JULY 1978

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7409	20p	7427	25p	7450	15p	7486	30p	74109	50p	74136	80p	74151	65p	74166	125p	74182	75p	74197	100p
7410	15p	7428	40p	7451	15p	7489	250p	74118	90p	74137	100p	74153	65p	74167	325p	74184	150p	74198	185p
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10/16	7p	3300/25	50p
10/25	7p	3300/63	90p
10/35	7p	4700/25	50p
10/50	7p	4700/40	65p
22/6V3	7p	4700/63	120p
22/10	7p		
22/16	7p		
22/25	7p		
22/35	7p		
22/50	8p		
33/6V3	7p		
33/16	8p		
33/25	8p		
33/40	8p		
33/50	9p		
47/10	8p		
47/16	8p		
47/25	8p		
47/35	8p		
47/50	9p		
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100/16	8p		
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4016	40p	4060	120p
4017	90p	4066	55p
4018	90p	4069	20p
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4022	90p	4072	16p
4023	16p	4081	16p
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ISSUE 857

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JULY 1978 · VOLUME 54 · NUMBER 3

BRITAIN'S LEADING JOURNAL FOR THE RADIO & ELECTRONIC CONSTRUCTOR

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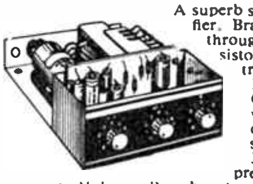
News and Views

For our Constructors

General Interest

SUPERSOUND 13 HI-FI MONO AMPLIFIER



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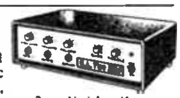

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400mW UNMARKED GOOD ZENERS 3·6v, 6·8v, 10v, 11v, 12v, 13v, 16v, 24v, 30v, 33v. All at 10 for 40p.
ASSORTED BRANDED VHF FETS at 12 for £1.
50 ASSORTED TANTALUM BEAD CAPACITORS for £1·50.
BF 451 PNP 300 MHz TRANSISTORS 6 for 35p.
T.V. S.A.W. FILTERS Untested. 3 for 35p.
ITT CAPACITORS PMT-2P ·1uf 100v.w. at 20p doz.
$\frac{3}{16}$" COIL FORMERS with core at 5p, 6 for 25p.
TBA 120S FM IC's with data untested. 6 for 60p.
AUDIO I.C. LM 380 with circuits at 80p.
50 2 WATT ZENERS Assorted Untested @ 57p.
BAW62 HIGH SPEED SILICON DIODES 12 for 35p.
50 BC 107-8-9 ASSORTED TRANSISTORS untested for 57p.
CERAMIC FILTERS 5·5MHz at 27p each.
McMURDO 8 PIN PLUG AND SOCKETS WITH COVER at 55p per set.
MULLARD PRE-AMPLIFIER I.C. TAA 435 with data @ 40p.
ITT ·15uf 400v.w. POLYESTER CAPACITORS at 20p doz.
MAINS TRANSFORMER 240v Input 55 volt 10 amp out @ £5·50.
T.V. WALL MOUNTING OUTLET BOXES @ 15p.
50 AC 128 TRANSISTORS Branded but untested @ 57p.
MAINS TRANSFORMER 240v input 24 volt Tapped at 14 volt 1 amp @ £1·25 (25p post and packing).
JACKSON TYPE 5pf AIR SPACED VARIABLE CAPACITOR @ 75p.
ITT ·1uf 100v.w. MINIATURE POLYESTER CAPACITORS 20p doz.
MULLARD 455 KHz PLUS 10·7MHz I.F. MODULE with data @ £4.
100uf 100v.w. ELECTROLYTICS at 3 for 25p.
2200uf 100v.w. ELECTROLYTICS at 60p each.
Please add 20p for post and packing on UK orders under £2 unless otherwise stated. Overseas orders at cost.

SINCLAIR PRODUCTS*
PDM35 digital multimeter £25·95. Mains adaptor £3·24. Deluxe padded carry case £3·25. 30kV probe £18·36. New DM235 digital meter P.O.A. Cambridge scientific programmable calculator £13·15. Prog. library £4·65. Microvision tv £200.

CUT PRICE TELETEXT
Texas Instruments XM11 tifax module £120. Labgear 7026 ready to use, attractively cased, complete unit. Plugs into tv aerial socket. Full colour. Remote control page select £355.

TV GAMES KITS
Send sae for free data. Tank Battle chip AY-3-8710 plus economy kit £17·95. Stunt Motor Cycle chip AY-3-8760-1 plus economy kit £17·95. 10 game paddle 2 chip AY-3-8600 plus economy kit £14·70. AY-3-8500 chip plus economy kit £8·95. Modified Shoot kit £4·95. Rifle kit £4·95. Colour generator kit £7·50. Joystick controls £1·90. 4·43Mhz pal crystals 90p.

ASSEMBLED TV GAMES
All attractively cased. 4 game black and white model (tennis, football, squash and pelota) £11·95. 6 game colour model with pistol attachment £21·95. Tank Battle game £39·95. Stunt Motor Cycle game £39·95. Stabilized mains adaptor for all games £3·10.

MAINS TRANSFORMERS
6-0-6V 100ma 79p, 1½a £2·35. 6·3V 1½a £1·89. 9-0-9V 75ma 79p, 1a £1·99, 2a £2·60. 12-0-12V 50ma 79p, 100ma 90p, 1a £2·49. 13V ½a 95p. 15-0-15V 1a £2·79. 30-0-30V 1a £3·59.

JC12, JC20 AND JC40 AMPLIFIERS
A range of integrated circuit audio amplifiers supplied with free data and printed circuits. JC12 6 watts £1·60. JC20 10 watts £2·95. JC40 20 watts £4·20. Send sae for free data on our range of matching power and preamp kits.

FERRANTI ZN414
IC radio chip £1·05. Extra parts and pcb for radio £3·85. Case £1. Send sae for free data.

PRINTED CIRCUIT MATERIALS
PC Etching kits: Economy £1·70, Standard £3·82. 50 sq ins pcb 40p. 1 lb FeCl £1·05. Etch resist pens: Economy 45p, Dalo 73p. Small drill bit 20p. Etching dish 68p. Laminate cutter 75p.

BATTERY ELIMINATOR BARGAINS
TV games power unit stabilized 7·7V 100ma £3·10. 3-way models with switched output and 4-way multi-jack: 3/4½/6V 100ma £2·92. 6/7½/9V 300ma £3·30. **100ma radio models same size as a PP9 battery, with press stud connectors.** 9V £2·85. 6V £2·85. 4½V £2·85. 9V + 9V £4·50. 6V + 6V £4·50. 4½V + 4½V £4·50. **Cassette recorder mains unit** 7½V 100ma with 5 pin din plug £2·85. **Car converters** 12V dc input. Output 9V 300ma £1·50. Output 7½V 300ma £1·50.

BATTERY ELIMINATOR KITS
Send sae for free leaflet on range. **100ma radio types with press stud connectors.** 4½V £1·80. 6V £1·80. 9V £1·80. 4½ + 4½V £2·50. 6 + 6V £2·50. 9 + 9V £2·50. **Cassette type** 7½V 100ma with din plug £1·80. **Transistor stabilized 8-way types** for low hum 3/4½/6/7½/9/12/15/18V. 100ma £3·20. 1Amp £6·40. **Heavy-duty 13 way types** 4½/6/7/8½/11/13/14/17/21/25/28/34/42V 1Amp £4·65. 2Amp £7·25. **Car convertor** kit input 12V dc. Output 6/7½/9V 1A stabilized. **Stabilized power kits** 3-18V 100ma £3·60. 3-30V 1A £9·95. 3-30V 2A £14·95.

S-DECS AND T-DECS*
S-DeC £3·39. T-DeC £4·44. u-DeCA £4·52. u-DeCB £6·73. 16 dil or 10T05 adaptors: With socket £1·91. New S-de-kit £4·95.

CONTINENTAL SPECIALITIES PRODUCTS*
EXP300 £6·21. EXP350 £3·40. EXP600 £6·80. EXP650 £3·89. EXP4B £2·48. PB6 £9·94. PB100 £12·74. LM1 £30·99. LP1 £33·48. LP2 £19·44.

BI-PACK AUDIO MODULES
Send sae for data. S450 tuner £23·51. AL60 £4·86. PA100 £16·71. SPM80 £4·47. BMT80 £5·95. MK60 £38·74. Stereo 30 £20·12.

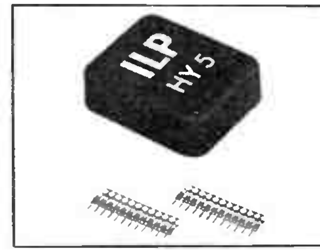
COMPONENTS
Resistors 5% carbon E12 10 to 10M. ¼W 1p. 1W 2p. **Polyester** capacitors 250V E6 ·01 to ·068mf 3½p. 0·1mf 2p. ·15mf 5p. ·22mf 4p. ·33, ·47mf 6p. **Polystyrene capacitors** E12 63V 15pf to 6800pf 2½p. **Ceramic** capacitors 50V E12 22pf to 1000pf 2½p. E6 1500pf to 47000pf 2½p. **Mylar capacitors** 100V ·001, ·002, ·005mf 4p. ·01, ·02mf 4½p. ·04, ·05mf 5½p. **Electrolytics 50V** ·47, 1, 2mf 5p. 25V 5mf 5p. 10mf 4p. 16V 22mf 5p. 33, 47, 100mf 6p. 220, 330mf 9p. 470mf 11p. 1000mf 8½p. **Zeners** 400mW E24 2V7 to 33V 7½p. **Preset pots** sub-miniature 0·1W horiz or vert 100 to 4M7 8½p. **Potentiometers** ¼W 4K7 to 2M2 log or lin. single 28p. Dual 76p.

SWANLEY ELECTRONICS

DEPT. PW, PO Box. 68, 32 Goldsel Rd., Swanley, Kent BR8 8TQ

Mail order only. Please add 30p to the total cost of order for postage. Prices include VAT. Overseas customers deduct 7% on items marked * and 11% on others. Official credit orders welcome.

15—240 Watts!



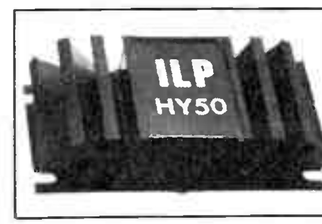
HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc) are catered for internally. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack—Multi-function equalization—Low noise—Low distortion—High overload—Two simply combined for stereo.

APPLICATIONS: Hi-Fi—Mixers—Disco—Guitar and Organ—Public address

SPECIFICATIONS:
INPUTS. Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; Input impedance 4·7kΩ at 1kHz.
OUTPUTS. Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS. Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION. 0·1% at 1kHz. Signal/Noise Ratio 68dB.
OVERLOAD. 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.
Price £5·22 + 65p VAT P&P free.



HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete Kit—Low Distortion—Short, Open and Thermal Protection—Easy to Build.

APPLICATIONS: Updating audio equipment—Guitar practice amplifier—Test amplifier—audio oscillator.

SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω: DISTORTION 0·1% at 1·5W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz—3dB.
SUPPLY VOLTAGE ± 18V.
Price £5·22 + 65p VAT P&P free.

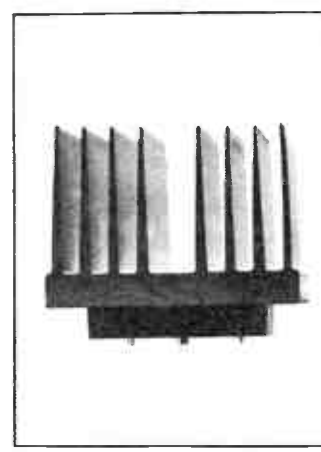
HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion—Integral Heatsink—Only five connections—7 amp output transistors—No external components

APPLICATIONS: Medium Power Hi-Fi systems—Low power disco—Guitar amplifier

SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz—3dB.
SUPPLY VOLTAGE ± 25V SIZE 105 50 25mm
Price £6·82 + 85p VAT P&P free



HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range. Designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

FEATURES: Very low distortion—Integral heatsink—Load line protection—Thermal protection—Five connections—No external components

APPLICATIONS: Hi-Fi—High quality disco—Public address—Monitor amplifier—Guitar and organ

SPECIFICATIONS
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0·04% at 60W at 1kHz
SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz - 3dB SUPPLY VOLTAGE ±25V
SIZE 114 50 85mm
Price £15·84 + £1 27 VAT P&P free.

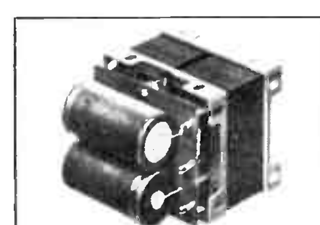
HY200
120 Watts into 8Ω

The HY200 now improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components

APPLICATIONS: Hi-Fi—Disco—Monitor—Power slave—Industrial—Public Address

SPECIFICATIONS
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz - 3dB SUPPLY VOLTAGE ±45V
SIZE 114 50 85mm
Price £23·32 + £1·87 VAT P&P free.



HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.

APPLICATIONS: Public address—Disco—Power slave—Industrial

SPECIFICATIONS
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0 1% at 240W at 1kHz
SIGNAL NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz - 3dB SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV SIZE 114 100 85mm
Price £32 17 + £2·57 VAT P&P free.

POWER SUPPLIES

PSU36 suitable for two HY30's £5·22 plus 65p VAT. P/P free.
PSU50 suitable for two HY50's £6 82 plus 85p VAT. P/P free.
PSU70 suitable for two HY120's £13·75 plus £1·10 VAT. P/P free.
PSU90 suitable for one HY200 £12·65 plus £1·01 VAT. P/P free.
PSU180 £23·10 + £1·85 VAT.
B1 £0 48 + £0·06 VAT.

TWO YEARS' GUARANTEE ON ALL OUR PRODUCTS

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Regd No. 1032630.

MAINS TRANSFORMERS

All these have 230/240v 50Hz Primary

VOLTAGE	CURRENT	REF.	PRICE
1v	2 amp	TM 1	£1·94
2·4v	5 amp	TM 2	£1·62
4v	7 amp	TM 32	£2·70
6v	½ amp	TM 3	85
6·5v	½ 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	¼ amp	TM 9	£1·05
13v	½ 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	¼ amp	TM 12	£1·62
18v	½ 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 45p.

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.

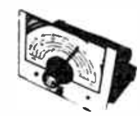
SPIT MOTOR WITH CARTER G/BOX

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

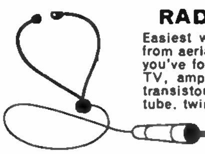
Japanese made in plastic container with leads size 2" × 1½" × 1½", this is ideal to power a calculator or radio, it has a full wave rectified and smoothed output of 9 volts suitable for a loading of up to 100mA. £2·53.

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

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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 oaper. 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 2½" long × 1½" wide × ½" 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. × 1½" 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 1½" apart. Spindles ½" diameter, extend 1½" 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.

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Also we stock, or can obtain, other 2N transistor types not listed below. So please write and let us know what you are looking for.
Please add 8% VAT to your 2N transistor orders, plus 25p per order for postage and packing.

Type	price	Type	price
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2N706	0.37	2N3766	0.86
2N706A	0.24	2N3866	1.05
2N708	0.30	2N4033	0.60
2N718	0.41	2N4123	1.94
2N914	0.32	2N4125	0.20
2N916	0.96	2N4400	0.15
2N918	0.38	2N4401	0.18
2N929	0.24	2N4402	0.21
2N930	0.24	2N4403	0.23
2N930A	0.25	2N4441	1.06
2N1132	0.85	2N4442	1.30
2N1613	1.27	2N4443	1.43
2N1711	0.32	2N4444	1.88
2N1890	0.77	2N4870	0.78
2N1893	0.30	2N4871	0.74
2N2102	0.93	2N4918	0.67
2N2218	0.29	2N4919	0.70
2N2218A	0.32	2N4920	0.74
2N2219	0.30	2N4921	0.63
2N2219A	0.31	2N4922	0.67
2N2221	0.23	2N4923	0.70
2N2221A	0.26	2N5060	0.42
2N2222	0.18	2N5061	0.43
2N2222A	0.21	2N5062	0.49
2N2369	0.21	2N5063	0.52
2N2369A	0.23	2N5064	0.55
2N2646	0.56	2N5088	0.21
2N2904	0.30	2N5108	4.03
2N2904A	0.31	2N5190	0.69
2N2905	0.38	2N5191	0.74
2N2905A	0.32	2N5192	0.80
2N2906	0.23	2N5193	0.75
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Featuring sleep and snooze timers, 24 hour alarm format, fast and slow setting, alarm output switch.

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ECC189	0·80
ECF80	0·50
ECF82	0·45
ECF801	0·75
ECH34	0·95
ECH35	1·50
ECH42	0·85
ECH81	0·45
ECH84	0·95
ECL80	0·60
ECL82	0·55
ECL83	1·20
ECL85	0·65
ECL86	0·55
EF37A	1·50
EF39	2·90
EF40	0·70
EF41	0·75
EF80	0·40

Type	£
EF83	1·50
EF85	0·45
EF86	0·55
EF91	0·65
EF92	0·75
EF95	0·45
EF183	0·55
EF184	1·60
EF804	2·00
EFL200	0·75
EH90	0·60
EL32	0·60
EL34	2·20
EL37	3·00
EL41	0·80
EL81	0·70
EL82	0·60
EL84	0·60
EL86	0·70
EL90	1·30
EL91	1·90
EL95	0·70
EL504	0·80
EL802	1·50
EL822	1·50
EM31	0·75
EM80	0·60
EM81	0·60
EM84	0·40
EM87	1·00
EY51	0·45
EY81	0·45
EY86/87	0·55
EY88	0·55
EZ80	0·45
EZ81	0·60
GY501	0·90
GZ32	0·65
GZ33	3·50
GZ34	2·00
GZ37	2·50
KT66	4·00
KT88	5·75
MH4	1·00
ML6	1·00
OA2	0·55
OB2	0·60
PABC80	0·40
PC85	0·50
PC86	0·85
PC88	0·75

Type	£
PC900	1·25
PCC84	0·45
PCC89	0·55
PCC189	0·65
PCF80	0·50
PCF82	0·40
PCF84	0·65
PCF86	0·65
PCF200	0·90
PCF201	0·90
PCF801	0·55
PCF802	0·65
PCF805	1·80
PCF806	0·85
PCF808	1·00
PCH200	0·80
PCL81	0·60
PCL82	0·65
PCL84	0·70
PCL86	0·70
PCL805/85	0·75
PD500	2·25
PFL200	0·85
PL36	0·80
PL81	0·75
PL82	0·50
PL83	0·50
PL84	0·65
PL504	1·10
PL508	1·30
PL509	2·40
PL802	2·80
PY33	0·60
PY80	0·60
PY81/800	0·55
PY82	0·45
PY83	0·50
PY88	0·65
PY500	1·35
PY859	5·75
PY801	0·60
QQV03-10	2·50
QQV03-12	2·50
QQV06-40A	14·00
QV03-12	2·00
SC1/400	4·00
SC1/600	4·00

Type	£
SP61	0·85
TT21	7·50
U25	1·00
U26	0·85
U27	1·00
U191	0·75
U801	0·80
UABC80	0·60
UBF80	0·55
UBF89	0·50
UBL1	1·00
UBL21	0·75
UCC85	0·50
UCF80	0·80
UCH81	0·60
UCL82	0·75
UF41	0·80
UL41	0·75
UL84	0·75
UM80	0·60
UY82	0·55
UY85	0·50
VR105/30	1·80
VR150/30	1·25
X66	0·75
X61M	1·50
Z800U	3·00
Z801U	3·50
Z900T	1·50
1A3	0·60
1L4	0·30
1R5	0·55
1S4	0·40
1S5	0·40
1T4	0·40
1X2B	1·10
2D21	0·55
2K25	9·00
2X2	0·80
3A4	0·60
3D6	0·40
3D21	20·00
3E29	5·50
3S4	0·50
3V4	0·85
5B/254M	6·50

Type	£
5B/255M	6·50
5B/258M	6·50
5R4GY	1·10
5U4G	0·95
5V4G	0·65
5Y3GT	0·65
5Z3	1·00
5Z4G	0·70
5Z4GT	0·75
6AB7	0·60
6AC7	0·60
6AH6	0·70
6AK5	0·55
6AK8	0·40
6AL5	0·40
6AL5D	0·65
6AM5	1·60
6AM6	0·65
6AN8	0·85
6AQ5	1·30
6AQ5W	0·85
6AS6	0·80
6AT6	0·75
6AU6	0·40
6AV6	0·50
6AX4GT	0·80
6AX5GT	1·00
6B7	0·75
6BA6	0·40
6BE6	0·50
6BG6G	1·00
6BJ6	1·10
6BQ7A	0·60
6BR7	2·30
6BW6	2·80
6BW7	1·00
6C4	0·40
6C6	0·55
6CH6	3·00
6CL6	0·75
6D6	0·50
6EA8	0·80
6F8G	0·75
6F12	0·65
6F17	1·00
6F33	4·20
6M6	4·20
6J4WA	1·75
6J5	0·75
6J5GT	0·55
6J6	0·50

Type	£
6J7	0·75
6J7G	0·50
6K7	0·70
6K7G	0·35
6K8GT	0·55
6L6M	1·90
6L6GT	0·90
6L7G	0·65
6SA7	0·55
6SG7	0·75
6SJ7	0·70
6SJ7GT	0·50
6SK7	0·60
6SL7GT	0·75
6SN7GT	0·75
6SQ7	0·75
6V6GT	0·75
6X4	0·60
6X5GT	0·55
6Y6G	0·95
6Z4	0·65
6-30L2	0·90
7B7	0·80
7V4	0·80
9D2	0·60
9D6	0·75
11E2	11·00
12A6	0·60
12AT6	0·45
12AT7	0·55
12AU7	0·50
12AV6	0·70
12AX7	0·50
12BA6	0·50
12BE6	0·60
12BM7	0·60
12C8	0·55
12E1	4·25
12I5GT	0·40
12K7GT	0·60
12K8GT	0·70
12Q7GT	0·50
12SC7	0·55
12SH7	0·70
12SJ7	0·55
12SQ7	0·55
12Y4	0·40
14S7	1·00
19AQ5	0·75
19G3	10·00
19G6	6·00
19H5	17·00
20P3	0·60
20P4	1·10

Type	£
25L6GT	0·80
30C15	1·00
30C17	1·10
30C18 see PCF805	
30F5	1·00
30F12	1·20
30FL12	1·20
30FL14	1·00
30L15	1·00
30L17	1·00
30P12	1·00
30PL1	1·00
30PL13	1·10
30PL14	1·10
35L6GT	0·80
35W4	0·60
35Z4GT	0·70
50C5	0·70
50CD6G	1·20
75	1·00
75C1	0·80
76	0·80
78	0·75
80	0·75
85A2	2·20
723A/B	9·00
803	6·00
805	18·00
807	1·00
813	8·50
829B	5·50
832A	4·50
866A	2·80
931A	6·00
954	0·50
955	0·50
956	0·50
957	0·90
1625	1·00
1629	0·70
2051	1·00
5763	2·00
5842	6·50
5933	3·00
6057	0·85
6060	0·85
6064	0·85
6065	1·20
6067	1·00
6080	3·50
6146	3·80
6146B	4·20
6360	2·00
8020	5·50

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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
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132	26
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153	25
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177	20
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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
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163	20
164	25
167	34
180	34
185	34
194	14
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200	34
224	20
240	20
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259	32
263	68
271	24
273	50
274	50
337	45
394	30
BFR39	27
40	26
41	27
79	27
BF521	2·50
28	1·35
BFW58	
BFX29	30
30	30
34	60
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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	

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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	
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1152	
1159	
5503	
5553	
7603	
7604	
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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
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301	14
302	22
311	16
313	18
500	14
501	14
502	16
503	14
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505	35
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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	
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5400	13
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1S44	7
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100	
103	
132	20
1555	
2472	
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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
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4402	17
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4919	60
4922	54
4923	68
5060	30
5069	95
5191	68
5192	72
5194	72
5195	86
5245	33
5276	
5296	40
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5298	40
5320	50
5447	14
5467	
5485	35
5490	57
5555	60
5717	
5777	45
6027	37
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 ·75
7824 1·50	
DL707	
747	
96439	
TIL 209	
R15/G20/Y25	

Prices missing P.O.A.

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V	I	£
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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
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30-0-30	1A	3·20

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16215 – 60 mixed ⅛w 10K ohms – 83K ohms **60p•**
16216 – 60 mixed ⅛w 100K ohms – 820K ohms **60p•**
16217 – 40 mixed ½w 100 ohms – 820 ohms **60p•**
16218 – 40 mixed ½w 1K ohms – 8·2K ohms **60p•**
16219 – 40 mixed ½w 10K ohms – 82K ohms **60p•**
16220 – 40 mixed ½w 100K ohms – 820K ohms **60p•**
16230 – 60 mixed ⅛w 1 Meg – 10 Meg ohms **60p•**
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AC127	£0·18
AC128	£0·18
AC128K	£0·26
AC132	£0·20
AC134	£0·20
AC137	£0·20
AC141	£0·22
AC141K	£0·30
AC142	£0·20
AC176	£0·18
AC176K	£0·26
AC178	£0·25
AC179	£0·25
AC180	£0·20
AC180K	£0·28
AC181	£0·20
AC181K	£0·28
AC187	£0·18
AC187K	£0·20
AC188	£0·18
AC188K	£0·20
AD140	£0·60
AD142	£0·85
AD143	£0·75
AD149	£0·60
AD161	£0·42
AD162	£0·42
AD161/161MP	£0·35
AF114	£0·21
AF115	£0·21
AF116	£0·21
AF117	£0·21
AF118	£0·40
AF124	£0·30
AF125	£0·30
AF126	£0·30
AF127	£0·32
AF139	£0·35
AF180	£0·40
AF181	£0·60
AF186	£0·58
AF239	£0·35
AL102	£0·38
AL103	£1·20
AU104	£1·18
AU110	£1·00
AU113	£1·00
BC107A	£0·08
BC107B	£0·08
BC107C	£0·08
BC108A	£0·08
BC108B	£0·08
BC109C	£0·08
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Type	Price
BC109C	£0·08
BC147	•£0·08
BC148	•£0·08
BC149	•£0·08
BC157	•£0·10
BC158	•£0·10
BC159	•£0·10
BC167	•£0·12
BC168	•£0·12
BC169	•£0·12
BC169C	•£0·12
BC170	•£0·10
BC171	•£0·10
BC172	•£0·10
BC173	•£0·12
BC177	£0·16
BC178	£0·16
BC179	£0·16
BC180	£0·25
BC181	•£0·25
BC182L	•£0·10
BC183	•£0·10
BC183L	•£0·10
BC184L	£0·60
BC207	£0·11
BC208	•£0·11
BC209	•£0·12
BC212	•£0·11
BC212L	•£0·11
BC213	•£0·11
BC213L	•£0·11
BC214	•£0·12
BC214L	•£0·12
BC237	•£0·16
BC238	•£0·16
BC251	•£0·15
BC251A	•£0·16
BC301	£0·28
BC302	£0·28
BC303	£0·28
BC304	£0·38
BC327	•£0·16
BC328	•£0·15
BC337	•£0·15
BC338	•£0·15
BC440	£0·30
BC441	£0·30
BC460	£0·38
BC461	£0·38
BC477	£0·20
BC478	£0·20
BC479	£0·20
BC547	•£0·12
BC548	•£0·12
BC549	•£0·12

Type	Price
BC550	•£0·14
BC556	•£0·14
BC557	•£0·13
BC558	•£0·12
BC559	•£0·14
BD115	£0·50
BD116	£0·80
BD121	£0·65
BD124	£0·70
BD131	£0·38
BD132	£0·40
BD131/132MP	£0·85
BD133	£0·40
BD135	£0·38
BD136	£0·35
BD137	£0·35
BD138	£0·40
BD139	£0·36
BD140	£0·36
BD139/140MP	£0·80
BD155	£0·80
BD175	£0·60
BD176	£0·60
BD177	£0·68
BD178	£0·68
BD179	£0·75
BD201/202MP	£1·70
BD203	£0·80
BD204	£0·80
BD203/204MP	£1·70
BDY20	£0·80
BDX77	£0·90
BF457	£0·37
BF458	£0·37
BF459	£0·38
BF594	•£0·30
BF596	•£0·28
BFR39	£0·24
BFR40	•£0·25
BFR79	•£0·28
BFR80	•£0·28
BFX29	£0·22
BFX30	£0·30
BFX84	£0·22
BFX85	£0·24
BFX86	£0·25
BFX87	£0·22
BFX88	£0·22
BFX90	•£0·55
BFY50	£0·16
BFY51	£0·16

Type	Price
BFY52	£0·16
BIP19	£0·38
BIP20	£0·38
BIP19/20MP	£0·80
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BU105	£1·40
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BU204	£1·70
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MJE2955	£0·98
MJE3055	£0·60
MJE3440	£0·52
MPB113	£0·52
MPF102	£0·35
MPF104	£0·38
MPF105	£0·38
MPSA05	•£0·30
MPSA06	•£0·30
MPSA55	•£0·28
MPSA56	•£0·28
OC22	£1·50
OC23	£1·50
OC24	£1·35
OC25	£1·00
OC26	£1·00
OC28	£0·80
OC29	£0·95
OC35	£0·90
OC36	£0·90
OC70	£0·24
OC71	£0·15
TIC44	•£0·29
TIC45	•£0·35
TIP29A	£0·40
TIP29B	£0·52
TIP29C	£0·50
TIP30A	£0·50
TIP30B	£0·60
TIP30C	£0·60
TIP31A	£0·45
TIP31B	£0·47
TIP31C	£0·49
TIP32A	£0·49
TIP32B	£0·51
TIP32C	£0·53
TIP41A	£0·49
TIP41B	£0·51
TIP41C	£0·53
TIP42A	£0·53
TIP42B	£0·55
TIP42C	£0·57
TIP2955	£0·65

Type	Price
TIP3055	£0·50
TIS43	£0·24
TIS90	•£0·22
UT46	•£0·22
ZTX107	•£0·10
ZTX108	£0·10
ZTX109	•£0·10
ZTX300	•£0·12
ZTX500	•£0·14
2N1613	£0·20
2N1711	£0·20
2N1889	£0·45
2N1890	£0·45
2N1893	£0·30
2N2147	£0·75
2N2148	£0·70
2N2160	£1·00
2N2192	£0·38
2N2193	£0·38
2N2194	£0·38
2N2217	£0·22
2N2218	£0·22
2N2218A	£0·20
2N2219	£0·20
2N2219A	£0·24
2N2904	£0·18
2N2904A	£0·21
2N2905	£0·18
2N2905A	£0·20
2N2906	£0·16
2N2906A	£0·19
2N2907	£0·20
2N2907A	£0·22
2N296G	•0·09
2N2926Y	•£0·08
2N2926O	•£0·08
2N2926R	•£0·08
2N2926B	•£0·08
2N3053	£0·16
2N3054	£0·40
2N3055	£0·40
2N3414	•£0·16
2N3415	•£0·16
2N3416	•£0·29
2N3417	•£0·29
2N3614	£1·00
2N3615	£1·05
2N3616	£1·05
2N3646	•£0·09
2N3702	•£0·08
2N3703	•£0·08
2N3704	•0·07
2N3705	•£0·07
2N3706	•£0·08
2N3707	•£0·08
2N3708	•£0·07

Type	Price
2N3708A	•£0·07
2N3709	•£0·07
2N3710	•£0·07
2N3711	•£0·07
2N3819	£0·20
2N3820	£0·35
2N3821	£0·60
2N3823	£0·60
2N4058	•£0·12
2N4059	•£0·14
2N4060	•£0·14
2N4061	•£0·12
2N4062	•£0·12
2N4284	•£0·18
2N4285	•£0·18
2N4286	•£0·18
2N4287	•£0·18
2N4288	•£0·18
2N4289	•£0·18
2N4290	•£0·18
2N4291	•£0·18
2N4292	•£0·18
2N4293	•£0·18
2N4921	•£0·55
2N4923	•£0·65
2N5135	•£0·10
2N5136	•£0·10
2N5138	•£0·10
2N5194	£0·56
2N5245	£0·40
2N5294	£0·34
2N5296	£0·56
2N5457	£0·32
2N5458	£0·32
2N5459	£0·35
2N5551	•£0·36
2N6027	£0·39
2N6121	£0·70
2N6122	£0·70
40311	£0·38
40313	£0·95
40316	£0·95
40317	£0·40
40326	£0·40
40327	£0·45
40346	£0·45
40347	£0·65
40348	£0·80
40360	£0·36
40361	£0·36
40362	£0·38
40406	£0·45
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40408	£0·52
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FULL SPECIFICATION GUARANTEED.

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	0·14	7409	0·15	7441	0·64	7482	0·85	7493	0·40	74122	0·50
7401	0·14	7410	0·14	7442	0·64	7483	0·85	7494	0·88	74123	0·70
7402	0·15	7411	0·23	7445	0·90	7484	0·98	7495	0·70	74141	0·75
7403	0·15	7412	0·23	7446	0·90	7485	1·00	7496	0·80	74154	1·20
7404	0·15	7413	0·27	7447	0·78	7486	0·30	74100	1·00	74180	1·00
7405	0·15	7414	0·58	7448	0·80	7489	2·50	74110	0·50	74181	2·00
7406	0·30	7416	0·28	7475	0·48	7490	0·42	74118	0·90	74190	1·40
7407	0·30	7417	0·28	7480	0·50	7491	0·75	74119	1·85	74198	1·85
7408	0·15	7440	0·15	7481	0·95	7492	0·45	74121	0·30	74199	1·85

CMOS IC'S

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	0·15	CD4012	0·20	CD4022	0·90	CD4031	2·20	CD4046	1·30	CD4071	0·23
CD4001	0·18	CD4013	0·52	CD4023	0·20	CD4035	1·30	CD4047	1·10	CD4072	0·23
CD4002	0·18	CD4015	0·98	CD4024	0·80	CD4037	0·95	CD4049	0·55	CD4081	0·20
CD4006	0·98	CD4016	0·50	CD4025	0·20	CD4040	0·95	CD4050	0·55	CD4082	0·23
CD4007	0·18	CD4017	0·98	CD4026	1·70	CD4041	0·82	CD4054	1·10	CD4510	1·30
CD4008	0·98	CD4018	1·00	CD4027	0·60	CD4042	0·82	CD4055	1·40	CD4511	1·60
CD4009	0·58	CD4019	0·55	CD4028	0·98	CD4043	0·98	CD4056	1·35	CD4516	1·40
CD4010	0·58	CD4020	1·10	CD4029	1·15	CD4044	0·94	CD4069	0·40	CD4518	1·25
CD4011	0·20	CD4021	0·98	CD4030	0·55	CD4045	1·40	CD4070	0·40	CD4520	1·25

LINEAR IC'S

Type	Price
CA3011•	£1·05
CA3014•	£1·70
CA3018•	£0·75
CA3020•	£1·70
CA3028•	£1·02
CA3035•	£1·70
CA3036•	£1·35
CA3042•	£1·50
CA3043•	£1·85
CA3046•	£0·80
CA3052•	£1·60
CA3054•	£1·35
CA3075•	£1·50
CA3081•	£1·50
CA3089•	£2·10
CA3090•	£4·25
CA3123•	£1·90
LM301•	£0·39
LM304	£2·00
LM308•	£1·60
LM309K	£1·50
LM320-5v	£1·50
LM320-12v	£1.50

Type	Price
MC1456G•	£1·40
MC1466L	£4·50
MC1469R	£2·95
MC1496G•	£0·98
NE536•	£3·50
NE515A•	£3·50
NE540•	£1·50
NE550•	£0·95
NE550D•	NLA
NE555	£0·32
NE556	£0·82
NE561•	£3·95
NE5628•	£3·95
NE565A•	£1·75
NE566•	£1·50
NE567•	£1·80
uA702C•	£0·46
72702•	£0·46
uA703A•	£0·25
uA709C•	£0·25
72709•	£0·46
709P•	£0·25

Type	Price
LM320-15v	£1·50
LM320-24v	£1·50
LM380-14P	£0·85
LM381•	£1·55
LM3900N•	£0·65
MC724P	£1·50
MC1303L•	£1·48
MC1304P•	£1·90
MC1310P•	£0·95
MC1312PQ•	£1·90
MC1330P•	£1·20
MC1350•	£1·20
MC1351P•	£1·20
MC1352P•	£1·40

Type	Price
uA710C•	£0·40
72710•	£0·30
uA711C•	£0·32
72711•	£0·32
uA723C	£0·45
72723	£0·45
uA741C•	£0·24
72741•	£0·24
741P•	£0·20
uA747C•	£0·70
72747•	£0·79
uA748•	£0·35
72748•	£0·35
748P	£0·35

Type	Price
SN76013N•	£1·75
SN76023N•	£1·75
SN76110•	£1·50
SN76115•	£1·90
SN76660•	£0·75
SL414A•	£1·95
TAA550B	£0·35
TAA621A•	£2·00

Type	Price
TAA661A•	£1·65
TAD100•	£1·30
TBA540Q•	£2·20
TBA641B•	£2·25
TBA800•	£0·80
TBA810S•	£1·05
TBA820•	£0·80
TBA920Q•	£3·40
TCA270S•	£2·20

MIDGET WAFER SWITCHES

1965	1 pole 12 way	48p•
1966	2 pole 6 way	48p•
1967	3 pole 4 way	48p•
1968	4 pole 3 way	48p•

IC PAKS

Manufacturers "Fall-outs" which include functional and part functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C's and experimental work.

16224 – 100 Gates assorted 7400-01-04-10-50-60 etc **£1·20**
16226 – 30 MXI Assorted types 7441-47-90-154 etc **£1·20**
16227 – 30 Assorted Linear Types 709-741-747-748-710-588 etc **£1·50**
16228 – 8 Assorted types SL403 76013 76003 etc **£1·00•**
16229 – 5 I.C's 76110 Eqv. to MC1310P-MA767 **£1·50•**

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16222 Transistors Germ and Silicon Rectifiers-Diodes-Triacs – Thyristors I.C's and Zeners ALL NEW & CODED. Approx 100 pieces. Offering the amateur a fantastic bargain PAK and an enormous saving **£2·25**

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UNTESTED SEMI-CONDUCTOR PAKS

16130 – 100 Germ. gold bonded OA47 diodes **60p**
16131 – 150 Germ. point contact 100mA OA70/81 diode **60p**
16132 – 100 Silicon diodes 200mA OA200 **60p**
16133 – 150 Silicon fast switch diode 75mA IN4148 **60p**
16134 – 50 Silicon rectifiers top hat 750mA **60p**
16135 – 20 Silicon rectifiers stud type 3 amp **60p**
16136 – 50 400mW zeners DO7 case **60p**
16137 – 30 NPN transistors BC107/8 plastic **60p•**
16138 – 30 PNP transistors BC177/178 plastic **60p•**
16139 – 25 NPN TO39 2N697/2N1711 silicon **60p**
16140 – 25 PNP TO39 2N2905 silicon **60p**
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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

PLEASE NOTE—CORRESPONDENCE

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

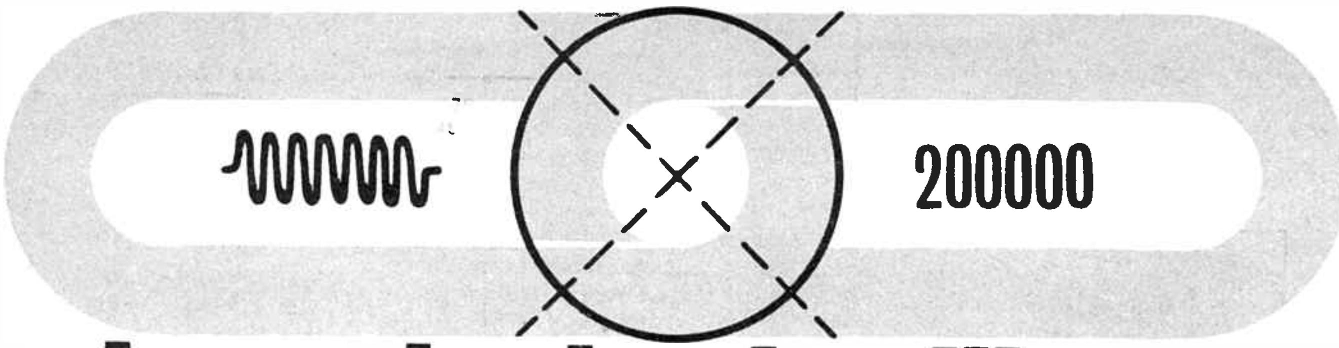
The Nunsfield House Community Association Amateur Radio Group are holding a mobile radio rally on Sunday 11 June 1978 at Elvaston Castle Country Park, which is located 5 miles south-east of Derby on the B5010.

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

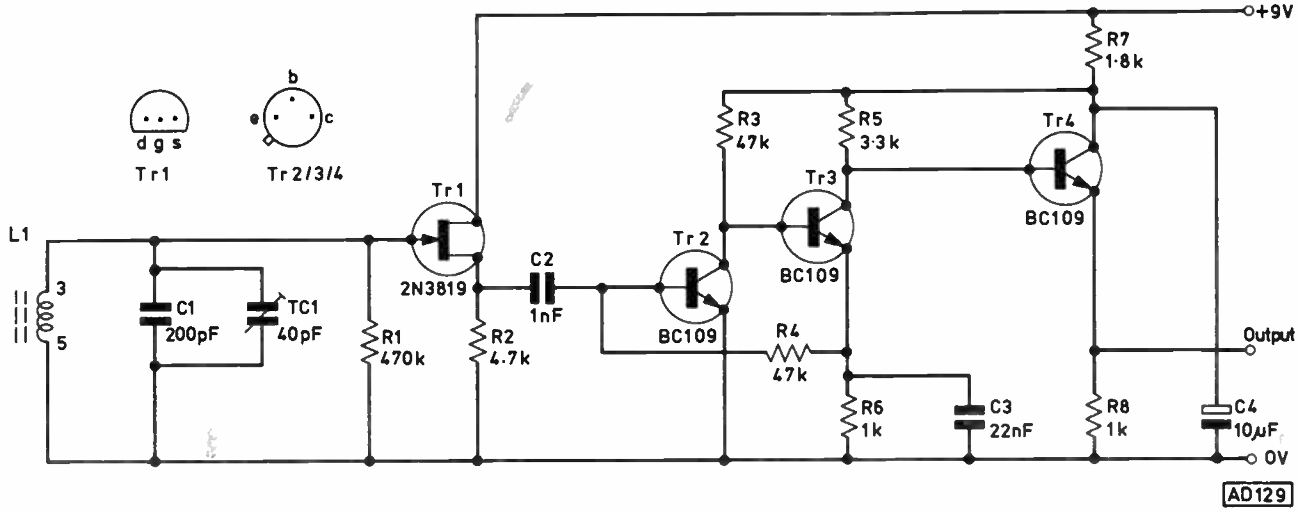
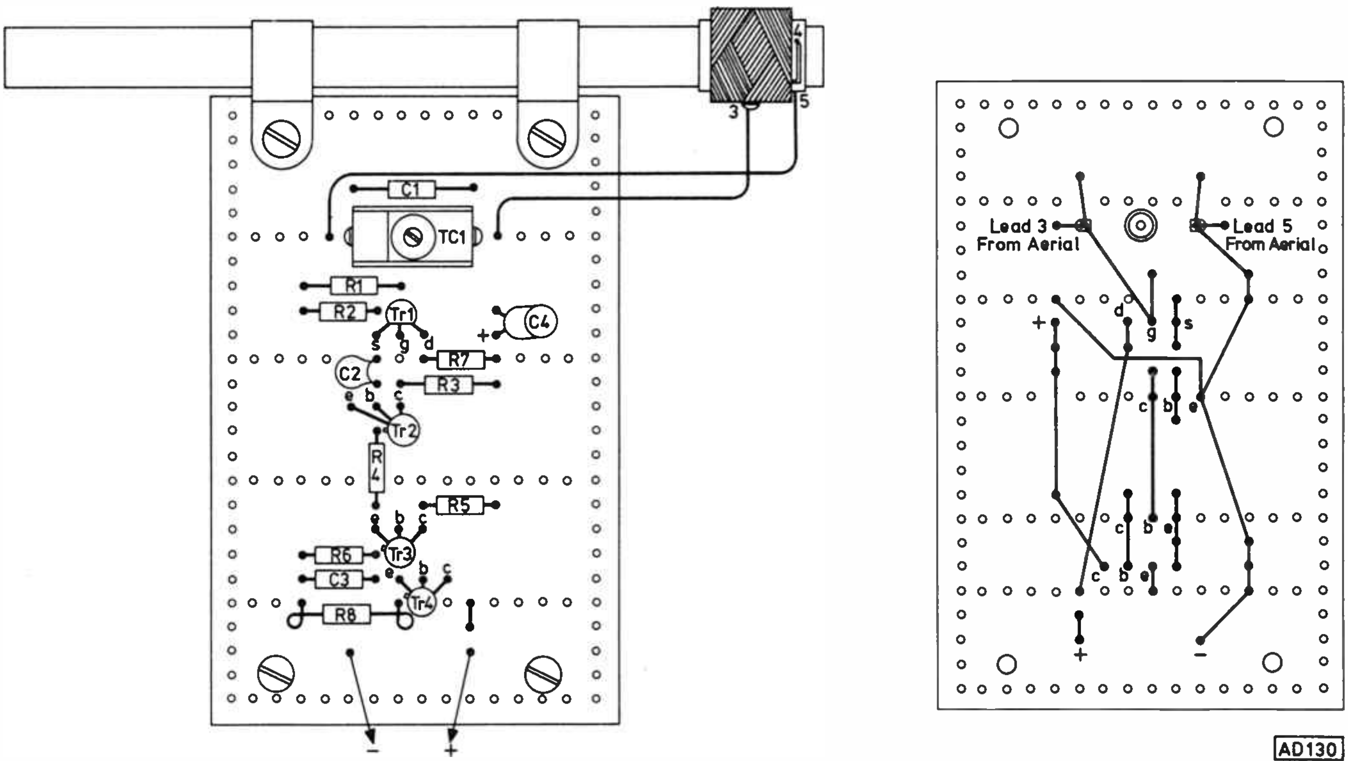


Fig. 1: (above) The complete circuit diagram of the Phase-Locked Calibrator

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 ½ to ¾ 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

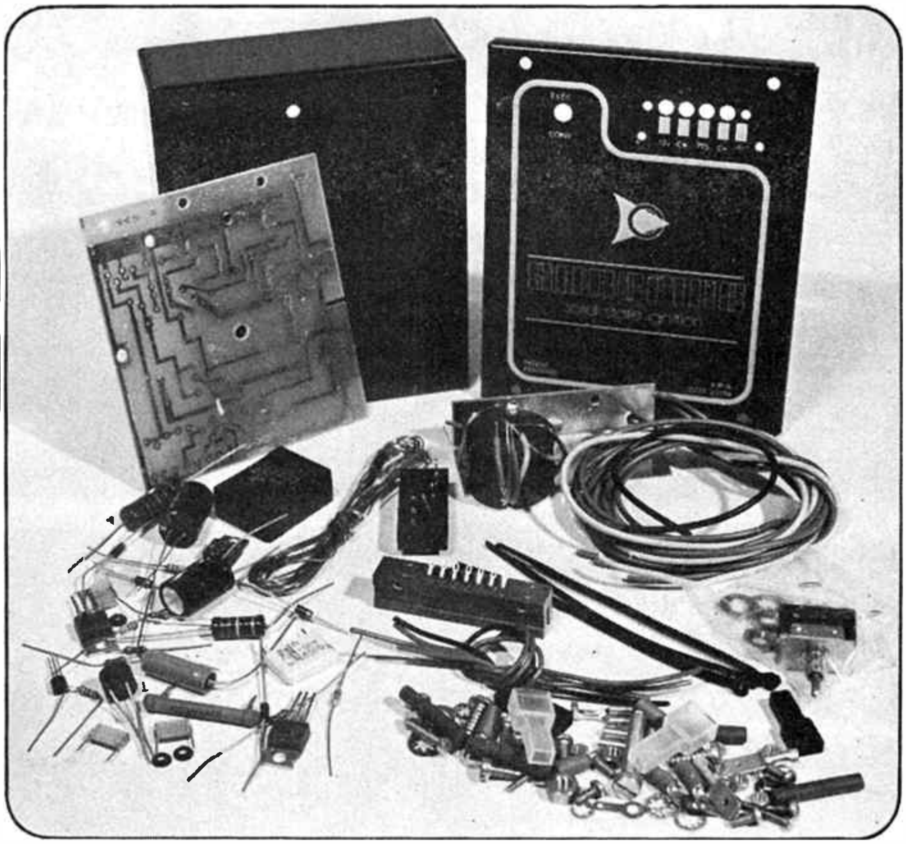
Remember that any digital frequency meter will have a last digit error of plus or minus one, so don't expect the readout to be rock steady. Static or man-made interference, including radiations from the meter itself, if too close, can cause a momentary spurious reading. The circuit, which consumes about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

SPECIAL PRODUCT REPORT

ses

'SUREFIRE' ELECTRONIC IGNITION KIT



The S.E.S. Capacitive Discharge Electronic Ignition System has been available for some time in ready-built form. It is now offered in kit form for the electronics constructor at £15·75 including post, packing and VAT, which represents a considerable saving in cost. Switched selection of electronic or conventional ignition is provided, plus an "isolated" position as an anti-theft device. All the electronics are mounted on a plug-in printed circuit board. This board can be returned to Surefire should service be required, leaving the case fitted to the vehicle, which can continue to run on conventional ignition. The board and edge-connector contacts are all gold plated for reliability.

Assembly

Putting the kit together is quite straightforward, following the clear instructions provided. Total assembly time for the review model was three hours. All the parts required are included—even down to the solder and heatsink compound. The components list allows each item to be easily identified, and also serves as a price list should any replacements be needed, though all components are guaranteed for twelve months.

Besides the assembly drawings, a system block diagram, a circuit diagram with typical oscilloscope waveforms, and a full circuit description are provided. There is also a "family tree" fault analysis and testing diagram.

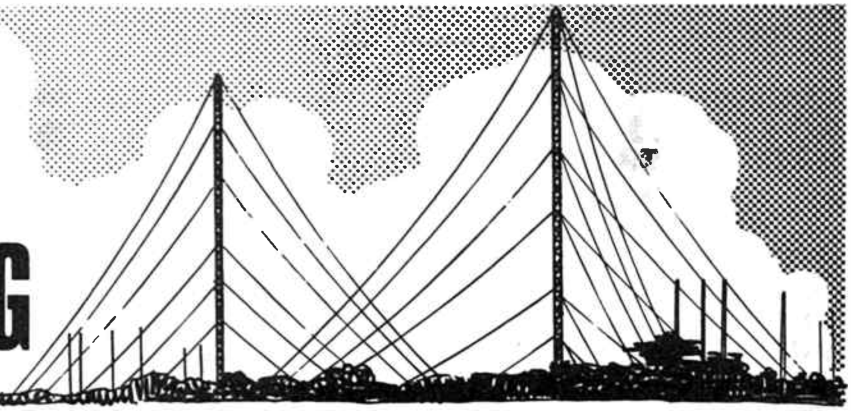
For constructors running into problems with their kits, Surefire offer a repair and fault diagnosis service. To diagnose and repair the printed circuit plug-in module, there is a standard charge of £3, while for the complete kit the charge is £5. In both cases this covers the cost of any parts used in the repair, and includes carriage, insurance and VAT.

Installation

Comprehensive fitting instructions are provided, which are claimed to cover most types of ignition systems likely to be encountered, including those with tachometers. In the case of the review kit, it was found necessary to transpose the male and female "Lucar" connectors on two of the leads connecting into the vehicle ignition system, compared with the assembly instructions given. It is probably best to check against your car before the leads are assembled.

The kits are available direct from **Surefire Electronic Systems, Piccadilly Place, London Road, Bath BA1 6PW.** ●

the start of EMPIRE BROADCASTING



RON HAM

On September 1st; 1927, a British radio amateur, Gerald Marcuse, G2NM, began Empire Broadcasting by transmitting a variety of home-made and recorded programmes on 32·5 metres, using a Zeppelin aerial, from a 100ft mast at his home, 700ft a.s.l., in Caterham, Surrey.

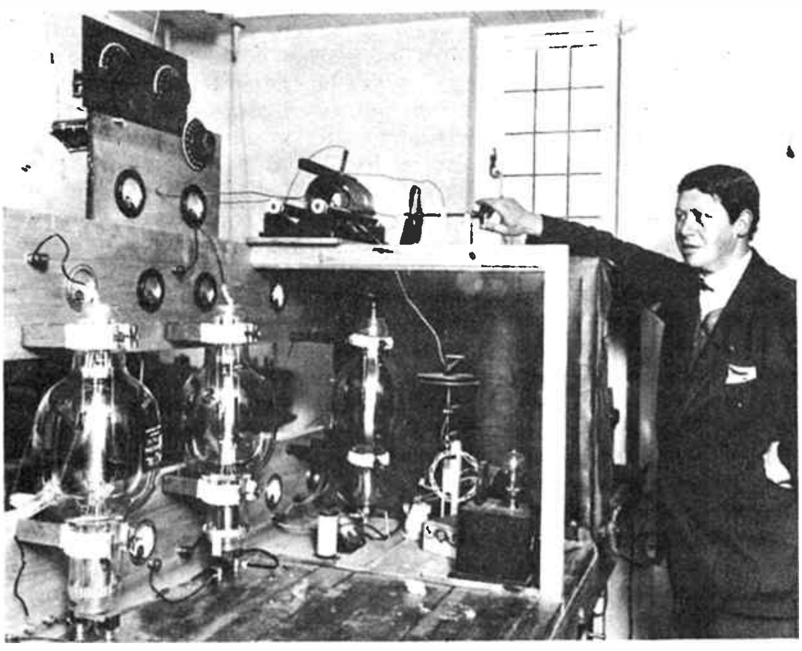
Wireless World, a weekly journal in those days, campaigned vigorously from about 1923 for the BBC to start a regular broadcasting service to the British Empire similar to that given by two Dutch stations (PCGG and PCJJ) to their colonies. Although at first, the BBC were cautious both technically and financially, they did commence tests from Chelmsford, (5SW), in November 1927 and inaugurated a regular Empire service, from Daventry, in December 1932. This has grown into the BBC World Service which dominates international broadcasting today.

Gerald Marcuse, who was born in 1886 and died in 1961, devoted the major part of his life to amateur radio establishing many "firsts" in global communications. He was President of the RSGB during the years 1929 and 1930 and made an Honorary Member of the Society in 1946, the highest award the RSGB can bestow, joining a list of famous names which includes Sir Oliver Lodge, Rene Klein, and Senatore Guglielmo Marconi. In 1922, Gerry held the first amateur licence for wavelengths below 200 metres and in 1923/24 he contacted Canada and the USA on 40 occasions as well as QSOs with the Canadian Steamer *Arctic* off Canadian Islands and the American Fleet voyaging from Honolulu to Australia. He broadcast concerts from the Savoy Hotel, London, to American amateurs in 1925 and in the same year he made the first phone contact with the US Carrier *Seattle*, 600 miles east of Australia.

South American Contact

G2NM's achievements were widely reported in the technical press and in January 1925, *Wireless Weekly* published a half page picture of his station and under the heading, British Amateur Works Brazil, are the words . . . "Perhaps the most fascinating of all wireless romances occurred recently when Mr Gerald Marcuse established communication with the Rice Expedition in Brazil, a distance of approximately 7000 miles" . . . This was a first between the UK and South America.

An interesting item appeared in the Current Topics section of *Wireless World* (7.9.27) entitled, Reciprocal Empire Broadcasting, which read . . . "Amateur broadcasting to the Empire was inaugurated on Thursday last by Gerald Marcuse (2NM), of Caterham, who transmitted a programme of musical items on a wavelength of 32·5 metres. Mr Marcuse informed *Wireless World* that the delay in the hour of starting was due to the excellence of reception from Australia,



A photograph of Gerald Marcuse standing alongside his transmitter at 2NM. Reproduced from the November 30th, 1927 *Wireless World*

the broadcasting station 2FC at Sydney sending out an excellent programme on 29·8 metres. Rather than upset reception 2NM delayed transmissions."

This was typical of Gerry's whole attitude to radio, the true amateur spirit prevailed at all times, he was one of the first British amateurs to use telephony and his voice was heard in many parts of the world by radio amateurs and short wave listeners using commercially-built receivers.

The RSGB's history book, *World at Their Finger Tips*, says that Gerry first got the idea of providing a broadcast service to the British Empire when an amateur, (BER) in Bermuda rebroadcast his transmissions to other amateurs in neighbouring islands.

After much correspondence and a great deal of pressure from G2NM the Postmaster General decided, on August 9th, 1927, to authorise him to transmit speech and music, for two hours daily, except Sundays, for a limited period commencing September 1st, 1927, with a power not exceeding 1kW and wavelengths of 23 and 33 metres. In fact transmissions from 2NM continued almost daily until the end of August 1928.

Among his programmes were the sounds of Big Ben, the songs of the blackbird and thrush from his garden, piano playing of a local friend, voices from his nearby church choir, gramophone records, rebroadcasts of 2LO transmissions and several concerts. Naturally, *Wireless World* followed Gerry's work and in the caption below a picture of his transmitter (*WW* 30.11.27) they proudly announced, "Mr Marcuse scored a new success on November 11th when his relay of the Albert Hall Armistice Concert was heard in Bombay".

The *Wireless World* Editorial (27.4.27) pointed out that British amateurs were accustomed to listening to the Dutch broadcast station at The Hague, PCGG, which sent out regular Sunday afternoon concerts for the benefit of UK listeners. Furthermore, Holland had again set an example by leading the way in short-wave broadcasting, because, on March 15th the station, PCJJ, established at the Philips Lamp Laboratories at Eindhoven communicated by wireless telephony with the Dutch station at Bandoeng, in the Dutch East Indies, on a wavelength of 30 metres. The Editorial continued "Since that initial success fairly regular broadcasting has been conducted. Now, as we go to press, comes the announcement that the Sydney station, 2BL, has successfully rebroadcast one of the programmes".

A reader, Arnold J. I. Bradley, writing to the Editor of *Wireless World* (12.10.27) said "My congratulations upon the splendid stand you have made in the interests of Empire broadcasting and to Gerald Marcuse for the excellent transmissions, restricted though they may be. I sincerely hope that as a result of this the British public will give credit, which is admittedly due to the splendid band of amateurs who, in spite of bureaucratic red tape, are doing their bit to keep alive that fine British pioneering spirit". Arnold Bradley's remarks were typical of many letters on this subject in the late twenties, and he continued "Let the BBC highbrows and "nobrows" listen to PCJJ's radio acknowledgements of regular reception by Britishers in the Antipodes—that should convince them that Empire broadcasting is possible". In another letter, reader J. D. Cumming, Cape Town, (*WW* 14.9.27) aimed at Captain P. P. Eckersley, then Chief Engineer of the BBC, said, "It is a pity that Mr Marcuse and Captain Eckersley cannot exchange enthusiasm for a few months".

BBC Experiments

The first experimental transmissions by the BBC to the British Empire took place on November 5th, 1927 from their experimental short-wave station at Chelmsford, 5SW, and as *World at Their Finger Tips* points out; "Marcuse had shown the advantages to be gained by using wavelengths around 32 metres for Empire broadcasting. The BBC began their overseas service on 20 metres with the result that for a long time signals from 2NM were received more consistently and more strongly in Australasia and other distant places than were those from the BBC short-wave station at Chelmsford".

Reader, J. W. Riddiough, Menston, Yorks, writes (*WW* 21.9.27), "Bravo, 2NM. If the BBC cannot or will not do it, there are amateurs who can and will".

To find the most suitable times for broadcasting to Australia the BBC engineers at Chelmsford conducted a 36-hour continuous transmission test which was monitored by Amalgamated Wireless (Australasia) Ltd from 12 noon GMT on November 5th, 1927, to midnight on the 6th. Questions were asked; What proportion of listener's money is being spent on Empire transmissions? and the answer, given to *Wireless World* by an official at Savoy Hill, "Not a penny, the BBC is collaborating with the Marconi Company in these tests, but we are not spending more money than the ordinary programmes demand. Our part in the experiments is to provide the Marconi Company with broadcast material. As on Armistice day, transmission of this material is also suitable for the British public; the Dominions merely have the opportunity to share it". Gramophone records were broadcast throughout the 36-hour tests.

Wireless World, (21.12.27) suggested that short-wave enthusiasts should make a point of listening for the transmissions from 5SW, Chelmsford, on a wavelength of 24 metres at 12.30 to 1.30pm and 7pm to midnight GMT. The programmes were relayed by line from London and consisted of the ordinary transmissions from 5XX. One valuable and possibly unique report came from H. A. Hankey, representative of the Wireless League, who, in the spring of 1928, made a voyage to the Antipodes, via South Africa, on the steamer *Demosthenes* of the Aberdeen Line. Hankey was permitted to install an Eddystone 3-valve (Det. and 2 l.f.) short-wave receiver, fed by a 50ft wire aerial, in the ship's navigation room just below the bridge. During the voyage he checked the Chelmsford signal at 35 different points en route and the results were published, along with a map indicating the check points, and a log of the respective signal strengths, in *Wireless World* (27.6.28). While off Loanda he heard a strength 9 signal of a special broadcast from the Albert Hall at which the Prince of Wales was present.

Along with international broadcasting came a demand for new short wave receivers and *Wireless World* (29.6.27) devoted 6½ pages to the detailed construction of a 2-valve receiver, by H. F. Smith, covering 20 to 70 metres, for Empire Broadcasting. Some 18 months later, the same author took another 6 pages to promote The New Empire Receiver, which had 3 valves, (Det. and 2 l.f.) and 3 plug-in coils for ranges 23-45 metres, 38-90 metres and an "ultra short-wave" band 16-28 metres. The approximate cost of the components, including cabinet, but without valves and accessories was £7.2s.6d. Early in 1929, Burndept produced their Empire Screened Four, "A Short-Wave

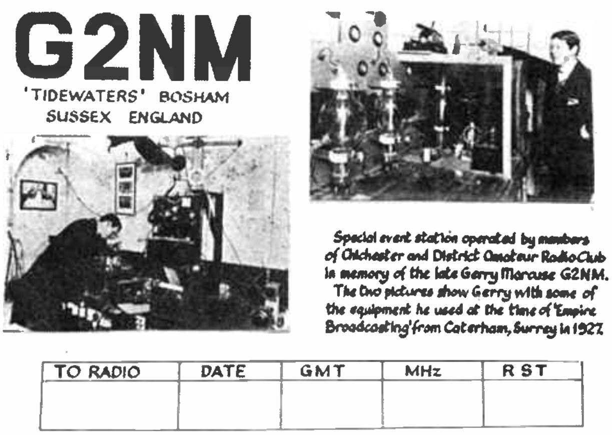
Receiver with Screened-grid H.F. Amplification" covering 20-48 metres. The circuit consisted of a screened grid h.f. stage followed by a leaky grid detector with reaction and two l.f. stages; the price, £25, exclusive of royalty, valves and batteries.

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. ●

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stray signals

by POINT CONTACT

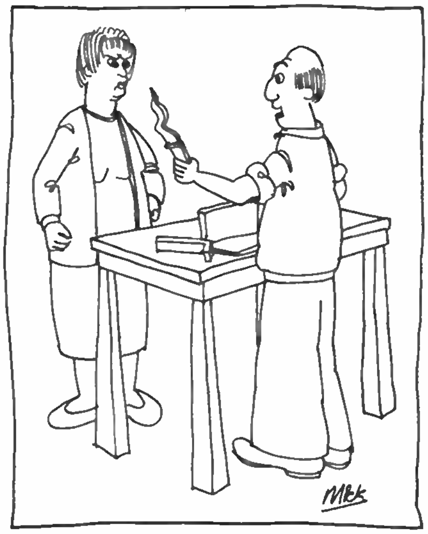
Constructors of electronic kits come in all varieties, as well as all shapes and sizes. What I mean is, for some the actual job of constructing a project and getting it going is what provides interest and gives them satisfaction. For others, this is only a means to an end, what they want is a finished disco or a 2 metre transceiver at less cost than the ready-made commercial equivalent. For these, things are very much easier than they used to be, with printed circuit boards and all components available by return of post. Gone is most of the sweat of "chassis bashing", often undertaken with woefully inadequate tools. (Have you ever made holes for five octal valve holders in a 16s.w.g. aluminium chassis with no more than a 4BA clear twist drill and a penknife?).

Of course, the two categories of constructor mentioned are opposite extremes of a spectrum. For example, hams and SWLs who make their own gear are usually equally absorbed in its design, construction, and mode of functioning on the one hand and in its operation and the contacts made with it on the other.

Whichever category you fall into, we all have to get interested in "how it works" when it doesn't, if you see what I mean. It can be very disappointing to make something up—a radio for example—only to be greeted by a sullen obstinate silence when it is switched on! Sometimes, visually checking everything over carefully again will reveal the fault, but regrettably this is rare. In this predicament, test equipment is the answer and of course the most basic item is a good multimeter, with a sensitivity of at least 10,000 ohms per volt. This enables all the d.c. conditions in a circuit to be checked out and it is surprising how often when they are put right it all works perfectly.

Even more powerful as a trouble-shooting tool than a multimeter is an oscilloscope, especially if it has calibrated Y-sensitivity and time-base ranges. A stabilised power supply, a signal generator etc., each is a god-send if at hand when needed. With designs for such things being published from time to time in *PW*, the enthusiastic electronics constructor nowadays has the opportunity to build up a first-class set of test equipment for the home laboratory.

Talking of test equipment, when walking through the lab the other day, Point Contact noticed a knot of curious engineers crowded round a bench. They were trying to guess the purpose of an object rescued from the scrap heap by one of the younger engineers. The cover had been removed exposing a few components and a mains transformer. This had the primary and secondary mounted side by side, separated by an extra limb of core laminations. On the front panel was a knob labelled ADJUST SPARK GAP and lower down there were two leads coming out. One was a three-core mains lead, the other terminated in the handle of what might have been a short stubby poker or a science fiction death-ray gun. The only other item on the front panel was a toggle switch, prosaically labelled MAINS ON-OFF.



IT'LL NEED SHARPENING, BUT IT CUT THE ALUMINIUM ALRIGHT!"

No one could think what the object was until the word TESVAC on the front panel prodded my memory. Many years ago, Point Contact used to use something similar for ***TES***ting ***VAC***uum systems. The fat insulated body of the poker contained an air-cored transformer or Tesla coil, the well-insulated high potential output lead of which projected three inches beyond the end of the SRBP body and terminated in a metal tip. We stuffed the end of the mains lead (the plug had disappeared) into the nearest 3-pin 5-amp socket—and nothing happened. Turning the knob, however, produced a fine fierce spark sizzling away continuously and a high-voltage mica capacitor picked off the h.f. components of this and fed them through the screened lead to the Tesla coil. Here the voltage was stepped up further to, I suppose, hundreds of kilovolts resulting in a continuous mauve corona discharge from the metal tip, while the lab rapidly filled with the pungent smell of ozone.

Oh yes—how does it test a vacuum? Well, lab vacuum systems are usually made of glassware and the inevitable leak is at a greased flange joint or through a sub-microscopic pin-hole. When your vacuum system won't pump down to as hard a vacuum as you'd like, you wave the metal end of the vacuum tester all over the glass surfaces. The air in the vicinity of the leak is ionised and as its pressure falls on passing through the leak into the near vacuum, it ionises much more readily. Great mauve streamers appear inside the glass, sprouting from the otherwise invisible leak.

Owing to the high source impedance the tester is quite safe; one can draw a three inch long spark to one's fingertip with no worse result than a sensation like a pin prick! ●

Introduction to LOGIG ~ 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.

Since logic devices first appeared a whole series of different families of logic, each with their own special characteristics, has been developed. As a result actual voltage or current levels representing the *0* and *1* signals can have a wide variety of values according to the particular family of logic being considered. Over the years some families of devices have become obsolete and others have never become available to the amateur user.

The two commonly met ranges of logic as far as the amateur is concerned are the 74-series TTL (transistor transistor logic) and the 4000-series CMOS (complementary metal oxide semiconductor) types. Sometimes 900-series DTL (diode transistor logic) may be met, but its signal levels are virtually the same as those for TTL.

In the case of TTL, where the devices run from a +5V supply, the *0* level is usually around 0 to 0·3V whilst the *1* level is normally about +4V to +5V. In the case of CMOS logic, the circuits will operate quite reliably over a range of supply voltages from +5V up to +15V. Here the *0* level is effectively 0V and the *1* level is virtually the supply voltage level. Later in the series we shall examine the logic levels rather more closely to see the effects of noise and loading on the performance but for the moment, assuming that we use either TTL or CMOS devices with a +5V supply, we can say that the *0* level will be 0V and that the *1* level will be +5V for all logic signals.

In a typical logic system there may be many input signals, each of which may be at either *0* or *1*, and these are combined together and operated upon in various ways to produce a series of digital output signals which will also be at either *0* or *1*.

Let us relate this to a simple real-life situation. Suppose we have a hot drinks vending machine and we want to produce a cup of coffee. First of all we shall need a "coffee" input which we shall call signal C. When C is at *1* it will cause a valve to open and pour a measured amount of coffee into the cup. Now some people like their coffee white whilst others prefer it black, so we need a second signal M to control the "milk" input to the cup. For black coffee M will be *0* (no milk) and for white coffee M will go to *1* to allow a shot of milk to be added to the coffee in the cup.

The third constituent of our cup of coffee may be sugar so we might have a third input labelled S which adds sugar to the coffee when S is set at *1*. Here we may run into a problem because some people prefer to have more sugar than others and at present we can only cater for no sugar at all or some sugar. We need some arrangement that will allow us to produce, say, one, two or three spoonsful of sugar as desired.

Suppose we have two inputs for sugar which we shall call S1 and S2. We can arrange that when S1 is at *1* it will cause one spoonful of sugar to be added. The valve controlled by S2 however is arranged to add two spoonsful when it is opened. Now if we set both S1 and S2 to *1* there will be three spoonsful of sugar added to the cup. Other combinations of the states of S1 and S2 will allow us to have two, one or no spoonsful of sugar in the coffee. This principle of

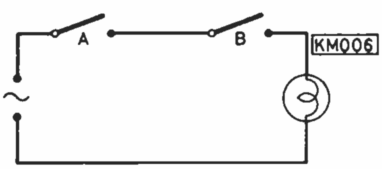


Fig. 1: An electrical AND gate

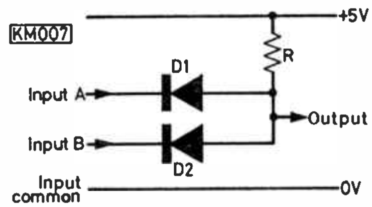


Fig. 2: A diode AND gate

having several "weighted" logic inputs to represent one input signal could be extended to give a finer control of the quantity of sugar selected. We shall see later that in this way analogue signals can be represented as a combination of several "weighted" digital signals.

Now by choosing various combinations of these four input signals C, M, S1 and S2 our drinks machine can be made to produce a wide variety of different combinations. Suppose we want to have a moderately sweet black coffee. The states of the four input signals might be set as follows:

C=*1*
M=*0*
S1=*0*
S2=*1*

Readers can work out the other possible combinations for themselves and will find that some are not very palatable. Will it work? Some of the latest drinks vending machines in the USA do in fact use logic, and microprocessors, to control their operation.

The "AND" Gate

Having seen how the digital signals themselves can be arranged, let us now examine some of the actual logic elements and see how they work. A large part of any logic system is likely to be made up from elements called "gates" so let's start with them. A gate is basically a logic unit whose output state is directly related in some way to the combination of logic signals applied to its inputs.

Suppose we have an electrical circuit consisting of a switched table lamp which is plugged into a switched wall socket. The circuit will be as shown in Fig. 1. It is obvious that the lamp can light only when both of the switches are closed to complete the circuit.

This electrical circuit is in fact performing the same function as a logic gate. Here the output signal is the light from the lamp so that the output is at *1* when the lamp is lit. The inputs to the gate are represented by the two switches. When a switch is closed that input is at *1* whilst an open switch gives a *0* input. With this arrangement we can get a *1* output (lamp lit) only when switches A AND B are both at *1* (closed). A gate performing this particular function is called an AND gate for obvious reasons.

We can produce an all-electronic AND gate by using diodes arranged as shown in Fig. 2. This is a 2-input AND gate of the type used in digital computers before the advent of digital integrated circuits.

Suppose both inputs A AND B in Fig. 2 are set at *0* (0V). Both diodes D1 and D2 will conduct and draw current through the load resistor R. Assuming that the resistor R has a much higher resistance than the forward resistance of the diodes, the voltage at the output point will fall to virtually zero giving a *0* output state. If we now set input A at *1* (+5V), diode D1 will cut off but provided input B is still at *0* diode D2 will now take up the current originally drawn by D1 and the output level will remain at *0*.

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

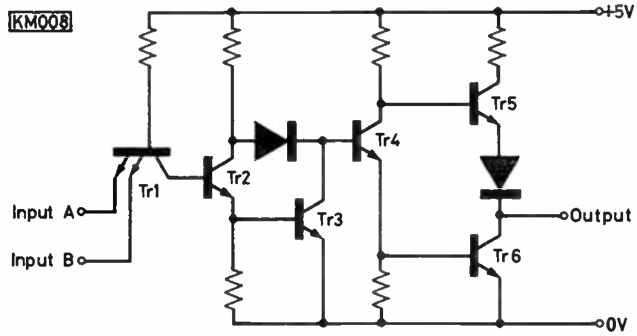


Fig. 3: A typical TTL AND gate

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.

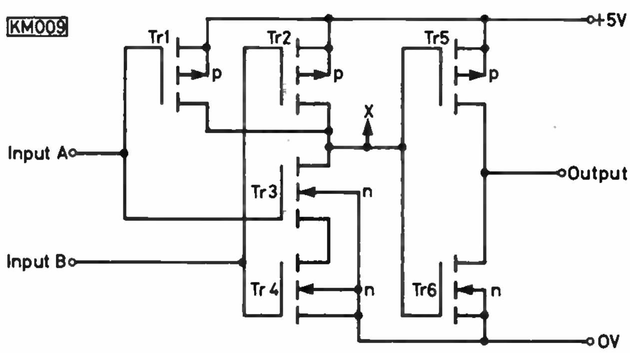
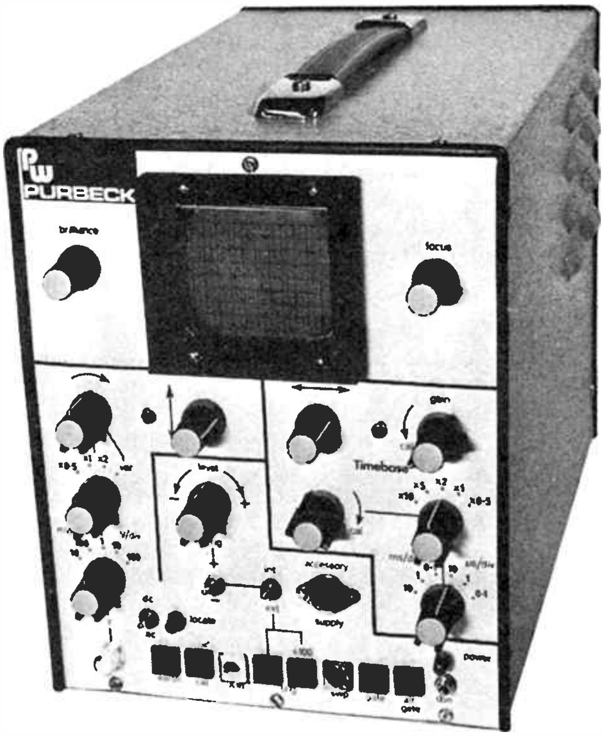


Fig. 4: A typical CMOS AND gate

continued on page 60

'purbeck' OSCILLOSCOPE



Part 4

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.

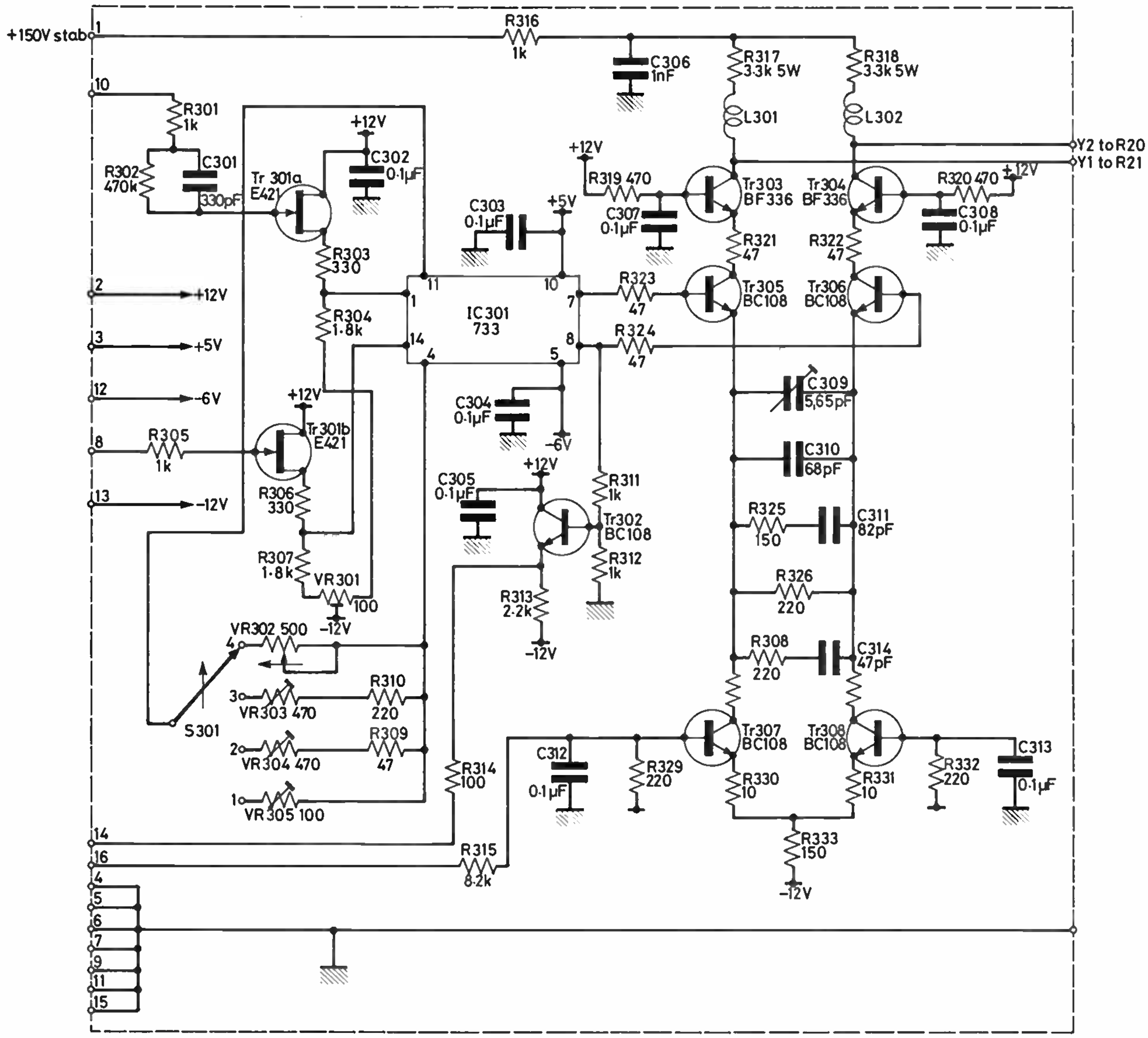


Fig. 1: The circuit diagram of the Y amplifier, clearly showing how the essential bandwidth is achieved; gain block IC301 couples to the Y deflection amplifier, and the R326 by-passing C/R network maintains upper frequency response. Note that R329 and R332 are connected to the –6V supply and that the 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 $3{\cdot}3 \times 10^{-8}$ 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

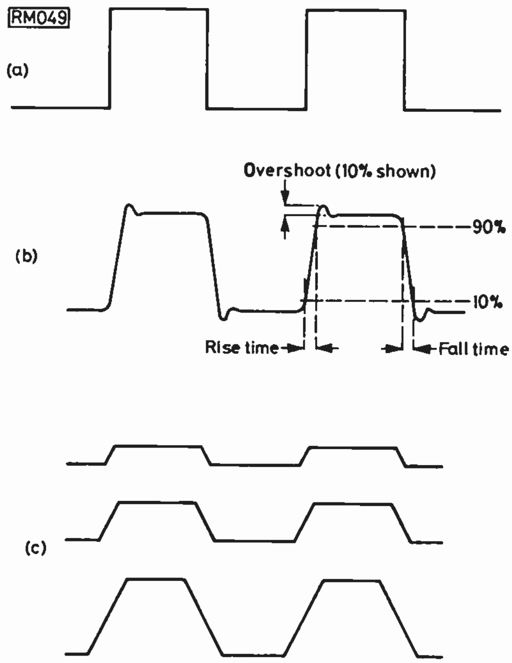


Fig. 2: An ideal square wave is shown in (a) with typical degradations which occur in practice shown in (b). At (c) are the output waveforms from a slew-rate-limited amplifier for three increasing values of input

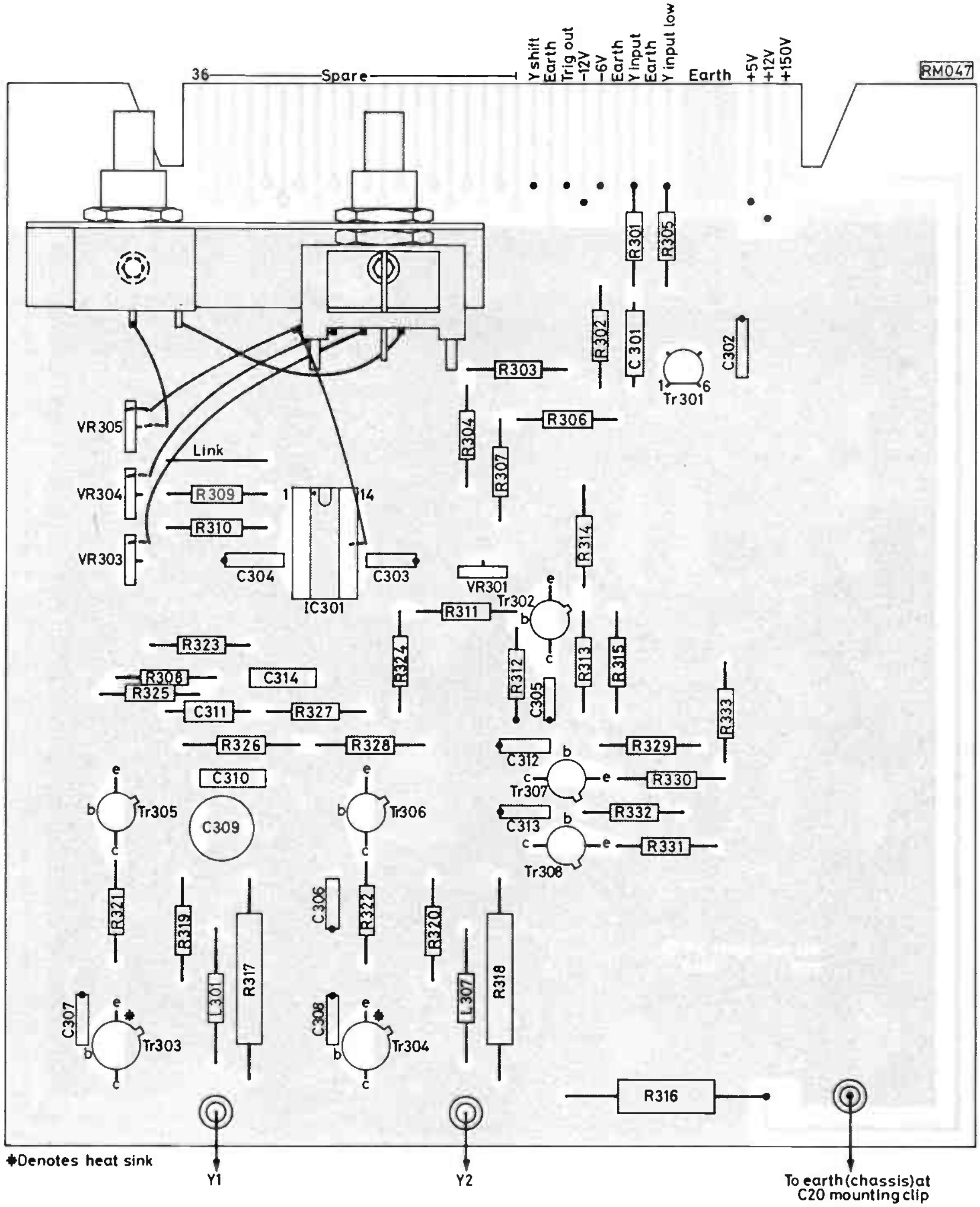


Fig. 3: The component layout of the Y amplifier board. Note that the components are mounted on the copper ground plain side of the board

reduced or its risetime were longer, the output voltage would be able to follow fast enough and the c.r.t. would display the waveform accurately. This is demonstrated in Fig. 2(c) and in fact for four divisions of vertical deflection ($^1_2$ screen) the −3dB point is 11 MHz, for two divisions 17 MHz and for one division a remarkable 21 MHz. In other words, the smaller the amplitude of the signal, the higher the frequency which can be displayed. Now many readers will know that a square wave consists of sine waves, i.e. a fundamental and its third, fifth, seventh, etc., harmonics, the amplitude of the harmonics being

Several readers have enquired about the possibilities of using alternative tubes for Purbeck. We cannot advise anyone as to the suitability of components other than those specified. Not only will the mechanical construction need alteration, but revised amplifiers and e.h.t. supplies will also be required.

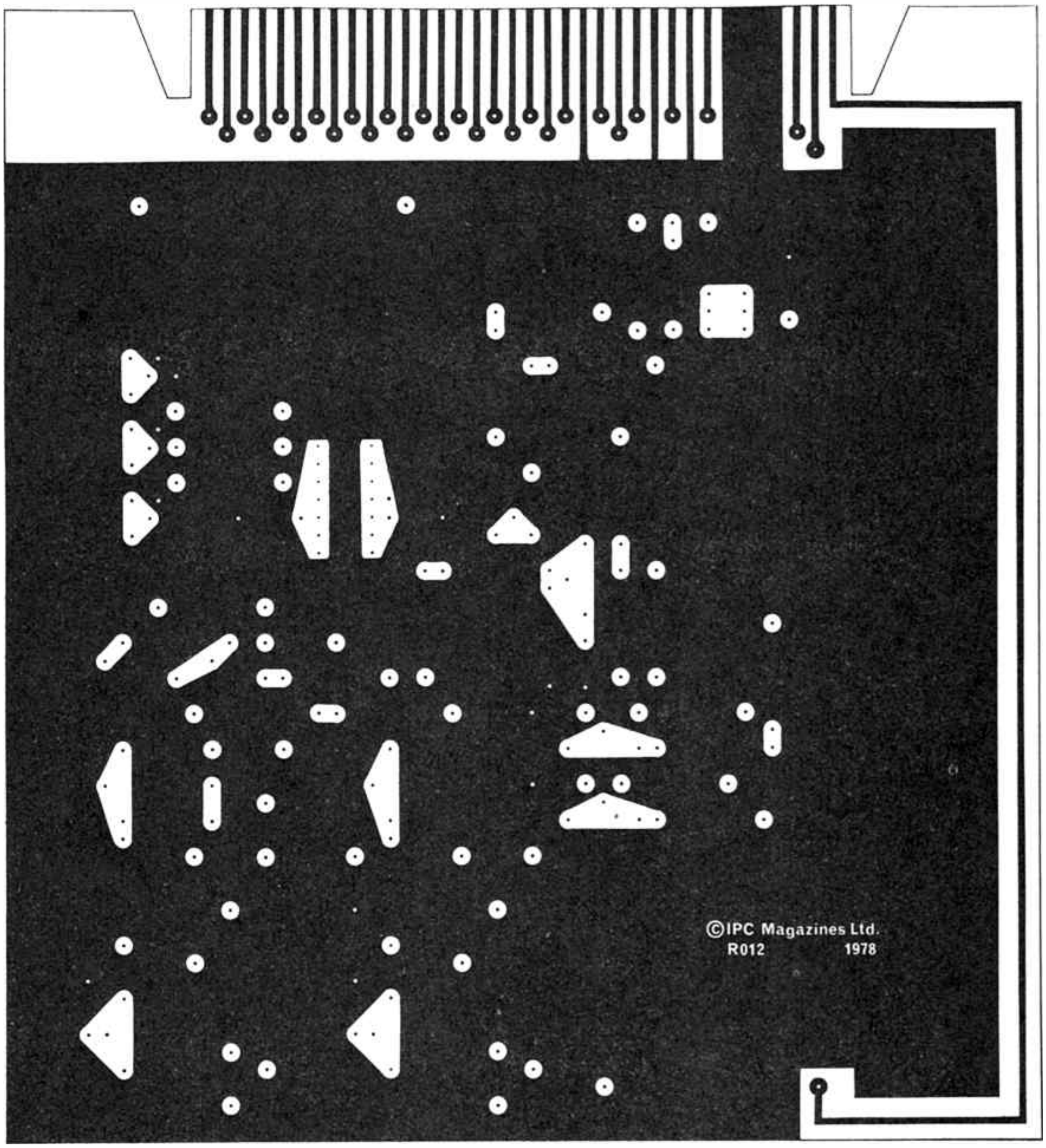


Fig. 4: The copper ground plain pattern of the Y amplifier board

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

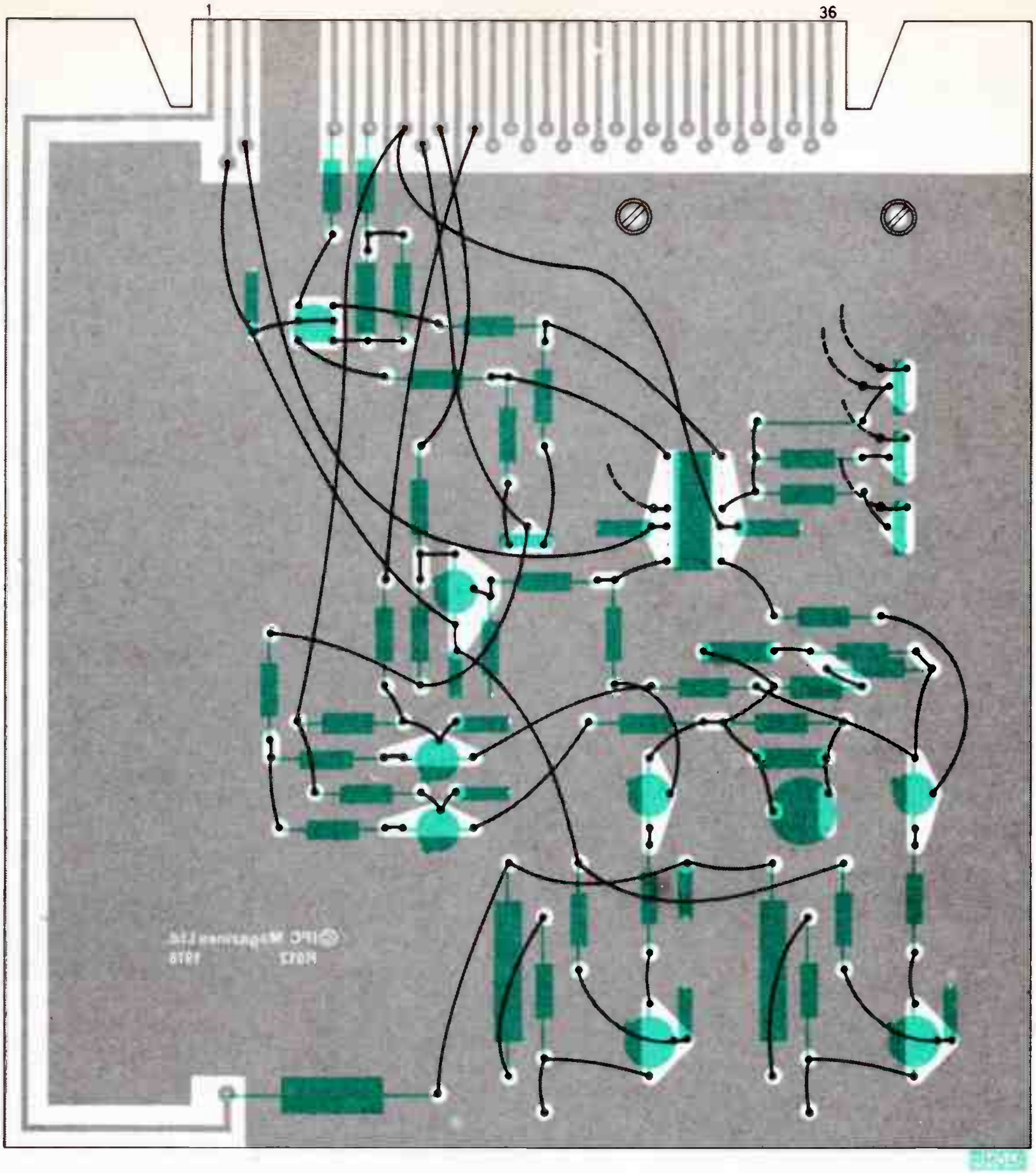


Fig. 5: Back wiring of the board, in relation to the components. This layout of the wiring should be followed to avoid any possibility of instability occurring

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.

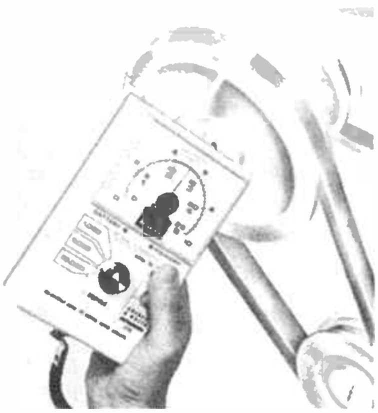
Next month we will look at the construction of Board 4, which carries the timebase circuits.

SHOW ROUND-UP

IEA ELECTREX EXHIBITION 1978

The Twelfth Instruments, Electronics and Automation Exhibition (IEA/Electrex) was held at the National Exhibition Centre, Birmingham, from 13-17 March, and about 300 companies demonstrated devices and components dedicated to improved efficiency in a variety of electronic applications.

This was an international event, but dominated by British manufacturers, and if the exhibition can be said to have suggested one particular theme, if would probably have been process control in its widest sense. Consequently, although there was little of direct relevance to the home constructor, individual elements and new component applications showed some of the latest developments of interest to anyone involved in electronics.



Graham and White's microprocessor-controlled tachometer.

Connectors are of course a perennial necessity, and Souriou displayed their latest range of high quality connectors for printed circuit and rack mounted applications, these being manufactured to BS, DIN, and VG specifications. Less basic in interest, except perhaps for the housewife eventually, was the display of advanced digital weighing systems with microprocessor control by W. and T. Avery, who have been in the field for many years. Amongst the units available were recording systems for load-cell weighers with options such as gross, net, and tare ticket printing, remote cut-off, data outputs, and axle-weighing facilities.

Elsewhere in technical processes, Graham and White showed their new tachometer with memory hold. This is an optical (hand) instrument with microprocessor control, which can be held up to 600mm from the shaft being checked. Reflected light pulses are converted to a meter reading, and the measured level can be "held" for 30 seconds.

Solid State Controls were justly proud of their 5kW direct temperature controller, which features proportional control in the -100°C–$+1600^\circ$C range, and is expected to replace more complex controllers in industrial situations.

Of more direct interest to us, Semiconductor Specialists featured a range of V-MOS power transistors by Siliconix which utilise the MOS process in power transistors for the first time. These devices can be fully driven by the output of a logic gate or microprocessor to deliver up to 2 amps from a 90V rail, making them suitable for audio and r.f. power amplifier applications. Broadly in the same field, Eagle International presented current extensions to their already large range, including the new K1400 high accuracy multimeter (20,000 ohms per volt) along with a new selection of public address amplifiers and associated items.

Although the exhibition was undoubtedly effective in bringing many new developments to the public eye, and was well organised in terms of balance, the same could not be said

The Eagle K1400 multimeter.

of the more human facilities provided by the Exhibition Centre itself. Food and drink was expensive and uninteresting for the captive thousands (eight miles from the city centre!), while the stereotyped snack and drinks bar—identical in each hall—provided little that could be considered conducive to productive conversation or inter-stand relaxation.

At least Pye-Ether provided some relief, however. By means of the lucky ticket system, it was possible to win a bottle of champagne once an hour. The method of selection was not revealed, and although the random pin is the approved traditional method, experience of the show might indicate a suitable ERNIE type microprocessor at the centre of this important operation. Technology rules—OK?

Ted Parratt

THE WIRELESS SHOW

If this magazine has maintained one central aim in the forty-odd years of its existence, it has been that of covering the needs and interests of those involved in constructing their own "wireless" equipment. Its identity and direction as a constructor's journal is not now so unswerving as it was in the heyday of sound broadcasting, and a diversity of technical innovations and developments have occasionally deflected it into other channels of activity.

Its current direction may be seen as a result of expansion to cover the interests of constructors in the domestic aids, home entertainment, test gear, and musical instrument fields, but at the root of its long-term personality there is still a deep involvement in the world of the radio amateur and the enthusiastic broadcast band listener. The "Wireless Show", held at the Victoria and Albert Museum from October to December 1977 and organised by Carol Hogben, Assistant Keeper of Regional Services, in association with the Vintage Wireless Society, must surely have been worthy of its attention.

Neither Oersted in 1820, Maxwell in 1864, nor even Hertz, sometimes regarded as the real "father" of radio experimentation, as late as 1888, could conceivably have imagined the dynamic reaction of manufacturers and designers to the stimulus they had created, nor could they have foreseen the almost architectural excellence represented by cabinet designs of the thirties.

The programme covering the range of exhibits described the show as "130 Classic Radio Receivers—1920s to 1950s," and gave an initial photographic glimpse of some of the stylish, yet functional designs which dominated the British radio receiver field.

It would take a great deal of space to give details of all the models shown, but some of the more unusual items were noted. The first one in the show was a Butler Crystal receiver (1922) which featured Vernier capacitor tuning, and was priced at £2/10/0 (£2·50). In the same year, Burndept produced their Mark IV Tuner and Ultra IV receiver, which was a valve model, battery operated, driving a Primax pleated cone loudspeaker. One of the first kits, the Cossor Melody Maker receiver, was produced in 1928. This was a 3 valve battery set with horn loudspeaker and cost £7/8/6d. (£7·42½).

Moving up into the "quality" class, the Philips 2511 (5 valve) a.c. mains receiver in "Philite" (Philips bakelite) case with cone speaker in heptagonal enclosure, was reputed to offer good value for money at £37/10/0 (£37·50), a considerable amount in 1930.

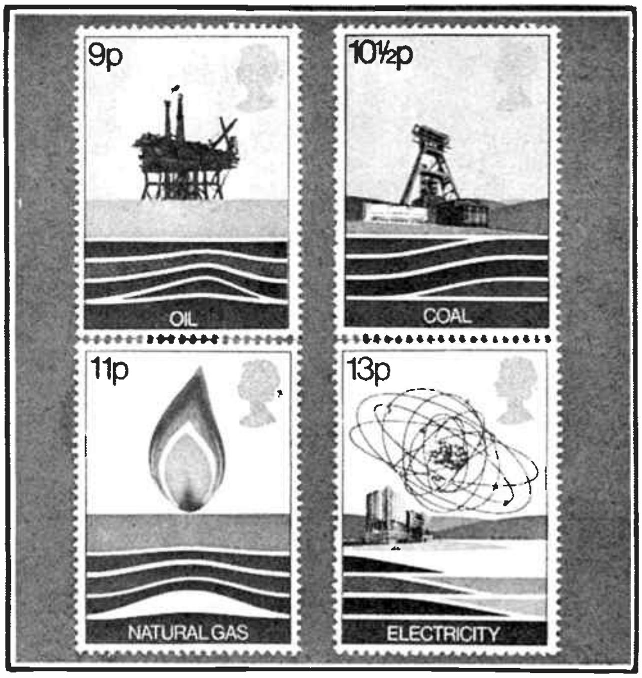
More mature readers may remember the Ekco Consolette SH25 of 1932, costing 24 guineas (£25·20). This was a 5 valve a.c./d.c. mains superhet designed by J.K. White, and was the first to feature a tuning scale with station names.

Another interesting model was the Ekco "Radiotime" receiver of 1947, which retailed at £24/3/0 (£24·15), an a.c. mains superhet featuring built-in clock and alarm, and this had a strikingly modern appearance. Further unusual receivers included the famous Murphy "Baffle Board" sets of 1946-50, designed originally by A.F. Thwaites. These were console receivers of much improved audio performance, featuring a six valve circuit for a.c. mains in a veneered wooden case.

In a world which has largely been taken over by an enormous quantity of trivia, dominated by scenes (some good, some bad) from the "box", it is refreshing to consider a period when the restriction to sound alone stimulated a powerful reaction of the imagination. While radio still posseses this potential force, it seems unlikely that its exploitation will reach such an exciting pitch as that displayed by the variety of designs evident at the show. Modern receivers are light, efficient, and economical in operation, providing in most cases excellent value for money and a high degree of fidelity. and it is not necessarily a disadvantage that a certain uniformity of shape and function has taken over. Nevertheless, anyone who visited the "Wireless Show" can hardly have failed to experience a sensation of mixed admiration and affection for the designs which represented the parents of high fidelity, a firm base built upon by future generations of engineer and designer in the quest for technical perfection and aesthetic appeal.

Ted Parratt

the energy show report



It has become almost commonplace in the last two or three years to allow the term "alternative energy" to slip into conversation about the broad base of human technology. As time passes, the vitality of the term will expand, for energy is the life-blood of an industrial society, and the need for a continuously expanding source of this commodity will surely become more deeply felt as production of consumer items expands, and the demand for warm and comfortable dwellings continues.

The coherent reactions of scientists and engineers to these needs found their fruition in the "Energy Show" held at Olympia last autumn, where many companies demonstrated a variety of answers to both the domestic and the industrial thirst for energy.

Although there were one or two somewhat bizarre contributions, such as the converter to produce natural gas from chicken excrement, which is then fed to a compressor and used to fuel a Land Rover, in the main the responses were related to the production of electricity, and the conservation of heat and power generally.

Lanchester Polytechnic demonstrated its wave power system, based upon the "duck" generators pioneered by Stephen Salter of Edinburgh University. Testing of strings of "ducks" is continuing under a two-year contract with Sea Energy Associates, and plans to test a 10 kilowatt system were well under way in October. The system appears highly viable, and measurements based upon annual averages indicate that the potential energy available from the British coastline should be within the range of 40 to 70 kilowatts per metre of wave front. Extrapolation of the essential figures (making a conservative assumption of a conversion level of 50% efficiency in the generator devices) shows that it is reasonable to expect that 1 kilometre of Scottish coastline will yield about 35 megawatts of power, sufficient to satisfy the electrical needs of a town of about 80,000 people.

Predictably, a large slice of the proceedings was taken up by stands dealing with solar power. While Lucas provided examples of secondary-cell charging systems utilising solar power, (and wind driven alternators), much the most dynamic illustrations were provided by the non-commercial contributors. The silicon solar cell found more public exploitation via the Royal Aircraft Establishment, Farnborough. One of their experimental solar cell batteries, used in an artificial satellite, was arranged so as to provide power directly to a model railway, access to the Sun's rays being at the mercy of the visitor to the stand. In this way, a direct relationship between Sun, cell and train, showing the link with the environment, was imaginatively established.

Another project, of similar value but only shown in model form, was the solar double-glazed panel installed at Wallasey School, Cheshire, used to augment the school heating system.

Perhaps the most controversial aspect of the entire show, however, and this is a personal opinion, was that dealing with the production of electrical power by nuclear means. The efficiency of the system can hardly be doubted since the cost, as quoted by the UKAEA, is 40% less than from comparable oil-fired stations, and 30% less than coal-fired. However, developments in fast-breeder reactors, and the vital problem of risks from their radioactive waste for future generations, were barely touched upon.

One rather novel exhibit was the National Coal Board's nitrogen operated go-kart. Heat is taken from the air by liquid nitrogen, which then boils, providing pressure for a pneumatic motor. It is hoped that the system can be adapted to power hand tools in mines and on building sites.

In addition to those companies interested in the production of energy, there were also those concerned with saving it. The techniques involved ranged from extensive air curtains for the conservation of heat in offices and factories, and for the maintenance of refrigerated conditions. These included improved insulation methods for domestic applications such as lofts and ceilings, and this section led eventually into a gastronomically interesting stand dealing with economical cooking methods.

Overall the show demonstrated a developing interest in the central problem of energy supply in an expanding community, and also the commercial dynamic which will clearly rise to meet it; most of all though, it displayed the increasingly sophisticated reaction of the inventive minds of engineers to the stimulus of shortage, and if current answers are anything to go by, this challenge will be effectively met.

Ted Parratt.

OF THE MONTH 69

Brian DANCE M.Sc

THOMPSON CSF 20W POWER AMPLIFIER

The ESM 532 20W Power Amplifier

During the past few years integrated circuits which can provide fairly high audio output power levels have become available and one can now obtain up to 20W from suitable monolithic devices. This article describes the new ESM 532 integrated circuit produced by Thompson-CSF Ltd. which can deliver up to 20W at 1% total harmonic distortion into a 4 ohm loudspeaker.

Characteristics

The ESM 532 is basically an operational amplifier which can deliver output currents of up to ±3·5A. The power supply voltage to the device can be a single supply of not more than 36V or balanced supplies of not more than ±18V; higher voltages are likely to damage the device even if the higher voltage is only applied as a 'spike' of very short duration. The minimum operating voltage is 9V (or ±4·5V with balanced supplies), but obviously the output power available is quite low at such voltages.

The ESM 532 is a quad-in-line device with the connections shown in Fig. 1. Alternate pins are bent so that their tips are at different distances from the body of the device. It can be seen that the normal inverting input (marked −) and non-inverting input (marked +) of an operational amplifier are provided. External frequency compensating components must be connected to pin 3 to ensure stability, whilst the bootstrap connection to pin 1 enables maximum power to be obtained.

A metal insert is fixed along the back of the device and must be clamped to a suitable heat sink. A layer of silicone grease should be placed between the metal insert and the heat sink to ensure good thermal contact; even better is one of the special heat conducting greases available. The thermal resistance between the silicon chip and the metal insert is about 5°C per watt; the heat sink should have a thermal resistance not much greater than 5°C/W.

The ESM 532 is not likely to be damaged by overheating if the heat sink is too small, since the device incorporates protective circuitry which will greatly reduce the output current if the temperature of the silicon chip exceeds the danger point of about 150°C. Nevertheless, it is bad practice to allow any integrated circuit to work at its maximum temperature for a long time.

An additional circuit in the ESM 532 prevents it from being damaged by high currents flowing when the output is accidentally shorted either to ground or to the positive supply line. When such shorting occurs, the internal circuit limits the maximum output current to ±3·5A at chip temperatures of up to 100°C or about 1A at a temperature of 150°C.

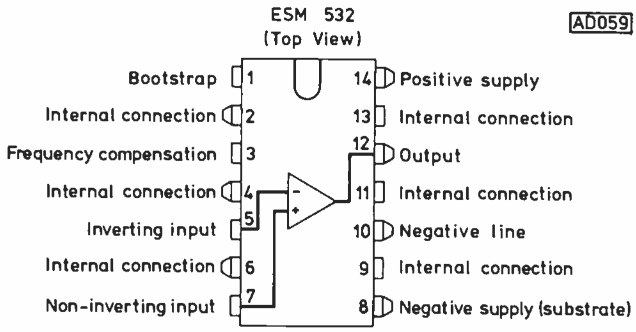


Fig. 1. The connections to the ESM 532

Circuits

Two circuits using the ESM 532 as an audio amplifier will be discussed. One of these employs balanced power supplies and the other a single power supply. The ESM 532 can also be used in television vertical sweep circuits, but these will not be covered here.

Balanced supplies

An ESM 532 20W amplifier circuit using balanced power supplies is shown in Fig. 2. The gain of the circuit is equal to (1+R5/R2) or about 32 (30db) with the values shown, but reasonable variations in the values of R5 and R2 can be made to achieve a fairly wide range of gain values.

The capacitor C1 prevents R5 and R2 from acting as a potential divider at zero frequency. Thus one obtains full negative feedback at this frequency with a circuit gain of unity. Any input offset voltage is

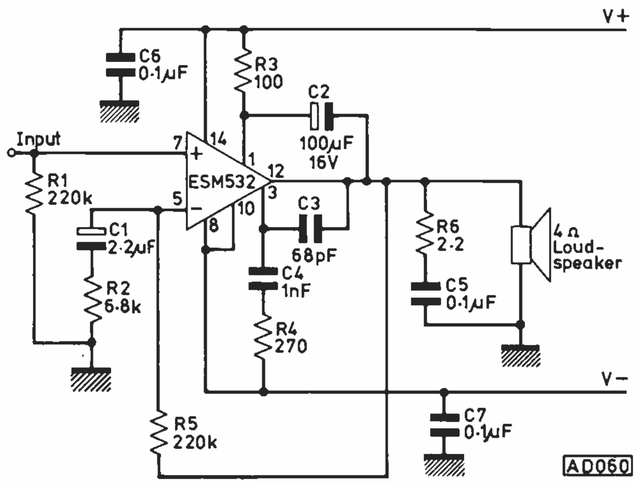


Fig. 2. A 20W amplifier circuit using balanced power supplies

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 1½ 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.

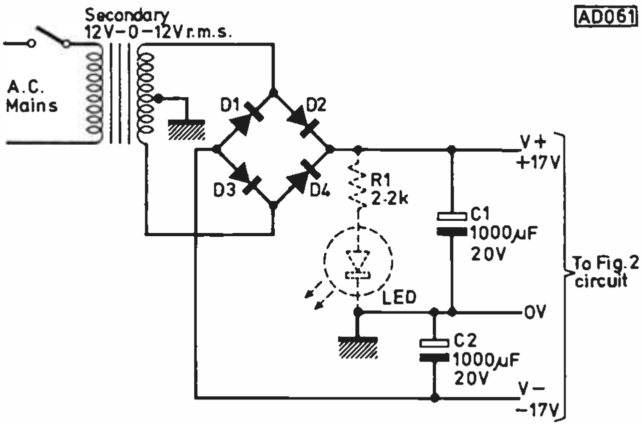


Fig. 3. A power supply circuit suitable for driving the Fig. 2 circuit

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

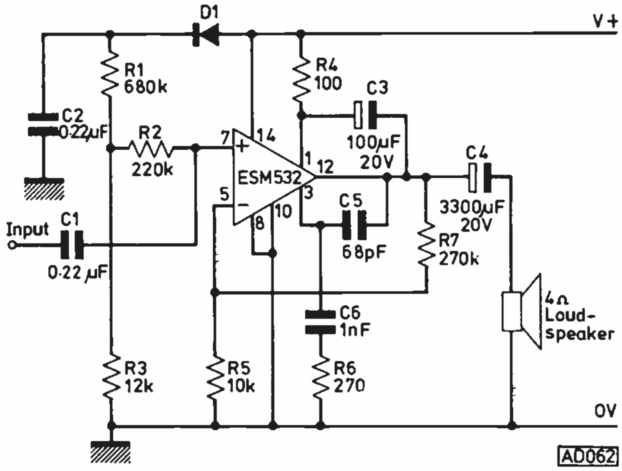


Fig. 4. A 20W amplifier using a single power supply

product of the values of this capacitor and resistor being appreciably less than the product of the value of C4 and the loudspeaker impedance.

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.

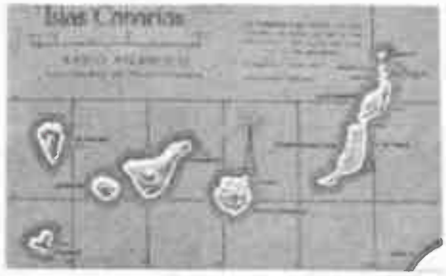
A lower voltage version of the ESM 532 is produced with a maximum rating of 30V under the type number ESM 432. The ESM 532N is similar to the ESM 532, but has a bracket for the connection of a heat sink.

Availability

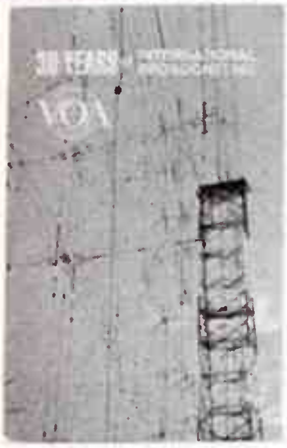
The ESM 532 is available from Phoenix Electronics Ltd., 46 Osborne Road, Southsea, Hants at £2·95 including VAT and packing and postage. ●

NEXT MONTH IN...
practical WIRELESS

ON SALE 7TH. JULY

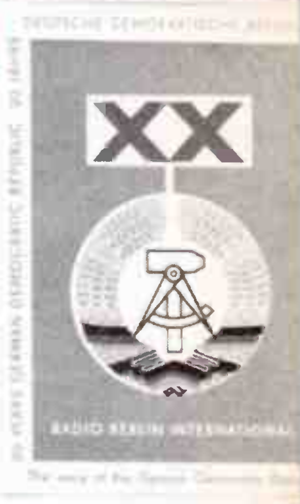


A.M. Receivers – DEVICES & CIRCUITS Part 1



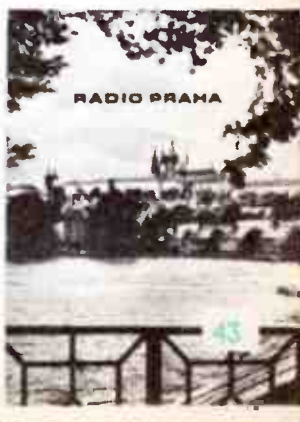
ALSO:

POWER SUPPLY INVERTOR FOR 'ECONOMY TIMING STROBE'



AND:

CAPACITOR DISCHARGE UNIT for Point Motors



THE PW 'AVO... 2m f.m. tra...

PART 1

With the increased activity on 2 metres, some who may have contemplated working this band, have possibly been deterred by the cost of a "black box" and the uncertainty of modifying commercial equipment. With this situation in mind, the Author has designed a simple, easily-built 2m f.m. transmitter, that can be assembled by anyone who can use a soldering iron and small tools whilst possessing a reasonable amount of patience. The completed unit will perform well, being as versatile as the constructor ultimately wishes to make it. An r.f. output of around 10 watts can be expected if the unit is constructed as described but power far in excess of this may be achieved if the design is regarded as a working basis and the p.a. stage is developed.

Construction

A simple printed circuit technique is employed, with most components fixed directly to the print side of the board. There are very few holes to be drilled and the units may be secured in a suitable housing by straightforward fixing screws. For continued ease of assembly, the transmitter is made on three separate boards; one contains the audio modulator and crystal oscillator, the others the frequency multipliers and the final the power output stage. For low power working (QRP) only the first two boards need to be made, as the output of the second is on 2m, although at only a few tens of milliwatts.

Constructors who have not yet etched a printed board will now find how easy it really is and full instructions are given with details of the board layouts. As with all projects of this nature, it is strongly recommended that the components used are of the kinds specified. Resistor wattages are not critical, but as their ultimate size is governed by their power-handling capacity, space may determine type.

The Crystal Oscillator and Audio Stages: Board 1

The theoretical circuit is given in **Fig. 1** and consists of a Colpitt's oscillator using 8MHz crystals. Six channels are shown in the schematics—three, in fact, were used for the prototype—but there is no reason why many crystals cannot be included by using a suitable multiway switch and increasing the number of islands on the board; using the smaller HC25 series crystals would permit more channels to be fitted in the space allotted. The trimmers in series with each crystal allow easy netting to the assigned frequency.

The f.m. is applied to the oscillator by a reactance stage, fed by two audio pre-amps. Deviation is controlled by a 10kΩ potentiometer and the maximum attained on the prototype was 8kHz. Notice the inclusion of decoupling in the audio stages to prevent r.f. pickup—so often a cause of poor audio quality in home-constructed equipment. The printed board layout is shown in **Fig. 2**.

Preparing Board 1 (Fig. 2)

Cut a piece of single-sided copper board to the size shown and with some fine abrasive paper, clean the copper surface to remove any oxide or tarnish.

COVER PROJECT

ON'
metre
n.
ansmitter

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.

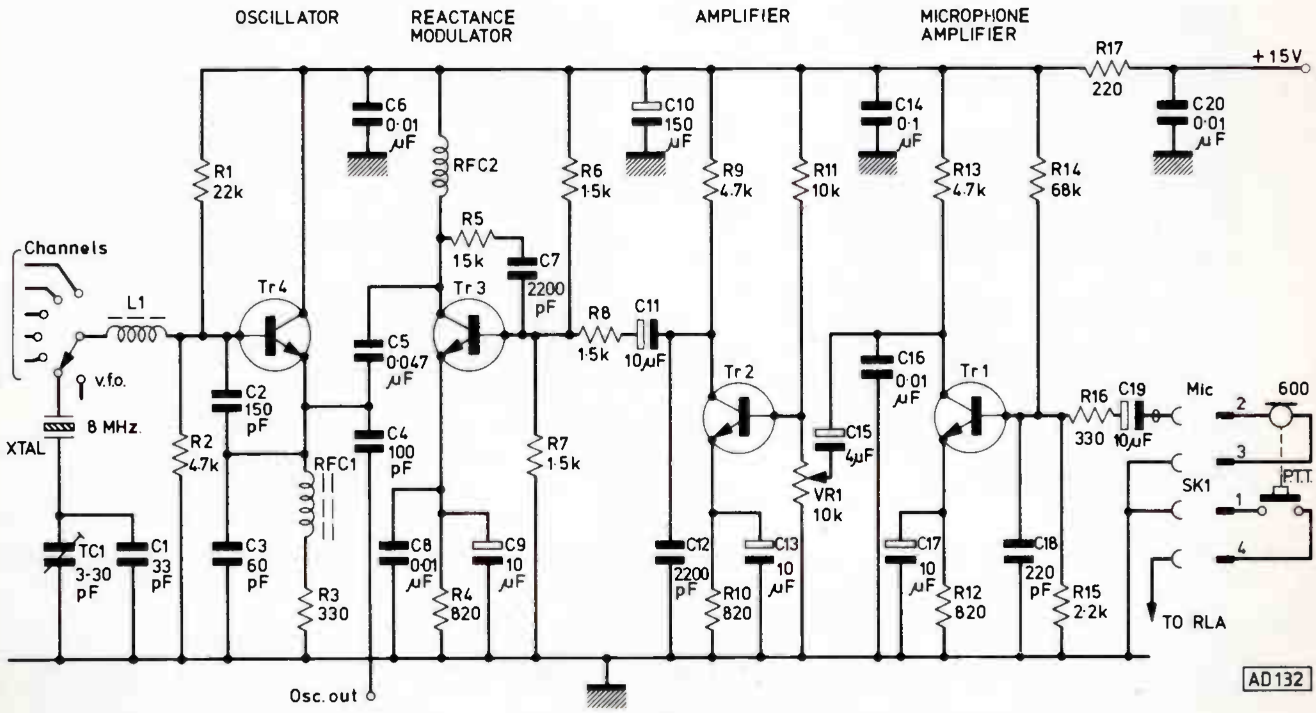


Fig. 1: Circuit diagram for the Crystal Oscillator and Audio Stages—Board 1

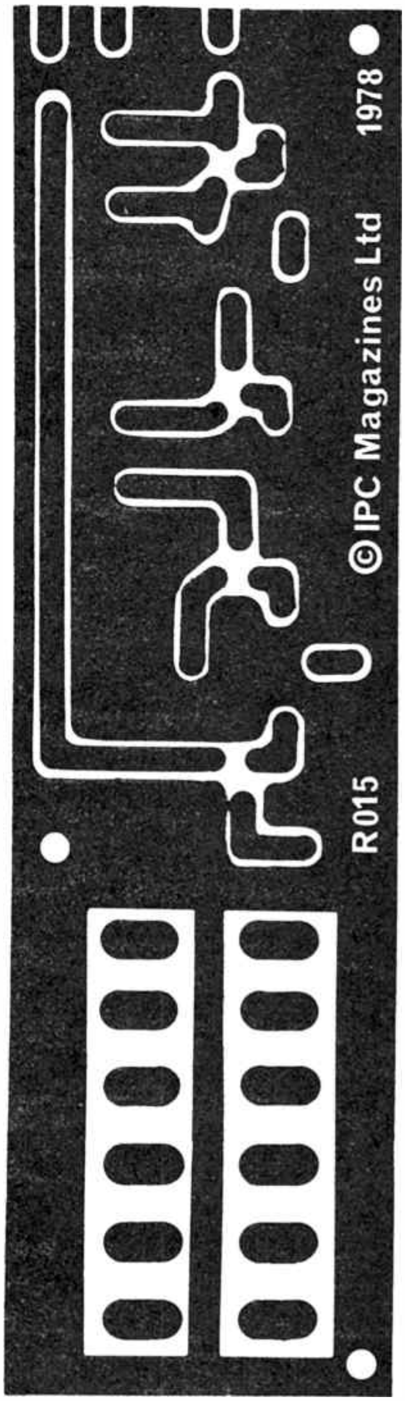


Fig. 2: Copper side layout of Board 1. Available from Reader's PCB Service (see page 27)

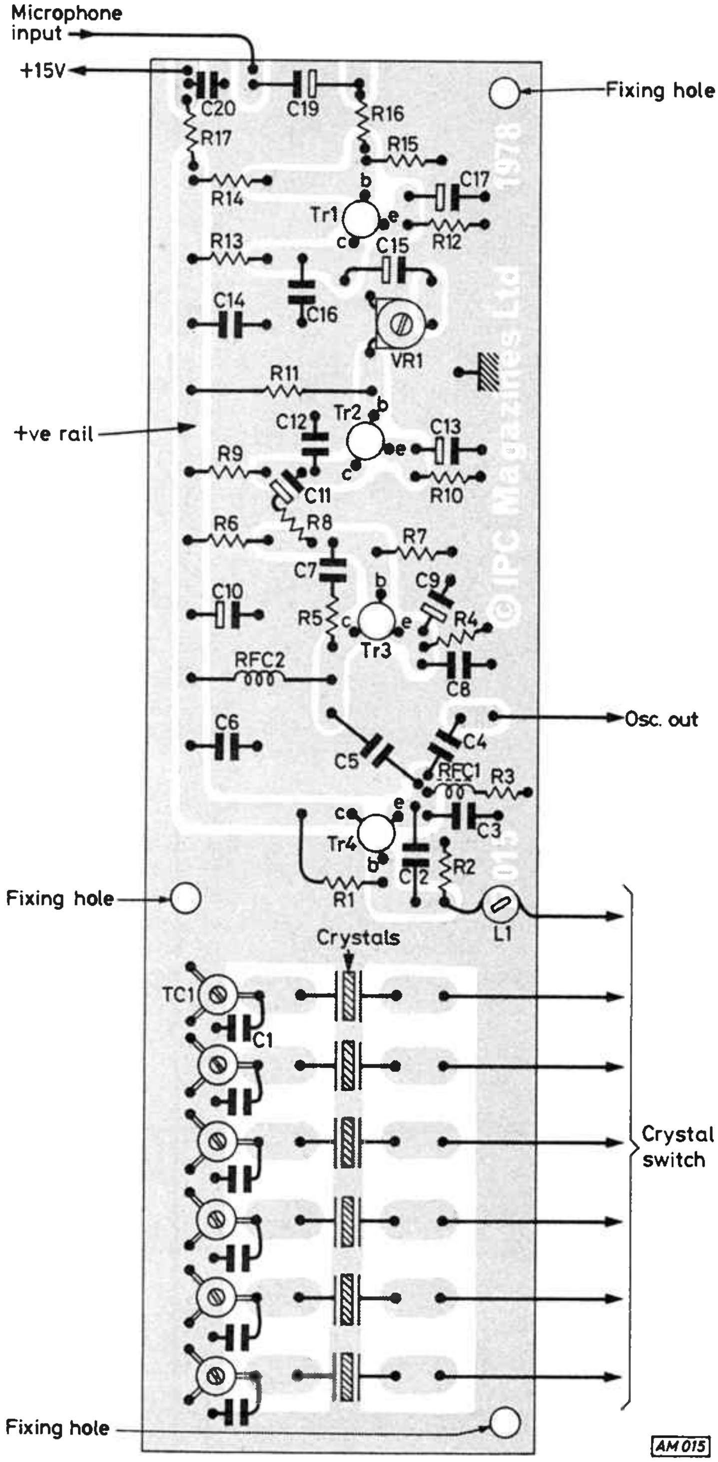


Fig. 3: Component layout of Board 1. Note components soldered direct to copper side of the p.c.b.

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.

★ components

BOARD 1

Resistors
⅛ watt 20%

220Ω	1	R17	4·7kΩ	3	R2, 9, 13
330Ω	2	R3, 16	5·6kΩ	1	R6
820Ω	3	R4, 10, 12	22kΩ	1	R1
1·5kΩ	2	R7, 8	33kΩ	1	R11
2·2kΩ	1	R15	68kΩ	2	R5, 14

Potentiometer
10kΩ log. pre-set 1 VR1

Capacitors
Ceramic 50V

33pF	*	C1	220pF	1	C18
60pF	1	C3	2200pF	2	C7, 12
100pF	1	C4	0·01μF	4	C6, 8, 16, 20
150pF	1	C2	0·047μF	1	C5

Polycarbonate
0·1μF 1 C14

Electrolytic 25V axial leads

4μF	1	C15
10μF	5	C9, 11, 13, 17, 19
150μF	1	C10

Trimmers
3-30pF ceramic * TC1

Semiconductors
BC173 4 Tr1, 2, 3, 4
BC 109C

Inductors

RFC1	10 turns 32 s.w.g. enamelled copper on ferrite bead
RFC2	As many turns as possible of 32 s.w.g. enamelled copper pile-wound onto a ½-watt 1MΩ carbon resistor
L1	10 turns 24 s.w.g. enamelled copper close-wound on 6mm former with iron-dust core

Miscellaneous
Crystal(s) within the 8MHz range.
Carrier frequency = crystal frequency × 18
Holders for type of crystal(s) selected
Miniature BNC socket—v.f.o. input. RS type 455·703
SK1 4-pin Tuchel socket, chassis mounting. (Microphone input)

* 1 required for each crystal

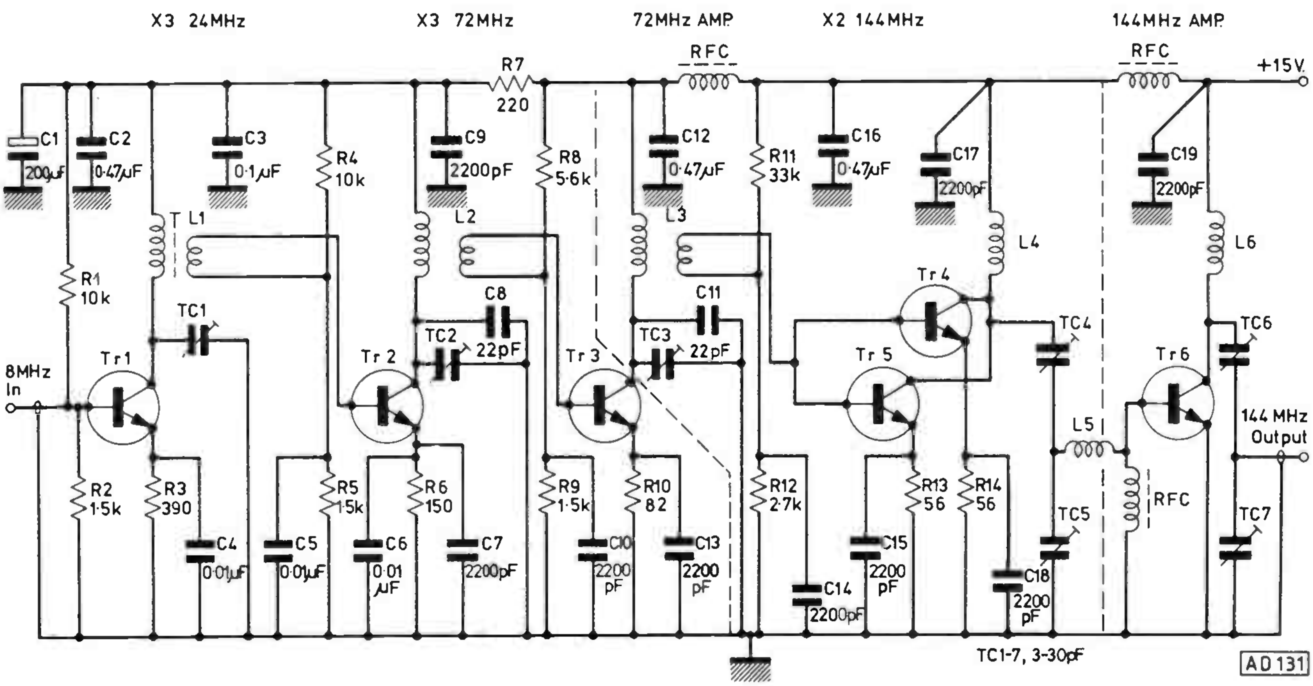
Testing Board 1

Connect a 15 volt supply to the board—having first established that the polarity is correct—and check the voltages shown: a 15 per cent error is quite acceptable, due to component tolerances. With a 600Ω microphone and a pair of earphones across C11 to the earth line, check for clean audio and the operation of the deviation control.

The oscillator can be tested by connecting a suitable 8MHz crystal in position (i.e. 8·08333MHz for S20-145·5MHz) and listening for the 8MHz signal on a tunable h.f. receiver, coupled loosely to the vicinity of the oscillator stage.

For the moment no audio will be apparent on the signal, because the amount of deviation available at the oscillator is small; it requires the multiplication of subsequent stages to raise this to the required level of 5-6kHz.

Fig. 4: Circuit diagram for the Multiplier Stages — Board 2



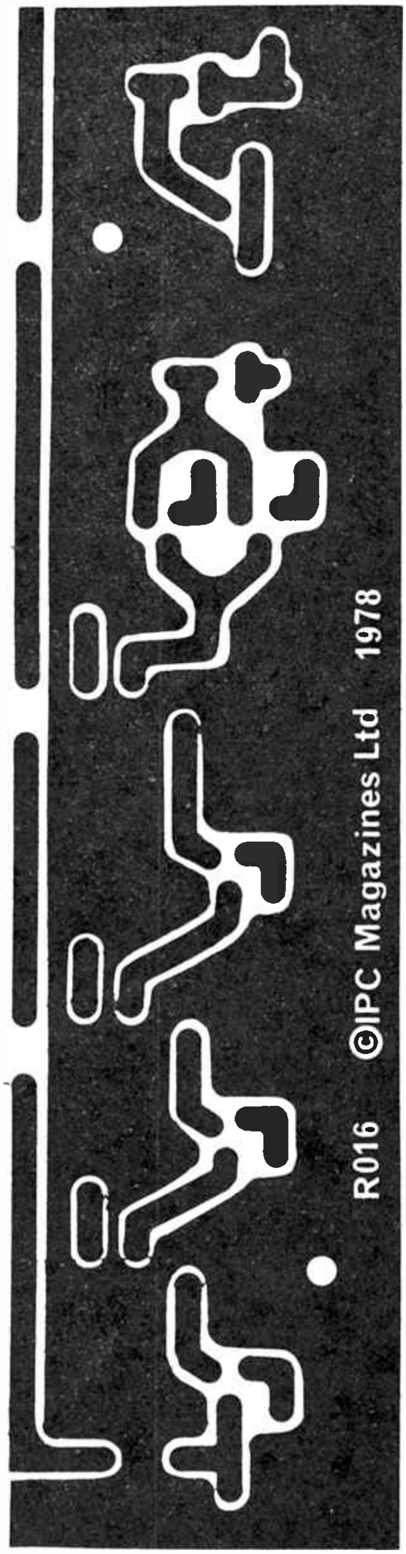


Fig. 5: Copper side layout of Board 2. Available from Reader's PCB Service (see page 27)

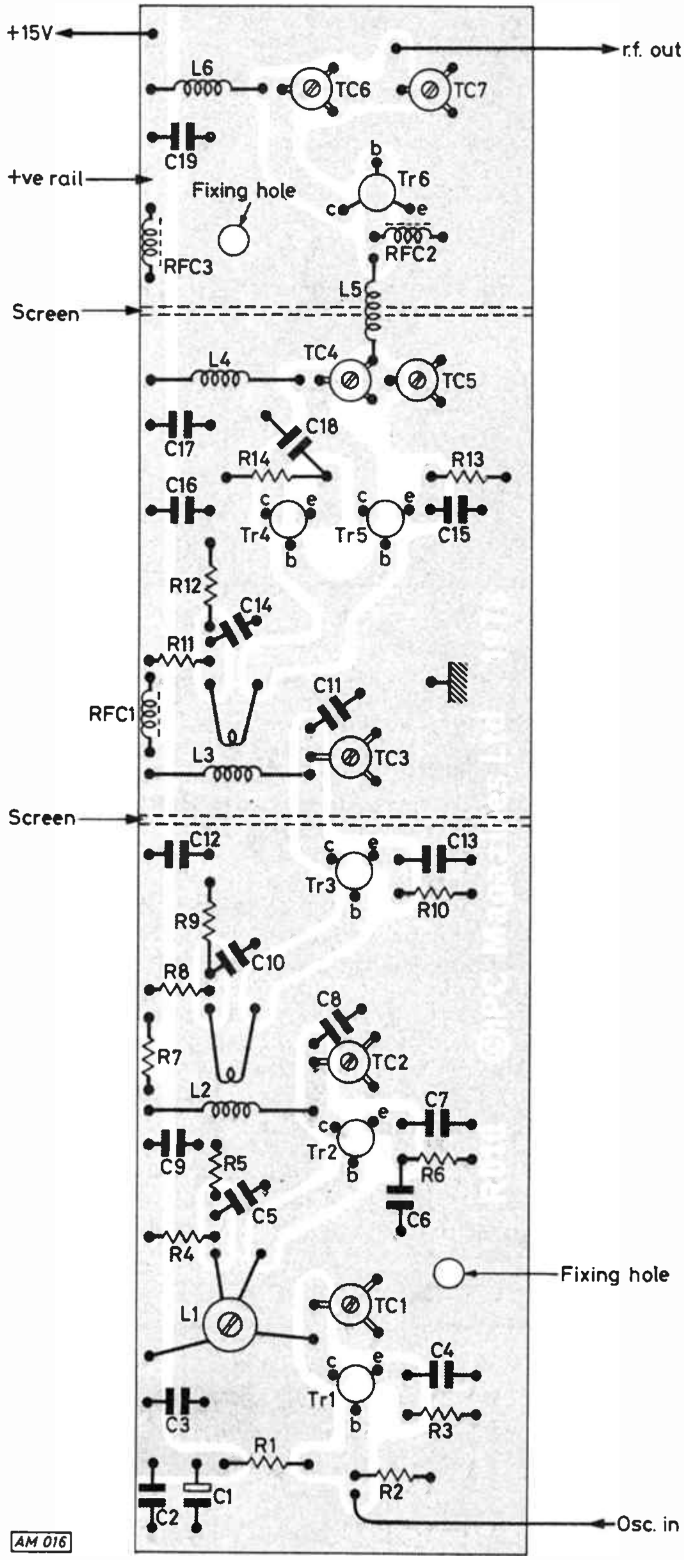


Fig. 6: Component layout of Board 2. Note components soldered direct to copper side of p.c.b.

★ components

BOARD 2

Resistors
⅛ watt 20%

56Ω	1	R14	2·7kΩ	1	R12
82Ω	1	R10	5·6kΩ	1	R8
150Ω	1	R6	10kΩ	1	R1
220Ω	1	R7	18kΩ	1	R4
390Ω	1	R3	33kΩ	1	R11
1·5kΩ	3	R2, 5, 9	56kΩ	1	R13

Capacitors

Ceramic 50V		
22pF	2	C8, 11
2200pF	9	C7, 9, 10, 13, 14, 15, 17, 18, 19
0·01μF	3	C4, 5, 6
Paper		
0·47μF	1	C3
Polycarbonate		
0·47μF	3	C2, 12, 16
Electrolytic 25V		
200μF	1	C1
Trimmers		
3-30pF ceramic	7	TC1, 2, 3, 4, 5, 6, 7

Semiconductors

BC173	5	Tr1, 2, 3, 4, 5
2N4427	1	Tr6

Inductors

RFC1	10 turns 32 s.w.g. enamelled copper on ferrite bead
RFC2	3 turns 24 s.w.g. enamelled copper on ferrite bead
RFC3	10 turns 32 s.w.g. enamelled copper on ferrite bead
L1	18 turns 24 s.w.g. enamelled copper, close-wound on 6mm former with iron-dust core. Coupling coil: 4 turns insulated, single-core wire at lower end of former. Fix with cyanoacrylate adhesive.
L2, L3	5½ turns 18 s.w.g. enamelled copper 6·3mm dia., spaced one wire apart. Coupling coil: 1½-2 turns insulated, single-core wire over centre of winding. Fix with cyanoacrylate adhesive.
L4, L6	3½ turns 18 s.w.g. enamelled copper 6·3mm dia.
L5	1 turn 18 s.w.g. enamelled copper on 6·3mm mandrel

Miscellaneous
Heat Sink. Push-on type 85° c/w for 2N4427. RS type 401·419

The Multiplier Stages: Board 2

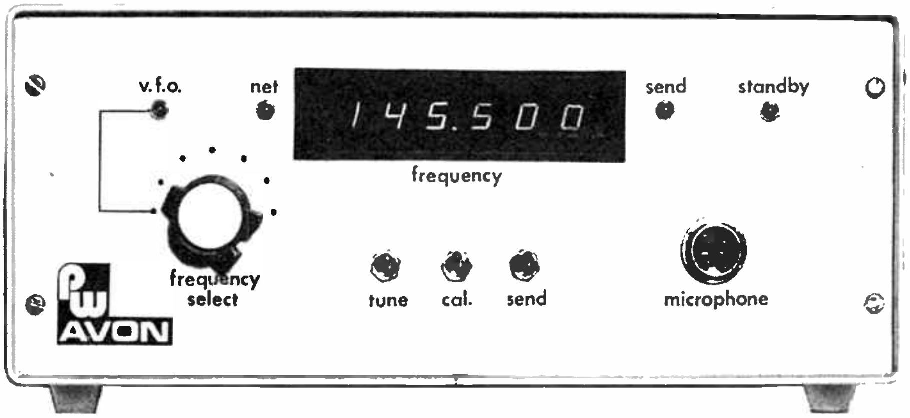
The circuit of the Multiplier is given in **Fig. 4** and consists of a stage of tripling to 24MHz followed by a further tripler to 72MHz and an amplifier into a doubler for 144MHz.

Transistor Tr1 accepts the crystal oscillator input in its base circuit, and the collector is tuned to 24MHz. This output is link-coupled to Tr2 and its collector is tuned to 72MHz by L2 which in turn is link-coupled to Tr3, also tuned to 72MHz. This brings the signal to a suitable level, sufficient to drive Tr4 and Tr5 in parallel to double to 144MHz in the collector circuit, via L4. Separate current-limiting resistors are used in each emitter circuit to ensure both transistors contribute equally to the output signal. Tests using a common-emitter resistor proved that invariably one transistor tends to be "lazy" and its partner does all the work. This is, of course, due to differences between transistor characteristics.

Drive to Tr6 is fed via a low impedance network through TC4 (tune), TC5 (load) and L5. This stage is tuned at its collector to 144MHz and again a capacitance/resistance arrangement is used to feed either the aerial (low power), or the following stage on Board 3. The r.f. output available at this point is about 80-100mW. The board etching layout is given in **Fig. 5**.

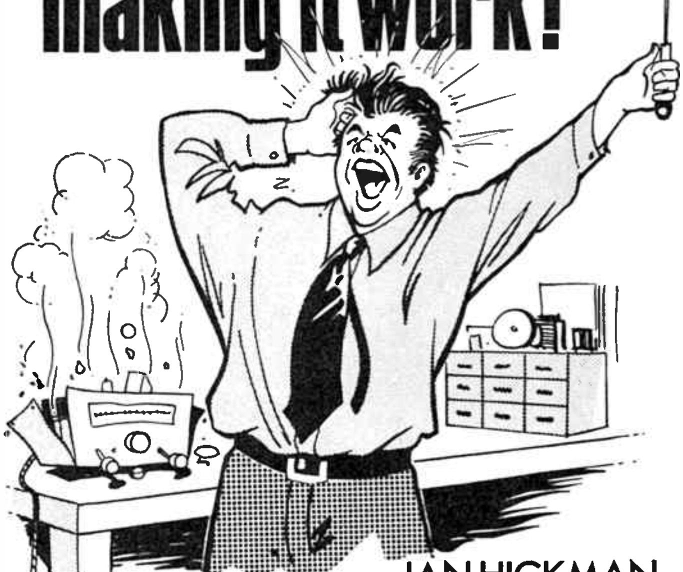
Board 2—Component Layout (Fig. 6)

A plan view of the board for etching purposes is given in **Fig. 5** and **Fig. 6** shows the component locations. There are two screens 25mm high on this p.c.b. to prevent feedback and instability. These are made from brass, tinplate or Radiometal, cut to size and soldered vertically across the board to the earth plane. Care is necessary when crossing "live" tracks: undercut the screen with a small file before fixing, to ensure adequate clearance.



Next month will deal with the Power Amplifier Board and the Aerial Filter

'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

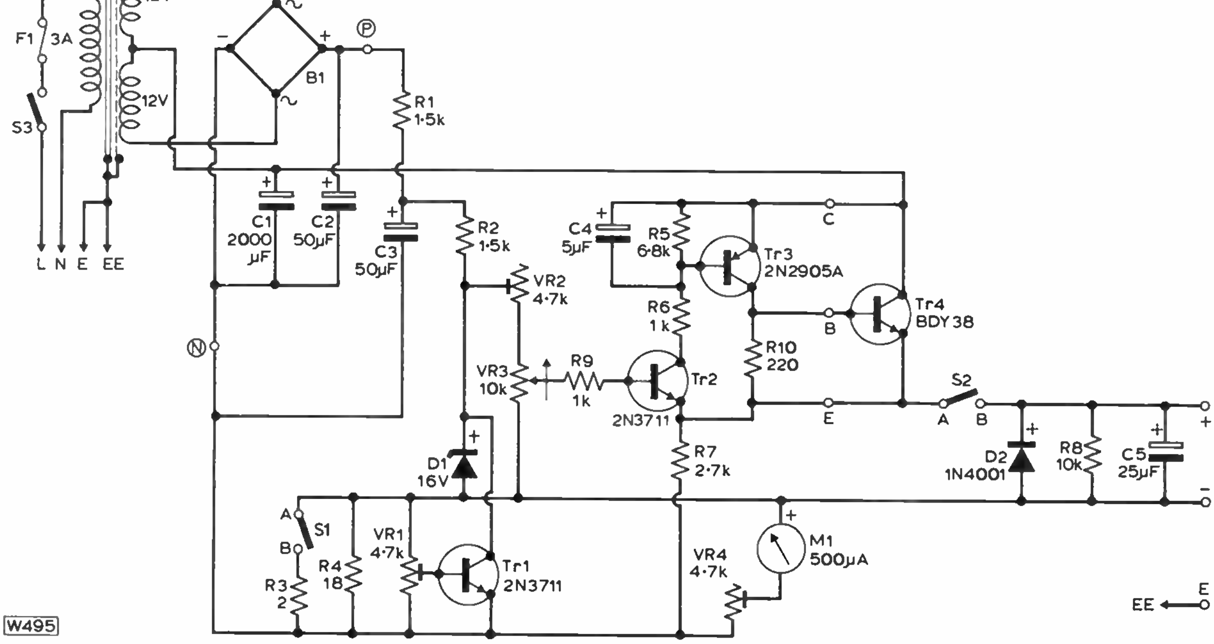
With so many readers building this design, one or two were bound to hit some snag or other, e.g. "... have completed the Mini Power Supply ... cannot adjust it at all with VR3 ... please can you help?", from J. D. of Huddersfield. This is where a systematic approach comes into its own, resulting in "... 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 $1\frac{1}{2}$W 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.

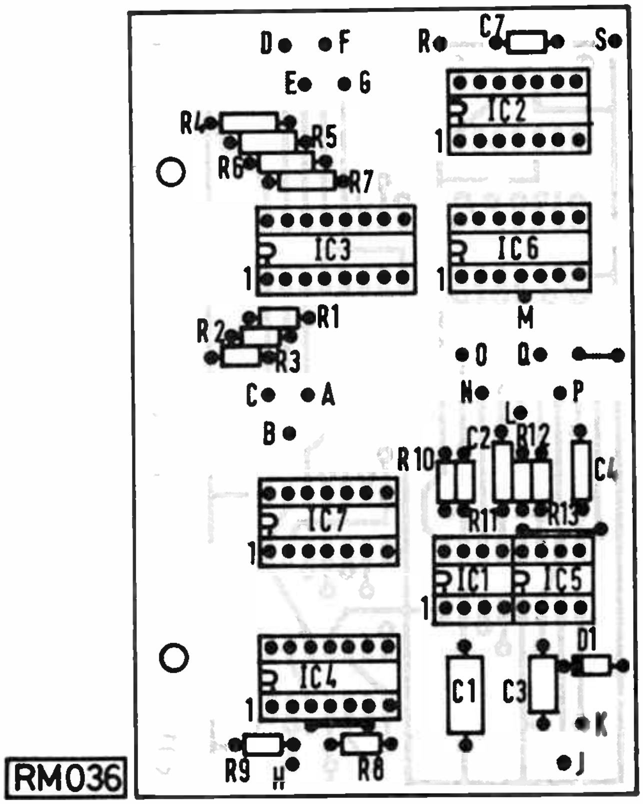
The principles of systematically getting a circuit going stage by stage are well illustrated by the above. If you are new to electronics or sometimes have problems getting a circuit to work, it would be well worth while studying the circuit of the original article in conjunction with the systematic approach 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–.–.

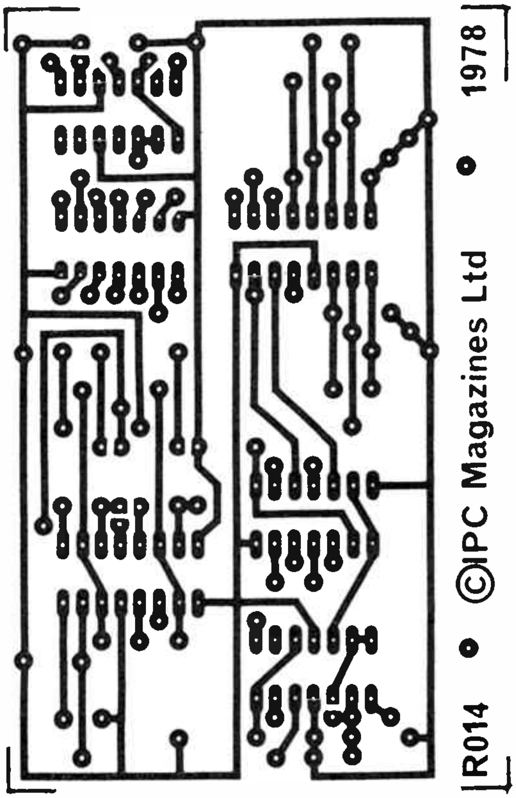


Component layout of the Morse Tutor

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.

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

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS

In general, the author does not have any more information on products than appears in the article.

Apple Scabs beware

An apple a day is said to keep doctors away, and even the old teacher has come in for one of these little green spheres. But have you ever thought how difficult it might be to get you a ripe apple? And did you know that electronics is helping, too?

Apparently, one of the evils of the apple (apart from Adam) is a thing with the endearing title of Apple Scab, a nasty fungus thing which does even nastier things to apples. By making careful measurements of the environment and equating this with the severity of the attack, growers were able to apply fungicide sprays. But what was the optimum and how could one get away with the minimum amount of spraying thereby saving costs and helping to combat environmental damager?

The answer is electronics. One with-it farmer has installed a complete Apple Scab Bashing system. Electronic sensors in the field (literally!) measure the air temperature, the degree of leaf wetness (hold up your twig I wanna take your temperature!) and relative humidity. All the information is collected and monitored by a predictive computer system complete with microprocessor. The systems gives instant information on how and when to do nasties to the fungus. The entire system electronics employs CMOS and draws only 60mW of power—ideal for battery operation.

Before electronics came on the scene, these figures and measurements took a great deal of time to accumulate, process and then interrogate. The current set up allows all this to be done instantaneously and an operator can be fully trained to handle the system and use it in less than one hour. The result will be, presumably, more happy teachers and fewer overworked doctors.

Smokers beware

Pollution is a current topic which receives much attention in the national press. Eventually, legislation will be brought in to limit the amount of pollution from things like car exhausts, factory chimneys etc. But how do you check if a very tall chimney is polluting or not—except by a long, hard climb?

Some university researchers in the U.S. have come up with a very useful solution based on a laser. It is accompanied by the staggering claim that it can detect and measure—accurately, pollution at a distance of eight miles! The system should be ideal for checking the pollution from those very high smoke stacks. It's even been rumoured that some tall chimney owners keep pollution down during "office" hours and burn all that nasty polluting stuff at night when no one can check.

The system can detect numerous nasties, such as sulphur dioxide and even water vapour. The laser beam is "shone" at the polluting air. Each pollutant absorbs the coherent (i.e. laser) light at different frequencies. So the system receives the reflected laser light and 'tunes' across the band to find out which absorbants/pollutants are there and how many of them there are. If distance appears to be no object, accuracy certainly isn't. The new laser set up can detect and measure concentrations of, for example, methane of one part per billion over a path of 100 metres.

Doubtless joyous headmasters will use such a device to detect the odd puff of Woodbine pollution generated from the rear of their cricket pavilions!

Solid State Cameras

Some time ago the charge-coupled device appeared on the professional electronics market. It appeared to have a number of applications one of which was to form a photosensitive array for use in solid state TV cameras. The very latest development in this field comes from Japan where a leading manufacturer has revealed some details of its new entirely solid state colour TV camera. This could be a significant breakthrough, and many feel that the vidicon colour cameras for home video just appearing on the market could establish good sales, but only to be ousted by the new solid state versions late in 1979. The camera from Japan uses three c.c. devices, one for each of the primary colours. Each c.c.d. array has some 111,192 separate picture sensitive elements on it—and the surface measures only 10·3mm × 9·1mm the Japanese have ended up with an effective sensor area of 8·8mm × 6·6mm which just happens be the size of 0·6 inch vidicons. This clever move allows the same cheap lenses to be used with the new solid state devices.

CB Linears Out

Have you noticed that the tempestuous uproar about the UK Citizens Band has now practically disappeared? There seems little doubt that it will come and, hopefully, we will have learnt something from the problems in the U.S. and will avoid these (are you listening Westminster?) The latest news from across the pond is that the FCC (they are the American Gods of what you can and cannot do with radio waves over there) has just announced a ruling making it illegal for anyone to produce, import or market linear amplifiers operating in the relevant band. The days when an innocent U.S. youth could purchase a 50mW Citizens Band transceiver—and then hook it up to a linear which took up half the garage are over. Apparently nearly 50 per cent of all interference complaints on TVs and radios were traced to linears, hence the ruling.

Fast Pot

Talking components, how about a potentiometer which has manufacturers data for 2,000 revolutions per minute! The design is a contactless one and uses optical means. Construction is quite clever. It consists basically of a resistive film plus an electrode, and sandwiched between them is a photoconductive film. For the technical buffs, the photoconductive material is officially named as cadmium-selenium which has been doped with tellurium—so there! This photoconductive film makes permanent contact between the contact electrode and the resistive film. A disc with a slit in it is attached to the rotary shaft of the potentiometer and a light source provides illumination. As the shaft is rotated, so the slit of light moves along the photoconducting film causing it to "connect" the contact on the side of it, with the part of the resistive element directly opposite on the other side.

Ginsberg

PRODUCTION LINES

alan martin

New receivers

National Panasonic have recently introduced two new radio receivers designed to appeal particularly to s.w. listeners. They are the RF-2200, an eight-band portable priced at £134·95 and the RF-4800, a ten-band communications receiver costing £319·95.

The RF-2200 is a comprehensive portable radio, built for the enthusiastic DX'er or the traveller who wants to keep in touch with world news, wherever they may be. Frequencies from m.w. to f.m. are covered in eight bands, tuned by a two-speed tuning knob coupled to a band dial that has 10kHz divisions, and a crystal marker calibrated at 500kHz and 125kHz intervals.

High selectivity is achieved by the double superheterodyne design—rarely found in portables—and the wide/narrow bandwidth switch, for s.s.b. and c.w. A b.f.o. is provided.

Other features include a meter that combines battery check, crystal marker check and optimum tuning indicator. Power output via a 10cm loudspeaker is 3W, with separate bass and treble controls.

Measuring 318 × 188 × 100mm, the RF-2200 weighs 3·0kg.

The RF-4800 communications receiver is designed for the amateur's shack or for mobile use.

Its ten bands range from l.w. (145–410kHz), m.w. (520–1610kHz) to s.w. split into seven bands including marine band and covering a range from 1·6–27·3MHz.

Tuned frequency is indicated by tuning scale for l.w./m.w. and s.w. up to 3·0MHz, and by a combination of tuning scale and a large five-digit l.e.d. display for the s.w.2–s.w.7 bands. Independent calibration of these s.w. bands is by separate control, and tuning to optimum signal strength on all bands is indicated by a tuning meter.

A 3W internal amplifier with separate bass and treble controls drive either an internal or external loudspeaker, or can be connected to an external amplifier via the 'rec out' sockets.

Powered by dry batteries, 12V car battery or a.c. mains, the RF-4800 measures 482 × 200 × 354mm and weighs 8·0kg.
Further information from: *National Panasonic (UK) Ltd., Whitby Road, Slough, Berks. Tel: 0753 34522.*

The RF-2200 portable radio

Keyboard switches

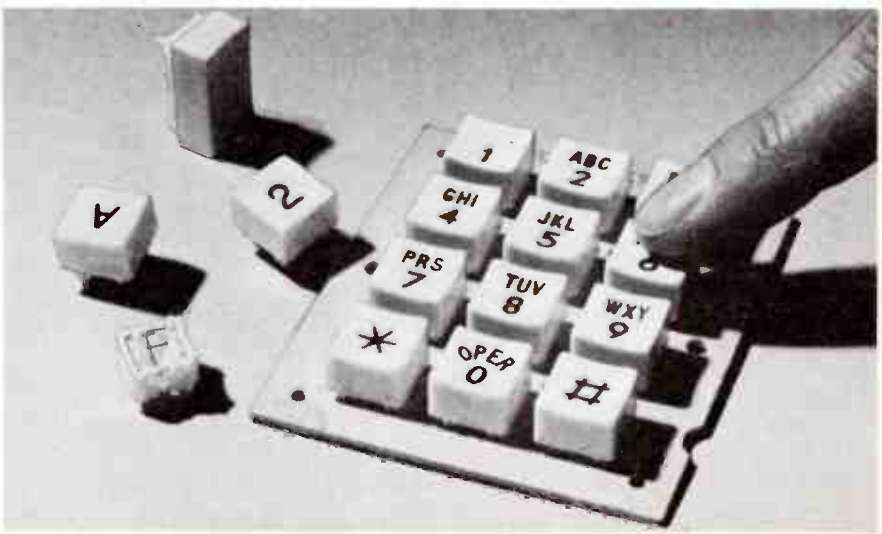
Erg is launching a unique push-button keyboard switch, the Erg-KEY RS5020.

The switches have two main features, first a contact bounce time of only 25μs. Rarely before has this speed been achieved in a mechanical switch.

Secondly, it has a very low profile; only 5·08mm above its mounting plane.

Extremely high reliability is achieved by using a unique, patented torsion bar technique. An operating life of 10 × 10^6 operations is expected over an operating temperature range of −40°C to +60°C.

Further information on price and availability from: *Erg Industrial Corp. Ltd., Luton Road, Dunstable, Bedfordshire LU5 4LJ. Tel: 0582 62241.*



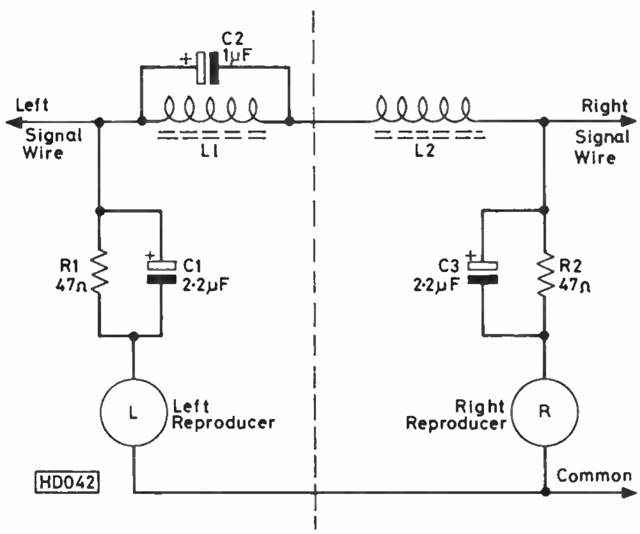
Ideas DEPARTMENT

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



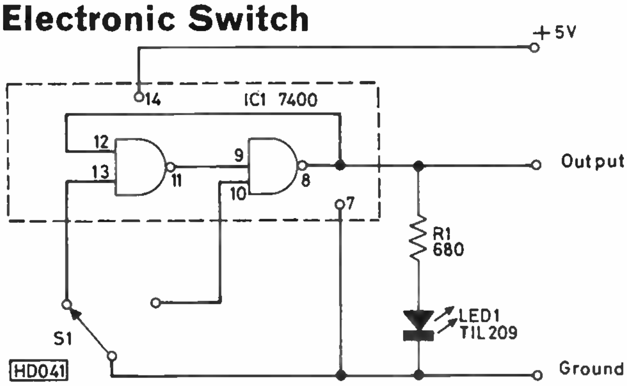
This circuit was developed to improve the stereo effect experienced when listening with stereo headphones. When listening with loudspeakers the stereo effect is produced by the interaction between the two speakers. With headphones, however, there is no such interaction and to obtain a realistic stereo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

Digital 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 1μA, 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

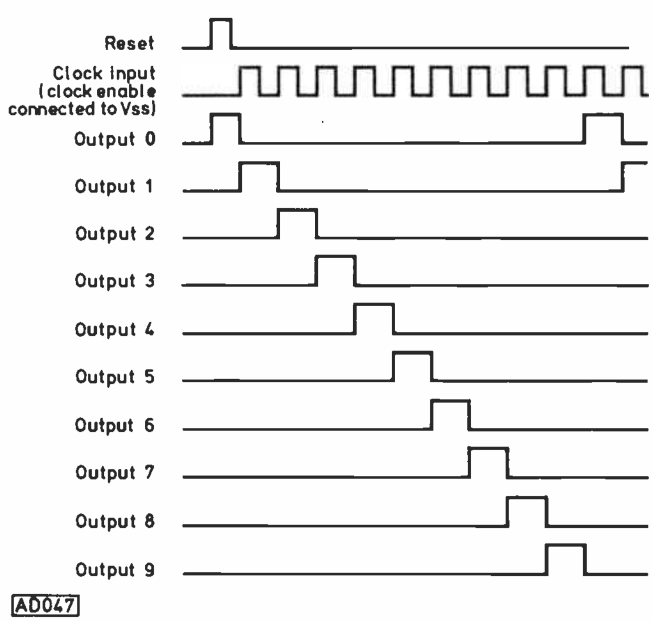


Fig. 1: Truth table for the CD4017 counter

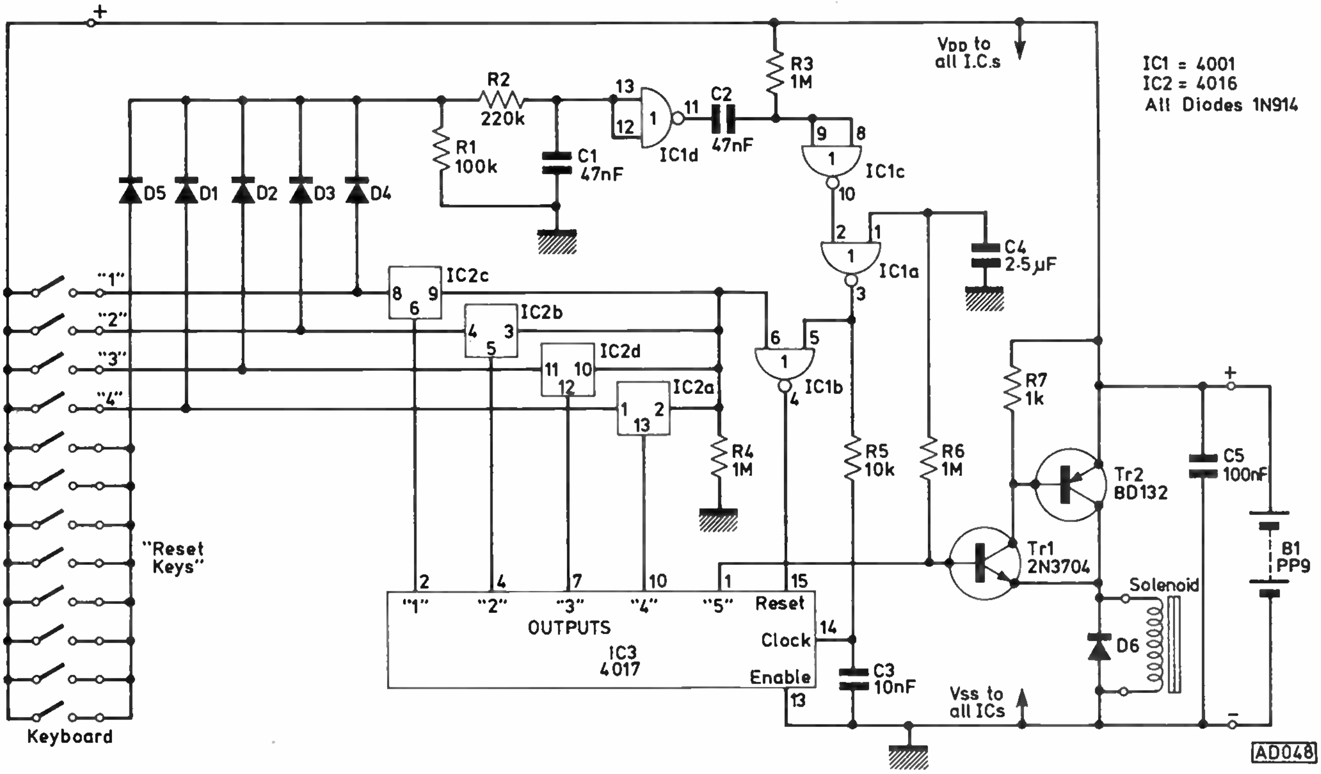


Fig. 2: Circuit diagram for the complete digital lock

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.

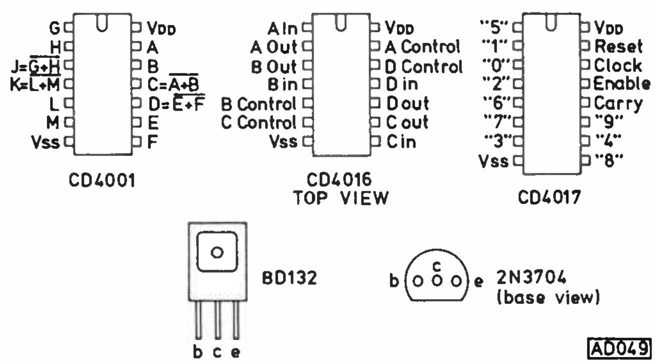
If a keyboard is available, with more than 12 keys, the remainder can be wired to the "reset keys" input on the p.c.b., thus effectively increasing the number of combinations available. Indeed as few as five keys could be used, with only one key connected to the "reset keys" input, the number of different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

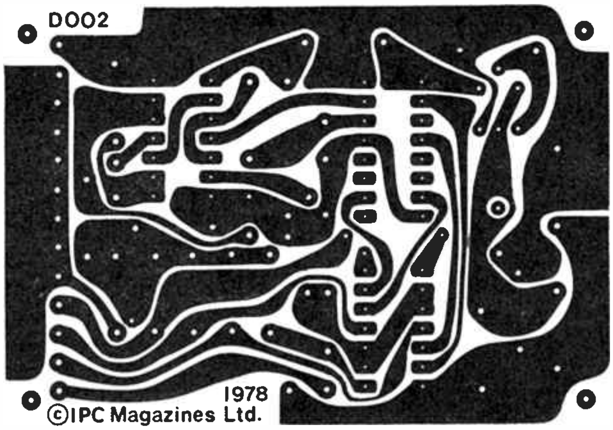
The other components are non-critical: almost any silicon diodes can be used, and most silicon transistors will suffice for the output stage, although the current rating of Tr2 should be well in excess of the load current of the solenoid.

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



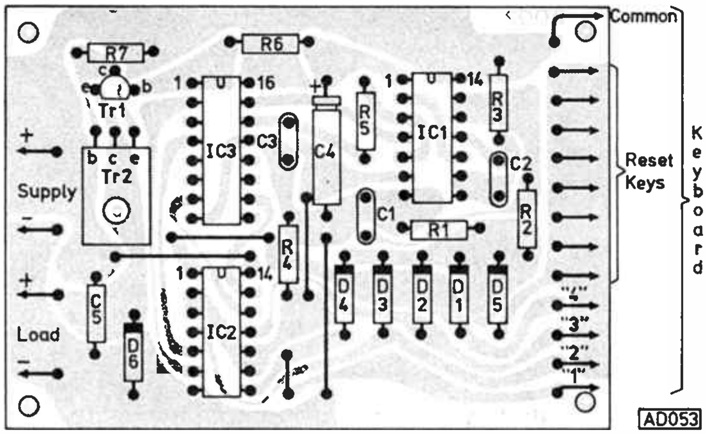


Fig. 3 (above): PCB viewed from the copper side. This board is available from the PW Reader's PCB Service

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.

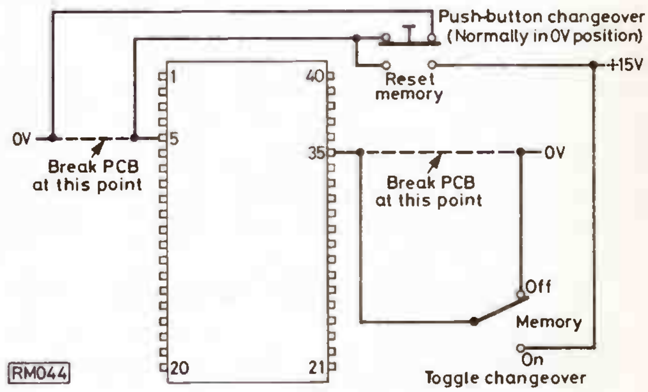
(2) November 1977, p 509. The circuit diagram of the accompaniment section shows the base of Tr5 connected to the 12V positive rail. This connection should be broken, leaving the base of Tr5 connected to the free end of R44 (1MΩ) only. The p.c.b. provided via Reader's PCB Services is correct.
The end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

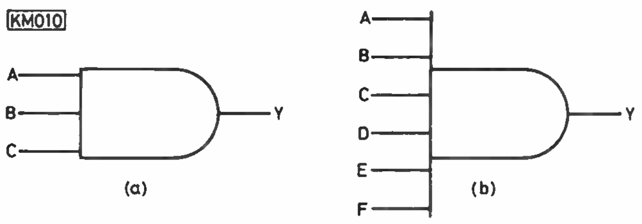


Fig. 5: AND gate symbols

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.

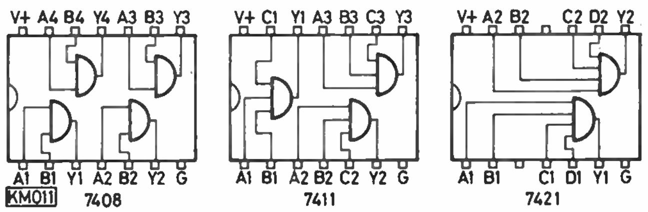


Fig. 6: Some actual TTL AND gates

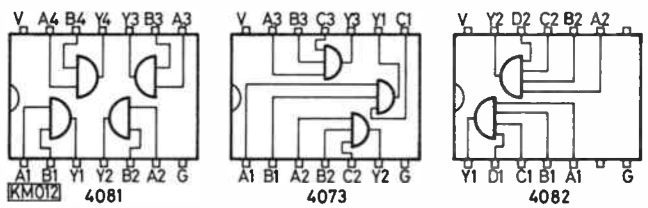


Fig. 7: Some actual CMOS AND gates

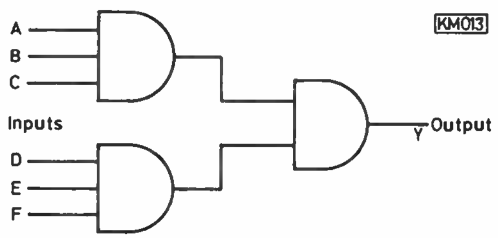


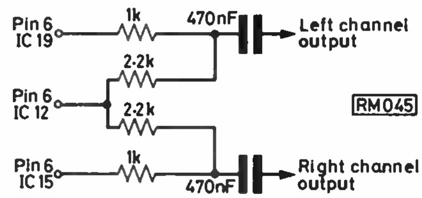
Fig. 8: Cascading AND gates to provide more inputs

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.

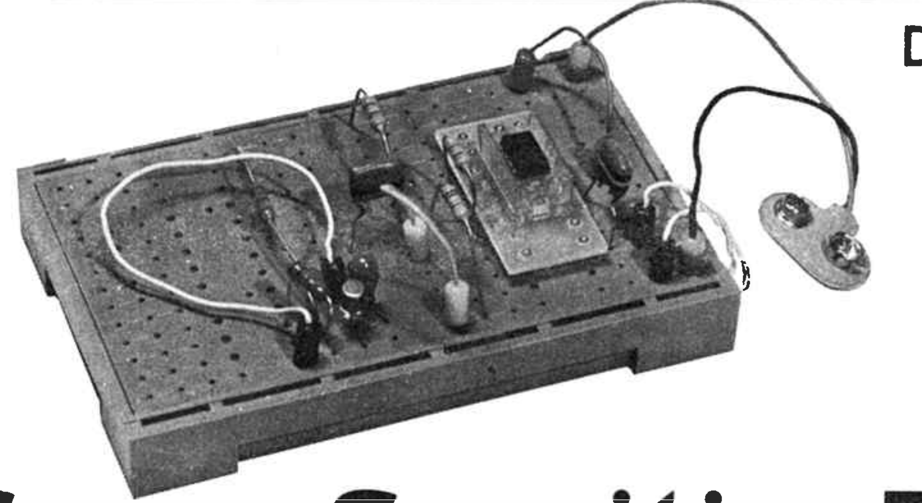
C24 should be connected to the tap on L2, not as shown in the circuit diagram (the printed circuit board is correct).

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.

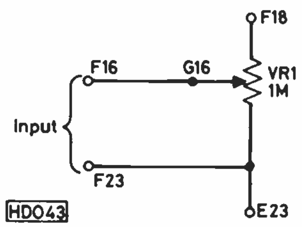


Fig. 2: Connections and hole numbers for the inclusion of a suitable volume control

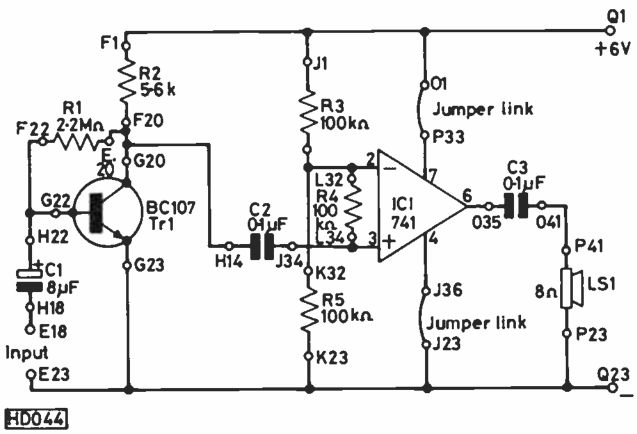


Fig. 1: Main circuit diagram including preamplifier

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

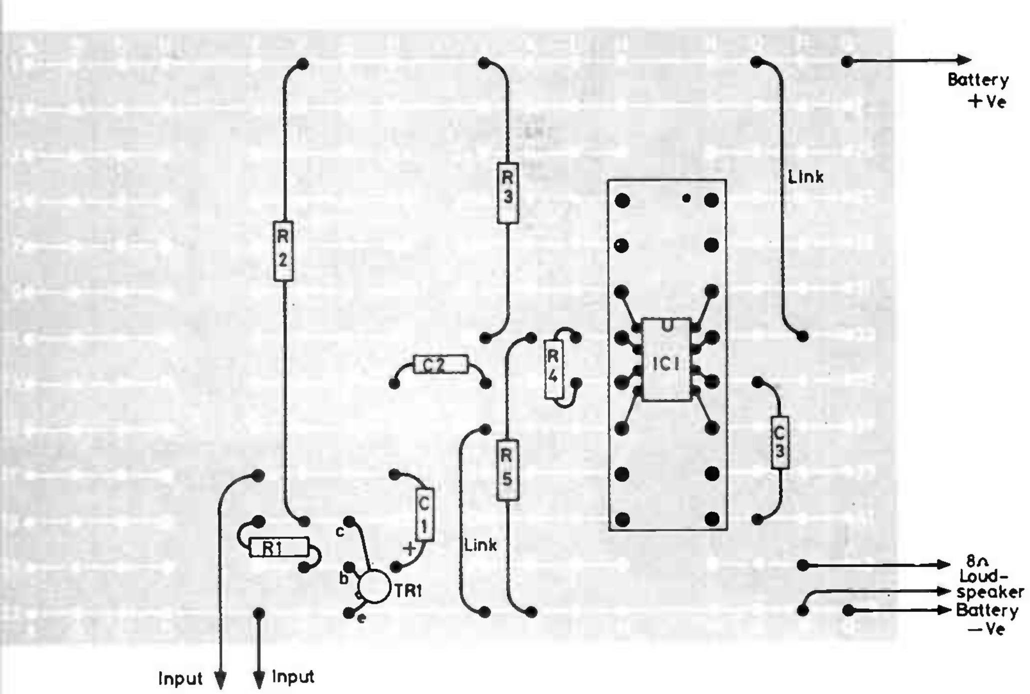


Fig. 3: The µDeC Layout of the "Super-Sensitive Fuzz"

required to guess what was being said (not easy when this unit is set for full fuzz).

The unit could be made completely portable with its own 12V battery. With 12V applied, the total current drawn by the circuit was barely 1mA quiescent. With speech going through this rose to average 2mA max so battery life would be very long.

If 12V is used it would be prudent to use a variable potentiometer, the input would then be connected between the slider of the pot and µDeC hole E23. (see Fig. 2).

The input and output blocking capacitors gave a degree of control of the sharpness of the sound—one hesitates to use the word "tone". The value of C1 specified gave reasonable results. Increasing it (more microfarads) gave more bass and less treble. Reducing it (down to 0·1µF) increased the top or treble considerably. Similarly one can try different values for C3. One could even switch in two or three values at C3 to give a built in control over the "bassiness" of the fuzz.

Just one word of warning before any fuzz fanatics start connecting the circuit up to external equipment. It would be dangerous to connect this circuit to cheap record players which might be live to the mains.

If you do connect it to a tape recorder, or amplifier (or whatever) it would be sensible to include 0·1µF (400V working) capacitors in all leads to and from the equipment.

The circuit has been tried with a battery tape recorder and worked well and with a hi-fi system. A radio signal from a simple diode tuner also gave acceptable results. An amusing exercise is to tune in to Radio 4 and listen to the news with the fuzz circuit connected: and then try to guess what the news was!

The component values are standard and easily available from advertisers in *Practical Wireless*. While most are uncritical it is suggested that they be adhered to until the circuit is made to work. Almost any transistor will work and those tried include the BC108 and BC109, 2N2926—but be careful that the lead connections are correctly identified. The BC107/8/9 are all the same and so no problems should be encountered.

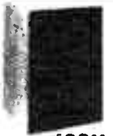
★ components

Resistors
- R1 2·2MΩ
- R2 5·6kΩ
- R3 100kΩ
- R4 100kΩ
- R5 100kΩ

Capacitors
- C1 8µF/12V electrolytic
- C2 0·1µF
- C3 0·1µF

Semiconductors
- IC1 741 Op amp
- Tr1 BC107

Miscellaneous
- LS1 8Ω loudspeaker
- One µDeC A
- One µDeC DIL holder
- µDeC jumper leads
- 6V or 12V battery



EASY BUILD SPEAKER DIY KITS

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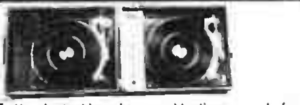

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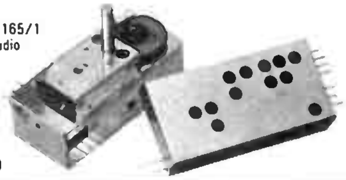

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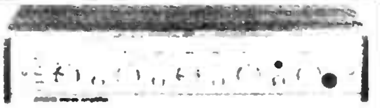

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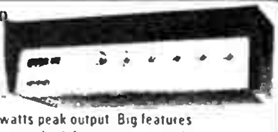

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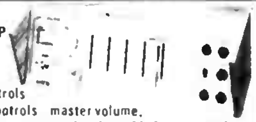

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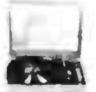

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ON THE AIR

AMATEUR BANDS

by Eric Dowdeswell G4AR

Some readers of this column may have become a little irritated at the frequent mention in the last few months, without explanation, of sunspot activity coupled with the increased action on the 10m (28MHz) band. So, let's try to account for this interesting phenomenon.

Sunspots and flares involve the release of vast quantities of energy from the surface of the sun which, radiating outwards, reach and ionise the outer layers of our atmosphere. Given sufficient ionisation these layers can then act as reflectors for radio signals that reach them from Earth. The principal layer that concerns us is the outer E layer.

With little or no ionisation, signals on the 10 and 15m bands tend to penetrate the E layer and be lost in space. As *Solar Event* on page 65 of the May issue of *PW* showed clearly, sunspots are increasing rapidly in number and in activity so that signals at the higher frequencies are now being returned to earth. In many cases the signal is then reflected up to the E layer, bounced down again, to give multi-hop worldwide paths.

Band I TV signals around 45MHz are already being received in southern Africa mainly due to a form of transequatorial propagation (TE). A similar north-south path can often be noticed on the 10 and 15m bands when ZS and ZE stations can be heard and worked from Europe to the exclusion of signals from other directions.

The effects of the daily, monthly and annual changes in propagation conditions may be fairly well known to the SWL but there is an eleven-year cycle of change that will not have been experienced by those taking up the hobby in fairly recent times. When the number of sunspots occurring is plotted against time, in years, it is found that the peaks repeat at roughly eleven year intervals, although the amplitude of the peaks can vary considerably.

We are now getting out of the sunspot doldrums of the early 1970s, when minimum sunspot activity favoured the lower frequencies, and into a period when working worldwide DX with a bit of wet string for an aerial will be no more difficult than making a local telephone call! With heavy ionisation the F layer can remain an effective reflector long after local sunset.

Remember that a half-wave aerial is only about 16ft or so on 10m, so a simple beam is not impossible in the tightest situation. With electrical loading the "wingspan" can be reduced even further. More importantly, a beam gives discrimination against signals off the back of the beam, which can be very worthwhile in the heavy QRM that is bound to accompany the increased use of the 10m band.

Newcomers

Tom Hillier of Paignton was staggered at the help and information he received from readers following his appeal in this column for info on the B40 receiver. "Real service here and a grand lot of chaps. I replied to each one by return post." So, Tom, I hope that you soon get settled down on the bands and start to send logs in on the rare DX.

From Wilmslow, Cheshire, **Steve Turner** BRS37620 sends his first letter although he has been reading *PW* for some time. He has a surplus R208 and inverted "L" aerial but confesses to occasionally listening on his dad's Trio 9R59DS. **Bill Land** of Cheltenham is a newcomer to this column but not entirely to radio. He is BRS34761 and at 73 can't get around too well nowadays. He has an Eddystone 750 and Trio 9R59DS that he'd like to swap for an S27, with adjustments, so if you can help, write to Bill at 7 Wellbrook Road, Bishop's Cleeve, Cheltenham.

Readers' News

A determined character is our **Brian Smith** of Barry, Glam. as he intends to enrol for an RAE course in September and take the exam in December! With the best will in the world OM I think that this is unwise. As I have said before, the RAE and expenses mean a lot of money and one must be reasonably sure of passing before taking the exams. Next May would be much more realistic. Brian's present project is the DXer's audio filter in the May *PW*.

Nice to hear from **Brian Hughes** in Worcester, again. His FRG7 has been patrolling the bands fed from dipoles and a 66ft wire. He found 10 and 15m very good listening all through March. G4GOF conceals the identity of **Jess Luxton** (Bergheim, Battery Hill, Fairlight Cove, Hastings) who writes to express his gratitude to all those who helped him to pass his Morse test. He'd be glad to QSL any reports on his 80m c.w., enclosing an s.a.e., to his QTH given here.

Another FRG7 enthusiast, **John Whiting** of Fareham, Hants, has a 135ft wire and is now BRS40086. Having told him that ZA is just about the rarest thing going he reports hearing ZA6KB on 14285kHz s.s.b! I hope you're right OM! **Bob Bell** in Blyth, Northumberland has actually been digging around inside his FRG7 putting one or two things right! Bang goes the guarantee!

David Greenhalgh BRS39965 (Poynton, Cheshire) and **John Hodgson** (Morpeth, Northumberland) both ask for guidance on the "rare" calls that I am always asking for in logs. Well, I do have a list and I'll publish it next month. In the meantime John seems to be doing pretty well already on all bands from 160 to 10m. He was not caught by AP1RIL however! Chaos! reports **Peter Cockerell** (Leigh-on-Sea, Essex) and other readers on the Clipperton Island DXpedition. Very rare indeed, so hardly surprising. Once the frequency is known it is a good idea to listen an hour or so before conditions peak for our area and thus avoid some of the QRM.

Club News

Blackwood & District ARS GW6GW is pleased to see the extra pages being allocated to "On the Air". Dates to note:— June 9th Gwent TV Group talk and demo, June 16th TVI by GW3NWS and June 23rd visit to BBC TV Cardiff. RAE class every week with meetings at Oakland Community College, near Blackwood, Gwent, 1930 on Fridays.

Don't forget the **Stevenage & District ARS** first and third Thursday 2000 at Hawker Siddeley Dynamics staff canteen. Code classes start half an hour earlier, with RAE course at local college. June 15th sees G4DDX talking on DF receivers.

Log Extracts (s.s.b.)

P. Cockerell:— 20m C5ABC (Gambia) CE0AE CO2GS FP0BC HC1BU HP1A HL9KL KG6SW PY0FN TR8GM ZL4LR/A (Campbell Is).

J. Hodgson:— 80m EA8ER EP2TY **40m** VK7AZ **20m** TR8AF VP2LLL VP8PU ZD8RP.

J. Whiting:— 20m HC2HM J3OH (Grenada) M1D TR8ACQ ZK2AT **10m** VP8PM ZF1JJ.

B. Hughes:— 20m J3AH VP2KT WD9FCC/VQ9 5U7AG **15m** EP2SI JA8GLP ZBC2J **10m** A2CBW KZ5JW 5T5KJ.

S. Turner:— 20m JT1BK JY9VK.

B. Smith:— 80m HC1WAS HK3BQM HV3SJ **20m** TR8GM.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:-

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport, PR8 3JG. Reports for both bands **must** be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

Every now and again a well established Radio Amateur on reading *Practical Wireless* comes across *Medium Wave DXing* and he decides to "have a go" on this band as a diversion from his normal activities. The results if reported to this column are invariably interesting and the report from **Ken Hurrell** G3NBC of Sturminster in Dorset is no exception. Using a Marconi Gannet marine receiver along with an 80ft horizontal wire aerial about 15ft above the ground he pulled in 9 Canadian and 22 US stations between 2300 and 0300GMT during the past winter months. Highlights of the log are WSM Nashville Tennessee on 650kHz, CBF Montreal 690, WLW Cincinnati 700, CBL Toronto 740, WBBM Chicago 780, Schenectady NY 810, KMOX St Louis 1120, WOAI San Antonio Texas on 1200. Ken remarks that in some cases the time of reception depended on the closing down of European stations. There were also a number of stations which could not be identified due to fading, QRM, etc—the real DX! With both WSM and WOAI reception was such that it was possible to listen to a complete programme and both stations verified with a QSL card. During DX conditions CJYQ, WINS, and WABC were listened to as regular programmes.

The interesting feature of this log is the fact that several rather difficult stations were heard using a long-wire aerial, due no doubt to picking the right time and skill in handling the receiver. Medium wave DXers invariably use a loop aerial to take advantage of its directional effect which reduces QRM and static. During DX conditions, i.e. when the path is open, some strong signals can be heard from North America, strong enough occasionally to be heard on a transistor portable using its internal aerial. The following night there may not be a North American to be heard with any type of receiver or aerial. The experienced DXer is aware of this, but the newcomer is often discouraged if he cannot hear DX on a first or second attempt. Patience and persistence are the qualities required in a medium wave DXer. Even at this time of year you can hear North America during DX conditions. Try it during the hour before sunrise; you may be surprised.

Loops and Wavetraps

A letter from **E. G. Oxtoby** refers to the *PW* Medium Wave Loop Aerial Wavetrap, which confuses two quite different pieces of equipment. A medium wave loop is a directional aerial and is used to pick up DX instead of an ordinary aerial. A wavetrap is not an aerial. It is a device, comprising a parallel tuned circuit, which is inserted between aerial and receiver to suppress or reduce the strength of a local station. Wavetraps are seldom used these days as receivers are now more selective than they used to be, but one could be of

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PW 7

use if the DXer lives near a broadcasting station. The Aerial Tuning Unit is another device that is sometimes confused with a loop. The a.t.u. matches an aerial to a receiver and a good match means maximum transfer of signal. An a.t.u. is unsuitable for use with a loop.

Ferrite Rod Aerials

"Would it be possible to make up a type of ferrite rod aerial in a box, on a swivel or something for use with the FRG7?" asks **Bob Bell** of Blyth who continues to say that he does not have a medium wave loop and a ferrite rod would be much handier size-wise. Yes, it is possible, I tried it several years ago using a $\frac{3}{8}$in diameter ferrite rod, 8in long, with 60 turns close-wound as the main winding and six turns for the coupling winding. The tuning capacitor was about 300pF. The results were disappointing as the pick-up was a lot less than from a standard 40in loop, though I did manage to hear WWL New Orleans 770kHz using this aerial and an R1155 receiver. Pick-up depends on the number of turns and the effective cross-sectional area enclosed by the windings, and a marginal improvement will be obtained by spacing the turns on the windings. The reduction in self-capacitance of the windings enables additional turns to be wound on.

At that time a DXer in the United States got hold of a mammoth ferrite rod one inch in diameter and 12in long, and he achieved quite good results with it. The largest rod I could find was $\frac{5}{8}$in diameter and 8in long. Two of these rods were used with a 10in length of Paxolin tubing of $\frac{5}{8}$in internal diameter. A rod was inserted into each end of the tubing so that they met in the centre. The rods were fixed to the ends of the tubing by adhesive so that the two ends inside the tubing were pressed hard against each other. Fortunately they were a tight fit. The main winding comprised 150 turns of plastic covered wire wound on top of the tubing, spaced at approximately one wire diameter and was tuned with a 330pF variable capacitor and slow motion drive. A coupling winding of 10 turns was led off to the receiver. The results were quite encouraging. The main advantage of this aerial was the high *Q* and consequent good selectivity, but the pick-up was still less than from a loop. The aerial was mounted on a small stand and was very convenient to use but it was rather top heavy and easy to topple over. A small loop would give as good results and would be a lot easier to make though the experimenter may find ferrite rods an interesting diversion.

Receivers

Experimenting of a different kind being done by **Derek Taylor** who has obtained a second-hand Barlow Wadley XCR30 and is making comparative tests with his FRG7, on the medium waves. He says "The receiver is very good on medium waves, especially when used with a loop, and in fact seems to be far more selective than the FRG7". It is interesting to note that these two receivers are reviewed in the 1978 edition of the *World Radio and TV Handbook* and the XCR30 is given "Good" for selectivity but "Poor" for overall performance on the medium waves. The corresponding rating for the FRG7 was "Fairly Good" and "Fair". These tests are of course subjective and one man's meat etc seems to apply to receivers in the DX world. Both the XCR30 and the FRG7 yield good logs for reporters to this column but it is interesting to compare results when the opportunity arises. To be of any value though, the two receivers should be checked for proper alignment, as they should be in any event when used for serious DXing.

Logs and News

Derek Taylor's log with FRG7 and loop includes Radio St Lucia 600kHz at 0110, WLW Cincinnati 700 at 0215, Ougadougou 746 at 2355, WJR Detroit 760 at 0216, WGY Schenectady 810, WCFL Chicago 1000 at 0345, Radio Lighthouse Antigua on 1165 at 0119. **James Edwards** who lives near Wigan, used the *PW* m.w. loop with his Realistic DX160, and between 0100 and 0300 he pulled in CFRB Toronto on 1010kHz, KDKA Pittsburg 1020 and WCAU Philadelphia 1210. **G. Cox** of Dudley reports that MEBO 2 is no longer on 773 but has moved to 908kHz. The current situation about this ship-borne radio in Libya is confusing. *Sweden Calling DXers* reports that this station and the Voice of Peace are both off the air but that MEBO 2 is expected to resume broadcasting before long.

BROADCAST BANDS

SHORT WAVE BROADCASTS

by Charles Molloy G8BUS

Peter Gatehouse of Buckingham mentions that the tree to which his long wire was attached blew down and he is now looking for a more suitable replacement. **Bill Stevenson** of Swinton had a similar experience though in his case it was the aerial that broke. An outdoor aerial should be anchored to a building or mast if this is possible, and in an exposed situation the mast should have guy wires or ropes to prevent it moving in strong winds. My experience indicates that it is not the effective part of the aerial, i.e. between the insulators, that breaks but the terminating wire between insulator and support. Thin nylon rope, which has a bit of "give" will help here.

It might be possible to put guy ropes onto the branch of a tree but the usual method recommended is to fit a pulley to the tree trunk, pass the terminal wire or rope over the pulley and fix a weight on the end of it. The idea is that as the tree moves in the wind the weight moves up and down taking the strain off the wire/rope. I have not tried it but it would be interesting to hear from any reader who has practical experience of this or any other method of using a tree instead of a mast.

"Does a 75 ohm screened feeder spoil the efficiency of a 300 ohm ribbon feeder dipole?" asks **D. R. A. Lowe** of Lichfield. Yes, there will be a mismatch loss at the resonant frequency of the dipole, though if the aerial is used at other frequencies it will not matter. Ribbon feeder with a characteristic impedance of 300 ohms is a convenient material with which to construct a folded dipole. A dipole incidentally, is a one-band aerial. Divide 468 by the frequency in MHz to get the length of the aerial in feet. A dipole for the 25m band for example would be 42ft long.

Cut a length of 300 ohm feeder to the correct length, bare the two wires at one end and solder them together and then do the same at the other end. Fit an insulator to each end and you now have the aerial. Find the exact centre of the aerial and cut one of the two wires at this point. The impedance here is 300 ohms. This is the place to join another length of 300 ohm feeder which will be the downlead and there will be a perfect match between downlead and aerial. The feeder is joined to the balanced (A and A1 or dipole) input to the receiver. If you want to use the dipole at other frequencies join together the two wires at the receiver end of the feeder and connect to the normal aerial socket and you will now have a "T" aerial.

11 Metre Band

Activity on the 11 metre band (25605-26095kHz) is stirring as broadcasting authorities realise that solar activity is on the increase. A recent report in *Sweden Calling DXers* referred to a programme in Afrikaans on 25790kHz at 2000 which was probably a test transmission from Radio RSA. It is worth watching this band during the daytime and reports, even if the exact frequency is uncertain, will be welcome, but watch out for harmonics. **Bob Bell** (Blyth) mentions hearing Italy on 25285kHz at 1540 and if the frequency is correct then very likely it is a harmonic. Other interesting loggings from the h.f. end of the spectrum in Bob's log are USSR on 23920kHz, 24040, 24120 and 24720 which may be harmonics and Israel on 25605 and the VOA on 26040, all heard during the afternoon. Bob would like to contact anyone in the Blyth area interested in forming a DX club. Write to Bob Bell, 5 Byron Avenue, Blyth, Northumberland NE24 5RN. Bob feels that there may be many people like himself "tucked away in their shacks all over the Blyth area".

DX

World International Broadcasters is the full name of WINB Red Lion in the USA. **R. Guest** has had difficulty in contacting this station which transmits in English, welcomes reception reports and "verifies" with a QSL card. Write to WINB, PO Box 88, Red Lion, Penna 17356, USA, which is the address given in the *Word Radio and TV Handbook*. From Selly Oak, Birmingham comes news of **R. J. Irvine's** DXing activities using an ex-WD R209 receiver and a 30ft long wire. He mentions that this receiver does not have an r.f. gain control. Why not fit an aerial attenuator as described last month? Stations heard included United Nations Radio (relayed by the VOA), Moscow Radio Ping Pong Station on 12160kHz at 1540 (does anyone have any information on this station?) Sri Lanka in English on 17850 at 1900 wedged between Family Radio and the VOA.

"What is a DXer" is the title of an interesting article in *RSA Calling*, Nov 1977/April 1978 issue. The article traces the progress of the newcomer from being a Novice Radio Listener through being a Radio Country Chaser, Programme Listener, Short Wave Listener, Reception Monitor and finally to being a DXer. Radio RSA is anxious to hear reactions to the article and ask for letters on this subject to go to DX Corner, Radio RSA, PO Box 4559, Johannesburg, RSA.

Nick Stewart (Dundee) writes to say that he is now a reception monitor for Radio Budapest and he reports regularly to this station on their nightly transmission on 6110kHz. This type of reporting can be of immense value to a radio station and many international broadcasters have a network of "monitors" across the world, who give a regular picture of the ever-changing reception conditions.

Radio Grenada on 15105 with a good signal at 2000 is reported by **Harold Emblem** from Mirfield in Yorkshire who uses an Eddystone 730 and long wire. This station was also heard by R. Guest who reports that it has a request programme from 2045 to 2200 on a Thursday. Radio Grenada is listed as being on 15105 with a power of 5kW with broadcasts to Europe between 1945 and 2200GMT. Two unusual items from the ISWC are Radio Tahiti on 15170kHz in English at 1900 and Bangkok on 9655kHz in English at 1100.

VHF BANDS

by Ron Ham BRS15744

The auroral co-ordinator for the British Astronomical Association, **Ron Livesey** writes "Both my own solar observations and information from professional circles indicate that this coming solar cycle is going to be a strong one". I agree Ron, it looks that way. Although the BAA have a good visual auroral detection network, stretching from ships in the north Atlantic, through Britain, across Norway and Finland to the Russian border, their observations are limited to the hours of darkness, and then to clear skies.

We radio enthusiasts can therefore use our equipment, unrestricted by overcast skies, to help gather that wealth of natural information which will undoubtedly come over the next few years. To this end, both **Graham Knight**, GM8FFX, my opposite number in *Radio Communication*, and myself are co-operating with **Charlie Newton**, G2FKZ, RSGB Auroral co-ordinator, and Ron Livesey to ensure that the utmost value is gained from our readers' reports.

The "Active" Sun

Solar radio noise was recorded at 136MHz by **Cmdr Henry Hatfield**, Sevenoaks, and myself, and at 142MHz by **John Smith**, Rudgwick, Sussex, on about 15 days between March 23rd and April 18th compared with only one day for the same period in 1977. Large bursts of noise, some lasting several minutes, were received on March 26th and 27th and April 1st, 7th, 8th, 9th, 10th, 11th, 13th, and 18th, of which two were spectacular; at 1200 on the 9th I watched my radio telescope record a six-minute burst at 95 and 136MHz and heard the noise on other equipment working simultaneously on 28 and 50MHz. **Alan Baker**, G4GNX, Newhaven, heard this burst overpower terrestrial signals on 144 and 1·8MHz. During the early afternoon of the 11th, Henry Hatfield recorded two massive bursts which he associated with a bright ribbon flare, several baby flares and an ugly black filament which he saw on the sun with his spectrohelioscope. On this sunny April day there was 6 inches of snow in Henry's garden.

At 0730 on the 13th I heard strong bursts of solar noise on 10m with a long wire aerial feeding my FR101 and at 6m with a dipole into my R216. For several days Henry watched the progress of two sunspot groups and was not surprised when a radio noise storm raged from the 14th to the 18th, during which time G4GNX and myself heard this noise on several radio frequencies.

The 10 Metre Band

With solar particles battering the earth's atmosphere it was not surprising that radio blackouts and ionospheric disturbances, affecting the h.f. bands, were reported on April 5th, 11th and 14th by **Barry Ainsworth**, G4GPW, Sompting, Sussex, Alan Baker, **Roy Bannister**, G4GPX, Lancing, Sussex, the BBC world Service, the *Daily Telegraph* newspaper and **Dr Harold Brodribb**, St. Leonards-on-Sea. **Neil Clarke**, BRS 34306, Knottingley, Yorks, listens on 10m with a Yaesu FRDX400, fed by a TA32 beam at 25ft a.g.l., and like many of us he monitors the Cyprus, 5B4CY, and project TESSA, ZE2JV, beacons both of which he received almost daily throughout March.

On the 18th, G4GNX heard AA4AA, the first of the new American call-signs, strong signals from PY, RA, VU, and also worked two Russian stations on s.s.b. Between 1234 and 1858 on the 25th, Alan reported 589 signals from 5B4CY and had s.s.b. contacts with a K2, 2 UA6s, and 3 Ws. Both **Gordon Goodyer**, BRS 37345, Petworth, Sussex, and myself observed the excellent conditions on the 26th; around 1600, Gordon, using his Eddystone 750, heard strong signals from Africa, Europe, the Middle East and South America. Meanwhile at 1436 stations from North America were pounding in at my QTH and the beacon signals from Bahrain, A9XC, Florida, N4RD, ZE2JV, and 5B4CY were averaging 579. This same group of beacons were heard again at midday on April 9th and in the space of six minutes, from 1005, I heard a VK work OE, OH, PA0 and YU giving them reports of 57 and 59. JAs and VKs were again heard at 1000 on the 31st, and at 0850 on April 7th I received a 59 signal from JA8RUZ calling European stations from northern Japan.

Conditions were good on April 8th, 9th and 10th when strong signals were frequently received from the regular beacon stations, and on the 10th, **Nigel Golds**, BRS 36910, West Chiltington, Sussex, heard a 488 signal from the German beacon DL0IGI. Around 1830 on the 8th, Gordon Goodyer heard Ws 1, 2, 3, 5, 8, 9, and signals from Tanganyika to South America and Canada. On the 9th, he heard the Mauritius beacon, 3B8MS and signals from British Honduras, Brazil, Cyprus, Portugal and the USSR, while G4GNX, at 1445, worked WD4LBI on c.w.

Auroral Propagation

Between 1719 and 2015 on March 26th, **John Branegan**, GM8OXQ, Saline, Fife, had auroral contacts on 2m with GM8NCW, Fife, G8LVM, Stoke, G8BHH, Wolverhampton, and heard EI6AS on s.s.b., and DL, LA, and SM on c.w. At 1945, the radio aurora eased off and John said "we were treated to one of the finest visual aurora I have ever seen which started as a bright yellow-green band along the northern horizon and by 2000 had added a great stream of bands right up the northern sky and over my head to the south".

During a less intense event between 1656 and 1900 on the 27th he heard signals from DL, EI, GI, GW, and PA. This report fits nicely with the solar activity on the 26th and 27th and the 24-hour ionospheric disturbance reported by the BBC World Service on the 27th. At 1818 on April 4th **Dermot Cronin**, G4GRO/EI9DC stationed at the *Royal Sovereign* in the English Channel, heard GM8FFX, at 42A on s.s.b. Around midnight on April 11th/12th, **Mr McDonald**, seven miles east of Oban, saw an aurora which was mainly a white glow, with some movement, and indistinct beams.

OSCAR-8

Vic Hartopp, G8COB, Northampton, listened to the first few days of OSCAR-8's life and John Branegan worked out his own orbital parameters after the first three orbits, and has followed the satellite on all modes since. On March 19th, John's first OSCAR-8 QSO with PA0KT was spoilt by rapid fading which he thinks was due mainly to his horizontally polarised aerial. Since changing to a circularly polarised 2m helical he has worked several stations.

John has now built an OSCAR-8 plotter and contributes information to the Scottish AMSAT net, organised by GM8BKE, on Sundays at noon, 144·28MHz. "As yet", says John, "not many stations are using OSCAR-8. Reasons are—continuous high Doppler shift—the receiver must be tuned continuously to hold s.s.b.—the need for circular polarisation on the up-link, and on Mode J, the difficulty of reading the very weak down-link signal".

Readers' Equipment

Neil Clarke uses a 6-element beam at 30ft a.g.l. for 2m DX listening, and for the repeaters, he has a Lowe VHF Monitor receiver, AJV1515, with a ground-plane aerial at 35ft and a $\frac{5}{8}$-wave Mag Mount on his car. Harold Brodribb is building a tuner for the 6m band ready for the sporadic-E season and Gordon Goodyer is considering using a m.o.s.f.e.t. pre-amp in front of his CR100. **Frank Luman**, Glasgow, has added a $5\frac{1}{2}$in JVC TV set which tunes through Bands I and III and u.h.f., to his DXTV gear, and for the same reason I have installed a JVC 3060, $2\frac{1}{2}$in TV receiver tuneable through the European Channels 2-4, 5-12, and 21-69. **Denis Sullivan**, Chiswick, now has a new National Panasonic RF-2000 in addition to his Trio QR666.

Overseas DXers Visit BBC

One of our Swedish readers, Moritz Saarmann, on holiday with two friends, Håkan Holmlund and Jan-Olof Karlsson, visited the headquarters of BBC World Service at Bush House, London, on March 21st.

All three are SWL members of Radio Club Tellus, near Mölndal, just south of Gothenburg, which has its own amateur station, SK6IQ, comprising a Swedish receiver, similar to the Hammarlund Super Pro, a much modified R208, and a Heathkit SB102 transmitter. The club, where some twenty members meet weekly, uses all bands and runs courses on DXing for beginners, c.w. and a variety of technical subjects.

At home Moritz uses a Drake SW4 on the h.f. bands, a Hallicrafters SX42 (500kHz to 108MHz), for part of the v.h.f. bands and a Dynaco FM5 stereo for Band II. His aerials are dipoles for both h.f. and v.h.f. and a long wire. Håkan and Jan-Olof use long wire aerials feeding an Eddystone 960 and a Kungs domestic receiver respectively. Hakan, who also has a Hallicrafters SX18 and a Pioneer stereo which he uses on Band II, is Deputy Secretary General of the Swedish DX Federation, whose annual meeting, the traditional DX Parliament, will be held from June 9th to 11th this year.

While at Bush House the three visitors were studio guests for a recording of a World Radio Club letters programme, with Peter Baresby, Mark Deutch, Henry Hatch and the Author.

Tropospheric Openings

At 2110 on April 7th, Frank Luman received a picture from NRK, Oslo, Ch.E-6, and during the following evening he watched RTE, Dublin. Conditions on v.h.f. fluctuated frequently during early April; on the 3rd, **Garry Hibbert**, G8HXB, Portslade, Sussex, heard repeaters GB3BC, BM, and PI while static on Devils Dyke, Brighton; at 0142 on the 5th G4GNX heard a GW8/M working through GB3LO and at 1555 on the 9th he had a s.s.b. contact with G8KHD/P who was running 10 watts from a Liner-11 in Buxton. **Brian Fenwick**, G8BTC, Brighton, heard both GB3BC and FZ1THF on R6 during the evening of the 8th and FZ3THF, R4, on the 9th. On the 17th, **Keith Smith**, G3TLB, Crowborough, heard ON0OV on R4 and Dermot Cronin heard a GU direct at *Royal Sovereign*.

Nigel Hewitt, G8JFT, used his Uniden 2m rig and a ¼-wave ground plane to work locals and the West Country from his bedside in the Royal Sussex County Hospital, Brighton, while recovering from appendicitis. We all hope that Nigel will be fully fit and that conditions are good for the RSGB VHF National Field Day and SWL contest on July 1st and 2nd.

Thanks again for all your interesting reports; there is a lot happening so let me hear from you soon.

VHF PERSONALITY

JOHN BRANEGAN ***by Ron Ham***

One of John Branegan's earliest memories of home is listening to *Chidrens Hour*, on a 3-valve straight set, built by his Father around 1933 from what he thinks was a design by F. J. Camm in *Practical Wireless*.

John, born in 1927, moved to Woolston, Southampton, in 1935, where his Father was involved with the building of Spitfires, and in 1938, at the age of 11, he became an SWL when he first heard American short-wave stations on his Father's new Murphy superhet. In 1943, John left the King Edward VI Grammar School, Southampton, and joined the Royal Navy as Electrical Apprentice transferring to Radio Artificer before completing his training.

On his first ship, the aircraft carrier *Illustrious*, John had charge of two v.h.f. radars and rooms full of v.h.f. communications equipment. Later, while serving in the Mediterranean and in particular at a shore wireless station in Malta, he became interested in propagation. Meanwhile he passed the City and Guilds final in telecomms, and in 1953, while serving with submarines, he took the examination for a Commission. In 1954, John became a Sub-Lieutenant and joined a frigate for service in the Far East which was interrupted by a spell at Heriot Watt, Edinburgh, where he obtained graduate qualifications for IERE.

In 1963, he began training for nuclear submarines where he served until he retired in 1977 having been promoted to Commander in 1973. At his present QTH, a bungalow, 360ft a.s.l. in Saline, Fife, he now spends all of his spare time on v.h.f. with a special interest in satellite work and propagation studies. For the h.f. bands he uses an FRG-7 receiver preceded by Microwave Modules converters for 2m and 70cm, in addition, a GEC receiver covers Band II f.m. and a much modified Pye TV is used for video DX. In his aerial farm are crossed dipoles for 10m, OSCAR down-link and CB, an 8-element rotatable Yagi for 2m DX, a 7-element fixed Yagi for 2m auroral studies, a home-brew 14-element parabeam for 70cm DX and OSCAR-7 and 2 fixed aerials for the 70cm repeaters GB3ML,, Central Scotland, RB10, and GB3ED, Edinburgh, RB14.

Commander John Branegan, now GM8OXQ, is a regular contributor to the auroral sections of the British Astronomical Association and the RSGB, and to my v.h.f. column, and is always pleased to meet any local radio enthusiasts who want help or just to have a natter.

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71	2	1	3·51	0·78
18	4	2	4·03	0·96
70	6	3	5·35	0·96
108	8	4	6·98	1·14
72	10	5	7·67	1·14
116	12	6	8·99	1·32
17	16	8	10·39	1·32
115	20	10	13·18	2·08
187	30	15	17·05	2·08
226	60	30	26·82	OA

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Prim 220/240V Sec 0-20-25-33-40-50V 20V-0-20V or 25V-0-25V available by connection to appropriate taps.

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103	1·0	4·57	0·96
104	2·0	6·98	1·14
105	3·0	8·45	1·32
106	4·0	10·70	1·50
107	6·0	14·62	1·64
118	8·0	17·05	2·08
119	10·0	21·70	OA

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Ref	VA (Watts)	£	P & P
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149	60	6·20	0·96
150	100	7·13	1·14
151	200	11·16	1·50
152	250	12·79	1·84
153	350	16·28	1·84
154	500	19·15	2·15
155	750	29·06	OA
156	1000	37·20	OA
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350	247	14·11	1·84
1000	250	41·78	OA
2000	252	54·25	OA

30 VOLT RANGE
Prim 220/240V Sec 0-12-15-20-24-30V 12V-0-12V or 15V-0-15V available by connection to appropriate taps.

Ref	Amps	£	P & P
112	0·5	2·64	0·78
79	1·0	3·57	0·96
3	2·0	5·27	0·96
20	3·0	6·20	1·14
21	4·0	7·44	1·14
51	5·0	8·37	1·32
117	6·0	9·92	1·45
88	8·0	11·73	1·64
89	10·0	13·33	1·84

60 VOLT RANGE
Prim 220/240V Sec 0-24-30-40-48-60V. 24V-0-24V or 30V-0-30V available by connection to appropriate taps.

Ref	Amps	£	P & P
124	0·5	3·88	0·96
126	1·0	5·58	0·96
127	2·0	7·60	1·14
125	3·0	10·54	1·32
123	4·0	12·23	1·84
40	5·0	13·95	1·64
120	6·0	15·66	1·84
121	8·0	20·15	OA
122	10·0	24·03	OA
189	12·0	27·13	OA

AUTO TRANSFORMERS

Ref	VA (Watts)	Volts	£	P & P
113	15	0-115-210-240	2·48	0·71
64	75	0-115-210-240	3·95	0·96
4	150	0-115-200-220-240	5·35	0·96
67	500	0-115-200-220-240	10·99	1·64
84	1000	0-115-200-220-240	18·70	2·08
93	1500	0-115-200-220-240	23·36	OA
95	2000	0-115-200-220-240	34·82	OA
73	3000	0-115-200-220-240	48·00	OA

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500	15·73	1·64	67W
750	18·55	1·76	83W
1000	22·68	OA	84W
1500	26·02	OA	93W
2000	37·85	OA	95W

SCREENED MINIATURES

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212	1A, 1A	0-6, 0-6	2·85	0·78
13	100	9-0-9	2·14	0·38
235	330, 330	0-9, 0-9	1·99	0·38
207	500, 500	0-8-9-, 0-8-9	2·59	0·71
208	1A, 1A	0-8-9, 0-8-9	3·53	0·78
236	200, 200	0-15, 0-15	1·99	0·38
214	300, 300	0-20, 0-20	2·58	0·78
221	700 (DC)	20-12-0-12-20	3·41	0·78
206	1A, 1A	0-15-20-0-15-20	4·63	0·96
203	500, 500	0-15-27-0-15-27	3·99	0·96
204	1A, 1A	0-15-27-0-15-27	5·39	0·96
239	50	12-0-12	1·99	0·38
S112	500	12-15-20-24-30	2·64	0·78

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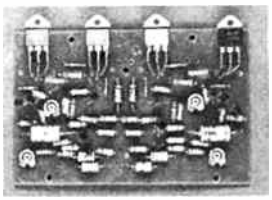

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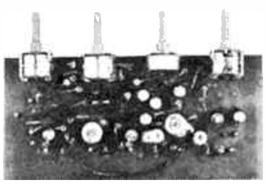

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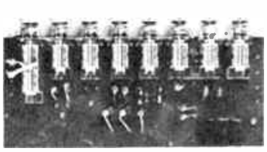

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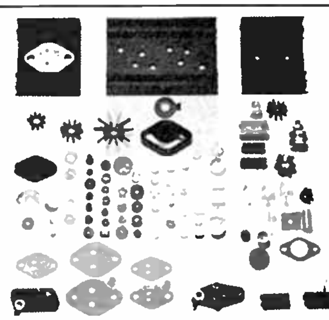

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BC173	0·15*
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OC71	0·45
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OC75	0·50
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2N698	0·30
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2N708	0·21
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2N1309	0·60
2N1613	0·33
2N1671	1·50
2N1893	0·33
2N2147	1·40
2N2148	1·65
2N2218	0·33
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2N2220	0·35
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2N2222	0·25
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2N2368	0·17
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2N3706	0·14*
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2N3710	0·14*
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ECL80†	0·60*
ECL82†	0·55*
ECL83	1·50*
ECL86†	0·65*
ECLL800	7·00*
EF37A†	1·60*
EF39†	1·60*
EF40	1·15*
EF41	1·20*
EF42	2·00*
EF50†	0·60*
EF80†	0·45*
EF83	1·75*
EF85†	0·50*
EF86†	0·45*
EF89	0·60*
EF91†	0·65*
EF92†	0·75*
EF98	1·25*
EF183†	0·50*
EF184†	0·50*

EH90	0·75*
EL32	1·50*
EL33	3·50*
EL41	1·25*
EL42	1·75*
EL81	1·10*
EL84†	0·45*
EL86†	0·50*
EL91	3·85*
EL95†	0·80*
EL360	2·75*
EM80	1·10*
EM81	1·00*
EM84	1·00*
EM85	1·25*
EM87	1·50*
EN91†	0·55
EY51†	0·75*
EY86†	0·50*
EZ40	1·25*
EZ41	1·25*
EZ80†	0·30*
EZ81†	0·35*
EZ90†	0·45*
GZ32	0·75*
GZ33	4·00*
GZ34†	1·52*
KT61	3·50*
KT66	4·50*
KT88	6·25*
KTW61	1·75*
KTW62	1·75*
KTW63	1·75*
MU14	1·00*
N78	7·50*
OA2†	0·45
OB2†	0·45

OC3†	0·45
OD3†	0·45
OZ4	0·75*
PC86†	0·85*
PC88†	0·85*
PC97	1·08*
PC900†	0·75*
PCC84†	0·45*
PCC88	0·65*
PCC89†	0·65*
PCC189†	0·65*
PCF80	0·96*
PCF82†	0·50*
PCF86†	0·85*
PCF87†	1·00*
PCF200†	1·05*
PCF201†	1·05*
PCF801†	0·55*
PCF802†	0·88*
PCF805	1·44*
PCF806	0·80*
PCF808	1·44*
PCL82†	0·50*
PCL83†	0·92*
PCL84†	0·50*
PCL85†	0·96*
PCL86†	0·50*
PCL805/85†	0·96*
PD500	3·60*
PFL200	1·12*
PL36†	1·12*
PL81	0·55*
PL81A†	1·12*
PL82	0·60*
PL83†	0·55*

PL84†	0·60*
PL504/500†	1·20*
PL508†	1·60*
PL509†	2·72*
PL519†	3·60*
PL801	1·10*
PL802†	3·00
PY33	0·68*
PY81†	0·72*
PY82	0·45*
PY83	0·60*
PY88†	1·18*
PY500A†	1·60*
PY800/81†	0·92*
PY801	0·92*
QQV02-6	9·60
QQV03-10†	2·00
QQV03-20A†	10·50*
QQV06-40A†	13·00*
R17	1·65*
R19	1·00*
R20	1·44*
U18-20	2·50*
U25	1·18*
U26	1·44*
UABC80†	0·50*
UAF42	0·75*
UB41	1·25*
UBC41†	0·75*
UBF89	0·50
UCC84	0·75*

UCC85†	0·50*
UCF80	0·75*
UCH42	1·20*
UCH81†	0·50*
UCL82†	0·50*
UCL83	1·44*
UF41	0·75*
UF80†	0·50*
UF85†	0·50*
UF89†	0·50*
UL41	1·00*
UL84†	0·60*
UM80	1·00*
UY41†	0·75*
UY85†	0·65*
1B3GT†	0·55*
1R5†	0·55*
1S5†	0·40*
1T4†	0·40*
2AS15	10·00
2D21†	0·80
3A5	1·35
3CX100A5	20·00
3S4†	0·75*
3V4†	1·00*
4CX250B	17·50
5R4GY†	1·00*
5U4G	1·52*
5U4GB	1·00*
5V4G†	0·85*
5Y3GT	0·85*
5Z3	1·50*
5Z4G	1·12*
5Z4GT	1·00*
6-30L2	1·00*
6AB7	0·75*

6AC7	0·75*
6AF4A†	0·70*
6AG7	0·75*
6AH6†	0·70*
6AK5†	0·30
6AK6	0·95*
6AL5†	0·30*
6AM4	2·30*
6AM5	3·85*
6AM6†	0·65*
6AN5	2·50*
6AN8A†	0·70*
6AQ5†	0·75*
6AR5	0·70*
6AS6†	0·80*
6AS7G†	1·50*
6AT6†	0·65*
6AU5GT	4·26*
6AU6†	0·55*
6AV5GT	3·74*
6AV6†	0·50*
6AW8A†	1·00
6AX5GT	3·10*
6B7	0·75
6B8	0·75
6BA6†	0·50*
6BA7	5·12*
6BA8A	3·75
6BC4	3·71
6BE6†	0·45*
6BH6†	1·20*
6BJ6†	0·80*
GBK4	4·21*
6BL6	85·00
6BL7GT	3·86*
6BN6	0·80*
6BQ7A	1·55*

6BR7	4·00*
6BR8†	1·20*
6BS7	4·00*
6BW6	3·75*
6BW7	1·12*
6BX7GT	4·96*
6BZ6	1·78*
6C4†	0·40*
6CB6A†	0·50*
6CD6GA	4·00*
6CG7	1·72*
6CH6	4·42*
6CL6†	0·75*
6CW4	4·72*
6D2†	0·30*
6DK6	2·49*
6DQ6B	3·04*
6EA8	2·21*
6EB8	2·12*
6EW6	0·80*
6F6	0·75
6F23	1·60*
6F28	1·60*
6H2N	0·75*
6H3N	0·75*
6H6	0·75*
6J4†	0·75*
6J6†	0·55*
6J7	0·75*
6K4N	0·75*
6K6GT	0·75*
6K7	0·75*
6K8	0·75*
6KD6	4·79*
6L6G	2·50*
6L6GA	1·50*
6L6GT	0·85*

6L6GC	1·75*
6L7	0·75
6N2P	0·75
6N3P	0·75
6N7	0·75*
6P25	3·60*
6Q7	0·80*
6R7	0·80*
6SA7	0·80*
6SC7	0·80*
6SF7	0·80*
6SH7	0·88*
6SJ7	0·80*
6SK7	0·80*
6SL7GT†	0·70*
6SN7GT†	0·70*
6SQ7	0·75*
6SR7	0·75*
6SS7	0·75*
6U5G	2·00*
6U8†	0·40*
6U8A†	0·55*
6V6GT†	0·60*
6X4†	0·45*
6X5GT†	0·55*
7B7	1·00*
7C5	1·75*
7C6	1·25*
7H7	1·00*
7R7	1·50*
7S7	2·25*
7Y4	0·75*
7Z4	0·75*
12AT6	0·45*
12AT7†	0·45*

12AU6	0·50*
12AU7†	0·45*
12AV6	0·60*
12AV7	2·84*
12AX7†	0·45*
12AY7†	0·82*
12B4A†	1·00*
12BA6	0·50*
12BE6	1·60*
12BH7†	0·60*
12BY7†	0·80*
12E1	4·00
30C15	1·20*
30C17	1·20*
30C18	1·44*
30F5	1·60*
30FL1/2	1·12*
30FL12	1·72*
30FL14	1·44*
30L1	0·84*
30L15	1·72*
30L17	1·72*
30P4	0·92*
30P19	1·12*
30PL1	1·32*
30PL13	1·72*
30PL14	1·68*
30PL15	1·72*
35W4	0·60*
50C5	0·70*
85A2	1·50
90AG	7·26
90AV	7·16
90C1	1·50
90CG	5·74
90CV	5·99
92AG	7·26

92AV	7·16
150B2	1·80
150C2	1·50
150C4	2·30
211	5·00
723AB†	8·00
807†	1·00
811A†	3·80
812A	7·25
813†	10·00
833A	30·00
866A	8·85
872A	11·40
931A	12·24
2050	2·50
5642	3·18*
5654	3·61*
5651	1·80*
5670	2·86*
5814A	2·60*
6080†	6·65*
6146A	5·12*
6146B	5·58*
6159	6·00
6442	15·00
6973	2·61
7586	6·79
7587	12·54
7868	2·93*
8068	5·50
8136	1·54

INTEGRATED CIRCUITS

7400	0·20
7401	0·20
7402	0·20
7403	0·20
7404	0·26
7405	0·23
7406	0·55
7407	0·55
7408	0·28
7409	0·28
7410	0·20

7412	0·26
7413	0·45
7416	0·40
7417	0·40
7420	0·20
7422	0·25
7423	0·35
7425	0·35
7427	0·35
7428	0·50
7430	0·20

7432	0·36
7433	0·37
7437	0·42
7438	0·37
7440	0·22
7441AN	0·92
7442	0·78
7447AN	1·20
7450	0·20
7451	0·20
7453	0·20

7454	0·20
7460	0·20
7470	0·35
7472	0·36
7473	0·36
7474	0·40
7475	0·59
7476	0·42
7480	0·60
7482	0·85
7483	1·00
7484	1·00
7486	0·40
7490	0·52

7491AN	0·85
7492	0·60
7493	0·70
7494	0·80
7495	0·80
7496	0·90
7497	3·67
74100	1·75
74107	0·45
74109	0·86
74110	0·57
74111	0·88
74116	1·89
74118	0·95

74119	2·00
74120	1·10
74121	0·45
74122	0·60
74123	1·00
74125	0·80
74126	0·80
74128	0·80
74132	0·80
74136	0·68
74141	0·85
74142	3·00
74143	3·00
74144	3·00

74145	1·00
74147	2·45
74148	2·00
74150	1·75
74151	0·90
74154	2·00
74155	0·90
74156	0·90
74157	0·90
74159	2·50
74170	2·60
74172	5·00
74173	1·75
74174	1·57

74175	1·00
74176	1·10
74178	1·65
74179	1·65
74180	1·65
74190	1·48
74191	1·48
74192	1·25
74193	1·25
74194	1·25
74195	1·10
74196	1·20
74197	1·00
74198	2·25

74199	2·25
76013N	1·75*
LM309K	1·50
TAA570	2·30*
TAA630S	3·50*
TBA480Q	1·84*
TBA520Q	2·30*
TBA530	1·98*
TBA540Q	2·30*

TBA550Q	3·22*
TBA560CQ	3·22*
TBA673	2·19*
TBA700	1·52*
TBA720Q	2·30*
TBA750Q	2·07*
TBA990Q	2·99*
TCA270Q	2·99*
TCA760A	1·38*

DIL Sockets

8 PIN	0·15
14 PIN	0·15
16 PIN	0·17

BASES

BG7 unskirted	0·15
B7G skirted	0·30
B9A unskirted	0·15
B9A skirted	0·30
Int Octal	0·20
Nuvistor base	0·55
Loctal	0·55
8 pin DIL	0·15
14 pin DIL	0·15
16 pin DIL	0·17
Valve screening cans all sizes	0·30

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2AP1*	8·50
2BP1*	9·00
3BP1	8·00
3DP1*	5·00
3EG1*	7·00
3FP7*	3·00
3GP1	6·00
3JP1*	8·00
3JP2*	8·00
3JP7*	10·00
3KP1*	15·00
3RP1*	35·00

4EP1	25·00
4EP7	25·00
4EP11	25·00
5ADP1	35·00
5BP1*	10·00
5CP1*	5·00
5CP1A	40·00
5FP15A	5·00
5UP7*	5·00
DG7-5	25·00
DG7-32	36·00
DH3-91	31·00
DH7-11	68·00
VCR97*	5·00
VCR138*	10·00

VCR138A*	12·50
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VCR517B*	6·00
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Handy size Reels & Dispensers

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Ersin Multicore Solder contains 5 cores of non-corrosive flux that instantly cleans heavily oxidised surfaces and makes fast, reliable soldering easy. No extra flux is required.

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handy solder dispenser

Contains 2.3 metres approx. of 1.22 mm Ersin Multicore Savbit Solder. Savbit increases life of copper bits by 10 times.

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For soldering fine joints

Two more dispensers to simplify those smaller jobs. PC115 provides 6.4 metres approx. of 0.71 mm solder for fine wires, small components and printed circuits.

PC115 69p

Or size 19A for kit wiring or radio and TV repairs. 2.1 metres approx. of 1.22 mm solder.

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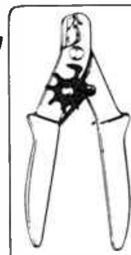

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Pot core unit, has six pot cores including one FX2243 (45mm) and two FX2242 (35mm) 3 TO3 sil. power transistors on heat sink, 3 2ohm panel fuseholders and panel with various transistors, diodes and a 5 amp plastic SCR, £1·75p plus 75p postage.

MOTORS, Model type 1·5–6 volts 20p, 'BIG INCH' sub min motor 115 vac, 3 r.p.m. 25p. 24 OVAC SYNCH. MOTORS WITH GEARBOX, 1/5 r.p.m. 75p, 1/24th r.p.m. 75p, 15 r.p.m. £1·20p, Crouzet 115 VAC 4 r.p.m. 95p.

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PAK D: 12 x BC109	£1*
PAK G: 7 x BFY51	£1*
H: 7 x 2N3819E FET	£1
K: 40 x 1N4148	£1*
M: 4 x pair 2A NPN/PNP	£1
PAK N: 50 x 0A81/91	£1
PAK P: 20 x P/BC109	£1
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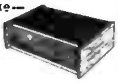

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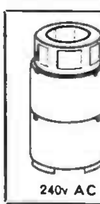

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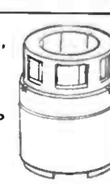

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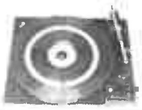

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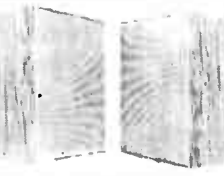

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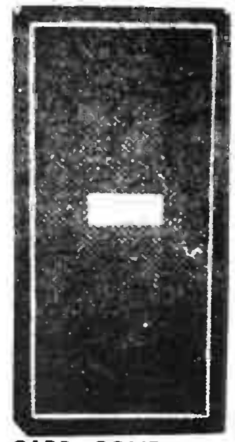

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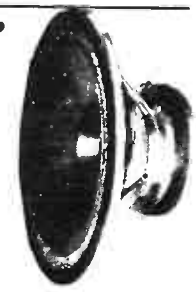

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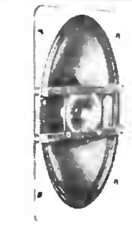

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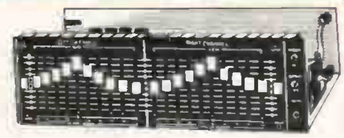

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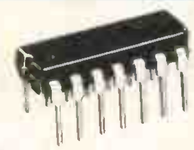

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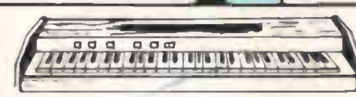

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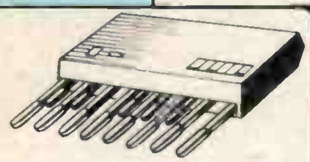

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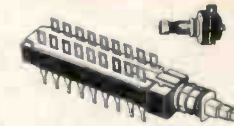

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