic devices originally developed for use in digital computers and industrial control systems.

What can Logic do for us?

So all of these digital logic chips are available but how can they be used in amateur projects? Let us consider radio communication. Amateur radio operators and keen short wave listeners often need to measure frequencies accurately. The old methods of using heterodyne wavemeters, calibration charts or even crystal markers work quite well but they are rather inconvenient. Modern communications receivers often indicate the frequency, to perhaps the nearest 100 hertz, as a number on a digital display. This facility is achieved by using logic circuits.

Basically all we need do to measure frequency is to count the number of cycles of the signal that occur in an accurate time period. If the time period is a millisecond then the answer will be the frequency in kilohertz. Logic devices are very good at counting things and measuring time periods.

To measure time we simply count down from an accurate crystal-controlled oscillator. The count can be arranged to provide the answer in hours, minutes and seconds. In fact this is precisely how a digital watch or clock works.

Many amateur radio stations use the radioteletype (RTTY) mode of communication where signals from a typewriter-style keyboard are converted into coded patterns of pulses and then transmitted. At the receiving end, the pulse patterns are decoded and the message is printed out as text on a sheet of paper. Because printers are rather expensive some stations display the messages as text on a modified television receiver. Extensive use is made of digital logic for coding, decoding and displaying the RTTY messages. Morse code, still used by many radio amateurs, can be dealt with in the same way. Messages, typed on a keyboard, are converted by logic to perfect Morse code and at the receiver the signals are decoded and displayed as text on a TV screen.

Logic is very good at sequential control tasks such as running a model railway, controlling a machine, or even switching the lights on a Christmas tree. There are many ways we can use this capability for amateur projects.

Recently logic has crept into television in the form of TV games and Ceefax/Oracle decoders. There are some TV sets which can display the time or channel number on the screen by using logic. In other cases, digital techniques may be used for tuning and for remote control. Even those touch switches on the front of some sets use digital logic.

Some large scale integrated (l.s.i.) digital circuits have been specially developed for use in electronic organs, digital multimeters, digital clocks and calculators. By far the most complex of the logic devices are microprocessors which, unlike the more specialised circuits, can easily be programmed to perform an almost infinite variety of tasks perhaps only limited by the imagination of the user.

People sometimes regard digital circuits as rather mysterious. It is true that when we enter the digital world we shall meet some new concepts, new devices, new circuit symbols and a whole new vocabulary of technical terms. In fact, however, digital systems are not too difficult to understand, and in this series we shall explore the way in which they work and some of the ways in which they can be used.

Digital Signals

First, let us take a look at the signals involved in a digital logic system. Readers will already have met analogue signals, such as those in an audio amplifier, where the level of the voltage or current in the circuit varies in proportion to the signal level. Thus the amplitude can vary continuously over the whole range of signal levels, to give a virtually infinite number of discrete voltage or current levels.

In contrast to the analogue case the signals in a digital logic system can have only two possible levels. One of these is called the "zero" or *0* level, and this corresponds to the signal being turned off. The second level is called the "one" or *1* level and is equivalent to the signal being turned on.

Sometimes in the literature and in data sheets for logic circuits, other names may be used to describe these two signal levels. As an example the *0* level may be referred to as the "low" or "false" level, but it will still have the same value as the *0* level. Alternative names for the *1* level are "high" and "true" respectively. In this series we shall use the *0* and *1* terminology since it seems to be the most popular.

When both A AND B inputs are set at *1* both of the diodes will cut off and no current will flow in R. Now the output level will rise to +5V to give a *1* output state. Thus the diode circuit produces the same logical results as the electrical lamp and switch circuit.

If we needed to have more input signals these could be provided by merely adding more diodes. With more inputs the *1* at the output should only occur when all of the input lines are at the *1* level.

Truth Table

A convenient way of setting down the various logic conditions in a gate circuit is by means of a Truth Table. In this table all of the possible combinations of input states are listed, together with their corresponding output states.

For a two-input AND gate such as that shown in Fig. 2 the truth table would be as shown in Table 1. In the case of an AND gate which has three inputs the truth table will have eight possible states as shown in Table 2.

TABLE 1

Input		Output
A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

TABLE 2

Input			Output
A	B	C	Y
0	0	0	0
1	0	0	0
0	1	0	0
1	1	0	0
0	0	1	0
1	0	1	0
0	1	1	0
1	1	1	1

Try working out the truth table for a four-input AND gate and you should end up with 16 combinations but the output will be at *1* only when all of the inputs are at *1*.

Integrated Gate Circuits

In an actual TTL 2-input AND gate the circuit is roughly as shown in Fig. 3 and is much more complex than our simple diode gate.

The gate action proper occurs in transistor Tr1 which has two emitters. This stage acts in much the same way as the diode gate so that the transistor

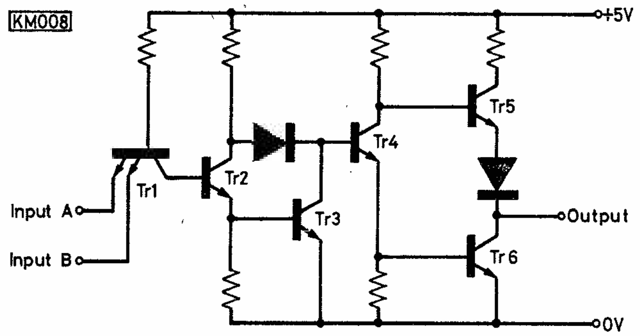


Fig. 3: A typical TTL AND gate

stops conducting if both emitter inputs are at *1*. Transistors Tr5 and Tr6 form a "totem pole" output stage which gives a low output impedance and fast switching. For a *1* output Tr5 is "on" and Tr6 is "off" and vice versa for the *0* state. Thus the output is clamped to either 0V or +5V through one or other of the output transistors. The other transistors in the circuit provide the required drive signals for the output stage.

In the 4000-series CMOS circuit a 2-input AND gate would be made up roughly as shown in Fig. 4. In this circuit the series *n*-channel transistors provide the AND gate action operating in much the same way as the series switches in our electrical circuit. The *p*-channel f.e.t.s Tr1 and Tr2 are used to pull the point X up to the supply rail if either of the inputs is at *0*. When both inputs are at *1* Tr3 and Tr4 will both conduct to bring point X down to 0V. The output stage in this case is a push-pull complementary pair. If X is at *0*, Tr6 will be "off" and Tr5 will be "on" so the output terminal will be clamped to the positive supply rail to give a *1* output. If X is at *1* the output level will be clamped to *0* via Tr6. In some cases there may be several other stages to provide full drive for the output stage but the operation is much the same.

For more inputs a TTL gate would have more emitters on Tr1, whilst a CMOS gate will have more transistors in series.

Symbol for an AND Gate

Obviously we cannot draw out the complete circuit for every gate so a special symbol is used to indicate an AND gate. This is shown in Fig. 5(a) for a 3-input gate. Where there are a lot of inputs the gate symbol may be modified as in Fig. 5(b) for drawing convenience.

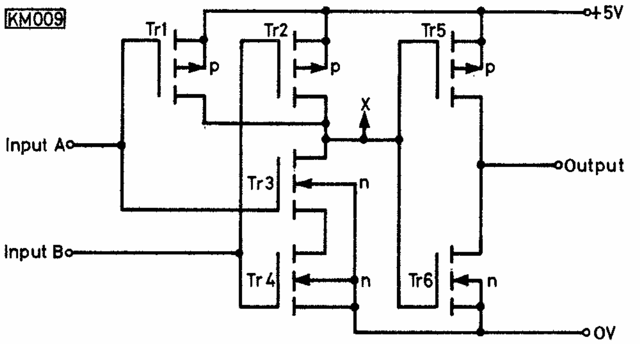
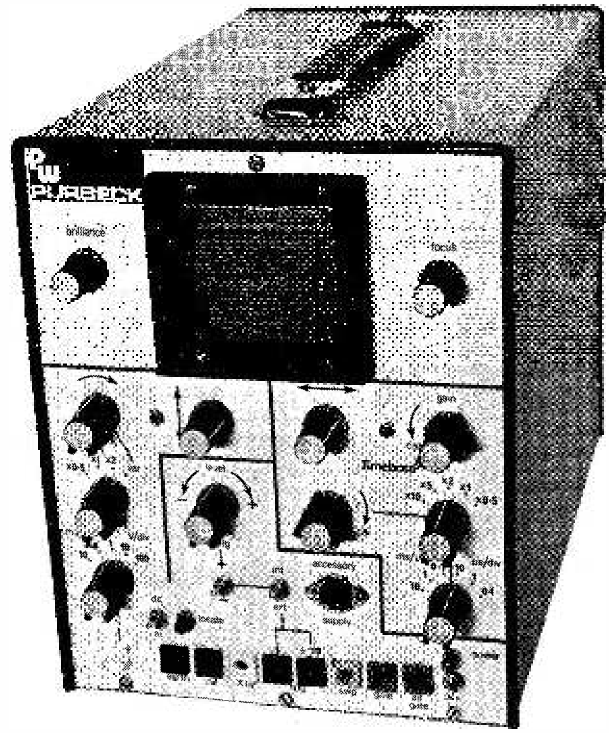


Fig. 4: A typical CMOS AND gate

continued on page 60

'purbeck'



Part 4

OSCILLOSCOPE

IAN HICKMAN

This month's instalment deals with the construction of Board 3, the Y amplifier. This board uses a ground plane, in view of the high gain and wide bandwidth. With a ground plane, a low impedance earth return is available everywhere, ensuring that decoupling capacitors are fully effective.

As double sided boards were ruled out on the grounds of excessive cost, the component interconnections use conventional wiring. It may well be possible to produce a successful single sided printed wiring layout, but the author lost a considerable amount of time trying to do just this and therefore returned to the ground plane construction used in a previous oscilloscope design. Figs. 3 and 5 show the component layout and wiring, which should be followed closely to avoid instability. Note that i.c. sockets must not be used.

Up to this point, the components mentioned have all been fairly conventional, apart from the special mains transformer and the tube itself, of course. On this board we encounter some more out of the way components, but their use is more than justified by the performance which is obtained.

Take the dual junction gate f.e.t. type E421 (Siliconix) used in the input stage for example. The low temperature coefficient of input offset results in no drift of the trace level from switch on, even on the most sensitive setting of about 2·5 mV per division.

This dual f.e.t. acts as a source follower, providing the necessary high input impedance for use with the frequency compensated input attenuator S3 and a low output impedance to drive the 733 video amplifier IC301. Network R301, R302 and C301 protects Tr301a from excessive input voltages without causing deterioration of high frequency response. R303, R304 and R306, R307 provide d.c. level shifting of Tr301's outputs to bring them within the input range of IC301. They result in a small degree of attenuation of the input signal at d.c. and are therefore not bypassed, to keep the a.c. and d.c. gains equal.

The purpose and adjustment of VR301 is covered in the last article, and at this stage it should simply be set to mid-travel.

The 733 video amplifier IC301 forms the main gain block, and its gain is switched by S301 to provide an overall sensitivity for the complete instrument of 5, 10 and 20 mV/division. A fourth position of S301 brings VR302 into circuit, providing a continuously variable gain facility and incidentally providing a maximum sensitivity of approximately 2·5 mV per division.

The bandwidth of the 733 varies with gain, but even at maximum gain it is 40 MHz, so that in practice the bandwidth of the complete instrument is determined entirely by the Y deflection amplifier Tr303 to 308.

Note that owing to its common mode rejection (typically 60 dB even at 5 MHz) the output of IC301 is balanced, even though an unbalanced input is applied at pin 1.

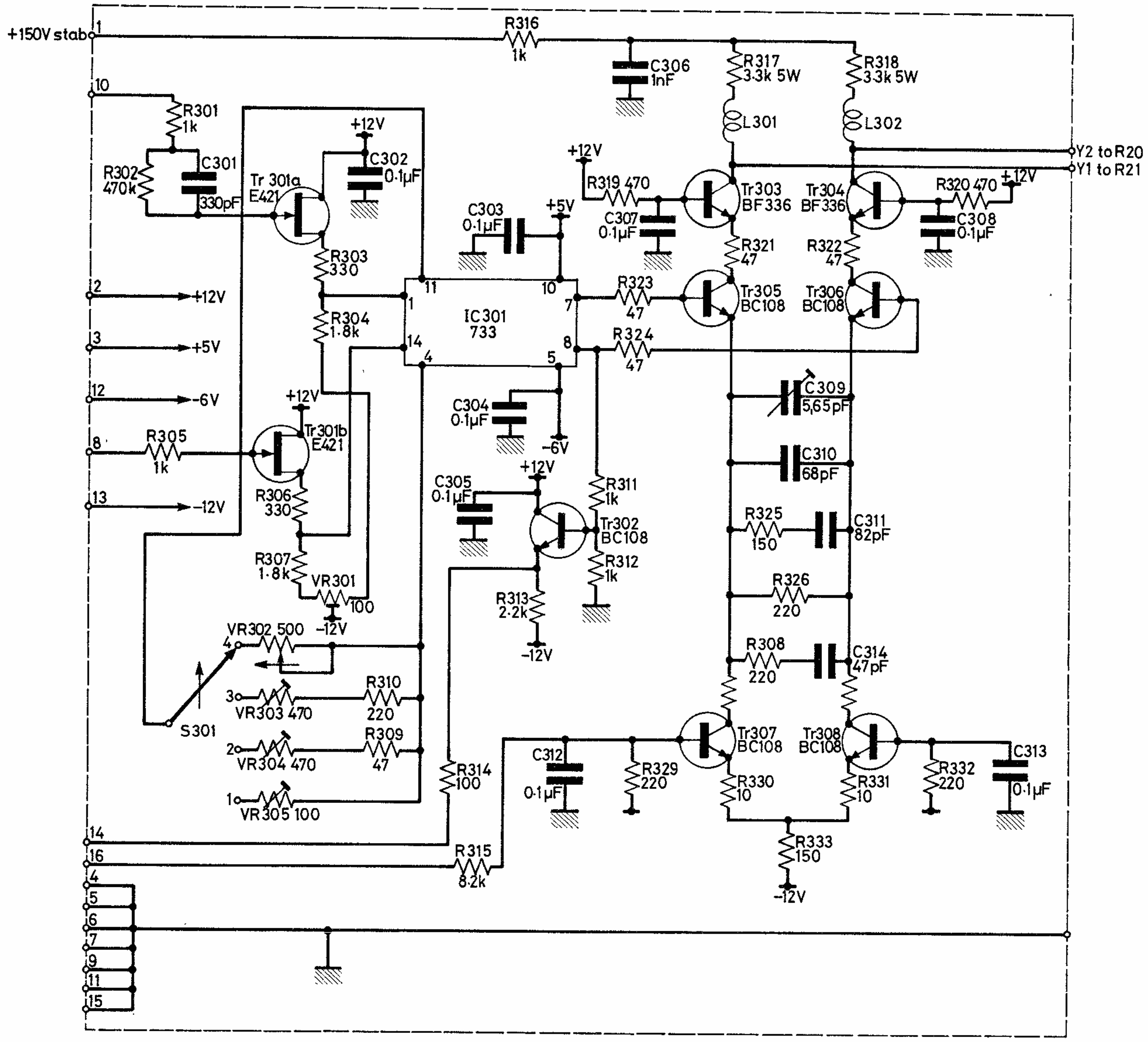


Fig. 1: The circuit diagram of the Y amplifier, clearly showing how the essential bandwidth is achieved; gain block IC301 couples to the Y deflection amplifier, and the R326 by-passing C/R network maintains upper frequency response. Note that R329 and R332 are connected to the –6V supply and that the unmarked resistors in the collector circuits of Tr307 and Tr308 are both 47Ω (R327, 328)

Tr302 is the trigger pick off amplifier. This is by no means a trivial function, as the action of an oscilloscope's trigger slicer circuit can easily reflect back a small disturbance into the Y amplifier. This results in slight notches in each cycle of the displayed waveform, which move up and down as the Trigger Level control is varied. Here, R311, R312 attenuate the signal by a factor of 2 and emitter follower Tr302 acts as a buffer.

An emitter follower provides only limited reverse isolation at high frequencies, but disturbances emanating from the trigger circuit, before they can reach the Y deflection amplifier input, are also attenuated by the ratio of R311 to the output impedance of IC301. This ratio is very much greater than 2:1, as IC301's output stages are emitter followers.

Further buffering is provided by another emitter follower and 2:1 attenuator on Board 4, described next month. R314, like the 47Ω resistors in the Y deflection amplifier, is an anti-parasitic stopper resistance.

The bandwidth of an oscilloscope is usually limited by the Y deflection amplifier. Certain steps can be taken to maximise the bandwidth and a fairly obvious one is to use symmetrical deflection, i.e. to drive the deflection plates in antiphase. For if only one of the two plates were driven, twice the voltage swing would be required, so needing twice as high a collector supply voltage.

For a given deflection transistor dissipation, we would then have to halve the standing current through the output transistor. Twice the voltage at half the current means four times the collector load resistance and this would result in a quarter of the bandwidth!

The Y output transistors Tr303 and Tr304 are used in the grounded base mode. The low input impedance at their emitters results in virtually no signal voltage swing at the collectors of Tr305 and Tr306. There is therefore no Miller multiplication of their internal collector/base capacitance, minimising capacitive loading on IC301's outputs.

The collector/base capacitance of a BF336 is approximately 3·5 pF and this, together with the Y plate capacitance of the 3BP1 c.r.t. and wiring strays, results in a total capacitive loading at the output of Tr303 (and Tr304) of around 10 pF. A peak to peak voltage swing of around 90V is required to provide a reasonable degree of overscan and choosing a conservative value of dissipation for Tr303 and 304 leads us to a standing current for each of just over 15 mA, with 3·3kΩ collector loads. Allowing a minimum Vce of 10V to maintain a good high frequency response leaves us with an h.t. requirement of 120V—the excess 30V is dropped by R316.

★ components

Resistors		
¼W 5% carbon film		
10Ω	2	R330, 331
47Ω	7	R309, 321, 322, 323, 324, 327, 328
100Ω	1	R314
150Ω	2	R325, 333
220Ω	5	R308, 310, 326, 329, 332
330Ω	2	R303, 306
470Ω	2	R319, 320
1kΩ	4	R301, 305, 311, 312
1·8kΩ	2	R304, 307
2·2kΩ	1	R313
8·2kΩ	1	R315
470kΩ	1	R302
5W w.w.		
1kΩ	1	R316
3·3kΩ	2	R317, 318
Potentiometers		
Miniature vert. skeleton preset		
100Ω	2	VR301, 305
470Ω	2	VR303, 304
¼inch diameter spindle		
500Ω	1	VR302
Inductors		
See text		L301, 302
Capacitors		
Ceramic		
47pF	1	C314
68pF	1	C310
82pF	1	C311
330pF	1	C301
Disc ceramic		
1nF	1	C306
0·1μF	8	C302, 303, 304, 305, 307, 308, 312, 313
Trimmer		
5–65pF	1	C309
Semiconductors		
Transistors		
BC108	5	Tr302, 305, 306, 307, 308
BF336	2	Tr303, 304
E421	1	Tr301 (Siliconix)
Integrated circuits		
LM733	1	IC301
Switches		
1p 4w rotary	1	S301
Miscellaneous		
Printed circuit board (1) (Watford Electronics)		
Printed circuit board test pins and matching sockets (3)		

Now 3·3kΩ and 10pF gives a time constant of $3{\cdot}3\times10^{-8}$ sec corresponding to a −3dB point of 5MHz and this is in fact the measured −3dB frequency of the oscilloscope for full screen Y deflection. With suitable inductive peaking in the collector circuits, this could be extended by about 20 per cent to 6MHz or a shade more if overshoot were accepted on fast edges. This bandwidth would be independent of the amplitude of the Y deflection. However, in this design a different approach has been adopted. The voltage gain of the Y deflection amplifier from the bases of Tr305, 306 to the collectors of Tr303, 304 is the ratio of the collector to collector load resistance (3·3kΩ+3·3kΩ) to the emitter to emitter resistance (R326, 220Ω).

A gain of 30 for a cascade stage is quite modest, considerably more gain could be obtained by using a lower value for R326.

Advantage has been taken of this extra available gain by partially bypassing R326 at high frequencies with capacitors C309, 310, 311 and 314. This provides increased output current swing at Tr303, Tr304 collectors at high frequencies to charge the capacitance of the Y plates, so maintaining the frequency response level.

This substantially reduces the rise time when displaying pulses or square waves, but there *is* a limit.

After all, the available current through Tr303 and Tr304 together is set by the tail resistor R333. All the input signal can do is alter its distribution between them.

If due to the large size and fast risetime of an input square-wave, the current needed to charge the deflection plate capacitance quickly enough exceeds the tailcurrent, then we cannot faithfully display the waveform.

The "in" phrase for this is to say that the output voltage of the Y deflection amplifier is "slew-rate-limited". If either the amplitude of the input were

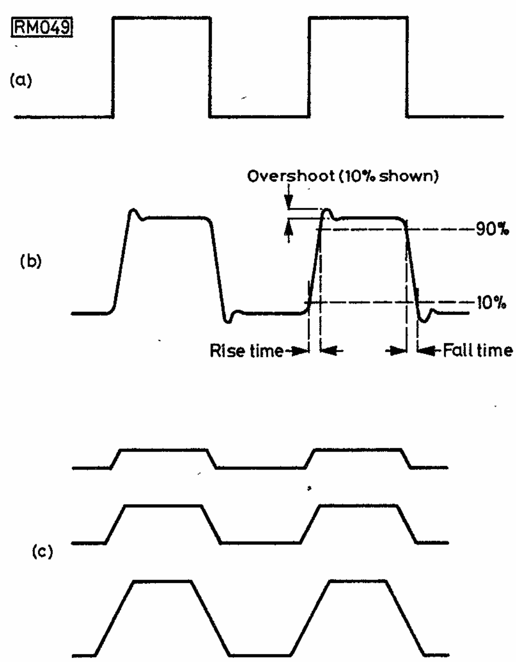


Fig. 2: An ideal square wave is shown in (a) with typical degradations which occur in practice shown in (b). At (c) are the output waveforms from a slew-rate-limited amplifier for three increasing values of input

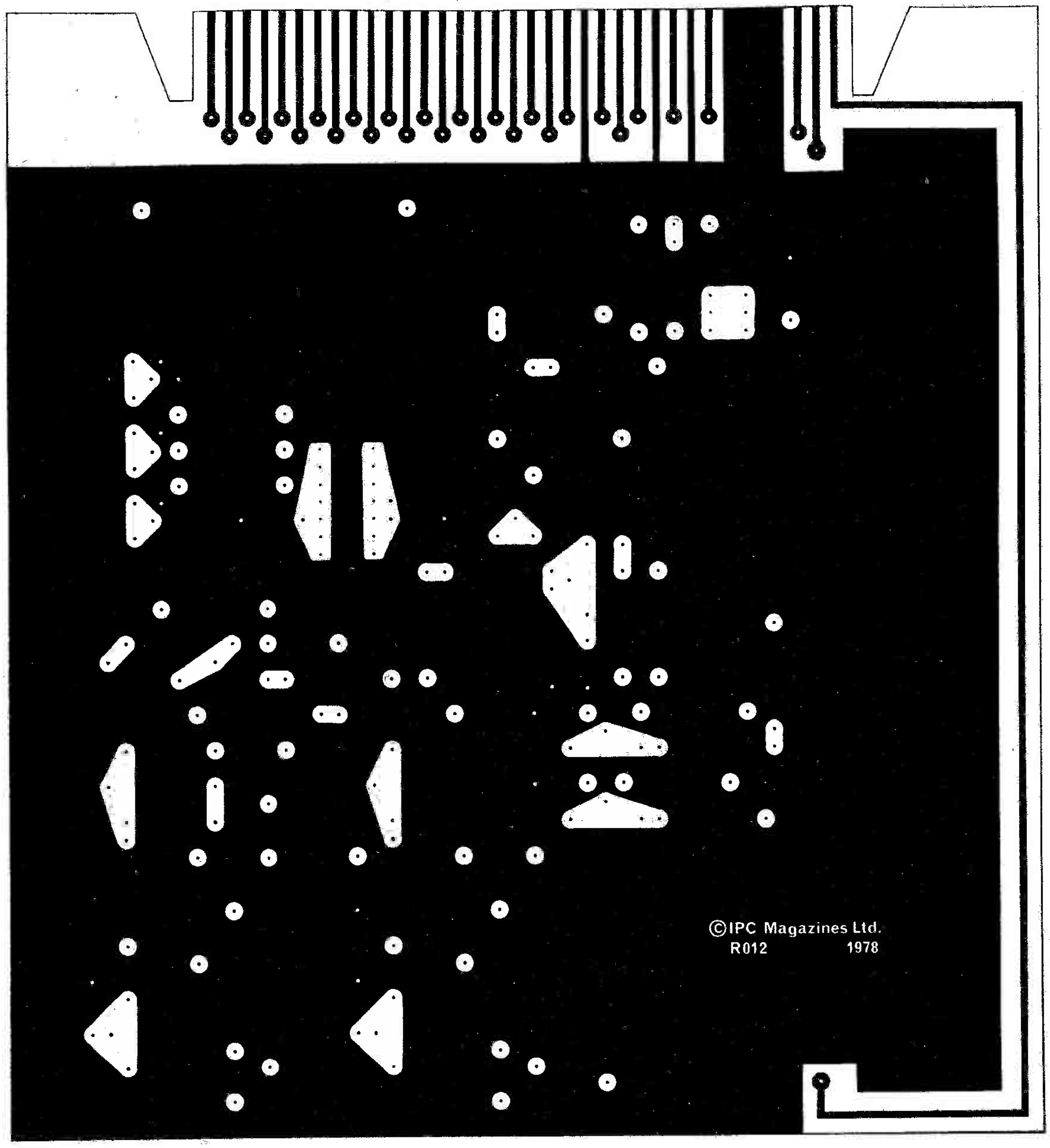


Fig. 4: The copper ground plain pattern of the Y amplifier board

smaller, the higher their frequency.

In other words, the amplitude/frequency characteristic of the amplifier matches the requirements for displaying square waves and pulses. For a vertical deflection of 1 division, the rise time of the oscilloscope is 20 ns, so the display of a 5MHz square wave looks commendably square, whilst even a 10 MHz square wave looks as if it is obviously meant to be square! L301, 302 provide a modest degree of peaking, as do L1 and L2, but are not in any way critical. L301, 302 are 35 turns of 38 s.w.g. wire on 100kΩ carbon composition resistors. L1, 2 (see Part 3) are similarly constructed with 15 turns of 38 s.w.g. wire. R308 and R325 shape the peaking provided by C311, 314 to give a flat frequency response and minimise overshoot and ringing on fast edges.

The emitter current of Tr305, 306 is provided by a long tailed pair TR307, 308. These provide a convenient means of injecting the Y shift voltage via R315. If the Y shift were injected ahead of IC301, the position of the trace would change when the Y gain selected by S301 was changed.

The author has not seen six transistors used in this configuration before: readers might like to think up a name for it—a long-tailed cas-cascode perhaps.

WARNING

Extra care must be taken when working on any part of this instrument while power is switched on. 1100 volts can kill. When delving into the insides of the scope for any reason with power on keep one hand in your pocket

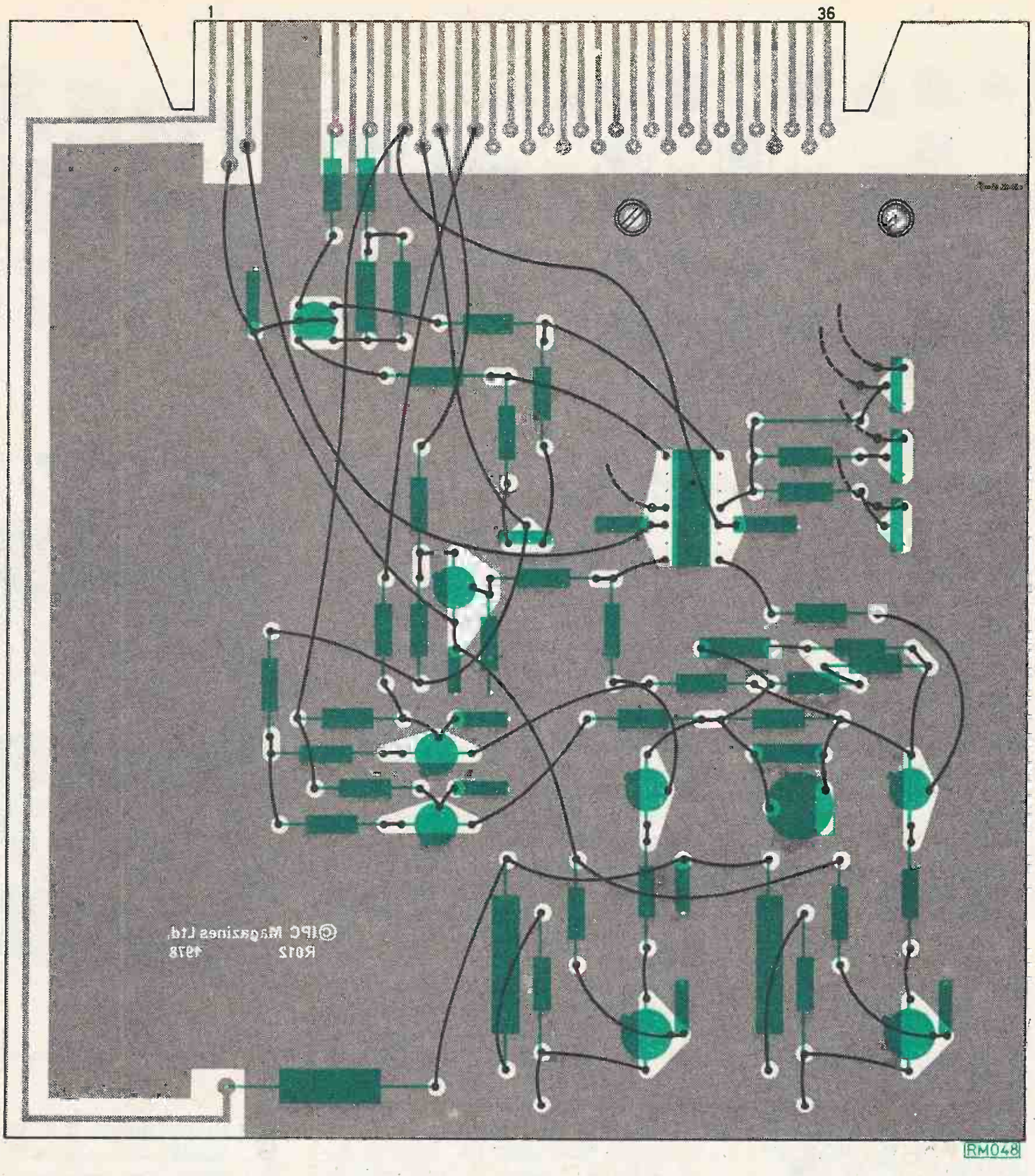


Fig. 5: Back wiring of the board, in relation to the components. This layout of the wiring should be followed to avoid any possibility of instability occurring

When Board 3 has been assembled, check each power supply pin to 0V with an ohmmeter to make sure none is short circuit and centre all pre-set pots and C309. Then plug it into the main frame, disconnect the Y plates from the temporary 47kΩ and 100kΩ resistor chain across the +150V STAB supply (see last month) and connect them via R21, L1 and R20, L2 sockets to pins Y1 and Y2 of the board.

Don't forget the ground link at the rear of the board either. You can also put up a crude timebase of sorts by disconnecting one of the X plates from the 47kΩ and 100kΩ resistors and reconnecting it via a 47kΩ resistor. A 0·1μF capacitor from the Y plate to pin 2 of Board 1 will give a small 50Hz sinusoidal X deflection. So, plug in briefly and check that all stabilised supply voltages are normal, indicating no short circuits anywhere.

It should be possible to centre the trace vertically with the Y shift control. If not, adjust VR301 as necessary. With a suitable range selected at S3, feed in a sine wave from an audio oscillator. When its frequency is carefully adjusted to exactly 50Hz, 100Hz, 150Hz, etc, a stationary pattern known as a Lissajous figure should be obtained. At 50Hz, this will vary from a line to an ellipse and more complicated figures will be obtained at higher frequencies.

This simple test will enable you to check that the Y amplifier is basically operational and to test that the Y shift works, also that the gain can be varied in steps by S301 and in position 1, by VR302.

Next month we will look at the construction of Board 4, which carries the timebase circuits.

therefore not multiplied by the audio frequency gain of the circuit and the quiescent output voltage is very close to the ground potential; the steady quiescent current passing through the loudspeaker can therefore be kept very small.

The bandwidth (or rather the high frequency response) of the circuit is controlled by the value of C3, the compensation capacitor. The bandwidth is approximately equal to $2 \cdot 7 \times 10^{-4}$ R2/R5C3; thus with the values shown, the response extends to about 160kHz, but can be reduced by increasing C3.

The capacitors C6 and C7 are required for good high frequency decoupling to ensure stability; they should be soldered close to the ESM 532. Although these capacitors are connected in parallel with very much larger capacitors in the power supply, the latter capacitors are electrolytics with a fairly large effective series inductance and may be some distance from the device. C6 and C7 have a far smaller series inductance than electrolytics.

Power Supply

A simple power supply for feeding the circuit of Fig. 2 is shown in Fig. 3. D1 to D4 may be four separate diodes (e.g. 1N4002) or a single bridge rectifier containing four diodes (e.g. type REC 63 from Doram). Full wave rectification occurs in this circuit, the output voltage being nearly $1\frac{1}{2}$ times the transformer secondary voltage.

The use of the light emitting diode and its series resistor R1 to indicate when the power supply is switched on is, of course, optional.

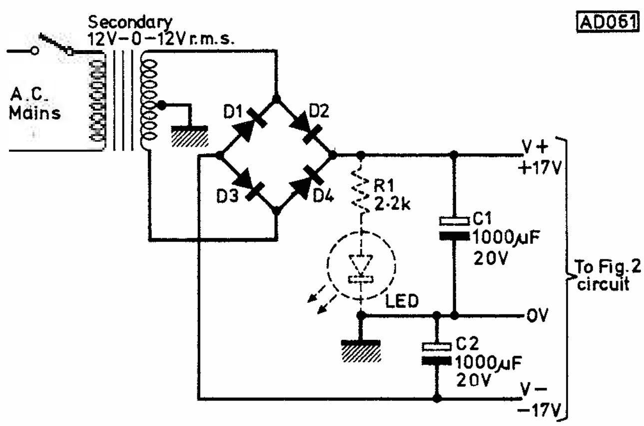


Fig. 3. A power supply circuit suitable for driving the Fig. 2 circuit

Single Supply

The circuit of Fig. 4 has a similar performance to that of Fig. 2, but a single power supply is used. A positive bias must be applied to the non-inverting input in this circuit otherwise the output would be at a low voltage and would not be able to swing lower in voltage to amplify negative going peaks. The positive bias brings the output potential to a positive quiescent value and therefore a large electrolytic capacitor C4 must be included in series with the loudspeaker to prevent a constant quiescent current from flowing through the loudspeaker.

The gain of the circuit is approximately equal to R7/R5 +1 or about 28 (29db) with the circuit values shown. The bandwidth is about 12Hz to 140kHz with the value of C5 shown. At high values of gain a capacitor in series with a resistor should be connected from the junction of R7 and R5 to ground, the product of the values of this capacitor and resistor being appreciably less than the product of the value of C4 and the loudspeaker impedance.

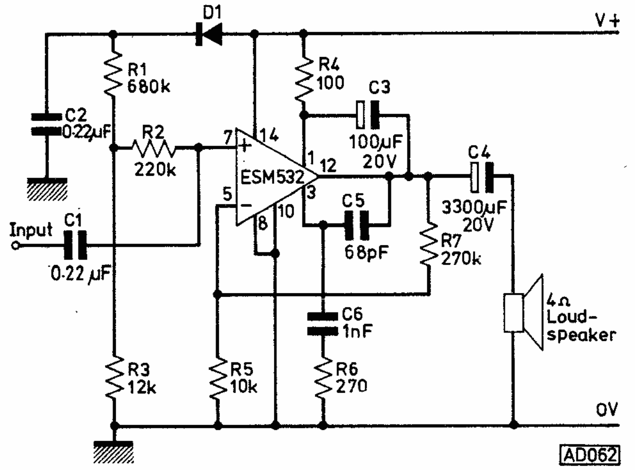


Fig. 4. A 20W amplifier using a single power supply

Comparison

In general readers will find the circuit of Fig. 2 more convenient than that of Fig. 4, since no large output capacitor is needed in series with the loudspeaker. Thus the high switch-on transient currents are eliminated together with the switch-on 'plop' noise and one obtains optimum response at low frequencies. On the other hand, the power supply used with the Fig. 2 circuit does require a tapped secondary winding on the mains transformer.

Heat sinks suitable for use with the ESM 532 are available from Staver Thermal Products Ltd., Heron Trading Estate, Bruce Grove, Wickford, Essex SS11 8BS under the type numbers V3-3-2020 and V3-5-2020, the latter having the lower thermal resistance of 4·5°C/W. When the ESM 532 has been connected on its circuit board, silicone grease should be placed on it and the heat sink bolted to the board so that it is held in good contact with the ESM 532. Readers can make their own heat sinks using a sheet of metal of area not less than about 70 sq. cm. and bending it as required, leaving the part in contact with the device quite flat.

Other devices

One may well ask how the ESM 532 compares with other 20W devices? It has the same maximum current rating as the SGS-ATES TDA2020, but has a somewhat lower voltage rating than the latter. At present the ESM 532 appears to be somewhat cheaper than the TDA2020 and has the advantage that its typical quiescent current is only 25mA at 28V. The TDA2020 has the lower thermal resistance of 3°C/W (junction to case). The other characteristics of the two devices are quite similar, but the connections are different.

A lower voltage version of the ESM 532 is produced with a maximum rating of 30V under the type number ESM 432. The ESM 532N is similar to the ESM 532, but has a bracket for the connection of a heat sink.

Availability

The ESM 532 is available from Phoenix Electronics Ltd., 46 Osborne Road, Southsea, Hants at £2·95 including VAT and packing and postage. ●

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BRIAN L. PHILLIPS G8FWM

Readers who intend to operate the Avon Transmitter should be in possession of the appropriate licence issued by the Home Office to those who have passed the City and Guilds Radio Amateurs' Examination. Details may be obtained from: The Home Office, Radio Regulatory Department, Amateur Licensing Section, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

Using a soft, lead pencil, draw out the islands on the board, and then draw around these and the interconnections of the earth plane edge. The small islands and fine connections are then filled in by means of an etch-resist pen or fine paint brush, using quick drying paint, such as car touch-up paint, thinned down if necessary. The larger areas are then put in carefully and when the board is dry, each island and connection examined to make sure no copper bridges exist between them. One should also ensure adequate clearances.

Place the board in a suitable plastic or earthenware container and pour on just sufficient ferric chloride solution as is necessary to cover it. The solution can be purchased ready-mixed from most radio component stores, or can be made up by a chemist. It is however a corrosive, albeit a mild one, so handle carefully and wash off any of the solution that comes into contact with the skin *immediately*.

Initially, leave the board submerged for about twenty minutes, agitating occasionally. You will see the chemical action taking place quite clearly and when all the unwanted copper has been eroded, take out the p.c.b., wash in clean water and then dry.

Using a wet abrasive pad—such as a Brillo pad—the paint is now removed and a final wash and dry will leave the copper gleaming. After a final check of the work, drill the mounting holes for fixing to the metal chassis.

Each board in the transmitter is etched in this way and provided the simple instructions are followed you should easily be able to provide good examples.

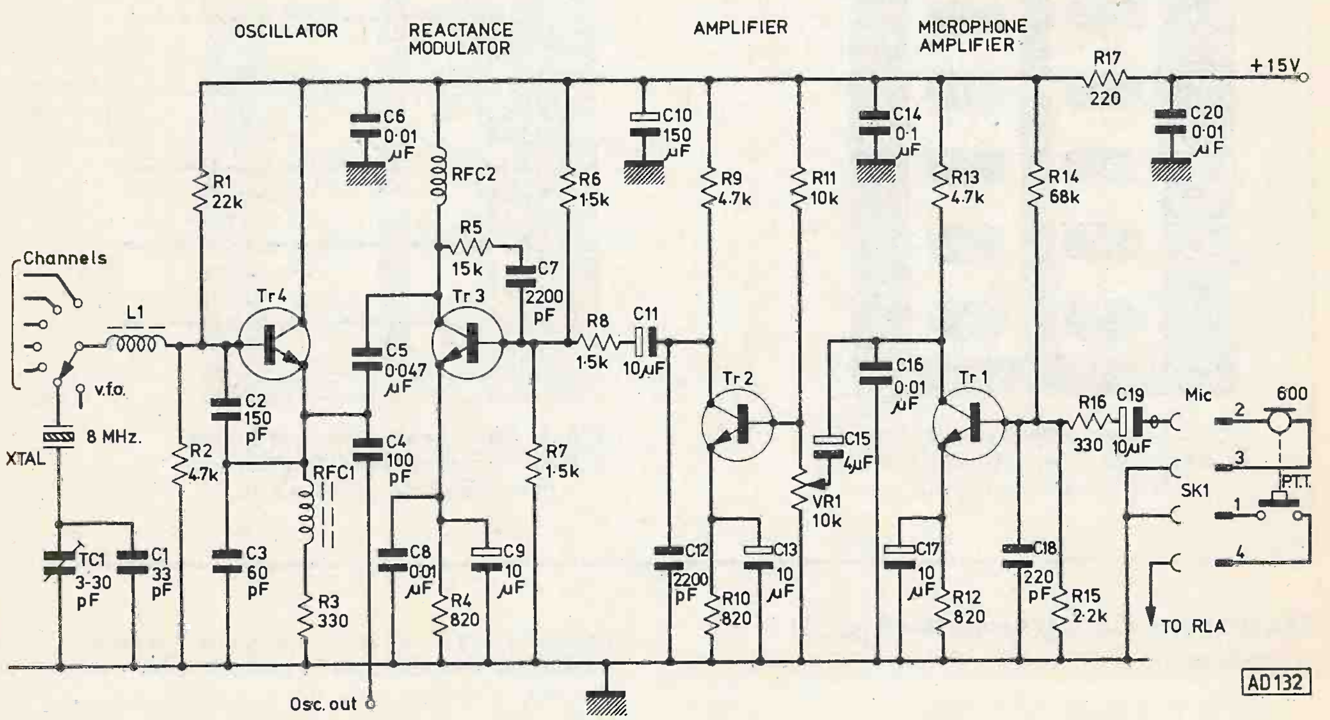


Fig. 1: Circuit diagram for the Crystal Oscillator and Audio Stages—Board 1

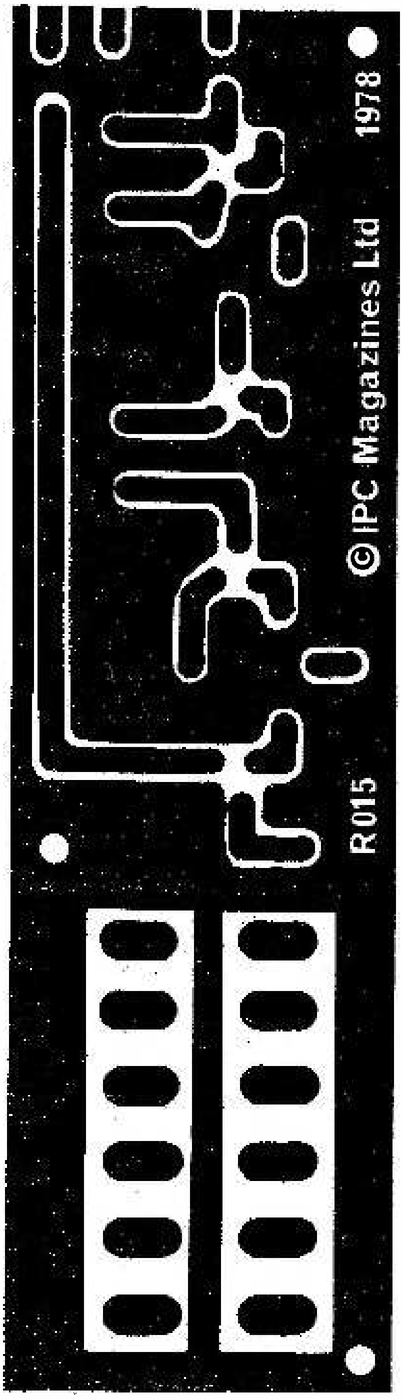


Fig. 2: Copper side layout of Board 1. Available from Reader's PCB Service (see page 27)

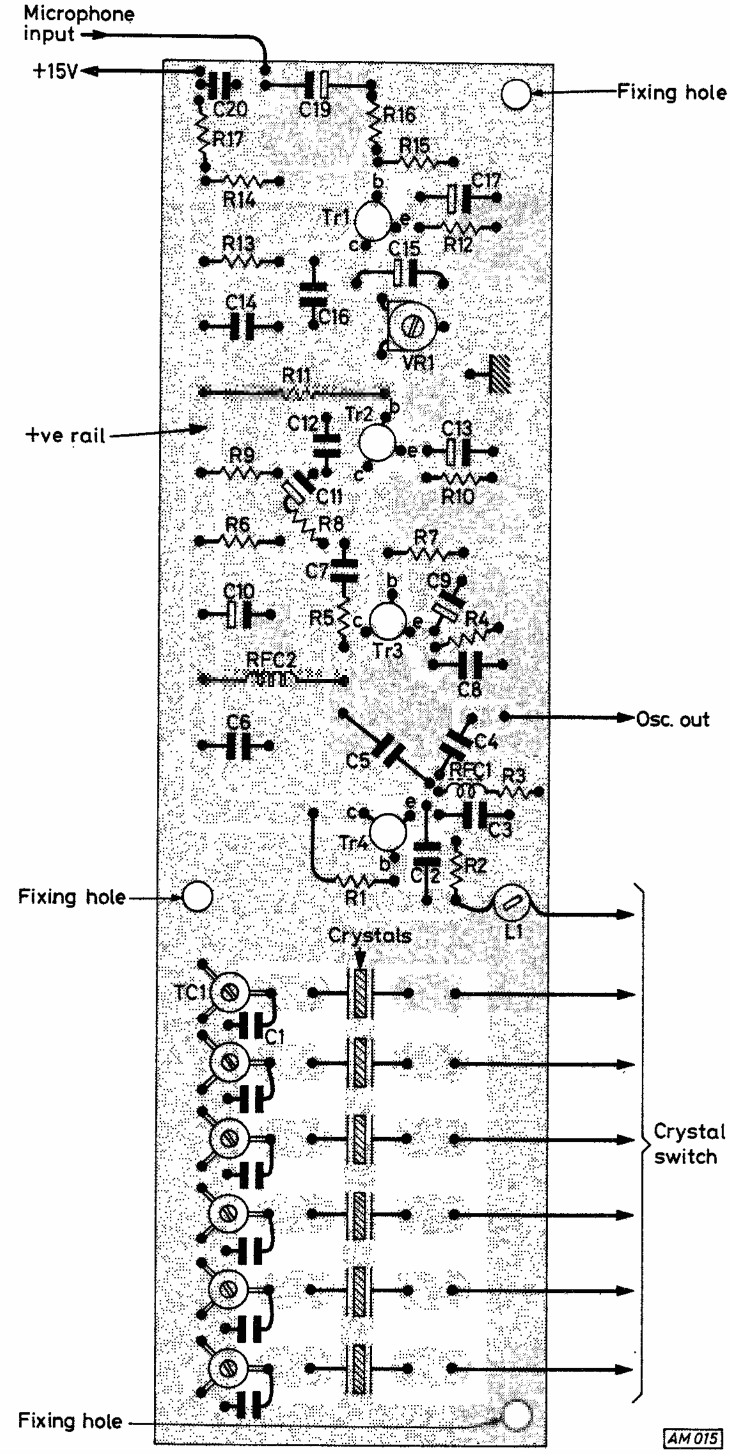


Fig. 3: Component layout of Board 1. Note components soldered direct to copper side of the p.c.b.

Mounting Components (Fig. 3)

There is no hard-and-fast rule about fixing the components to the board, but the Author favours soldering the resistors first, followed by the capacitors, the coils and finally the transistors. Keep lead lengths short—typically 6-12mm for transistors—and solder neatly, holding the iron in place just long enough for the solder to flow to the joint. An iron of 15W rating with a bit size of 3mm or so is to be preferred for work of this nature.

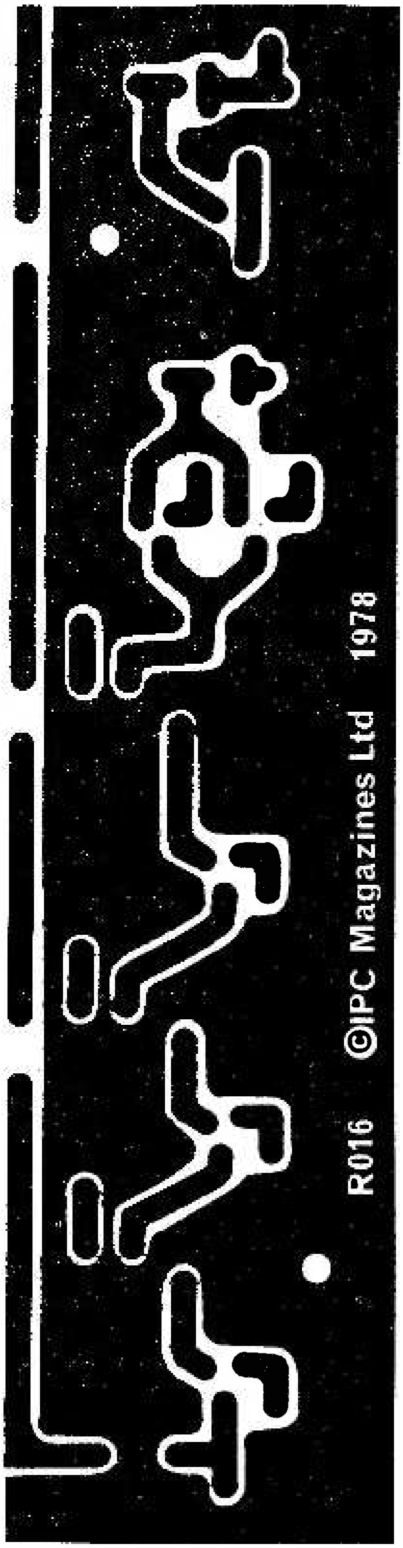


Fig. 5: Copper side layout of Board 2. Available from Reader's PCB Service (see page 27)

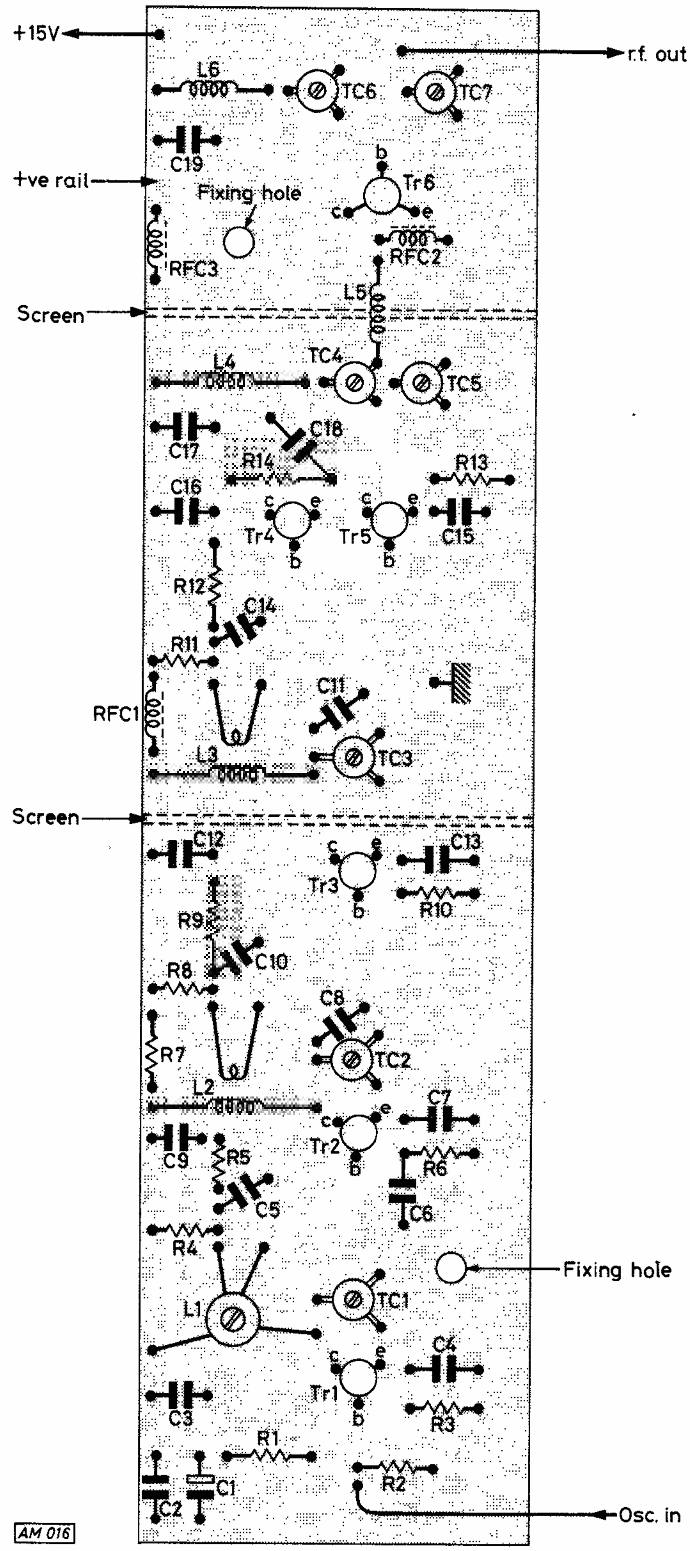
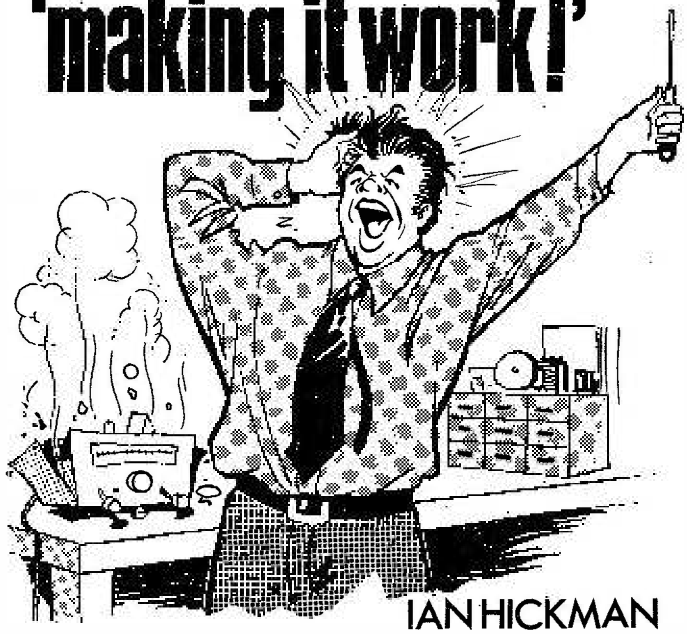


Fig. 6: Component layout of Board 2. Note components soldered direct to copper side of p.c.b.

'making it work!'



IAN HICKMAN

Nothing is more frustrating than getting all the bits to build a *PW* project, spending time putting it all together and then switching on only to find it doesn't work! Unfortunately, however much care one takes in the constructional stage, this is always a possibility and when it happens, many readers are at a loss to know how to proceed.

From time to time articles have appeared purporting to give the answer to this problem, but people still get stuck, as my postbag shows. Yet really, with a methodical approach one can steadily and reliably progress through a circuit and finish up with it all working. So how? Instead of abstract generalisations, readers may get a much better insight into how to go about it if I give a specific example—a "case study" if you like. And since it has proved such a popular constructional project, I've chosen my "Handy-Mini Power Supply" published in the August 1977 issue, page 260, as the example.

Systematic Approach

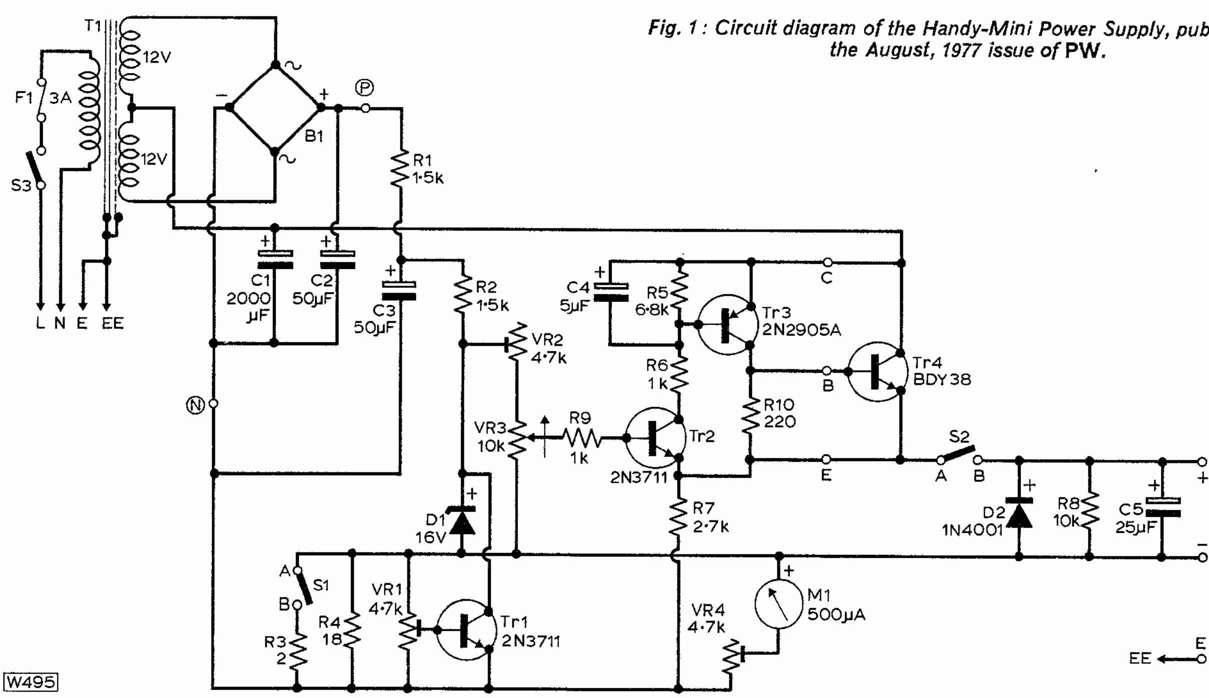
With so many readers building this design, one or two were bound to hit some snag or other, e.g. "... have completed the Mini Power Supply . . . cannot adjust it at all with VR3 . . . please can you help?", from J. D. of Huddersfield. This is where a systematic approach comes into its own, resulting in ". . . After following your instructions . . . Another Tr4 and everything is working correctly . . . Thanking you once again for your help" from—you've guessed it—our old friend J. D. again.

So how do we go about it? Well, let's assume you've made up a Handy-Mini Power Supply, tried it and found that it doesn't work. First of all, you may have noticed a slip-up in the editing (*mea culpa!*). Fig. 3 incorrectly labels the capacitor between base and emitter of Tr3 as C5, actually it's C4, 5μF, as shown in the circuit of **Fig. 1** reproduced here, and the component list. (A correction has, in fact, since been published, but never mind, either value in either place would actually work.)

Multimeter

The technique is to get the circuit working bit by bit. First of all, check that all the circuitry is completely insulated from the metal box, heatsink, etc. Use the highest ohm range on your multimeter for this purpose. If you haven't got a multimeter yet, you really should. It's not necessary to pay an enormous

Fig. 1: Circuit diagram of the Handy-Mini Power Supply, published in the August, 1977 issue of **PW**.



price, but it *is* worth getting one with a sensitivity of at least 10,000 ohms per volt. Very good value for money is the U4324, advertised in this magazine at £14·50 upwards, but adequate multimeters can be found at a few pounds less than this. They usually use 3V internal batteries for the ohms range and are not likely to damage any common diodes or transistors on any of the ohms ranges.

Stage by Stage

Next, set all preset pots to mid travel, put a short circuit across R4 and disconnect: Tr1 collector, Tr2 base and collector, Tr3 collector, Tr4 base and emitter and the point *P*. Switch S2 to OFF. These moves have isolated the current limit circuit (Tr1, etc.) and divided the rest of the circuit up into sections so we can bring it into operation in stages. With experience you will get into the habit of *building* a circuit in stages and testing it again and again as each stage is added. Now switch on and check that there is approximately 18V across C1 and 36V across C2. (All voltages measured with the negative lead of the voltmeter on the negative lead of C5).

If only one of the voltages is correct, most likely the wiring or B1 is faulty. Before replacing the latter, remember it may have been damaged by a short-circuited C1 or C2, so check these as well. If neither voltage is there, the trouble may be the wiring, the fuse or T1. From now on, I won't keep saying "the wiring" every time when pointing out possible faults, but remember that if you are using good quality components from a reliable supplier, the wiring is always the most likely cause of trouble. If you are using salvaged components or gems from the junk box—well, good luck! Apart from costing you a lot of time, dud components can cost you money by burning out other good components.

Safety

So now you've checked your "raw supplies" are present and correct, reconnect point *P* and check that there is approximately 26V across C3 and 16V across D1. **ALWAYS PULL OUT THE MAINS PLUG AND DISCHARGE C1 AND C2 THROUGH A 470Ω RESISTOR BEFORE WORKING ON THE UNIT.** Faults should be fairly obvious, e.g. 30V or so across D1—it's open circuit; just under 1V—it's in back to front! Having checked that the voltages are now right, measure the voltage across the track of VR3 and set it to 12·7V by adjusting VR2. Check that the voltage at the slider of VR3 can be adjusted from 0 to 12·7V. Reconnect the base of Tr2 and temporarily link its collector to point "c"—i.e. top end of R5. We have thus connected Tr2 as a straightforward emitter follower and adjusting VR3 should swing the voltage at Tr2 emitter from 0 to 12V. If it doesn't, it can only be wiring or components and our bit-by-bit approach has only added R9, Tr2 and R7 since the last stage.

Progressing

So assuming you've surmounted that hurdle, remove the temporary connection from Tr2 collector and connect the collector to R6 as in Fig. 1. Also reconnect Tr3 collector to R10. You should now be able to vary Tr2 emitter voltage from 0 to 12V with VR3 as before. Tr2 and Tr3 are now acting as a "complementary compound emitter follower". Sounds technical doesn't it? All it means is that Tr3 does most of the work, with Tr2 turning on just enough to provide sufficient base current to Tr3 to cause it to turn on and pull Tr2 emitter up to about 0·6V below the voltage at the slider of VR3. So Tr3 is supplying most of the current drawn by the load, which in this case consists just of R7 and your voltmeter.

If for any reason you aren't getting this negative feedback from Tr3 via R10—C4 short circuit or Tr3 open circuit for example—Tr2 emitter voltage might not quite make 12V because now all the load current will have to pass through R6. To make quite sure, temporarily put 2·7kΩ in parallel with R7—you should still be able to make 12V at Tr2 emitter.

Assuming all is well, reconnect Tr4 base and emitter. Now we have two d.c.-coupled complementary stages of amplification (Tr2 and Tr3) driving an emitter follower which provides 100 per cent negative feedback to the emitter of Tr2, and again we should be able to adjust the output from 0 to 12V with VR3. At this stage, we have only added a single component, Tr4, so if something is wrong now the answer is pretty obvious.

Load Testing

Set the voltage at Tr2 emitter to 12V and connect a 100Ω resistor (at least 1½W rating) in parallel with the voltmeter. The output voltage as measured by the voltmeter should not change by more than the thickness of the pointer. With S1 open, remove the short from across R4 and reconnect Tr1 collector. Check that VR3 can set Tr2 emitter volts to 12V as before. Now on connecting 100Ω in parallel with the meter the output voltage should fall (set VR1 so that it falls to around 5V) but should return to 12V on closing S1. If this is not the case, one of the components in the current limit circuit, R3, S1, R4, VR1 or Tr1, is faulty. For example, output stuck at 0V—Tr1 collector-emitter short circuit. Now close S2 and check that 0 to 12V is available at the output terminals. We have now checked that everything is functional and it only remains to calibrate the unit as in the original article.

The principles of systematically getting a circuit going stage by stage are well illustrated by the above. If you are new to electronics or sometimes have problems getting a circuit to work, it would be well worth while studying the circuit of the original article in conjunction with the systematic approach described above, even if you have no intention of making up a Handy-Mini Power Supply. You will then grasp the principles and be able to apply them to repairing a transistor radio or getting a hi-fi amplifier to work, etc. Although the example given is a simple one, the principles are quite general and the more complex the circuit, the more important it is to divide it up and get it going stage by stage.

Purbeck Oscilloscope

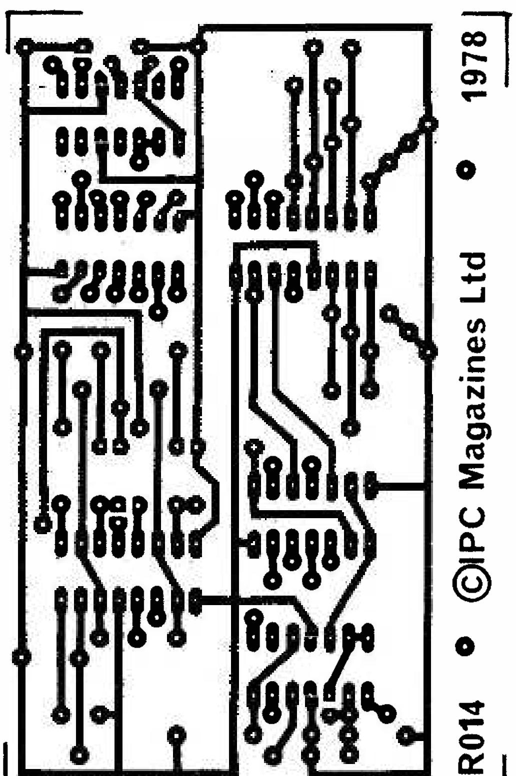
This approach is followed in the *PW* Purbeck now being published, and should allow any *PW* reader with an elementary knowledge of how transistors work and a little constructional experience to build a high-performance oscilloscope for a fraction of the cost of a comparable commercial instrument. ●

Follow-up to morse tutor A._ B_... C_._.

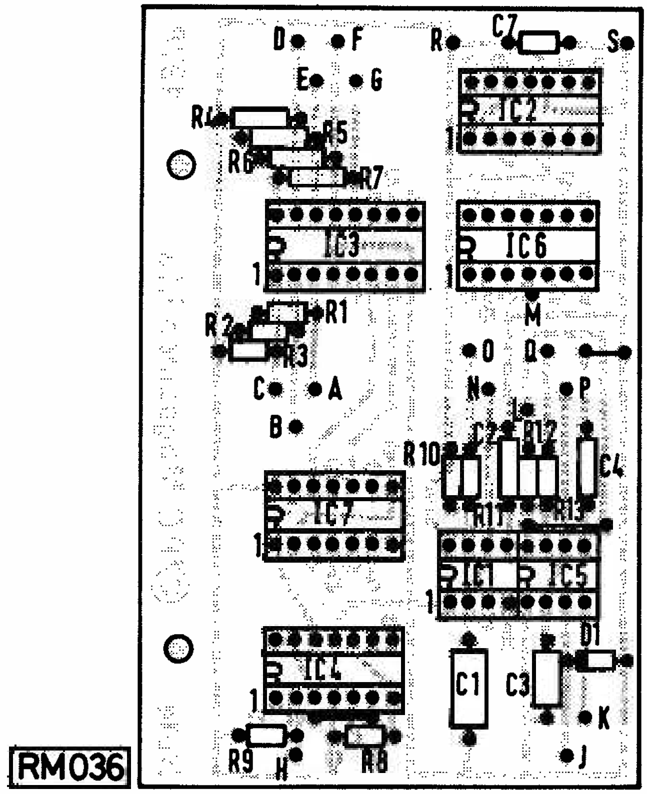
Although we try to take every reasonable precaution to ensure accuracy of presentation and technical efficiency in our constructional projects, it sometimes happens that circuit references turn out to be incorrect or the occasional instance of a reversed diode or capacitor causes universal consternation. When this happens, the editorial department attempts to publish a correction as soon as possible.

In the case of the Morse Tutor, of our August 1977 issue, the details have only just emerged of a divergence between the theoretical and practical instructions. The details are as follows:

The circuit diagram on p. 264 is correct except for the omission of the input B connection to IC2. This should be shown as pin 1. In the "Pin Connections" table on p. 266, "R" and "S" are reversed, i.e. "S" is the 0V terminal.



Copper track layout of the p.c.b.



Component layout of the Morse Tutor

The facts concerning the layout on Veroboard are not so simple. It appears that the component overlay relating to a p.c.b. layout was somehow confused with a Veroboard layout, resulting in the essential interconnections being lost. This refers to board A only, and the two remaining boards are correct. How the error arose is not clear, but was probably due to the major changes occurring at the time in the editorial team, with a retiring member handing over the half-formed details to his replacement, the fault probably appearing at the original artwork stage.

Whatever the facts, we have now prepared an accurate p.c.b. layout, complete with component overlay, to assist those who attempted this project. The new p.c.b. and the original code cards are available from Reader's PCB Service.

NEW BOOKS

THE SECRET WAR
by Brian Johnson
Published by the British Broadcasting Corporation, 35 Marylebone High Street, London W1M 4AA
352 pages, 243 × 170mm. Price £6·50

Those who have been fascinated by the recent BBC Television Series *The Secret War* will be enthralled by this book, which is based upon it, with some additional material. The earliest developments in radar and other radionavigational systems by both the combatants are described in some detail, with a wealth of photographs and drawings. In all, there are over 350 illustrations in the book, many of them previously unpublished.

GCA

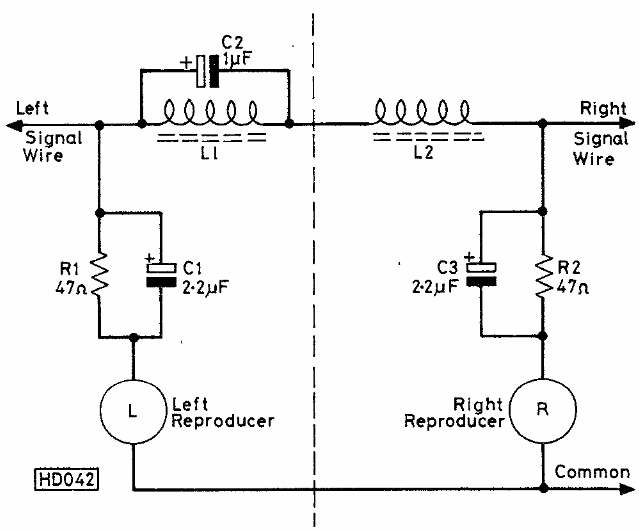
Ideas DEPARTMENT

Some original circuit ideas provided by our readers. These designs have not been proved by us, and we cannot therefore guarantee their effectiveness. They should at least provide a basis for experimentation.

Why not send us your idea? If it is published, you will receive payment according to its merits. Articles submitted should follow the usual style of PW in circuit diagrams and the use of abbreviations. Diagrams should be clearly drawn on separate sheets, not included in the text.

Each idea should be accompanied by a declaration that it is the original work of the person submitting it, and that it has not been accepted for publication elsewhere.

Stereo Headphone blender



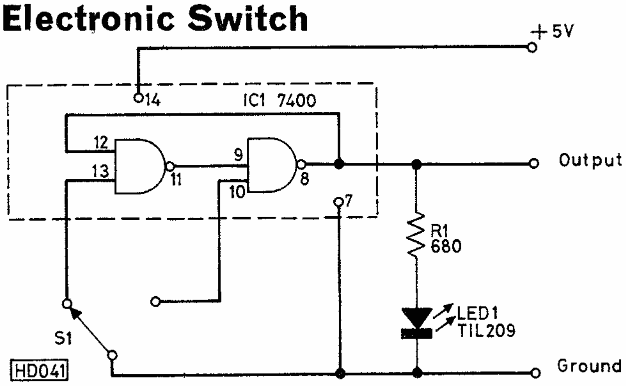
This circuit was developed to improve the stereo effect experienced when listening with stereo headphones. When listening with loudspeakers the stereo effect is produced by the interaction between the two speakers. With headphones, however, there is no such interaction and to obtain a realistic stereo image some form of blend circuit is needed.

The network of capacitors and inductors alters the amount of blend with frequency, the amount increasing at those frequencies which provide the main directional information.

The phones used for the prototype were of an inexpensive type which could be taken apart easily and the components were mounted inside the headphone bodies. The 10mH chokes used were Repanco type CH4 and the capacitors were of the tantalum variety. An extra wire was threaded through the headband to connect the right- and left-hand parts of the circuit. The original signal wires to the headsets need to be disconnected and the blend circuit inserted. R1, C1, C2 and L1 are mounted inside the left headphone and R2, C3 and L2 inside the right-hand one. The circuit can be used with all stereo headphones of 4 to 8Ω nominal impedance.

R. N. Soar,
Mexborough, S. Yorks.

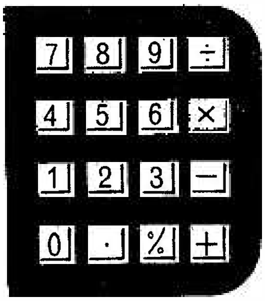
Electronic Switch



When testing JK flip-flops it is unsatisfactory to use an ordinary switch connected to the clock input. This electronic switch uses a 7400 i.c. in an 'anti-bounce' circuit, with an l.e.d. to indicate a high or low output.

Connect a +5V supply to pin 14 and 0V (Ground) to pin 7. A 6V battery could be used. The unit is a bistable which does not change state when the switch is momentarily open circuit. The circuit can be constructed simply using Veroboard.

A. P. Cooper,
Wimborne St. Giles, Dorset.

igital Lock

P. J. WHEELER

Introduction

This is a design for an electronic lock which can replace the standard mechanical lock in many applications. It is impossible to "pick" as with a mechanical lock, and can have over 250,000 million different combinations, which will take all but the luckiest thief many hours to work through!

The lock can be used to disable a burglar alarm, taking the place of a mechanical key switch. Operation of the lock consists of depressing five keys on a keyboard in the correct sequence, the first key resetting the lock, and the other four keys providing the code.

The circuit can easily be extended with the addition of another i.c. and a few diodes to accept a nine digit code, which provides for extra security, although for most applications it is very tedious keying nine digits once the novelty has worn off, let alone trying to remember them! The operating code is programmed into the lock by the wiring between the keyboard and the p.c.b. and can easily be changed in the future.

The lock uses CMOS logic integrated circuits which have the advantage of negligible power consumption, thus continuous battery operation is quite feasible.

On the prototype, the quiescent current was about $1\mu A$, giving a battery life of well over 6 months. The output can be used to switch almost any solenoid, via a separate relay, if necessary, or can be used to disable a burglar alarm direct.

Operation

The operation of the lock is dependent on a decoded decimal counter type CD4017. From the truth table for this device given in Fig. 1, it can be seen that for each clock pulse, the counter switches to another output in sequence. The circuit for the lock is shown in Fig. 2.

Each time a key is depressed, one of the diodes D1-D5 conducts and C1 charges through R2. When the voltage on C1 reaches the threshold voltage of IC1d, the output will go low, charging C2 through R3 thus producing a pulse of about 50ms duration at the output of IC1c. C1 and R2 delay the production of the pulse to eliminate any effects due to contact bounce in the keyboard switches.

The first key to be depressed can be any one of the keys connected to the "reset keys" input. Irrespective of the position of the counter, none of the keys will be gated to R4, therefore it will be at logic 0. The pulse produced by depressing the key is therefore gated through IC1b to the reset input of IC3, which resets the counter. After a short delay due to R5 and C3, this pulse clocks the counter to output 1, enabling IC2c, which is an analogue switch. This sounds rather complex, but can be considered as an electronic relay.

When the control terminal is low, there is a very high resistance between the input and output (about $10^{10}\Omega$), and is effectively an open switch. However, when the control terminal is high, the resistance between the input and output is about 300Ω, which is virtually a closed switch. Thus any voltage on pin 8 of IC2 will appear across R4 when the counter is at position 1. This effectively connects the first key of the code to R4, and if this key is depressed, pin 6 of IC1 will be at logic 1, and the pulse will be inhibited from the reset input of the counter by the action of the NOR gate IC1b. The clock pulse will still reach the counter and advance it to output 2. This enables the second key, and the process is repeated.

If the wrong key is depressed at any time, R4 will be at logic 0 and the counter will reset to its initial condition as described above. As the correct keys are

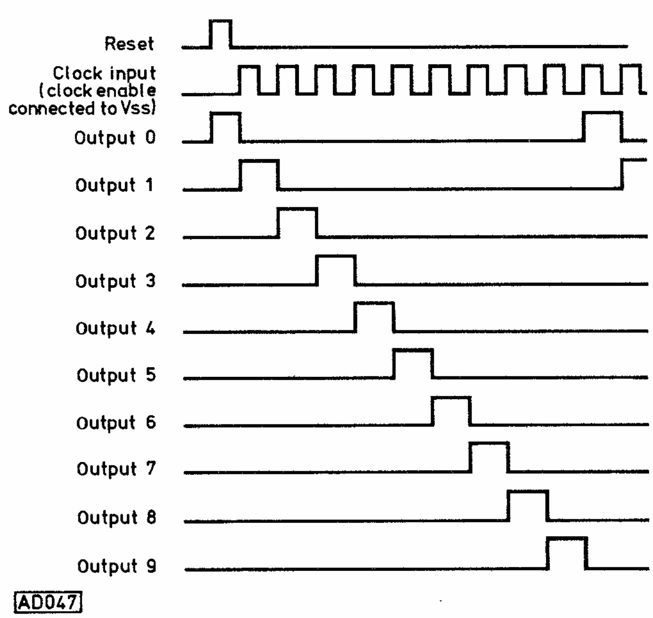


Fig. 1: Truth table for the CD4017 counter

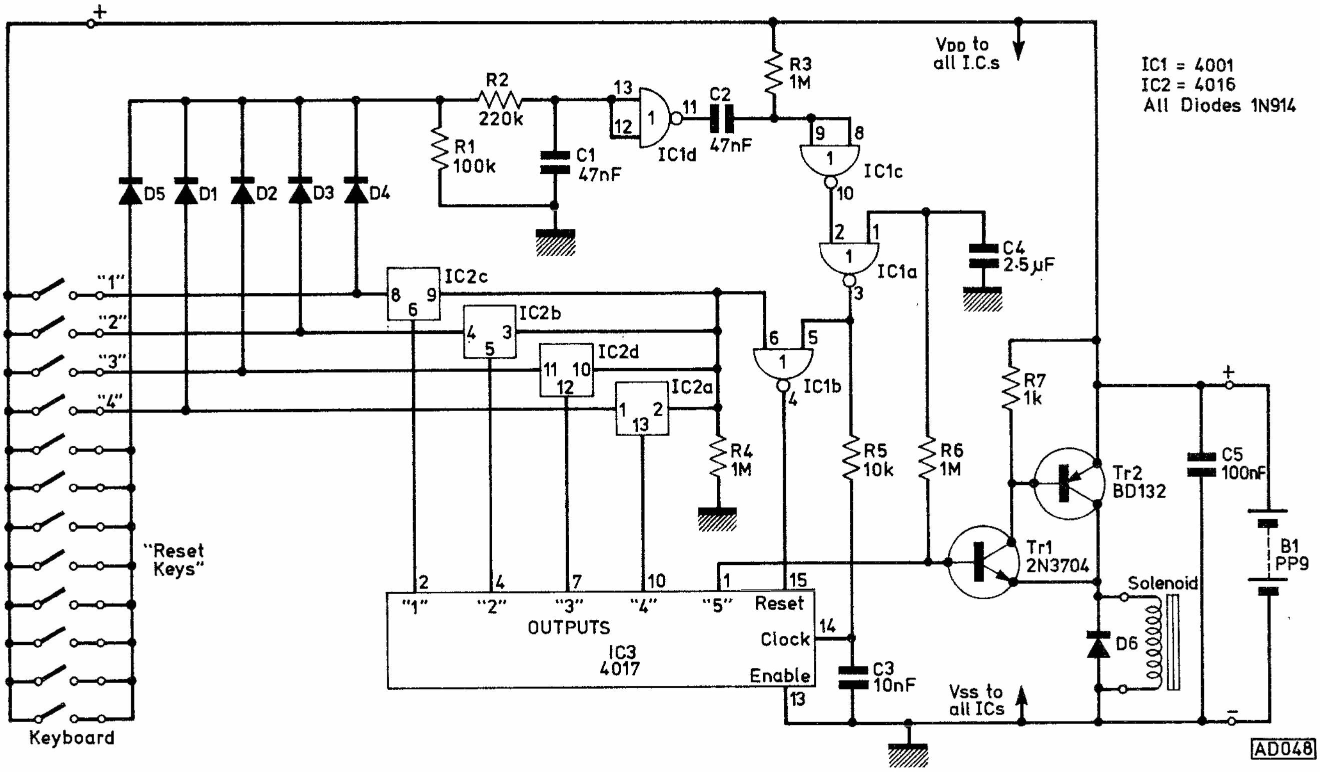


Fig. 2: Circuit diagram for the complete digital lock

depressed, the counter will increment to output 5, which will switch on the complementary output pair, Tr1 and Tr2. This energises the load, D6 providing protection against back e.m.f. from inductive loads. C4 also charges through R6, and after about $2\frac{1}{2}$ seconds, the counter is reset to its initial condition via gate IC1a. C5 provides suppression of spikes that can appear on the supply line and interfere with the logic activity.

Component Selection

Probably the most difficult item to obtain will be the calculator keyboard. This consists of 19 switches mounted on a p.c.b., which should be waterproof types, for use outdoors. These are dome type switches, operated by a thin piece of domed metal collapsing and making contact when pressure is applied.

This type of keyboard really needs a mounting frame and buttons, which are not readily available, however, the following method makes a presentable unit from this keyboard.

A small piece of white Fablon may be stuck over the entire front face of the unit, and Letraset numbers (or letters if you are hopeless at remembering numbers—the code can easily consist of an easily memorised word) put over the top of each dome.

The entire keyboard is then covered with a sheet of transparent self-adhesive plastic to protect the Letraset from rubbing off while in use. The keys can still be operated through the layers of plastic, and this makes the keyboard reasonably immune to cups of coffee being spilt over it!

Many types of calculator keyboard have the keys wired in a matrix arrangement, as opposed to one common rail and a lead to each switch. If this is the case, it will be necessary to remove the interconnecting tracks from the board, and rewire the unit.

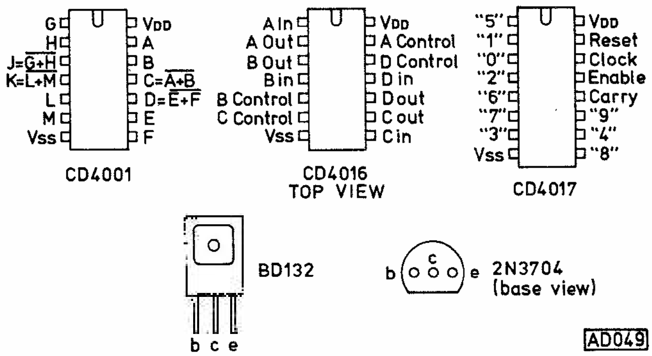
If a keyboard is available, with more than 12 keys, the remainder can be wired to the "reset keys" input on the p.c.b., thus effectively increasing the number of combinations available. Indeed as few as five keys could be used, with only one key connected to the "reset keys" input, the number of different combinations going down to a mere 3,125.

Solenoid selection can also be a problem. The lock will operate on any supply voltage between 4 and 15 volts, and the solenoid should be chosen to suit this.

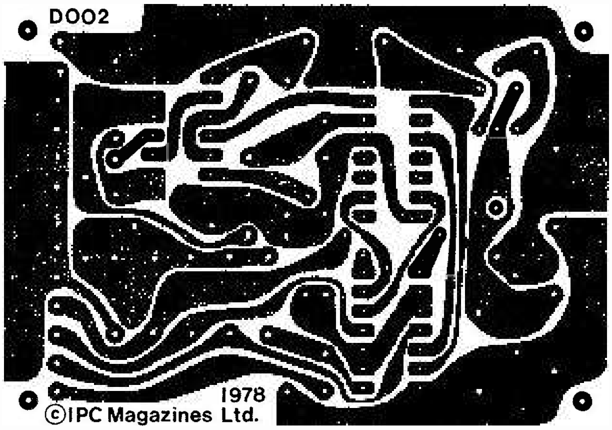
The other components are non-critical: almost any silicon diodes can be used, and most silicon transistors will suffice for the output stage, although the current rating of Tr2 should be well in excess of the load current of the solenoid.

Construction

Most of the components are mounted on a p.c.b., the track and component layout being shown in Figs. 3 and 4 respectively. There are four links needed on the board, and these should be inserted first, followed



Connections to the integrated circuits and transistors



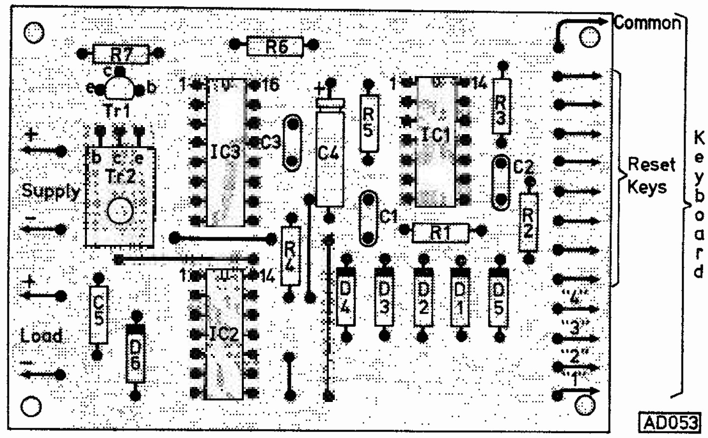


Fig. 3 (above): PCB viewed from the copper side. This board is available from the PW Reader's PCB Service

Fig. 4 (above right): Component layout of the digital lock

by the other components, leaving the integrated circuits until last, as they are easily damaged by static. The use of sockets is advised unless you have a properly earthed soldering iron. Tr2 is mounted with its metal face in contact with the board, with a short 6BA nut and bolt securing the transistor to the board. It is a good idea to connect fairly long wires from the keyboard to the p.c.b. as the code, and consequently the wiring, may need to be changed in the future. The load should not be connected yet, but if a spare l.e.d. is available, this can be connected across the load pins on the board with a 1kΩ series resistor for testing purposes.

★ components

Resistors
- R1 100kΩ
- R2 220kΩ
- R3 1MΩ
- R4 1MΩ
- R5 10kΩ
- R6 1MΩ
- R7 1kΩ
- *All ¼W 5%*

Capacitors
- C1 47nF Ceramic
- C2 47nF Ceramic
- C3 10nF Ceramic
- C4 2·5μF Electrolytic (16V)
- C5 100nF Ceramic

Semiconductors
- D1-D6 1N914, 1N4148
- Tr1 2N3704
- Tr2 BD132
- IC1 CD4001AE or MC14001CP
- IC2 CD4016AE or MC14016CP
- IC3 CD4017AE or MC14017CP

Other Components
- 2 off 14 pin DIL sockets
- 1 off 16 pin DIL socket
- Keyboard (see text)
- Solenoid (see text)
- PP9 Battery and Connector
- Printed Circuit Board

Testing

If the lock does not work, connect a voltmeter between pin 10 and IC1 and earth. Each time a key is pressed, the voltmeter should give a short positive "kick" and then return to zero. This should be checked for all the keys, and they must work every time if the lock is to be reliable.

If that does not identify the problem, connect a voltmeter across R4. The meter should read almost supply volts while the correct keys are pressed. When the lock is working, connect the supply direct to the board, and the load across the output. After further checking, the digital lock can be installed.

Possible Modifications

If a nine digit code is required, an extra CD4016 can be wired to switch 4 more keys to R4, controlled from outputs 5-8 of IC3. The output stage is taken from output 9 of IC3. Remember to include a diode from each extra key to R1, so that these keys produce a clocking pulse to operate the circuit.

If the lock is to be used with a burglar alarm, a relay can be used to disable the alarm, and the output stage can be made to stay on until another key is pressed by removing R6 and replacing C4 with a link.

However, the current drawn when the relay is on for long periods will probably be too high for economical battery operation, therefore the lock could draw its supply from a mains operated power supply, or from the burglar alarm itself.

If the load is to be switched on for other periods the values of R6 and C4 can be altered, the time the load is on being approximately given by T=R6×C4. R6 can be increased up to about 10MΩ, but if an electrolytic capacitor is used for C4, R6 should not be increased above 4·7MΩ, due to leakage current in the capacitor causing large timing errors. Care should be taken to prevent voltage spikes greater than 15V reaching the CMOS, since they can cause irreparable damage. ●

Follow-up to THE PW 'jubilee' ELECTRONIC ORGAN

Notes on the Jubilee Organ project

Although the Jubilee Organ has undoubtedly emerged as very popular, in the time which has elapsed since its final part was published in our January 1978 issue, certain points have arisen which could cause some confusion. In order to dispose of these details, the following notes are provided as a complete list of published corrections, along with suggested modifications.

General Constructional Corrections:

(1) September 1977, p 353. Transistor BFY71 should read BCY71.

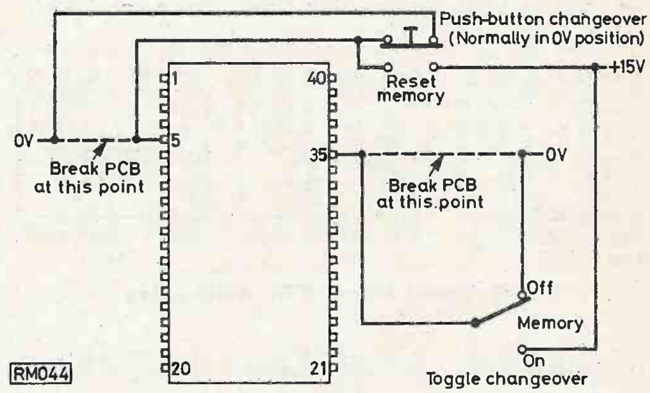
(2) November 1977, p 509. The circuit diagram of the accompaniment section shows the base of Tr5 connected to the 12V positive rail. This connection should be broken, leaving the base of Tr5 connected to the free end of R44 (1MΩ) only. The p.c.b. provided via Reader's PCB Services is correct.
The end of R45, shown connected to the 12V positive rail, should be connected to the junction of R40 and C17. Again, the recommended p.c.b. is correct.

(3) The collated components list, September 1977 p 353, contains the information "3-off 33nF". This should read "3-off 3·3nF Polystyrene".

Operational and Setting-Up Instructions:

November 1977, p 506—in describing the interim keying tests, a mistake was made in the text. When the flying lead is connected to the +12V point (positive end of C8) the note is inhibited. It is when the lead is removed from this point that the note will sound, and it is under this condition that VR5 should be adjusted. Re-applying the 12V will terminate the tone according to the sustain setting of VR6. When S2 is open the tone burst will occur when the flying lead is removed from the 12V point. The same reversed logic would apply to testing the repeat percussion effect.

Our "Postscript" in the final part of the article (January 1978) gave details of a modification to enable major chords to be memorised, thereby introducing a continuous "vamp" facility. The fact that no drawings accompanied the text seems to have caused considerable confusion, so in order to illuminate the situation, the relevant diagram, showing the necessary switching, is now provided for reference.



Circuit diagram of the Major Chords Memory modification

As published originally, the text could be misleading, and should have said that to enable the memory, pin 35 of IC13 should be connected to +15V, while pin 5 should normally be at 0V, but momentarily connected to +15V via the push-button changeover when the memory is to be reset. This will cancel any previously selected chord.

Suggested Modifications

Manfred Pfeifer of Bristol suggests in a letter to the author the following swell pedal modification:

"The volume is controlled by a foot operated pedal, linked via a l.d.r. To maintain a suitable range, the l.d.r. (ORP12) is connected in series with a 16µF capacitor, and then wired in parallel with R92. A small bell transformer supplies 5V a.c. to provide a light source for the l.d.r."

Another constructor, Lorin Knight, of Letchworth, suggests some further improvements. He has included three extra stops (one for future use), with one used for continuous rhythm as already described, and one used as an additional percussion stop for the melody. C12 is shunted with a 47kΩ preset and an extra 4·7µF. The preset is adjusted so that the amplitude only drops 6-10dB after the percussive attack, giving rise to a gradually "flattening" envelope shape, similar to that of a piano.

INTRODUCTION TO LOGIC—*continued from page 31*

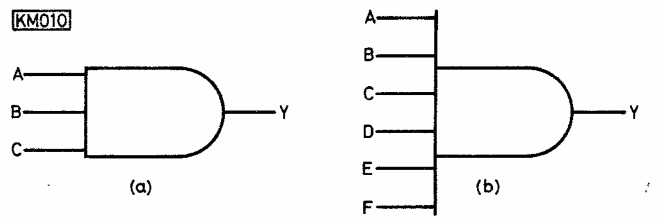


Fig. 5: AND gate symbols

Practical Gate Devices

Let's now take a look at some of the actual AND gates available in integrated circuits.

In 74-series TTL the most commonly met AND gate is likely to be the 7408, which contains four separate 2-input AND gates in one package. Other types are the 7411 which has three 3-input AND gates, and the 7421 which is a dual 4-input AND gate. The function and pin connections for these types are shown in Fig. 6.

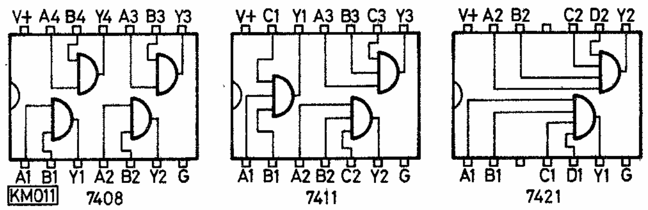


Fig. 6: Some actual TTL AND gates

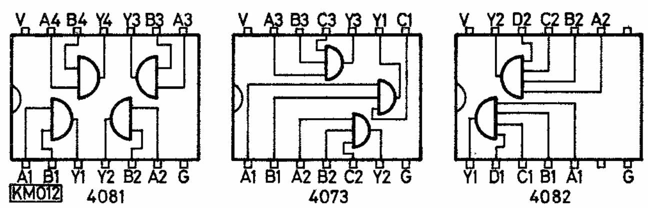


Fig. 7: Some actual CMOS AND gates

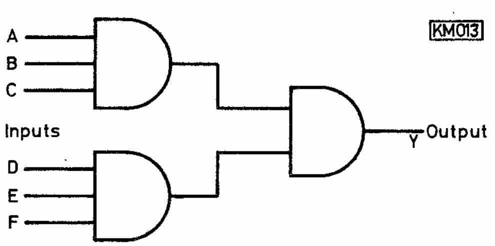


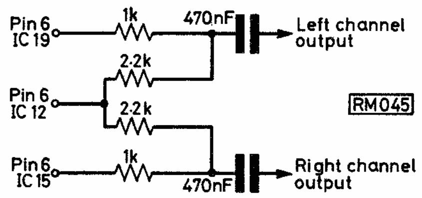
Fig. 8: Cascading AND gates to provide more inputs

The 4081 in the CMOS series provides the same logic functions as a 7408 but the pin layout is different. Other gates in the CMOS series are the 4073 triple 3-input AND gates and the 4082 which contains two 4-input AND gates. Fig. 7 shows the pin connections and functions of these CMOS devices.

If we wanted a 6-input AND gate this could be made up by using two 3-input gates feeding into a 2-input gate to form a cascaded tree of gates as shown in Fig. 8. This principle could be extended to give any number of inputs if desired.

Next month we shall look at some of the other types of gate circuit used in logic systems.

He also suggests modification of the DIN output socket, to introduce stereo effect. This gives drums to the left, melody centre, and accompaniment to the right.



Circuit diagram for Stereo Effect modification

Several readers have requested detailed cutting and drilling instructions for alternative keyboard versions. It was felt that in cases where the calculator keyboard was not opted for, general details for other types would necessitate a proliferation of differing instructions. Aside from this confusion, the conventional keyboard, for which we had approximate constructional details, appeared to be in limited supply (very limited supply as it eventually proved), and so we decided to confine our constructional notes to the details for the calculator version in general, and the initial measurements for the front and back panels. This was considered enough to cover the bare essentials, and the majority of constructors seem to have come to terms with this problem. ●

KINDLY NOTE!

Bovington Tank Battle Game, June, page 38

The coil winding details for this project were inadvertently omitted from the components list. L1 80 turns 40 s.w.g. enam. copper wire on 6mm dia. former with dust core. L2 3 turns 22 s.w.g. tinned copper wire 6mm dia. x 8mm long air-spaced, tapped ¾ turn from top.

Tr1 should be a BC108.

C24 should be connected to the tap on L2, not as shown in the circuit diagram (the printed circuit board is correct).

A small section of track is missing from the p.c.b. copper track pattern shown in the article. To overcome this a thin wire link should be used to connect together the pads for the +ve ends of C12 and C13. Solder this link onto the copper track side.

D3 to D12 are type 1N4148.

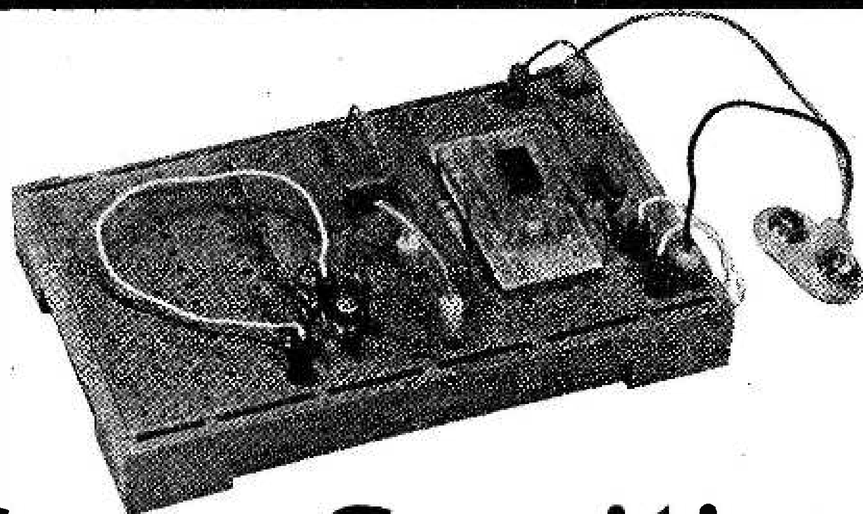
R32 is selected according to type of indicator used. (Shown in Fig. 7.)

μ-DeCnology

DAVID GIBSON

4

THIS MONTH



'Super Sensitive Fuzz'

In recent years "fuzz boxes" have been rife on the pop scene particularly with regard to guitars. The idea seems to be that one uses a fuzz box to make a guitar not sound like a guitar!

This month's μDeCnology circuit shows a very simple circuit for obtaining a fuzz effect. It is very sensitive and can be used to fuzz sound direct from a microphone or even a record player.

The commonest approach to fuzzing involves taking a luckless sine wave, chopping the tops or peaks off (known by the purists as "squaring"), and then amplifying the resultant noise with an ordinary audio amplifier.

We are cheating a little with our circuit by simply using the very high gain of the 741 op. amp. with no negative feedback. To increase the sensitivity still further, an extra stage of preamplification has been added by using a BC107 transistor. This preamp stage is also very simple, being reduced to a bare minimum of components.

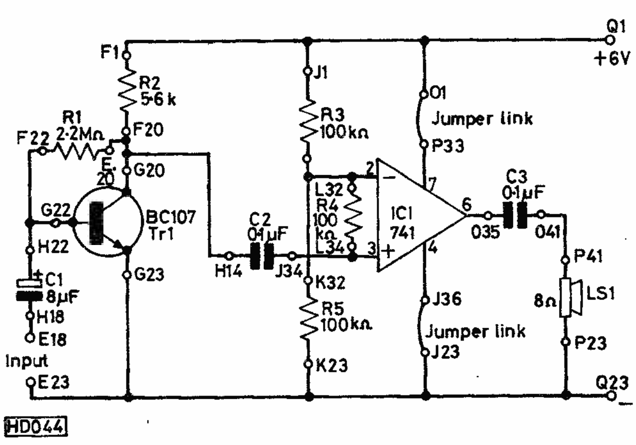


Fig. 1: Main circuit diagram including preamplifier

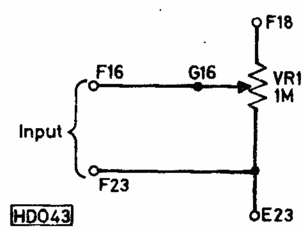


Fig. 2: Connections and hole numbers for the inclusion of a suitable volume control

When you have "plugged" the components into your μDeC by their own leads (see **Fig. 1**) you should connect 6V to holes Q1(+) Q23(−). The input is connected to holes F22 and E23. On test it was found that almost any microphone would work well and give a horrendously fuzzed voice output. Those tried included a cheap crystal insert, a commercial crystal microphone, a magnetic type (some 300Ω impedance), and a small loudspeaker. Even small earpieces were tried and found to work.

Six volts proved ample for good sensitivity. Increasing this to 12V made the circuit super sensitive and if this is done there is a good chance of positive feedback which will make the circuit oscillate. In a permanent form, one could transfer the components from μDeC to Blob Board and then put the Blob Board in a metal case thus screening the circuitry from both the output loudspeaker and the microphone. This should prevent instability and make a useful fuzz box which could be used in many applications. For example, as a party game or at a disco, records could be announced with fuzz in followed by the record. Alternatively, the participants might be

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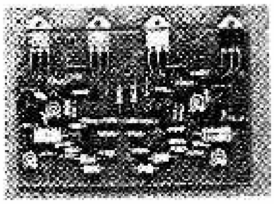

- ★ Class AB Operation
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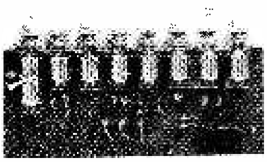

When used in conjunction with PR 020 provides switching for different inputs. Features Mono/Stereo switch. Loudness/Filter/Tape replay playback, Phono, Auxiliary + two other inputs. Has PC Board mounting 5 Way Din socket for tape deck.

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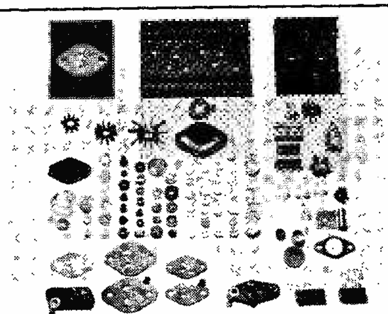

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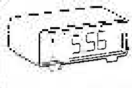

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POLYESTER RADIAL LEAD (Values in µf). **250V:** 0·01, 0·015, 0·022, 0·027 **5p**; 0·033, 0·047, 0·068, 0·1 **7p**; 0·15 **8p**; 0·22, 0·33 **10p**; 0·47 **14p**; 0·68 **18p**; 1·0 **22p**; 1·5 **29p** 2·2 **31p**

FEED THROUGH CAPACITORS 1000pF/350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). **250v:** 100 **65p**; **63v:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8, 10, 15, 22 **8p**; 47, 32, 50, **11p**; 63, 100, **27p**; **50V:** 1·0, **7p**; 50, 100, 220, **25p**; 470, **50p**; 1000, **62p**; 2200, **68p**; **40V:** 22, 33µF, **9p**; 100, **12p**; 3300, **62p**; 4700, **64p**; **35V:** 10, 33, **7p**; 330, 470, **32p**; 1000, **49p**; **25V:** 10, 22, 47, **6p**; 80, 100, 160, **8p**; 220, 250, **13p**; 470, 640, **25p**; 1000, **27p**; 1500, **30p**; 2200, **41p**; 3300, **52p**; 4700, **54p**; **16V:** 10, 40, 47, 68, **7p**; 100, 125, **8p**; 470, **16p**; 1000, 1500, **20p**; 2200, **34p**; **10V:** 4, 100, **6p**; 640 **10p**; 1000, **14p**.
TAG-END TYPE: 70V: 2000, **98p**; 4700, **121p**; **50V:** 10,000 **245p**; 3000 **75p**; **40V:** 2500, **65p**; **25V:** 4700, **48p**; 2000, **37p**; **40V:** 2000+2000, **95p**; **350V:** 32+32, **185p**.

TANTALUM BEAD CAPACITORS **35V:** 0·1µF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2µF, 3·3, 4·7, 6·8. **25V:** 1·5, 10. **20V:** 1·5µF **13p** each. **10V:** 22µF, 33, **6V:** 22µF, 47, 68, **3V:** 100µF **20p** each. **10V:** 100µF **30p**. **16V:** 47, 100µF **40p**

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01µF **5p**
0·015, 0·02, 0·03, 0·04, 0·05, 0·056µF **7p**
0·1µF, 0·15, 0·2 **9p**. **50V:** 0·47µF **11p**

CERAMIC CAPACITORS 50V.
Range: 0·5pF to 10nF **3p**
15nF, 22nF, 33nF, 47nF, **4p**. 100nF **6p**

POLYSTYRENE CAPACITORS:
10pF to 1nF, **8p**. 1·5nF to 47nF, **10p**.

POTENTIOMETERS (AB or EGEN)
Carbon Track, 0·25W Log & 0·5W Linear values

500 Ω, 1K & 2K (LIN ONLY) Single	26p
5KΩ–2MΩ single gang	26p
5KΩ–2MΩ single gang D/P switch	55p
5KΩ–2MΩ dual gang stereo	70p

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track

5KΩ–500KΩ single gang	70p
10KΩ–500KΩ Dual gang	80p
Self-Stick graduated Alum. Bezels	22p

PRESET POTENTIOMETERS

0·1W 50Ω–2·2M Mini. Vert. & Horiz.	8p
0·25W 100Ω–3·3MΩ Horiz. } larger	10p
0·25W 250Ω–4·7MΩ Vert. }	10p

SILVER MICA (pF)
3·3, 4·7, 6·8, 10, 12, 18, 22, 27, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 200, 250 **9p** each.
300, 330, 360, 390, 600 & 820pF **16p** each.
1000, 2200pF **20p** each.

CRYSTALS

100KHz	365p
1MHz	323p
1·6MHz	395p
3·2768MHz	380p
4·433619MHz	125p
Holder HC6U	18p

RESISTORS–Erie make 5% carbon Miniature High Stability, Low Noise

	RANGE	Val.	1–99	100+
0·25W	2·2Ω–4·7M	E24	1·5p	1p
0·5W	2·2Ω–4·7M	E12	2p	1·5p
1W	2·2Ω–10M	E12	5p	4p
2% Metal Film 10Ω–1M			6p	4p
1% 0·5W 5Ω–1M		E24	8p	6p

JACKSONS VARIABLE CAPS.

Dielectric	
100/300pF	105p
500pF	125p
6:1 Ball Drive 4511/DAF	107p*
Dial Drive 4103 6:1/36:1	520p
Drum 54mm	30p*
0-1-365pF	245p
00 2·365pF	275p
0 2 365pF with slow motion Drive	325p
00 208/176	285p
″ ″ with slow motion drive	325p
C804–5pF; 10; 15; 25; 50pF	175p*
100, 150pF	215p*
'L' 3x310pF	428p
00-3x25pF	386p

HEAT SINKS*

TO92	9p
TO5	9p
TO18	9p
TO220	22p
TO3	22p
TO66	22p
TO5 85°C	20p
Silicon Grease 5ml. Tub	48p
20ml. Syringe	125p
Insulation Kit for TO3, TO66 or TO220	2p Kit

EARPHONES
Magnetic

2·5mm	18p
3·5mm	18p
Crystal	33p

FIGARO GAS and SMOKE DETECTORS*
Types: 109, 308, 812 or 813 **415p each**
Sockets for above **25p**

CERAMIC TRIMMER CAPACITORS
2–7pF; 4–15pF; 6–25pF; 8–30pF **20p**

S-DEC	225p*
T-DEC	399p*
U-DEC 'A'	425p*
U-DEC 'B'	699p*

MINIATURE TYPE:
2·5–6pF; 3–10pF;
3–30pF; 10–40pF **22p**
5–25pF; 65pF; 88pF **30p**

COMPRESSION

3–40pF; 10–80pF	22p
25–200pF	33p
100–500pF 1250pF	45p

ULTRASONIC TRANSDUCERS
Receiver and Transmitter 40KHz **480p** per pair

AUDIBLE Warning
Buzzers 6V or 12V **65p***

TRANSFORMERS* (Mains Prim. 220-240V)

6-0-6V 100mA	90p
9-0-9V 75mA	95p
12-0-12V 100mA	98p
0-12 0-12V 150mA	140p
0-15 0-15V ·2A	260p+
2 x 4·5V 0·6A	260p+
12-0-12V 0·5A	260p+
0-12 0-12 0·5A	280p+
15-0-15V 0·5A	260p+
24-0-24V 0·5A	260p+
9-0-9V 1A	275p+
12-0-12V 1A	275p+
0-12 0-12V 1A	295p+
30-24-20-15-12-0 1A	
Multi tappings	360p+
30-24-20-15-12-0 2A multi tap	445p+
15-0-15V 1A	275p+
18-0-18V 1A	295p+
30-0-30V 1A	315p+
20-0-20 2A	340p+
6-0-6V 1·5A	345p+
0-18 0-18V 1·5A	379p+
9-0-9V 2A	315p+
12-0-12V 2A	320p+
30-25-20-0-20-25-30 2A	497p+
0-6 0-6V 6VA	240p

"Purbeck" Transformer 7559
250-0–250; 12-9-0–12·9; 6·3V **625p** (p & p add 75p)
LT44 **42p**
LT700 Min. O/P Pri. 1·2K, Sec. 3·2Ω **42p**
MOT Min. O/P Pri. 1·2K, Sec. 8Ω **38p**

(Please add 48p p&p charge to all prices marked +, above our normal postal charge.)

DENCO COILS
Dual Purpose 'DP' VALVE TYPE
Range 1-5 B,Y,R,W **86p**
6-7 B,Y, R, **75p**
1-5 Green **92p**
'T' Type (Trns. tuning)
Rng. 1-5 B, Y, R, W, **92p**

B9A Valve Base	25p
RDT2	92p
RFC 5 chokes	91p
RFC 7(19mH)	96p
1FT 13/14/15/16 17	85p
1FT 18/1·6 or 465	99p
TOC1	86p
MW 5FR	82p
MW/LW 5FR	103p

RF CHOKES
1µH, 4·7, 10mH **35p** each
22, 33, 47, 100, 200, 470, 750 µH 1mH, 2·5, 5 10 **35p** each
43mH, 100 **60p** each

PANEL METERS* FSD
60x46x 35mm
0-50µA
0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300VAC
"S"
"VU"
410p each
4½x3½x1½″
0-50µA
0-100µA
0-500µA
530p each
DUAL "VU" METER **550p**
EDGWISE 160µA **180p**

TRANSISTORS

	p
AC107*	23
AC117*	35
AC125*	19
AC126*	19
AC127*	18
AC128*	18
AC141*	24
AC141K*	38
AC142*	24
AC142K*	38
AC176*	18
AC187*	20
AC188*	20
ACY17	35
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
ACY40	48
ACY41	39
ACY44	39
AD149*	60
AD161*	42
AD162*	42
AF106	70
AF114*	25
AF115*	25
AF116*	25
AF117*	25
AF118*	55
AF121*	48
AF124*	55
AF125*	35
AF126	55
AF127*	35
AF139*	35
AF178*	70
AF180*	70
AF186*	50
AF239*	42
AFZ11	128
AFZ12	126
ASY26*	40
ASY27*	45
ASY50*	95
ASY76*	95
BC107*	9
BC107B*	10
BC108*	9
BC108B*	12
BC108C*	12
BC109	9
BC109B*	12
BC109C*	12
BC113	17
BC114	19
BC115	19
BC116	19
BC117	15
BC118	15
BC119*	26
BC134	19
BC135	20
BC136	18
BC137	20
BC140*	28
BC142*	25
BC143*	25
BC147	7
BC147B	10
BC148	7
BC148B	10
BC148C	10
BC149	8
BC149C	10
BC153	14
BC154	14
BC157	10
BC158	11
BC159	11
BC160*	27

	p
BC167A	11
BC168C	12
BC169C	10
BC170	17
BC171	11
BC172	10
BC173	12
BC177*	15
BC178*	14
BC179*	14
BC182	9
BC183	9
BC184	9
BC182L	10
BC183L	10
BC184L	10
BC186	21
BC187*	28
BC212	9
BC212L	10
BC213	9
BC213L	11
BC214	9
BC214K	14
BC214L	10
BC307B	14
BC308	13
BC327	15
BC328	13
BC338	12
BC441*	30
BC461*	30
BC547	11
BC548	11
BC549C	11
BC557	13
BC558	12
BC559	20
BCY30*	57
BCY34*	75
BCY39*	80
BCY40*	78
BCY42	48
BCY43	75
BCY58	22
BCY59*	22
BCY70*	15
BCY71*	15
BCY72	16
BCY78	20
BCZ10	145
BCZ11	145
BD112	95
BD115*	62
BD121	95
BD123	98
BD124*	115
BD131*	38
BD132*	38
BD133*	43
BD135*	36
BD136*	37
BD137*	36
BD138*	36
BD139*	36
BD140*	36
BD142*	59
BD144*	198
BD145*	198
BD181	85
BD205	110
BD222	60
BD378*	65
BD434	42
BD517*	65
BD695A*	75
BD696A*	75
BDY11	220
BDY17*	195
BDY60*	110
BDY61*	165
BF115*	22
BF154*	23
BF158	29
BF160	30

	p
BF161	60
BF167	25
BF173*	25
BF177*	24
BF178*	25
BF179*	30
BF180*	20
BF181*	30
BF182*	30
BF183*	30
BF184*	30
BF194	10
BF195	10
BF196	10
BF197	10
BF198	18
BF199	18
BF200*	28
BF224A	18
BF244	24
BF244B	30
BF256*	50
BF257*	26
BF258*	26
BF259*	30
BF336	30
BF394	22
BF594	40
BF595	38
BFR39	25
BFR40	25
BFR41	28
BFR79	28
BFR80	28
BFR81	28
BFR98	105
BFX29*	26
BFX81*	130
BFX84*	24
BFX85*	24
BFX86*	28
BFX87*	23
BFX88*	24
BFY18*	50
BFY50*	20
BFY51*	20
BFY52*	20
BFY53*	28
BFY55*	45
BFY64*	40
BFY71*	20
BLY83	83
BSX20*	18
BSX26*	75
BSX29*	45
BSX78*	55
BSY95A	25
BU105*	140
BU205	190
BU208	228
E421	96
MD8001	158
ME1120	25
ME4102	10
ME6002	14
MJ400*	90
MJ491*	160
MJ2955*	99
MJE340*	45
MJE370*	55
MJE371*	60
MJE520*	45
MJE521*	65
MJE2955*	115
MJE3055*	80
MPF102	30
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPS3904	40
MPSA05	24
MPSA06	24

	p
MPSA55	24
MPSA56	24
MPSA70	34
MPSU02	58
MPSU05	48
MPSU06	54
MPSU52	65
MPSU55	53
MPSU56	56
MPU131*	39
OC23*	150
OC25*	120
OC26*	150
OC28*	99
OC29*	160
OC35*	80
OC36*	99
OC41*	48
OC42*	32
OC43*	55
OC44*	31
OC45*	20
OC46*	28
OC70*	19
OC71*	25
OC72*	30
OC74*	45
OC75*	45
OC76*	36
OC77*	76
OC79*	76
OC81D*	28
OC82D*	48
OC83*	48
OC84*	44
OC122*	48
OC123*	48
OC139*	85
OC140*	85
OC141*	85
OC170*	40
OC171*	40
OC200*	48
OC201*	75
OC202	85
OC203*	85
OC204*	85
SJE5039*	95
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	47
TIP30A	47
TIP30B	64
TIP30C	65
TIP31*	40
TIP31A*	40
TIP31B*	40
TIP31C*	65
TIP32*	45
TIP32A*	49
TIP32B*	70
TIP32C*	70
TIP33*	80
TIP33A*	88
TIP33B*	100
TIP33C*	105
TIP34*	85
TIP34A*	85
TIP34B*	110
TIP34C*	110
TIP35*	219
TIP35A*	225
TIP35B*	240
TIP35C*	270
TIP36*	280
TIP36A*	265
TIP36B*	300
TIP36C*	325
TIP41A*	63
TIP41B*	73
TIP42A*	64
TIP42B*	82
TIP2955*	63

	p
TIP3055*	52
TIS43	36
TIS44	45
TIS45	45
TIS46	45
TIS47	50
TIS48	50
TIS49	50
TIS50	47
TIS60	45
TIS62	45
TIS74	47
TIS90	18
TIS91	22
ZTX107	11
ZTX108	11
ZTX109	11
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	18
ZTX303	21
ZTX304	24
ZTX311	17
ZTX314	24
ZTX320	30
ZTX326	40
ZTX341	20
ZTX500	13
ZTX501	14
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250	85
40251	97
40311*	50
40313*	125
40315	55
40316*	85
40317*	52
40319	71
40320	56
40323	60
40324	85
40326*	52
40327*	62
40347*	80
40348*	101
40360*	43
40361*	45
40362*	48
40406	65
40407	50
40408	75
40411*	285
40412*	63
40467*	95
40594*	80
40595*	90
40603*	65
40636*	125
40673*	68
2N697*	21
2N698*	39
2N699*	39
2N706A*	19
2N707*	50
2N708*	19
2N914*	32
2N916*	27
2N918*	30
2N920*	51
2N1131*	22
2N1132*	22
2N1303*	50
2N1304*	50
2N1305*	28
2N1306*	35
2N1307*	50
2N1308*	46
2N1613*	23
2N1670*	150
2N1671B*	195

	p
2N2160*	105
2N2217*	48
2N2218A*	31
2N2219A*	22
2N2220A*	26
2N2221A	23
2N2222A*	20
2N2303*	45
2N2368	21
2N2369A*	15
2N2483*	28
2N2484*	30
2N2646*	48
2N2784	55
2N2904*	22
2N2905A*	20
2N2906*	18
2N2907*	20
2N2907A*	22
2N2926G	10
2N3011*	24
2N3053*	20
2N3054*	49
2N3055*	55
2N3108	39
2N3442*	131
2N3563	20
2N3614*	169
2N3615*	135
2N3663	24
2N3702	10
2N3703	11
2N3704	10
2N3705	11
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	16
2N3711	10
2N3772*	170
2N3773*	288
2N3819	22
2N3820	32
2N3823*	65
2N3824*	70
2N3866	90
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037*	52
2N4041*	80
2N4058	17
2N4061	17
2N4062	13
2N4064*	120
2N4069	45
2N4236	145
2N4288	20
2N4289	20
2N4427	27
2N4859	45
2N4922*	55
2N5135	42
2N5136	42
2N5138	20
2N5172	24
2N5179	60
2N5180	60
2N5191	65
2N5305	24
2N5457	32
2N5458	32
2N5459	32
2N5485	32
2N5777	56
2N6027	40
2N6109	45
2SD234*	85
3N128	85
3N140	85

Matched Pair 10p extra

LINEAR IC'S

702	75
709C 8 pin	35
723* 14 pin	45
741* 8 pin	22
747C 14 pin	70
748C 8 pin	36
753 8 pin	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-5050	241
AY-1-5051	145
AY-1-6721/6	195
AY-3-8500*	450
AY-3-8550*	595
AY-3-8600*	900
AY-3-8710*	978
AY-5-1224A*	260
AY-5-1230*	450
AY-5-1315	560
AY-5-1317A	630
AY-5-3500*	510
AY-5-3507*	415
AY-5-4007	650
CA3011*	82
CA3014*	137
CA3018*	68
CA3020	170
CA3023	170
CA3028A*	80
CA3035	140
CA3036	110
CA3043	190
CA3045	140
CA3046	71
CA3048	200
CA3075	175
CA3080E*	80
CA3081	190
CA3089E	210
CA3090AQ	390
CA3123	200
CA3130*	85
CA3140	92
ICL7106*	975
ICL7107*	975
ICL8038CC*	370

ICM7205*	1150
LM300H	170
LM301A	30
LM304	240
LM308T	110
LM318H	205
LM318S	195
LM324A	79
LM339	80
LM348	120
LM379	375
LM380	95
LM381N	145
LM381AN	248
LM382	125
LM3900	60
LM3909N	70
LM3911	125
LM732	125
M252AA*	750
M253AA*	795
MC663	275
MC724*	175
MC1303	88
MC1304P	260
MC1310P	175
MC1312PQ	195
MC1458P*	50
MC1459*	435
MC1495	535
MC1496L	92
MC1710CG	79
MC3340P	150
MC3360P	120
MC3401	70
MEM780	205
MFC4000B	85
MFC6040*	97
MK50362*	650
NE350	160
NE518A	210
NE555*	29
NE556DB*	60
NE560*	325
NE561*	395
NE565A*	120
NE566*	160

NE567V*	170
NE571	450
RAM2102-2*	170
RC4136D	120
ROM2513*	700
SG3402*	295
SL403D	250
SL437A	560
SN72710*	43
SN72733	125
SN76003N	211
SN76013N	140
SN76013ND	120
SN76023N	140
SN76023ND	120
SN76033N	211
SN76115N	215
SN76227N	115
TAA550	50
TAA621AX1	228
TAA661A	155
TAA700	353
TAA960	300
TAD100	150
TAD110	170
TBA120S	70
TBA540	215
TBA540Q	220
TBA550Q	330
TBA641-A12/BX1 or BX11	250
TBA651	180
TBA800	90
TBA810S	105
TBA820	70
TBA920Q	260
TCA270Q	220
TCA270SQ	220
TDA1022	595
TDA2020	320
TLO81CP*	52
TLO82CP*	79
TLO84CP*	130
UAA170	198
ZN414	105
ZN424E	130

TTL 74* (TEXAS)

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	38
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
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