

PRACTICAL

ELECTRONICS

JULY 1974

25p

20+20

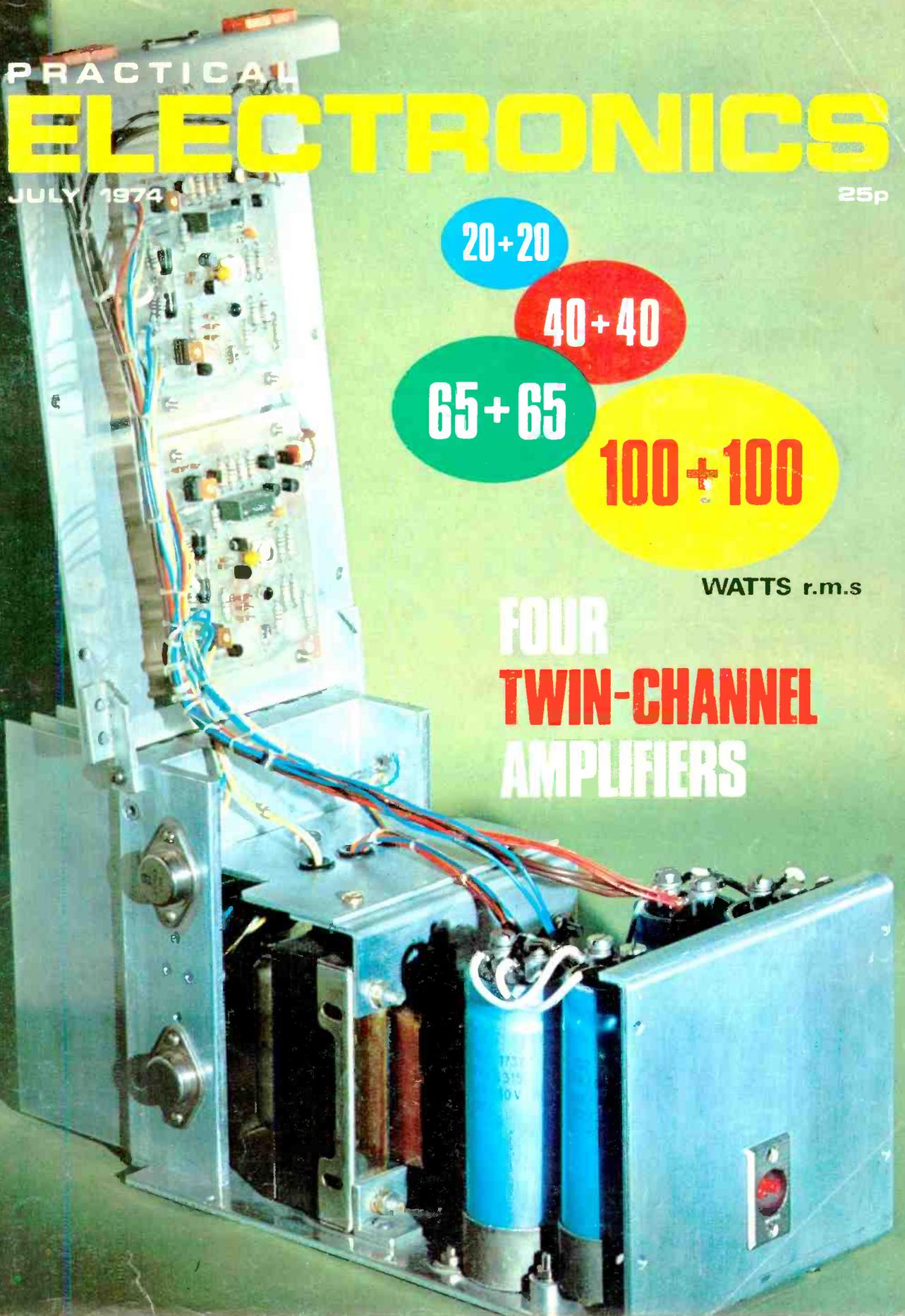
40+40

65+65

100+100

WATTS r.m.s

FOUR
TWIN-CHANNEL
AMPLIFIERS



NEW EDU-KIT MAJOR

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



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Components include:

- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN -PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal Radio
- One Transistor Radio
- 2 Transistor Regenerative Radio
- 3 Transistor Regenerative Radio
- Audible Continuity Tester
- Sensitive Pre-Amplifier
- 24 Resistors
- 21 Capacitors
- 10 Transistors
- 3 1/2 Loudspeaker
- Earpiece
- Mica Baseboard
- 3 1/2-watt Connectors
- 2 Volume Controls
- 2 Slider Switches
- 1 Tuning Condenser
- 3 Knobs
- Ready Wound MW/LW/SW Coils
- Ferrite Rod
- 6 1/2 yards of wire
- 1 yard of sleeving, etc.
- Parts price list and plans 50p (free with parts)

NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT

Nine Transistors, 9 Tunable wavebands, as Roamer Ten.

Built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors. 9 Transistors and 3 diodes. Tuning condenser with VHF section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wave change controls. Attractive all white case with red grille and carrying strap. Size 9 1/2in x 7in x 2 1/2in approx. Parts price list and plans 30p (FREE with parts).

£6-95 P.P. & INS. 44p
(+10% VAT 69p) (OVERSEAS P. & P. £1-85)



NEW EVERYDAY SERIES

Build this exciting New series of designs

EV5 5 Transistors and 2 diodes MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9in x 5 1/2in x 2 1/2in approx. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS £2-73
(+10% VAT 27p) P.P. & INS. 30p (OVERSEAS P. & P. £1-25)

EV6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt Battery. Ferrite rod aerial, 3" loudspeaker, etc. MW/LW coverage. Push Pull Output. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS £3-60
(+10% VAT 36p) P.P. & INS. 30p (OVERSEAS P. & P. £1-25)

EV7 Case and looks as above. 7 transistors and 3 diodes. Six wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt Battery Push Pull Output. Telescopic Aerial for Short Waves. 3" Loudspeaker. Parts price list and easy built plans 20p. Free with parts.

TOTAL BUILDING COSTS £4-08
(+10% VAT 40p) P.P. & INS. 31p (OVERSEAS P. & P. £1-85p)

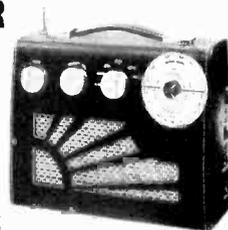


ROAMER TEN WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS, 9 TUNABLE WAVE BANDS, MW1, MW2, LW, SW1, SW2, SW3, TRAWLER BAND, VHF AND LOCAL STATIONS, ALSO AIRCRAFT BAND

Latest 4" 2 watt Ferrite Magnet Loudspeaker. Built-in ferrite rod aerial for MW/LW. Retractable, chrome plated 7 section telescopic aerial, can be angled and rotated for peak short wave and VHF listening. Push-pull output using 600mW transistors. Car Aerial and tape record sockets. 10 transistors plus 3 diodes. Ganged tuning condenser with VHF section. Separate coil for Aircraft Band. Volume/on/off, wave change and tone controls. Attractive case in black with silver blocking. Size 9in x 7in x 4in. Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS £8-50
(+10% VAT 85p) P.P. & INS. 52p (OVERSEAS P. & P. £1-85)



POCKET FIVE

3 Tunable wavebands. MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 5 1/2in x 1 1/2in x 3 1/2in approx. Plans and parts price list 15p (FREE with parts).



Total Building Costs **£2-28**
(+10% VAT 22p) P.P. & Ins. 26p (Overseas P. P. £1-25)



Total Building Costs **£2-50** P.P. & Ins. 26p
(+10% VAT 25p) (Overseas P. & P. £1-25)

TRANSONA FIVE

Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and parts price list 15p (FREE with parts).

ROAMER EIGHT Mk. I

NOW WITH VARIABLE TONE CONTROL

7 TUNABLE WAVEBANDS:

MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND. Built-in ferrite rod aerial for MW and LW. Retractable chrome plated telescopic aerial for short waves. Push-pull output using 600mW transistors. Car aerial and tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Latest 4" 2 watt Ferrite Magnet Loudspeaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone control. Attractive case in rich chestnut shade with gold blocking. Size 9in x 7in x 4in approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

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EDU-KIT

Build Radios Amplifiers, etc., from easy stage, diagrams.

Five units including master unit to construct.

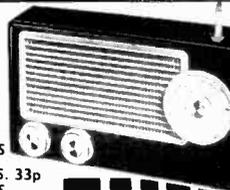
Components include: Tuning Condensers: 2 Volume Controls: 2 Slider Switches: Fine tone 3" moving coil Speaker: Terminal Strip: Ferrite Rod Aerial: Battery Clips: 4 Tag Boards: 10 Transistors: 4 Diodes: Resistors: Capacitors: Three 1in Knobs. Units once constructed are detachable from Master Unit, enabling them to be stored for future use. Ideal for Schools, Educational Authorities and all those interested in radio construction. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £5-50
(+10% VAT 55p) P.P. & INS. 33p (OVERSEAS P. & P. £1-85)

TRANS EIGHT 8 TRANSISTORS AND 3 DIODES

6 TUNABLE WAVEBANDS, MW, LW, SW1, SW2, SW3 AND TRAWLER BAND. Sensitive ferrite rod aerial for MW, and LW. Telescopic aerial for short waves. 3in speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Push-pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £4-48
(+10% VAT 44p) P.P. & INS. 33p (OVERSEAS P. & P. £1-25)



ROAMER SIX CASE AND LOOKS AS TRANS EIGHT

6 TUNABLE WAVEBANDS: MW, LW, SW1, SW2, TRAWLER BAND PLUS AN EXTRA MW BAND. Sensitive ferrite rod aerial and telescopic aerial for short waves. 3in speaker. 8 stages 6 transistors and 2 diodes, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9in x 5 1/2in x 2 1/2in approx. Plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS £3-98
(+10% VAT 39p) P.P. & IN. 31p (OVERSEAS P. & P. £1-85)

RADIO EXCHANGE LTD

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PRACTICAL ELECTRONICS

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A family of dual-channel high power audio amplifiers 590
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A simple lighting unit capable of producing an endlessly varying and unpredictable pattern of colours 607
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Our August issue will be published on Friday, July 12, 1974

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1/4W Iskra high stability carbon film—very low noise—capless construction
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ELECTROSIL TR5

Power watts	Tolerance	Range	Values available	Price
1/4	5%	4.7 Ω-2.2 MΩ	E24	1-99 100+
1/4	10%	3.3 MΩ-10M Ω	E12	1-3p 1-1p
1/4	2%	10 Ω-1M Ω	E24	1-3p 1-1p
1/4	10%	1 Ω-3.9 Ω	E12	1-3p 1-1p
1/4	5%	4.7 Ω-1M Ω	E12	1-3p 1-1p
1/4	10%	1 Ω-10 Ω	E12	1-3p 1-1p

Quantity price applies for any selection. Ignore fractions on total order.

DEVELOPMENT PACK

0.5 watt 5% Iskra resistors 5 off each value 4.7 Ω to 1M Ω.
E12 pack 325 resistors £2.40. E24 pack 650 resistors £4.70.

POTENTIOMETERS

Carbon track 5k Ω to 2M Ω, log or linear (log 1/4W, lin 1/4W).
Single, 14p. Dual gang (stereo), 49p. Single D.P. switch 28p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500 Ω and decades to 5M Ω. Horizontal or vertical P.C. mounting
(0.1 matrix).
Sub-miniature 0.1W, 5p each. Miniature 0.25W, 7p each.

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The GDI is the world's first semiconductor that can convert a concentration of gas or smoke into an electrical signal. The sensor decreases its electrical resistance when it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide, methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or smoke. This decrease is usually large enough to be utilized without amplification. Full details and circuits are supplied with each detector. Detector GDI1, £2. Kit of parts for mains operated detector including GDI1 but excluding case, £5.60. Suitable case, £1.50. Kit of parts for 12 or 24V battery operation, including GDI1 and P.C. board, £7.70. As above for PP9 battery, £6.90. Note: The battery operated kits incorporate our patented circuit to minimise battery drain—typically 90mA for 24V.

PRINTED BOARD MARKER

Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, the immerse the board in the etchant. On removal the circuit remains in high relief. 97p

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0.001μF, 0.0015μF, 0.0022μF, 0.0033μF, 0.0047μF, 3p, 0.0068μF, 0.01μF, 0.015μF, 0.022μF, 0.033μF, 33p, 0.047μF, 0.068μF, 0.1μF, 5p, 0.15μF, 6p, 0.22μF, 7p, 0.33μF, 11p, 0.47μF, 13p.

160V: 0.01μF, 0.015μF, 0.022μF, 0.033μF, 0.047μF, 0.068μF, 3p, 0.1μF, 3p, 0.15μF, 4p, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 7p, 0.68μF, 11p, 1.0μF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p, 0.033μF, 0.047μF, 0.068μF, 3p, 0.1μF, 4p, 0.15μF, 5p, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 8p, 0.68μF, 11p, 1.0μF, 13p, 1.5μF, 20p, 2.2μF, 24p.

MYLAR FILM CAPACITORS 100V CERAMIC DISC CAPACITORS 100pF to 10,000μF, 2p

0.001μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF, 0.05μF, 0.1μF, 4p.

ELECTROLYTIC CAPACITORS—MULLARD O15/6/7

(μF/V) 1/63, 1.5/63, 2.2/63, 3.3/63, 4.7/63, 6.8/40, 6.8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/63, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6.3, 68/16, 100/4, 100/10, 100/25, 150/6.3, 150/16, 220/4, 220/6.3, 220/16, 330/4, 6p, 47/63, 100/40, 150/25, 220/25, 330/10, 470/6.3, 7p, 68/63, 150/40, 220/40, 330/16, 1,000/4, 10p, 470/10, 680/6.3, 11p, 100/63, 150/63, 220/63, 1,000/10, 12p, 470/25, 680/16, 1,500/6.3, 13p, 470/40, 680/25, 1,000/16, 1,500/10, 2,200/6.3, 18p, 330/63, 680/40, 1,000/25, 1,500/16, 2,200/10, 3,300/6.3, 4,700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS

0.1μF 35V	2.2μF 35V	22μF 16V	12p
0.22μF 35V	4.7μF 35V	33μF 10V	
0.47μF 35V	6.8μF 25V	47μF 6.3V	
1.0μF 35V	10μF 25V	100μF 3V	

VEROBOARD

2 1/2" x 3 1/2"	0.1	0.15
2 1/2" x 5"	24p	20p
3 1/2" x 3 1/2"	28p	28p
3 1/2" x 5"	28p	28p
3 1/2" x 5"	32p	32p
17" x 2 1/2"	85p	67p
17" x 3 1/2"	120p	108p
17" x 3 1/2" (plain)	76p	52p
17" x 3 1/2" (plain)	—	41p
2 1/2" x 5" (plain)	—	12p
2 1/2" x 3 1/2" (plain)	—	11p
Pin insertion tool	62p	62p
Spot face cutter	52p	52p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard insulated	28p	2.5mm insulated	12p
Standard screened	18p	3.5mm insulated	12p
Stereo screened	40p	3.5mm screened	18p
Standard socket	20p	2.5mm socket	10p
Stereo socket	30p	3.5mm socket	11p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin, 7 pin
Plug 12p. Socket 8p.
4 way screened cable, 25p/metre.
6 way screened cable 30p/metre.

BATTERY ELIMINATOR

£1.70
9V mains power supply. Same size as PP9 battery.

FERRIC CHLORIDE

Anhydrous to Mill-spec in 1lb sealed packs 1lb 55p (20p). 3lb £1 32 (30p). 10lb £3 85 (60p).

VERSATILE POWER UNIT

Contains mains transformer, 2A thermal cut-out and bridge rect. Will give 1.7-10.5V output with 2 extra capacitors. Brand new. Only 85p (20p). Also available in a toy garage with press switch lamp etc. (Used for 'Hot Wheels') Only £1.85 (30p).

AMPLIFIER UNIT

Intfully screened case 5 1/2" x 5 1/2" x 3 1/2" 2 GET116 on heat sink 2 zeners, 3 pot cores, 4 small transformers, 1% R.S. C.s. etc 70p (30p) with circuit.

3W CASED AMPLIFIER

Polished wooden cabinet 14in x 13in x 9in, containing a sensitive (20μV) 4 valve amplifier with tone and volume controls. Gives 3 watts output to the 7in x 4in 3Ω speaker. Also a non-standard tape deck. Supplied in good working condition with circuit. Standard mains operation, £3.50 (£1). Suitable cassette £1.10 (30p). Spare head 33p. Tape (ex-computer) 75p (20p). Amplifier chassis only, complete and tested (2 x ECC83, EL84, EZ80) - speaker £2.50 (40p).

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Hundreds of new components—resistors, capacitors, pots, switches, + PC boards with transistors and diodes, also crystals and loads of odds and ends. Amazing value. £1.82 (40p)

Scopes in stock for callers, ring for details. S.A.E. List. All prices include VAT. Carriage in brackets, small parts 5p.

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New wholesale/retail shop and mail order department. Other retail shop at 38 Lower Addiscombe Road, Croydon. Tel. 01-688 2950.



Beginner's Guide To Electronics

3rd Edition

T.L. Squires and C.M. Deason

ELECTRONICS



This book describes as simply as possible the basic concepts in electronic engineering and the various components used in electronic equipment so that the reader gains an understanding of the terms used and the practical side of the subject. Prominence throughout has been given to the transistor and the integrated circuit.

- Provides a 'short cut' for those wishing to obtain a quick acquaintance with modern electronics
 - Completely revised and brought up-to-date
 - Each section is dealt with non-mathematically and explanatory diagrams are used throughout
- 240 pages 191 x 128mm. ISBN 0 408 00126 7
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B2004 2 ch. Stereo mixer 6.75 p & p 15p
PK3 Kit £1.95 p & p 20p

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MW/LW CAR RADIO
+ or - Earth with speaker
and fixings. £6.50 c/p 30p.
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£4.50. RH700 £6.75. RH430
£3.30. Rotel RA310 15+15
watt Stereo Amplifier
(List £52.00) £34.52. Wem
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Portable MW/LW radio kit
using Mullard RF/IF
module.
Features MW - bandspread for extra
selectivity. Slow motion tuning.
Fibre glass PVC cabinet. 600MW
output. All parts £7.98 (battery
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0.01 diam. Mono Filament £3.00 per 50 metre reel
0.11 diam. 64 Fibres Sheathed £1.00 per metre.
SPRAY5 15mm diam. (Mare's Tail Spray £10.50, 7mm
diam. £5.00).

SPECIAL PURCHASES

UHF TV TUNERS CHANNELS 21 TO 64
Brand new transistorised geared
tuners for 625 Line Receiver
IF output. £2.50. Post 20p.



EASY TO BUILD KITS BY AMTRON— EVERYTHING SUPPLIED

Model No.	£ p	Model No.	£ p
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300 4-channel R/C transmitter	5.95	780 Metal Detector	9.65
345 Superhet R/C receiver	5.95	790 Capacitive Burglar alarm	6.85
455 AM signal generator	12.33	835 Guitar preamp.	4.25
65 Simple transistor tester	1.40	840 Delay car alarm	6.15
115 8 watt Amplifier	3.90	875 CAP Discharge ignition (for car engine (-Ve Earth))	13.15
120 12 watt amplifier	4.70	80 Scope Calibrator	2.25
125 Stereo control unit	5.70	255 Level Indicator	6.15
130 Mono control unit	3.60	525 120-160mHz VHF timer	11.30
605 Power supply for 115	4.55	715 Photo cell switch	7.70
610 Power supply for 120	4.55	795 Electronic continuity tester	4.30
615 Power supply for 2-120	5.73	860 Photo timer	13.25
230 AM/FM aerial amplifier	2.93	871 Slide projector auto feed control	7.15
240 Auto packing light	5.90	235 Acoustic Alarm for driver	7.60
275 Mic. preamplifier	6.08	465 Quartz XTAL checker	8.75
570 LF generator 10Hz-1mHz	15.80	220 Signal Injector	2.30
570 Sq. wave generator 20Hz-20kHz	14.60	390 VOX	15.50
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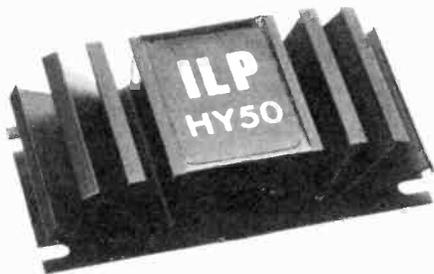
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INPUT IMPEDANCE: 47kΩ.
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SIZE: 105 × 50 × 25mm.

Price £5.80 mono £11.60 stereo. Price inclusive of VAT & P. & P.

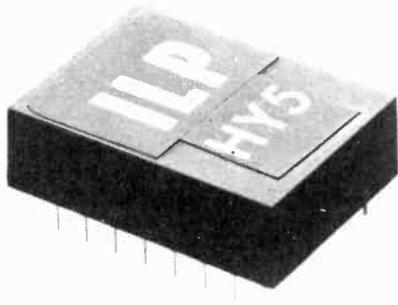
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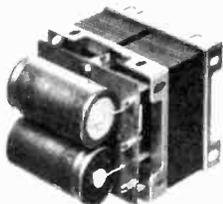


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SPEC.

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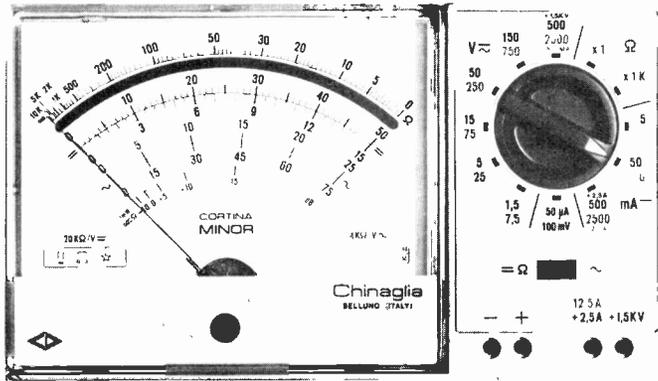


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- SENSITIVITY 20,000Ω/VOLT (D.C.), 4,000Ω/VOLT (A.C.).
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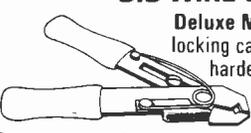
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and semi-conductors of many types from simple diodes to ICs photo-sensitive devices, threshold switches, etc., etc.

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EV CATALOGUE 7

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Code	Watts	Ohms	1 to 9	10 to 99	100 up
C	1/3	4.7-470K	1.3	1.1	0.9 nett
C	1/2	4.7-10M	1.3	1.1	0.9 nett
C	3/4	4.7-10M	1.5	1.2	0.9 nett
C	1	4.7-10M	3.2	2.5	1.9 nett
MO	1/2	10-1M	4	3.3	2.3 nett
WW	1	0.22-3.9	9	9	8
WW	3	1-10K	7	7	6
WW	7	1-10K	9	9	8

(see note below)

Codes:

C = carbon film, high stability, low noise.
MO = metal oxide, Electrofil TR5, ultra low noise.
WW = wire wound, Plessey.
Values: All E12 except C $\frac{1}{2}$ W, C $\frac{3}{4}$ W, and MO $\frac{1}{2}$ W.
E12: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and their decades.
E24: as E12 plus 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and their decades.
Tolerances: 5% except WW1 10%
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Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) Prices for 100 up in units of 100 only.

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Axial Lead	3V	6-3V	10V	16V	25V	40V	63V	100V
0.47	—	—	—	—	—	—	11p	8p
1.0	—	—	—	—	—	—	—	8p
2.2	—	—	—	—	11p	—	—	8p
4.7	—	—	—	11p	—	8p	8p	8p
10	—	—	—	—	8p	8p	8p	8p
22	—	—	—	—	8p	8p	8p	10p
47	8p	—	—	—	8p	8p	8p	10p
100	9p	8p	8p	8p	8p	8p	10p	12p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

ZENER DIODES full range E24 values: 400mW; 2.7V to 36V, 14p each; 1W; 6.8V to 82V, 21p each; 1.5W; 4.7V to 75V, 48p each. Clip to increase 15W rating to 3 watts (type 266F) 5p.

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Copper clad 0.1 in. matrix—2.5 x 3.75 ins. 27p. 3.75 x 3.75 ins., 30p. 2.5 x 5 ins., 30p. 3.75 x 5 ins., 33p.
Copper clad 0.15 in. matrix—2.5 x 3.75 ins., 20p. 3.75 x 3.75 ins., 30p. 2.5 x 5 ins., 30p. 3.75 x 5 ins., 36p.
Vero spot face cutter (any matrix), 43p. 0.040 pins (for 0.1 matrix) per 100, 35p. 0.052 pins (for 0.15 matrix) per 100, 35p.

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In a great variety of modern types, for $\frac{1}{2}$ in. shaft, from plastic to solid aluminium, from typically 63p per pack of two (Catalogue 7, page 62).

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**TABLE TOP
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22 INCHES**

At the head of our fibre optic kingdom stands the unique genesis. This fantastic model incorporates the largest mares tail you can buy. Now combined with the most sensational Kinetic light base ever designed in this field. This lamp is unique in the way that the base is opaquely translucent. The tinted upper section allows one to see a slowly rotating eight coloured sculptured wheel, that seems to be floating on a blue haze, that radiates a warm mystic glow.

Thousands of optical fibres energized with colour. Fibre tips flash like stars, bright with all the changing colours of the rainbow. Available in blue or green. M.M. Discount price £22.95 inc p.p. and VAT.



**Ready
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Cascade, the fibre optic that's also a beautiful corner light, M.M. Discount price £16.65 inc p.p. and VAT.



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LITTLE GEM

Little Gem, complete with the smaller mares tail, (8mm approx, 18" x 10" high, overall height from table approx 14"). With a single white light display, housed in a red translucent base, cowlled with a special moulded three dimensional filter that throws light in array. It's amazing, we have completely shattered the style of conventional optics with the fabulous little gem.

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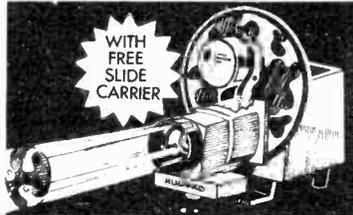
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Multi-coloured. For projecting psychedelic colours 6" or 4" diameter. Ideal for fibre optics. 6" oil wheel £5.00 + p.p. 15p. 4" (suitable for optics) £2.65 + p.p. 10p.

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A star for home parties, this budget priced 100-watt projector will transform your room into a swirling image of continuously changing liquid colour of reds, blues, yellows and greens. This machine is supplied with one six inch liquid wheel and includes lamp and lead. Complete with free 2 x 2 slide projection carrier. M & M discount price £19.95 post free.

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18mm ferrule, 11" high x 22" dia.

7,500 fibres, £10.50 +20p p.p.

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4,800 fibres £7.85 +12p p.p.

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Complete instructions supplied.

Display bunching of various types of fibres at low cost. TYPE A 1320. Fibres contained in a tough flexible sheath. Makes delightful displays.

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Each fibre .010 inch diameter in a flexible sheath

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flexible plastic that enables heat bending for

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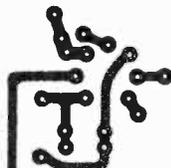


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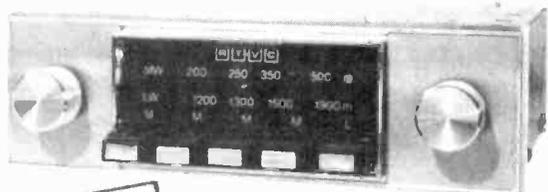
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Technical specification:

- 1.) Output 2.5 watts R.M.S. into 8 ohms. For 12 volt operation on negative or positive earth.
- 2.) Integrated circuit output stage, pre built three stage IF Module.

Controls Volume, manual tuning and five push buttons for station selection, illuminated tuning scale covering full medium and long wave bands.

Size Chassis 7 ins. wide, 2 ins. high and 4 1/8 ins. deep approx.

NOTE: The ability to solder on a printed circuitboard is necessary to complete this kit successfully. Circuit diagram and comprehensive instructions 55p. free with kit.

Car Radio Kit

£6.60 + 55p. postage & packing.

Speaker including baffle and fixing strips
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Recommended Car Aerial - fully retractable and locking.
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BSR 3 speed deck, automatic, manual facilities together with ceramic cartridge.

Two speakers with cabinets.

Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.

For the technically minded: -

Specifications:

Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 8-15 ohms. Stereo headphone socket with automatic speaker cutout.

Provision for auxiliary inputs - radio, tape, etc., and outputs for taping discs. **Overall Dimensions**. Speakers approx.

15 1/2" x 8" x 4". Complete deck and cover in closed position approx. 15 1/2" x 12" x 6". Complete only **£18.95**

Extras if required. £1.37 + £1.60 p & p.

Optional Diamond Stylus

Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**



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Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.

Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).

Inputs *5 Electrically Mixed Inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs.

*Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.

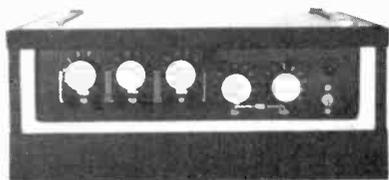
INPUT SENSITIVITIES

- 1) Crystal Mic or Guitar 9mV.
- 2) Moving coil Mic or Guitar 8mV.
- 3), 4), 5) Medium output equipment (Gram. Tuner, Monitor, Organ, etc.) - all 250mV sensitivity.

AC Mains 240V. operation. Size approx. 12 1/2 ins x 6 ins x 3 1/2 ins

£15.00 + 60p. postage & packing

DISCO 50



45 WATT R.M.S. MONO DISCOTHEQUE AMPLIFIER

Ideal for Disco Work. Output Power: 45 watts R.M.S. Frequency Response 3dB points 30Hz and 18KHz. Total Distortion: less than 2% at rated output. Signal to noise ratio: better than 60dB. Bass Control Range: 13dB at 60Hz. Treble Control Range: 12dB at 10KHz. Inputs: 4 inputs at 5mV into 470K. Each pair of inputs controlled by separate volume control. 2 inputs at 200mV into 470K. Size: 19 1/4 x 10 1/2 x 8 ins. approx. Amplifier **£27.50 + £1.50 p. & p**

Special Offer: Disco 50 plus two 15" E.M.I. speakers type 14A/780 (as illustrated on opposite page). **Complete £57.00 + £4.00 p&p.**

COMPLETE(*) STEREO SYSTEM



£51-00

40 Watt Amplifier.
Viscount III - R102 now 20 watts per channel.
System I includes,
Viscount III amplifier - volume, bass, treble
and balance controls, plus switches for mono/
stereo on/off function and bass and treble
filters. Plus headphone socket.

Specification
20 watts per channel into 8 ohms.
Total distortion @ 10W @ 1kHz 0.1%. *P.U.1* (for
ceramic cartridges) 150mV into 3 Meg. *P.U.2*
(for magnetic cartridges) 4mV @ 1kHz into 47K.
equalised within ± 1 dB R.I.A.A. *Radio* 150mV
into 220K. (Sensitivities given at full power).
Tape out facilities: headphone socket, power
out 250mW per channel. *Tone controls and filter
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60Hz. Bass filter: 6dB per octave cut. Treble
control: treble -12dB to -12dB @ 15kHz.
Treble filter: 12dB per octave. *Signal to noise
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Crosstalk better than 35dB on all inputs.
Overload characteristics better than 26dB on all
inputs. Size approx. 13 $\frac{1}{2}$ " x 9" x 3 $\frac{1}{2}$ ".

**Garrard SP25 deck, with magnetic cartridge,
de luxe plinth and hinged cover.**

Two Duo Type II matched speakers -
Enclosure size approx. 17 $\frac{1}{2}$ " x 10 $\frac{3}{4}$ " x 6" in
simulated teak. Drive unit 13" x 8" with parasitic
tweeter
Complete System £51-00 Available complete for only **£69-00** + £4 p & p
10W handling.

£69-00

System II
Viscount III amplifier (As System I)
Garrard SP. 25 (As System I)
Two Duo Type IIIA matched speakers -
Enclosure size approx. 31" x 13" x 11 $\frac{1}{2}$ ".
Finished in teak veneer. Drive units approx.
13 $\frac{1}{2}$ " x 8 $\frac{1}{2}$ " with 3 $\frac{1}{2}$ " HF speaker. Max. power
20 watts, 8 ohms. Freq. range 20Hz to 20kHz.

Complete System £69.00

PRICES: SYSTEM 1

Viscount III R 102 amplifier	£24-20	+ £1 p & p
2 Duo Type II speakers	£14-00	+ £2-20 p & p
Garrard SP25 with MAG cartridge de luxe plinth and hinged cover	£21-00	+ £1-75 p & p.

total £59-20

Available complete for only **£51-00** + £3-50 p & p.

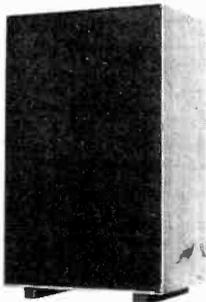
PRICES: SYSTEM 2

Viscount R102 amplifier	£24-20	+ £1-00 p & p
2 Duo Type IIIA speakers	£39-00	+ £4-00 p & p
Garrard SP25 with MAG cartridge de luxe plinth and hinged cover	£21-00	+ £1-75 p & p.

total £84-20

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THE ULTIMATE COMPLETE SPEAKER SYSTEM
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A professional standard five way speaker
system with enclosure giving top quality
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approx. (3ft. x 2ft. x 1ft.).

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Hand built - 15" diameter bass with 3"
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units, - two 3 $\frac{1}{2}$ " HF units, plus matching
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Power Handling
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15" 14A/780 BASS UNIT

Bass unit on a rigid diecast chassis.
Superior cone material handles up to 50
watts RMS, and is treated to give a smooth
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OUR PRICE £18-70 + £1-50 p & p + £1-50 p & p **Special Offer.**



**950
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Five matched speakers and crossover unit
for handling up to 45 watts, frequency
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Huge 19" x 14" (approx.) high efficiency
Bass-Speaker with 16,500-gauss magnet
built on a heavy diecast frame.

The four 10,000 gauss tweeters, each 3 $\frac{1}{2}$ "
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critically adjusts signal for maximum
fidelity. Impedance at 1 kHz is 8 ohms.
Bass coil 2", others 0-5". Recommended
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OUR PRICE £19.50



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Compatible with Viscount III system, Unisound module and the Stereo 21.
Technical specification: Mains input, 240V. Output sensitivity 125mV
Comparable unit sold elsewhere at £24-00 approx.

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SAJ110 7-stage frequency divider in one 14 pin DIL package. Sine or square wave input allows operation from almost any type of master oscillator including the DMO2 (when 97 notes are available). Square wave outputs may be modified to sawtooth by the addition of a few components. 8AJ110: £2.83 each OR special price for pack of 12: £25.00. S.a.e. please for data sheet.

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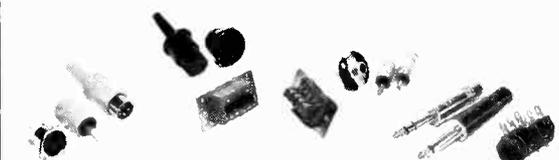
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6.8 63 6p	100 25 6p	100 100 10 12p	470 25 12p
6.8 63 6p	100 40 6p	100 150 6.3 10p	470 25 12p
10 25 6p	100 63 12p	150 16 6p	680 16 18p
10 63 6p	150 6.3 6p	150 25 6p	680 25 18p
15 40 6p	150 16 6p	150 40 6p	680 25 18p
15 40 6p	150 25 6p	150 63 12p	680 25 18p
15 63 6p	150 40 10p	150 100 10 12p	680 25 18p
22 10 6p	150 63 12p	150 150 6.3 10p	680 25 18p
22 25 6p	220 4 6p	150 220 6.3 10p	680 25 18p
22 63 6p	220 10 6p	150 220 16 6p	680 25 18p
33 6.3 6p	220 16 6p	150 220 25 10p	680 25 18p
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47 40 6p	220 150 16 6p	150 220 150 25 10p	680 25 18p
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PLUGS AND SOCKETS



DIN PLUGS
2 pin (1 flat) 6p
3 pin 6p
4 pin, 5 pin A pair 10p
(180°), 6 pin 10p

MAINS
P360 3 pin 1.5A chassis plug with line socket 2p
SA 2190 3 pin 5A chassis plug 20p
SA 1862 Line socket for above 23p

DIN Sockets
2 pin 6p
3 pin, 4 pin, 5 pin 6p
A (180°), 5 pin B RPS 8 way chassis plug 47p

RSR 8 way chassis socket 62p

PHONO
Plug plastic 5p
Plug screened 12p
Chassis socket 4p

JACK
Std. 1/2" mono plug Plastic 13p
Screened 21p

Std. 1/2" stereo plug Plastic 18p
Screened 30p
Open mono socket 1/2" 10p; Moulded mono socket 1/2" with 2 break contacts 13p; Moulded stereo socket 1/2" with 3 break contacts 18p; 3.5mm plug plastic 7p; screened 15p; open socket 8p.

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Sub-main. Mains Transformer
6-0-6V 100mA 95p, 12-0-12V 50mA 95p.
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Size: 46 x 31 x 38mm.
0-12V 250mA 0-12V 250mA £1.36.

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Pri. 200-220-240V. Sec. 12-15-20-24-30V 1A £3.31.

Mains Transformer MT206AT
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Hook-up wire, 7 strand 0.2mm. PVC covered tinned copper wire for light general connexions up to 1.4A 11 colours: black, blue, brown, green, grey, orange, pink, red, violet, white, yellow 10 metres of any one colour 20p. Pack of 11 (1 of each colour) 10m coils £2.05.

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Single gang Lin or Log 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M (and 1k Lin) 14p

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Single gang with DP switch 250V 2A Log or Lin 5k to 2M as above 28p

PRESETS
Sub-miniature 0-1W Vert or Horiz 100, 250, 500, 1k, 2.5k, 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M 25p

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1.H0042C, TO99 (TO5), FET 1/2p Op Amp £4.25
LM301A, 8-pin DIL, Op Amp 50p
LM380 14-pin DIL, 2W Audio Amp £1.32
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Carbon Film 1W 5% 10Ω to 10M E12 34p
Metal Oxide 1/4W 9% 10Ω to 1M E12 & E24 4p
Wirewound 2 1/2W 10% 0.22ohms to 0.47ohms E12 12p
Wirewound 2 1/2W 5% 1ohm to 27ohms E12 12p

E12 values 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades
E24 values 11, 13, 16, 20, 24, 30, 36, 43, 51, 62, 75, 91 and decades

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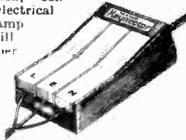
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SAFETY ISOLATING

Prim. 120/240V. Sec. 120/240V. Centre Tap with screen.		Price	Open	Post
VA	Ref.	£	£	£
(watts)	No.	Cased	£3-74	0-38
60	149	—	4-16	0-52
100	150	—	—	—
200	151	£9-48	7-48	0-52
250	152	12-05	9-57	0-65
350	153	14-00	11-44	0-80
500	154	15-80	13-20	1-00
1000	166	30-70	27-46	1-20
2000	168	60-95	55-44	—
3000	169	79-53	72-49	—

12 & 24 Volts

Amps	24V	Type	Price	Post
12V	No.	No.	£	£
0-3	0-15	242	1-34	0-22
0-5	0-25	111	1-34	0-22
1	0-5	213	1-59	0-22
2	1	71	2-09	0-22
4	2	18	2-75	0-38
6	3	70	3-56	0-42
8	4	108	3-98	0-52
10	5	72	4-87	0-52
12	6	116	5-87	0-52
16	8	17	6-84	0-52
20	10	115	10-23	0-69
30	15	187	13-75	0-97
40	20	232	18-26	1-00
60	30	325	22-52	1-10

30 Volts

Prim. 200-240V. Sec. 12, 15, 20, 24, 30V.		Price	Post
Amps	Type	£	£
0-5	112	£1-58	0-22
1	79	2-20	0-38
2	3	3-19	0-38
4	20	3-96	0-42
6	21	4-68	0-52
8	51	5-80	0-52
10	117	6-93	0-52
12	88	9-00	0-67
16	89	10-00	0-67

50 Volts

Prim. 200-240V. Sec. 19, 25, 33, 40, 50V.		Price	Post
Amps	Type	£	£
0-5	102	£2-11	£0-30
1	103	3-08	0-38
2	104	4-29	0-42
3	105	5-77	0-52
4	106	7-48	0-52
6	107	11-00	0-67
8	118	14-19	0-97
10	119	17-60	0-97

60 Volts

Prim. 200-240V. Sec. 24, 30, 40, 48, 60V.		Price	Post
Amps	Type	£	£
0-5	124	£2-10	£0-38
1	126	2-97	0-38
2	127	5-77	0-42
3	125	7-16	0-52
4	123	9-35	0-67
5	40	11-55	0-67
6	120	13-57	0-82
8	121	18-00	1-00
10	122	19-40	1-00
12	189	21-62	1-10

MINIATURE AND EQUIPMENT

Prim. 240V with screen.		Milliamps	Type	Price	Post
Sec. 1 Volts	Sec. 2	Sec. 1	Sec. 2	No.	£
3-0-3	—	200	—	238	1-23 0-10
0-6	0-6	500	500	234	1-80 0-10
0-6	0-5	1000	1000	212	1-88 0-22
9-0-9	—	100	—	13	1-23 0-10
0-9	0-9	330	330	235	1-48 0-10
0-8-9	0-8-9	500	500	207	2-28 0-22
0-8-9	0-8-9	1000	1000	208	3-03 0-30
15-0-15	—	40	—	240	1-23 0-10
0-15	0-15	200	200	236	1-30 0-10
20-0-20	—	30	—	241	1-23 0-10
0-20	0-20	150	150	237	1-80 0-10
0-15-20	0-15-20	500	500	205	2-97 0-38
0-20	0-20	300	300	214	1-78 0-22
0-20	—	3500 (No screen)	—	1116	3-00 0-40
20-12-0-12-20	—	700 (D/C)	—	221	1-55 0-30
0-15-20	0-15-20	1000	1000	206	3-80 0-38
0-15-27	0-15-27	500	500	203	3-08 0-38
0-15-27	0-15-27	1000	1000	204	3-24 0-38

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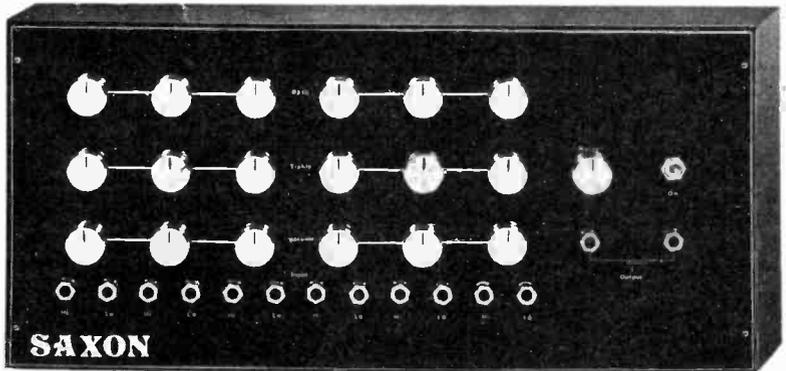
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Featuring multiples of our VA30 module, the M4HL and M6HL fulfil the requirements of all clubs, groups, etc. where a high quality mixer is required. Each channel has one high and one low impedance input, plus volume, treble and bass controls. Input impedances may, if required, be easily changed. The M4HL has four channels, and one output, and the M6HL six channels (12 inputs) and a master control and two outputs. Either unit may be used free-standing or panel mounted. These mixers will feed all types of amplifier. Recommended for their versatility and high performance, and excellent value for money.

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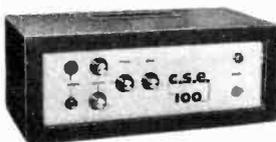
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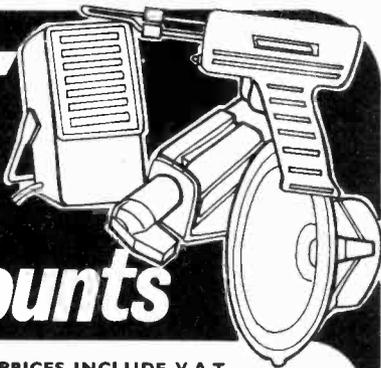
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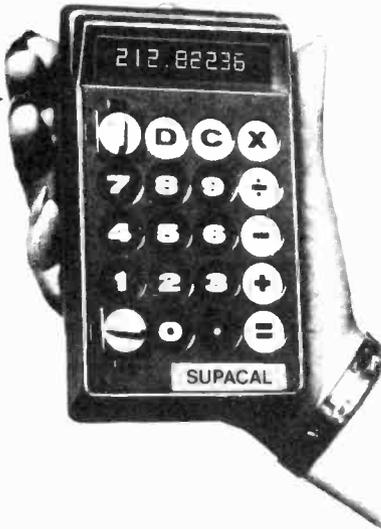
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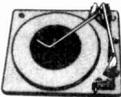
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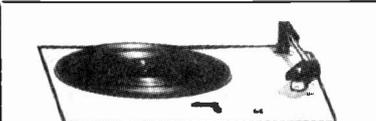


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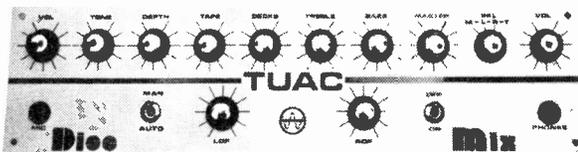
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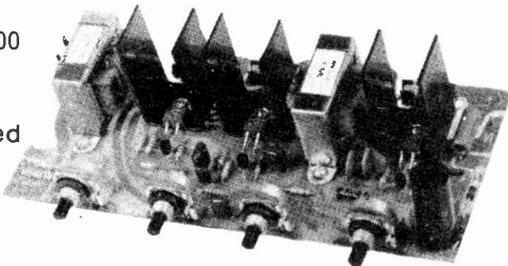
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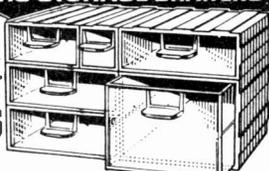
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 - DVT Diode Comparison Tables.
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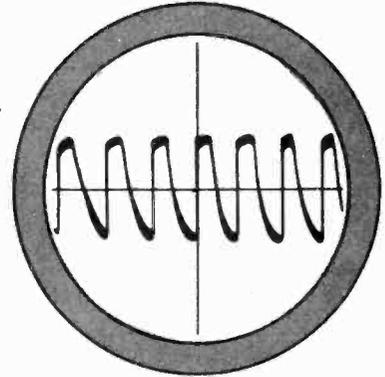
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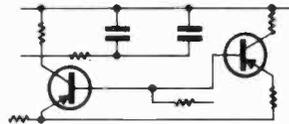
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SOUND POWER

AUDIO power amplifiers find their way into a very extensive and diverse range of equipments and systems, quite apart from the domestic entertainment area. The exuberant folk music of today, whether originated "live" or recreated from discs, is borne along on hundreds of watts. Public Address systems reach out as never before to cajole or inform captive audiences or, just as probably, innocent passers by. Just two of the more blatant uses of sound power.

No one can avoid the fact that amplified sound is very much part of the contemporary scene. The propriety of its widespread use can be argued about but its presence is real and, presumably, permanent.

Those concerned with technical matters can, at any rate, do their best to ensure that the amplifying medium, for its part, is beyond reproach and does not introduce gratuitously any (further) distortion. In fact, it is generally agreed that this branch of the technology has made impressive progress and audio engineering has reached almost the ultimate in the quest for faultless performance. The evidence lies among the huge variety of amplifier designs which have been developed.

Yet the question could well be posed: are there not too many designs?

The need for off-the-shelf designs to meet the constantly occurring demands for certain basic units (such as audio power amplifiers and power supply units) which form indispensable sections of many electronic systems, has been a theme of discussion among electronics people over the years. The logic behind this thought is undeniable, but the ideal general purpose design has never materialised, save in certain rather limited areas. So designs for standard routine functions still proliferate.

The continual up-dating of the technology through the introduction of new components is the stumbling block. Electronics is synonymous with change. A well proven standard device, equipment, or system is likely to have a limited life before the inevitable innovation or improvement happens.

Yet even within this volatile field there has perhaps been a rather excessive outpouring of amplifier designs than is altogether warranted.

There is still a reasonable life expectancy for many designs; and when considering a widely used item such as an a.f. amplifier there is good sense in stabilising the position as long as possible by fully exploiting one single design. If the design is capable of being produced in a number of different "sizes" so catering for the majority of power-requirements commonly called for through the simple expedient of changing component values, the attractiveness of this policy is unquestionable.

This idea materialises in our pages with the introduction of a family of audio power amplifiers. The P.E. Power Slaves comprise a family of four amplifiers having outputs of 20, 40, 65 and 100 watts respectively, suitable for use with hi fi pre-amplifiers. Furthermore any unit can easily be built in a two-channel form with a doubling of output power. Good performance, with low harmonic distortion and good signal to noise ratio, justify the claim that the P.E. Power Slaves are a step towards that goal of a universal power amplification block for embodiment in all kinds of sound reinforcement systems.

F.E.B.

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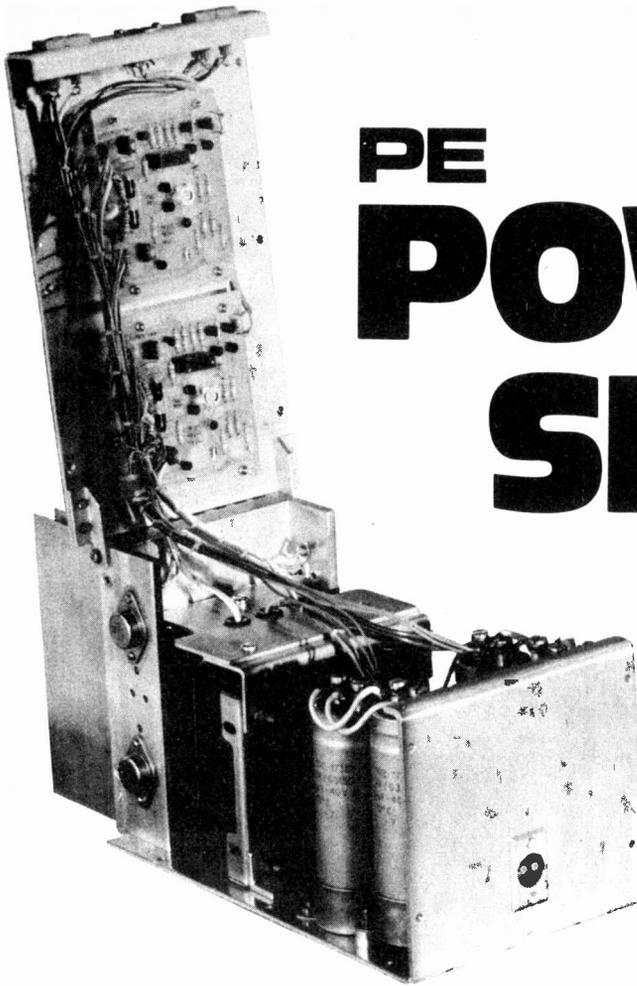
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PE POWER SLAVES

BY R. B. REESON



THE purpose of any audio chain is the accurate reproduction of live or recorded information, be it speech, music or just plain "sound".

Due to the low efficiency of transducers generally, with the possible exception of horn loaded systems, considerable power must be expended in order to produce sounds at an acceptable level; this level will obviously be different for different transducers in different applications. As the basic function is the same, it was felt that, rather than produce a flood of designs for specific purposes, a better approach was to produce a single basic design to fulfil all requirements.

From this article four amplifiers can be built all of them being based on a single circuit configuration. To realise the range of outputs of 20W, 40W, 65W and 100W component changes should be made according to the relevant parts lists.

Although a single amplifier is described the prototype units were designed as double channel, that is, where two amplifiers are contained on a single chassis. This, of course, means a doubling of output capability to 20 + 20W, 40 + 40W, 65 + 65W and 100 + 100W in each case.

DESIGN CRITERIA

Where a low power system is required, there is little to be gained, and much to be lost in producing a power amplifier with an output capability of less than twenty watts into eight ohms, as cost and

physical size will not be significantly affected, and performance criteria such as transient handling capability, signal to noise ratio and distortion are not likely to improve.

Turning to the upper end of the power scale, choice of maximum power can be arrived at by examination of the transducers to be driven. Modern composite high power speakers, and individual drive units, will accept continuous sine wave outputs of between 10 and 50 watts r.m.s. Unfortunately audio signals are rarely as predictable as sine waves, but it can be assumed that twice the continuous power can be handled on transients of short duration, thus a power capability of 80 to 100 watts will be required.

When two or more speakers are connected in series, or series-parallel to maintain impedance, then the power requirement can be greatly increased. No allowance has been made for this method of use, as the damping effect of the amplifier is lost, except when units are connected by separate leads to the amplifier terminals, and thus it is felt to be a bad policy.

A further problem arises when two speakers in parallel are driven to a peak level of 100 watts each, that is, a current handling capability of at least 10 amps is required, both in the amplifier and power supply unit, and this is dangerously close to the maximum current of a TO3 transistor (generally 15 amps).

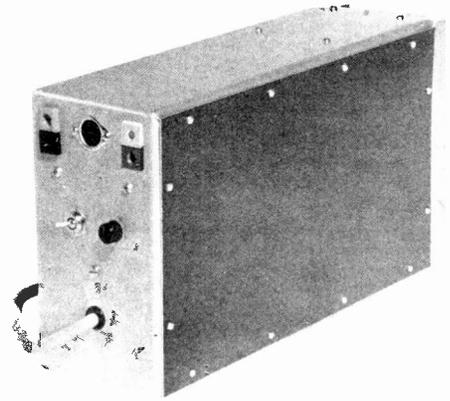
Thus a high quality amplifier should be capable of driving up to 100 watts into a single 8 ohm load, and, to satisfy the requirements of all applications, must have very low harmonic and intermodulation distortion figures, be overload protected, have a high damping factor, and a very high signal to noise ratio.

This final parameter is often neglected, and in most designs a figure of 80dB is considered good. However, a better figure to aim for is 100dB.

Power amplifiers can be functionally split into two sections, namely a voltage amplifier with low current gain, followed by a current amplifier with unity voltage gain, and at this stage the two sections will be considered separately.

Specification . . .

Power bandwidth	-6dB from 8Hz to 45kHz
Total harmonic distortion	0.02%
Intermodulation distortion	0.04%
Signal/Noise ratio	100dB
Input sensitivity into 200k Ω	1V r.m.s.
Input matched to 600 Ω line	
Overload protected	
May be d.c. coupled throughout for use as a servo amplifier	
Full bridge output to eliminate "turn-on plop"	



PROVIDING OUTPUTS OF 20, 40, 65, & 100 WATTS FROM ONE COMMON CIRCUIT CONFIGURATION

VOLTAGE AMPLIFIER

The basic voltage amplifier configuration used for the power amplifiers is shown in Fig. 1. It has the advantage of providing adequate performance without undue complexity and requires no setting up.

The input resistor R1 provides bias current for TR1 and defines the slave amplifier input impedance.

R12, R2 and C2 form an attenuator which determines the proportion of the output fed back to TR2 and hence defines the gain of the amplifier. C2 allows full d.c. feedback to stabilise the output at, or close to 0 volts. Transistors TR1 and TR2 form a differential amplifier, as do TR3 and TR4, the output of this second stage being fed to a common emitter amplifier TR5.

The overall combination will have a very high open loop gain, and will be non-inverting, as a positive going input tends to increase current in TR1 at the expense of TR2, so that TR4 turns on and

TR3 off. This reduces the current drawn by TR5 base and gives a positive going output at TR5 collector. Resistors R4, R5, R7, R8 and R9 enable a sensible standing current to be established in each stage, and eliminate any chance of leakage currents unbalancing the amplifier.

The problem of non-linearity in TR5 is overcome by operating this transistor at a constant collector current by bootstrapping the junction of R10 and R11 to the output by means of C3, providing an almost constant current in R11.

COMPOUND TRANSISTORS

The output stage is basically a Class AB compound amplifier using quasi-complementary transistors being made up of groups of three as seen in Fig. 3.

These triplet configurations have a number of advantages chief of which are (a) high current gain, (b) the inputs are presented through a single base

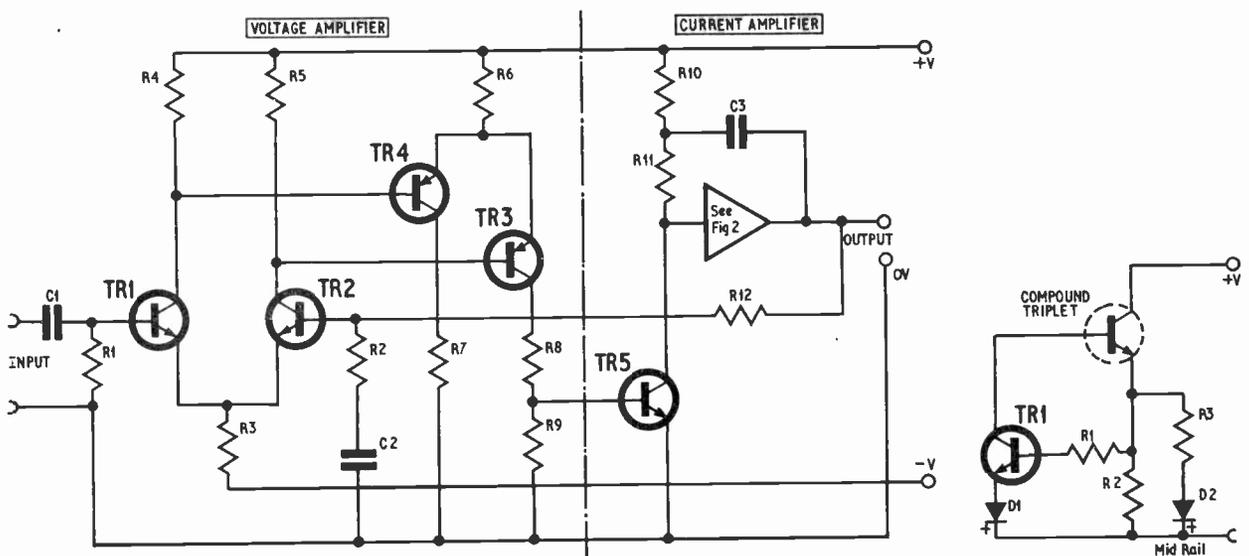


Fig. 1. Basic circuit arrangement for voltage amplifier

Fig. 2. Showing how current limiting is achieved

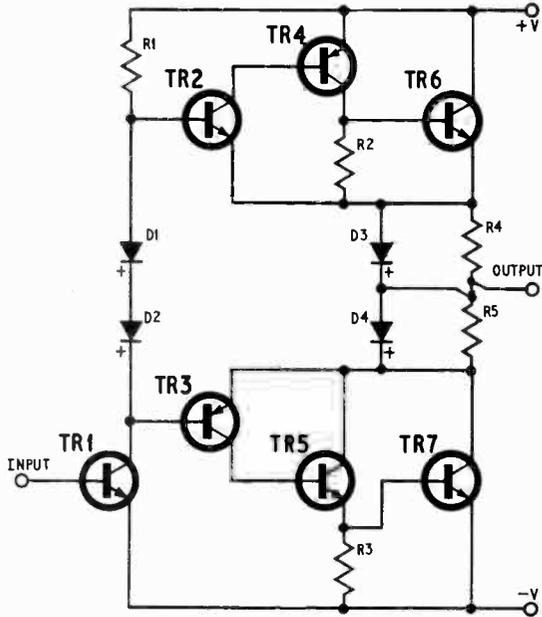


Fig. 3. Compound triplet arrangement for current amplifier

emitter junction which means that the output transistor junction temperature will not affect stability and (c) *npn* output transistors are relatively cheap and readily available.

In the quiescent condition the driver transistor TR1 is biased to provide a mid-rail voltage at the

output. With a signal applied the collector applies alternate drive conditions to the compound triplets so that first one group is conducting and then the other.

A "two stage" resistor is used to link the triplets to the output terminal, consisting of a fairly high value resistor shunted by a power diode and resistor.

The high value of resistance gives good quiescent stability, and the diodes limit the voltage drop under full drive conditions. To ensure reliable operation of the overload protection, a low value resistor is connected in series with each diode, and maximum current can be adjusted by means of this resistor.

OVERLOAD PROTECTION

Overload protection is provided by limiting the output current supplied by either compound triplet. The circuitry that achieves this is shown in Fig. 2 for one triplet only, a complementary circuit being used on the other.

The current supplied to the output terminal generates a voltage across the combination of R3, R2 and D2 which is related to the current flowing. When the current rises to a level sufficient to provide approximately 1.5V, base current is directed through TR1 and D1. Conduction of this transistor means that bias is removed from the triplet so that the output current is limited.

The peak current available before limiting must be higher than the peak current to be supplied to the load, and as this may be 5A, a dissipation of 225W can occur with a short circuit at the output. Because of this, a fuse circuit must be inserted (FS1) to give protection.

The complete circuit configuration for the basic amplifiers is given in Fig. 4.

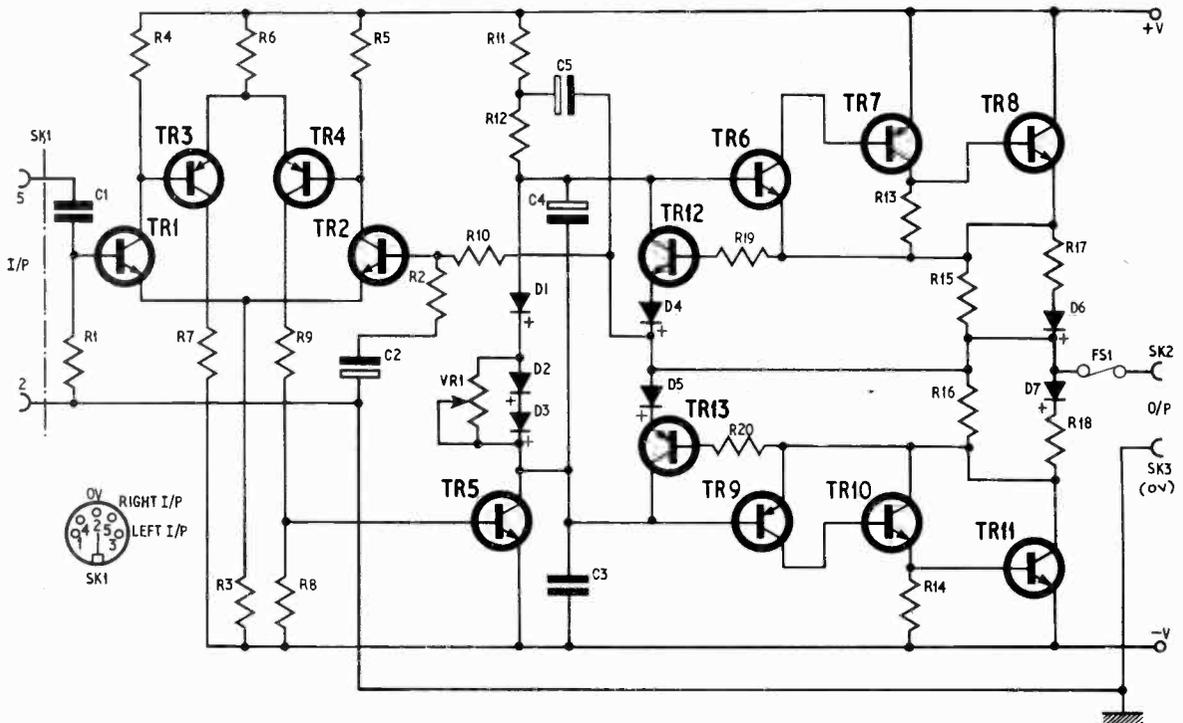


Fig. 4. Basic single channel (right) configuration common to all slave amplifiers. For component value variations, see components lists. The inset shows wiring for a 180 degree, 5 pin socket for two channel. When connecting a remote preamplifier the screen is connected to earth (0V) only at the slave to obviate hum loops

POWER SUPPLIES

Power supplies in a design such as this must provide a fairly steady supply voltage, with a high current capacity when required. As an example, 100 watts into 8 ohms will require a peak current of 5 amps per channel. This implies that for a stereo amplifier with a common power supply a peak requirement of 10 amps is necessary. The mean current drain will be 1/2.8 of this value, or 3.5 amps, and so a transformer rated at 4 amps continuous current would be suitable.

Decoupling should maintain the supply within about two volts of nominal, at full power, for one half cycle of mains current so that:

$$C = \frac{IT}{V} \text{ at peak output}$$

COMPONENTS . . .

where I is in amps, T in seconds and V volts. The equation then is:

$$C = \frac{10 \times 0.01}{2} \text{ Farads} = 50,000\mu\text{F}$$

A composite musical signal can be shown to have a short term mean level at least 12dB below maximum output. Occasional transients will reach maximum output, but these will generally be of short duration, two milliseconds or less being typical.

From similar calculations as above the decoupling requirement for music at -12dB is 5,000 μ F and for a 2mS transient, 6,000 μ F.

DESIGN CHOICE

If the amplifier is intended for home entertainment (domestic) reservoir capacitors of 6,000 μ F are

AMPLIFIERS					POWER SUPPLIES				
Resistors	20W	40W	65W	100W	Resistors	20W	40W	65W	100W
R1	200k Ω	200k Ω	200k Ω	200k Ω	R1	12k Ω	15k Ω	18k Ω	20k Ω
R2, R6	39k Ω	56k Ω	68k Ω	86k Ω	R2	100 Ω	100 Ω	100 Ω	100 Ω
R3, R4, R5	430k Ω	620k Ω	750k Ω	910k Ω	R3, R4	200 Ω	300 Ω	360 Ω	470 Ω
R7	91k Ω	120k Ω	150k Ω	160k Ω	R5	300 Ω	300 Ω	300 Ω	300 Ω
R8	6.2k Ω	6.2k Ω	6.2k Ω	6.2k Ω	R6	10 Ω	10 Ω	10 Ω	10 Ω
R9	82k Ω	110k Ω	130k Ω	150k Ω	R7	see text			
R10	200k Ω	200k Ω	200k Ω	200k Ω	R8	10k Ω	12k Ω	15k Ω	18k Ω
R11, R12	15k Ω	20k Ω	24k Ω	27k Ω	R9	1k Ω	1k Ω	1k Ω	1k Ω
R13, R14	100 Ω	100 Ω	100 Ω	100 Ω	R10, R11	2k Ω (1W)	2k Ω (1W)	2k Ω (1W)	2k Ω (1W)
R15, R16	10 Ω (1W)	10 Ω (1W)	10 Ω (1W)	10 Ω (1W)	Potentiometers				
R17, R18	0.11 Ω	0.08 Ω	0.07 Ω	0.06 Ω	VR1	1k Ω	1k Ω	1k Ω	1k Ω
R19, R20	4.7k Ω	4.7k Ω	4.7k Ω	4.7k Ω		all carbon linear			
All $\frac{1}{2}$ W 5% metal oxide except where otherwise stated	0.03 Ω /cm, 26 s.w.g. resistance wire				Capacitors				
Capacitors					C1, C2	10,000 μ F (40V)	10,000 μ F (50V)	10,000 μ F (63V)	10,000 μ F (63V)
C1	0.1 μ F	0.1 μ F	0.1 μ F	0.1 μ F	C4, C5	10,000 μ F (40V)	10,000 μ F (50V)	10,000 μ F (63V)	10,000 μ F (100V)
C2	10 μ F	10 μ F	10 μ F	10 μ F		All electrolytic			
C3	100pF	100pF	100pF	100pF	C3	100pF	100pF	100pF	100pF
C4	22 μ F	22 μ F	22 μ F	22 μ F	Transistors				
C5	1 μ F	1 μ F	1 μ F	1 μ F	TR1	BC204	BC204	BC204	BC204
					TR2, TR3	MPS-U01	MPS-U01	MPS-U01	MPS-U01
					TR4	MPS-U51	MPS-U51	MPS-U51	MPS-U51
					TR5	2N3055	SDT9203	SDT9203	SDT9203
Potentiometers					Rectifiers				
VR1	2.2k Ω	2.2k Ω	2.2k Ω	2.2k Ω	D1-D4		REC46 (150V, 10A)		
					D5		BZY88—C6V8		
Diodes					Transformer				
D1-D5	1N914	1N914	1N914	1N914	T1	24-0-24V @ 4A	30-0-30V @ 4A	33-0-33V @ 5A	36-0-36V @ 6A
D6-D7	1N5401	1N5401	1N5401	1N5401					
Transistors					Changes for Standard Supplies (Domestic and Monitoring versions)				
TR1, TR2	2N2484	2N2484	2N2484	2N2484	Capacitors				
TR3, TR4	BC212	MPS-L51	MPS-L51	MPS-L51	C1, C2	6,000 μ F (25V) (Domestic)	6,000 μ F (35V)	6,000 μ F (40V)	6,000 μ F (50V)
TR5	ME1120	ME1120	ME1120	ME1120	C1, C2	10,000 μ F (25V) (Monitoring)	10,000 μ F (35V)	10,000 μ F (40V)	10,000 μ F (50V)
TR6	BC182	MPS-L01	MPS-L01	MPS-L01	Rectifiers				
TR7	MPS-U57	MPS-U57	MPS-U57	MPS-U57	D1-D4		REC 43A (100V, 4A)		
TR8, TR11	2N3055	2N3055	SDT9203	SDT9203	Transformer				
TR9	BC212	MPSL51	MPSL51	MPSL51	T1	18-0-18V @ 3A	22-0-22V @ 4A	25-0-25V @ 4A	30-0-30V @ 4A
TR10	MPS-U07	MPS-U07	MPS-U07	MPS-U07				Douglas	Douglas
TR12	BC184	BC184	BC184	BC184				MT106	MT123
TR13	BC214	BC214	BC214	BC214	Miscellaneous				
Miscellaneous					FS1—	1A	1A	1A	1A
Heatsink	60D-0600-A-1 (Marston)		(100W and 65W)		S1—Double pole mains on/off, LP1—mains neon				
					FS1—IA				

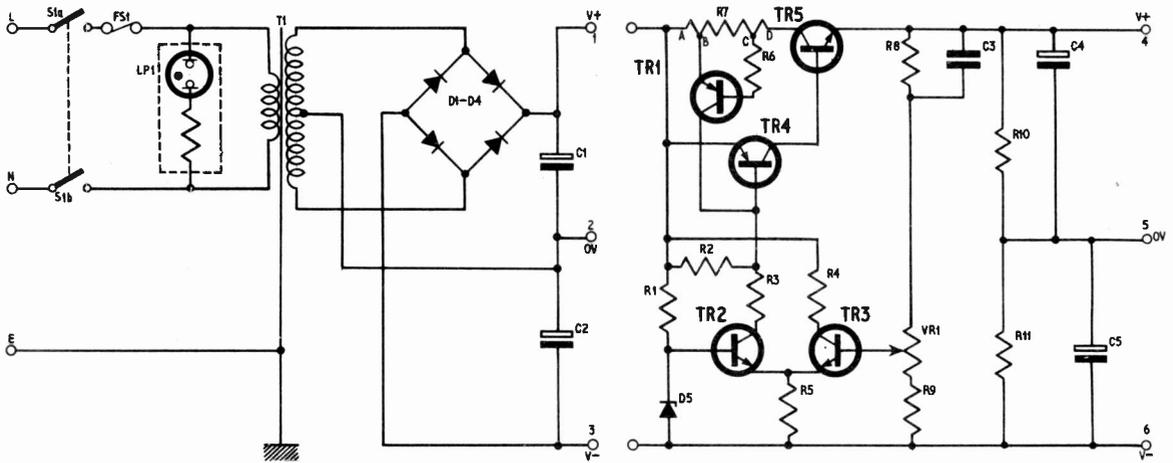


Fig. 5. Circuit for p.s.u. For the domestic version of amplifier the power rails are pins 1, 2 and 3. The monitoring version takes its supply from pins 4, 5 and 6. The current sensor R7 is made up from 26 s.w.g. Constantan resistance wire (0.03 ohm/cm). The tapping resistances are as follows: A to B ≤ 0.02 ohms; B to C = 0.07 ohms; C to D ≤ 0.02 ohms. Supply voltages for the 20, 40, 65 and 100W versions are approximately $\pm 25V$, $\pm 32V$, $\pm 36V$ and $\pm 46V$ respectively

adequate assuming that neither transients nor very loud passages coincide exactly in time if two channels are being used.

For "monitoring" quality, a higher value capacity, possibly 10 or 15,000 μF should be used, or alternatively a stabilised supply particularly when used for stereo to reduce cross talk.

A composite circuit diagram for the domestic and monitoring versions of the p.s.u. is shown in Fig. 5.

For the former points 1, 2 and 3 are connected to the amplifier. For the latter points 1 and 2 connect to the stabiliser circuit; no connection is made to 2.

The output mid-point in this case is derived using resistor and capacitors.

OPTIMUM LOAD

Optimum load impedance for all versions is 8 ohms but any load can be accommodated at reduced power, bearing in mind the peak voltage and current limitations.

Fig. 6 shows typical impedance curves for high quality domestic speakers demonstrating that the impedance is anything but constant. Indeed, it is not unusual to find dips of impedance as low as 1.5 or 2 ohms, causing severe current overload at critical frequencies.

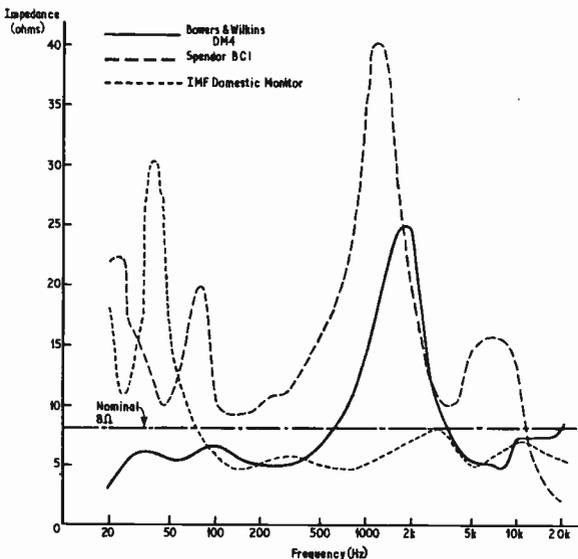


Fig. 6. Showing how speaker impedance changes with frequency

IMPORTANT

Two BA148 diode suppressors **MUST** be added to Fig. 4 as follows—Cathode and anode to $\pm V$ and SK2 and SK2 and $-V$ respectively. In Components List for all versions TR7 and TR10 should be MPS-U57 and MPS-U07; for the p.s.u. TR2, TR3 should be MPS-U07 and TR4, MPS-U57. (See next month.)

Next month constructional details for the amplifiers will be given

THE SUN, BY SKYLAB

From the last of the experiments aboard *Skylab* has come new knowledge and exciting data. There is no doubt that a new era has opened for astronomers and as a result of what has been noted many programmes will be instituted in solar physics.

Much of the success is due to the (ATM) Apollo Telescope Mounting. It enabled a new view of the solar system, the galaxy and, most important, the Sun itself.

Free of the atmospheric absorption the telescope showed that the Sun, far from being "quiet" at the near sunspot minimum was extremely active. This alone has justified the mission and also confirmed the need for man in space.

Practical Electronics received an invitation from the Institution of Radio and Electronic Engineers to attend the Clerk-Maxwell Lecture, "Man in Space" by Werhner von Braun. More than twice the number of persons attended than the seats available. Before the lecture began the writer had a conversation with Werhner von Braun and certain definite conclusions regarding the progress of physics emerged. In his words "... the time has come for another Maxwell to re-order our thoughts and set in their proper place the ever increasing number of particles, the black holes and the quasars." He also gave some information based on the early examination of some of the data.

The medical evidence is now clear and it is accepted that man could live in space indefinitely. The adaptability is not confined to man for the spider which was taken aboard *Skylab* was able to spin a perfect web. The pictures of the first attempts were not only comic but extremely interesting. It needed only a short while of accommodation before things were under control. The peculiar zigzag of the circles and the cross ties soon assumed the familiar shape and life went on.

The astronauts also attempted to move round the walls at a high rate to set up artificial gravity. In this they were not successful.

GREAT BALLS OF FIRE

One of the most spectacular events was a pulsing stream of plasma from the Sun which had a regular rhythm. More than forty of such events were recorded. An unexpected bonus was the ability to observe with the coronagraph these great blobs, as large as the



BY FRANK W. HYDE

Sun itself, as they moved up through the corona at a speed of 400km per second.

The variation of the intensity of the corona over the two hemispheres of the Sun were not anticipated. One section of the Sun seemed to be in the nature of a hole at a lower temperature than the rest of the surface. This was borne out by the X-ray pictures. It also appears that the corona is composed of closed loops which fit the magnetic line structure. In both the X-ray measurements and the white light coronagraph pictures this appears.

There were a number of instances, where the conditions for sunspot appearance appeared outside the normally observed belts. Some of the "holes" indicate the source of disturbances of the solar wind which effect terrestrial conditions.

There have been tens of thousands of frames taken of the coronal conditions, more than has been observed in a thousand years of eclipses. Continuous observations with the facility to select and also combine different types of telescope, made the *Skylab* control console a sort of astronomical organ on which the melody of the heavens could be produced. Nothing like this success was expected and now the knowledge of what can be done in this field must ensure that the next decade will add an unprecedented amount of data for study.

More than 600 pictures a day were recorded and the number of bits in each picture amounted to 10^8 . Among the many and continuous hours of study covering everything in the vicinity of the Sun there were two solar eclipses,

many eruptions and flares on the Sun itself, the perihelion of Kohoutek and a transit of Mercury.

The combination of control from the Johnson Spaceflight Centre and the astronauts aboard *Skylab* resulted in a magnificent scientific achievement. It is worth noting that the planned tasks for the crew were restricted to the pointing of the telescopes, target control and to collect and replace cameras and film. But, in fact, the crew did much more than that and it was their resource that made possible the full speed running of the observations. Despite some early difficulties, which were overcome, the crew settled down to do a job for which posterity must ever be grateful.

The cost of this mission was high and many thought wasteful. None would say this now and indeed, there is in this very extensive period of man in space, the certainty that money for the future missions will be forthcoming.

MORE OF VENUS

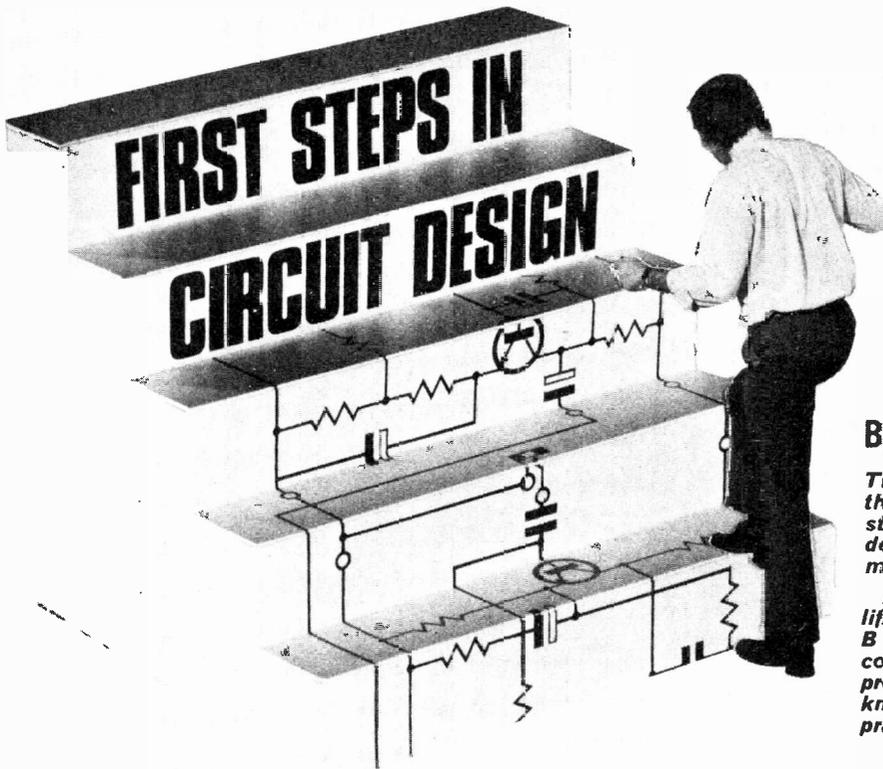
The Venus fly-by of *Mariner 10* has been a successful mission. But some of the data obtained will need months to extract the information sought.

The spacecraft approached Venus from the dark side and the first pictures showed the cusps which appear extended far beyond the normal. This is thought to be due to the atmospheric refraction. The scattering of light beyond the terminator will help to an understanding of the upper atmosphere. Haze shells were observed and these will reveal more data after computer processing.

One important aspect is the layering observed in the atmosphere. This is not yet understood nor is the material of the cloud strata.

There was great penetration of the atmosphere by the two radio probe signals. Though physical occultation began at about 10.17a.m. radio signals were still being received up to 17 minutes later. The aerial on *Mariner 10* was designed to change its pointing direction in order to compensate for the bending of the radio waves which takes place when travelling through the Venus atmosphere.

Much is expected of this technique in the observation of the density of the atmosphere and it is hoped also to resolve the differences of temperature given by earlier *Mariner* missions and by the USSR spacecraft *Venera*. Helium is known to be a constituent but it would have to be at least 3 per cent to account for the differences of temperature found.



4

By A. P. Stephenson

This series, specially written for the beginner, takes you step-by-step through transistor circuit design in a simple, non-mathematical way.

Design of a small signal amplifier will be followed by a Class B amplifier and the series will conclude with a constructional project so that your theoretical knowledge can be put into practice.

SO FAR we have only looked at the voltage divider method of biasing a transistor stage. This month we will look at another method which is simple and economical. These advantages are, however, at the expense of other parameters.

Once we are satisfied with a single stage amplifier, the

problem then arises of how to connect this into the system so that it does not disturb the driving or driven circuits. Sometimes direct coupling is possible but often we must make use of a d.c. blocking capacitor. The value of this component must be such as to maintain the required bandwidth of the system.

4.1. ALTERNATIVE BIASING ARRANGEMENT

There is an alternative to the R_1, R_2 divider (Part 3) known as "collector to base feedback bias". Only one resistor is needed instead of two and some bias stability is possible even without the inclusion of R_E (see Fig. 4.1).

The resistor R_B provides bias and also some negative feedback which tends to stabilise the collector current against changes in h_{FE} .

Suppose that h_{FE} is higher than predicted: this would tend to increase I_C which in turn would cause the output voltage to fall. This fall would be passed via R_B to the base causing a decrease in I_C . The base bias conditions are therefore stabilised.

HIDDEN FEATURES

Although the method appears delightfully simple and economic, there are certain hidden features which the designer must understand.

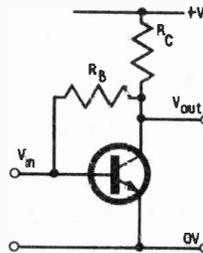


Fig. 4.1 Simple circuit illustrating collector to base feedback (left)

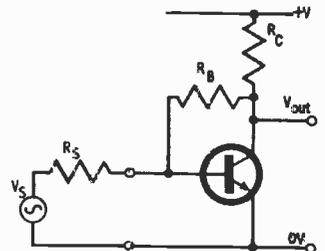


Fig. 4.2 The source resistance can be seen to be an important parameter in the calculation of the circuit gain (right)

(a) The feedback is in parallel with the input signal and therefore requires extra current drive from the signal input to the stage. In other words, the stage input resistance R_{IN} is lowered. In fact, the input resistance consists of two resistors in parallel, one of them being the normal $r_{IN} = h_{te} \times r_e$ and the other equal to R_B divided by the gain A . This is easily understood when it is realised that the signal voltage is at one end of the R_B and the output voltage (A times the input signal) is at the other.

Thus A times as much current must be provided by the signal, which is equivalent to saying that R_B behaves as if it were $A + 1$ times smaller and across the signal input.

(b) There is no actual reduction in voltage gain, as far as the gain from base-in to collector-out is concerned. The voltage gain is still

$$A = R_C/r_e \text{ or } R_C/(r_e + R_E)$$

(If R_E is present).

However the lower input resistance has the effect of lowering the gain measured from signal e.m.f. to collector output. The source resistance of the signal (R_S) in conjunction with R_E forms a kind of operational amplifier configuration (see Fig. 4.2).

If A was very high, the total gain from V_S to V_{out} would be approximately

$$A' = R_B/R_S$$

where A' is defined as the gain with feedback. Thus the gain is independent of the transistor.

This, however, is a gross oversimplification of the situation because the transistor gain A in such a simple single stage amplifier would not be "very high" and $A' = R_B/R_S$ would be greatly incorrect.

This analogy with the operational amplifier was only given as an aid to comprehension. It is always good practice to view circuit ideas from widely differing angles.

4.2. AN ALTERNATIVE EQUATION FOR GAIN

The previous circuit had no emitter resistor R_E which was the reason why the gain A was so high. Although a high gain may often be a desirable feature, there are two main reasons against achieving it by the omission of R_E .

(a) The gain is not too predictable because of its absolute dependency on r_e . The equation $r_e = 25/I_C(\text{mA})$ is very useful as a rough guide but it is well to remember that the equation is only approximate. The inclusion of R_E in the gain formula, although lowering the gain increases the accuracy of the equation (particularly if $R_E \gg r_e$).

(b) A more important reason is the rather remarkable twist of the gain equation when the bias is set to allow the collector to rest at half the supply voltage.

If $V_{out} = \frac{1}{2}V_{cc}$ then $R_C = \frac{1}{2}V_{cc}/I_C$. Now $A = R_C/r_e = \frac{\frac{1}{2}V_{cc}}{I_C} \div \frac{25}{I_C} = V_{cc}/50$.

But remembering that the figure "25" is millivolts, we must multiply by 1,000, giving

$$A = \frac{V_{cc} \times 1,000}{50}, \text{ thus } \boxed{A = 20V_{cc}}$$

This means that the gain of any grounded emitter stage operating without an emitter resistor is simply 20 times the supply voltage (assuming the collector is at half the supply voltage).

This applies whatever collector current we use, so it is impossible to set the gain at any other value than $20V_{cc}$ (unless of course we use negative feedback).

It is easy to see why R_E is almost always present in grounded emitter amplifiers.

4.3. COUPLING CAPACITORS

It is often required to connect two stages together by allowing the output signal of one stage to become the input signal of the next.

Sometimes the coupling can be achieved without disturbing the d.c. bias conditions, but this is sometimes unavoidable.

This problem can be overcome with the use of a "coupling capacitor" which enables the signal to pass relatively easily but blocks any d.c. from affecting the next stage.

CAPACITOR VALUE

The question is how big must the capacitor be. The answer depends on two pieces of information—the lowest frequency that the signal is likely to be, and the input resistance of the stage which the capacitor is to feed.

The skeletal circuit is shown in Fig. 4.3.

The capacitive reactance (X_C) and R_{IN} form a voltage divider, so it is clear that X_C should be considerably less than R_{IN} at the lowest frequency which it is desired to pass.

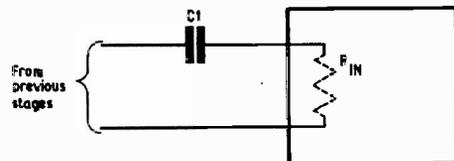


Fig. 4.3 The calculation of the coupling capacitor value is determined by the input resistance R_{IN} of the following stage

The simplest way is to find the value of C which makes $X_C = R_{IN}$ and then use the next highest preferred value.

Suppose the lowest frequency to be passed is 100Hz and $R_{IN} = 1k\Omega$.

Then if $X_C = R_{IN}$, then $1/2\pi fC = R_{IN}$ which gives $C = 1/2\pi fR_{IN}$.

Inserting values gives $C = 1.59\mu F$ so the next highest preferred value, $2\mu F$ would be used.

RULE OF THUMB

A neat little rule of thumb to save a lot of fiddling with powers of ten is

$$C = 0.2/f \times R_{IN}$$

where f is in kHz, R_{IN} in kilohms and C in μF .

The value for C is in no way critical, providing it is at least the value calculated by the method above. Twice or even ten times larger will not matter apart from the cost.

4.4. USE OF THE EMITTER FOLLOWER STAGE

An emitter follower stage provides an easy solution to the problem of matching from a high resistance signal source to a low resistance load.

Unlike the normal grounded emitter stage, the emitter follower has no voltage gain, in fact, there is a slight voltage loss. There is, however, a substantial current gain as a signal is passed through, because of the apparent change in source resistance.

Treating the emitter follower as a black box, the effect on the input signal is as shown in Fig. 4.4.

The figures shown in the figure are purely arbitrary and are chosen only to illustrate how the source

resistance can be substantially lowered by passing through the stage.

CURRENT GAIN

The concept of current gain can be appreciated by calculating the two short circuit currents.

If the original circuit was shorted out the current would be

$$i = 1\text{V}/100\text{k}\Omega = 0.01\text{mA}$$

If the output was shorted, the current would be

$$i = 1\text{V}/1\text{k}\Omega = 1\text{mA}$$

This shows that a theoretical current gain of 100:1 has been achieved. (The short circuit current dodge is used on paper only—don't take it literally and start sticking screwdrivers across the terminals.)

It must not be supposed that an actual emitter follower would provide a magical solution. The successful design of such a stage requires quite a bit of fiddling with values to get the input resistance as high as possible.

For example, Fig. 4.4 presupposes that the input resistance of the emitter follower stage is much higher than the $100\text{k}\Omega$ signal resistance. Unless this is so, it is clear that the signal would be attenuated by voltage divider action between the $100\text{k}\Omega$ and R_{IN} of the emitter follower.

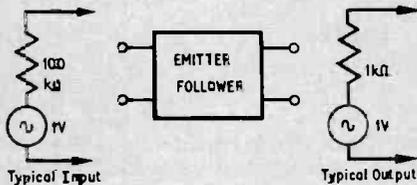


Fig. 4.4 An emitter follower transforms a high input impedance into a low output impedance

4.5. TYPICAL CIRCUIT AND EQUATIONS OF THE EMITTER FOLLOWER

An emitter follower circuit using voltage divider feed for base bias is shown in Fig. 4.5.

We are not concerned with the design factors for setting up the correct d.c. conditions, this problem is dealt with elsewhere. Instead, we state some important equations which decide the voltage gain, input resistance and output resistance.

1. VOLTAGE GAIN

For most practical purposes, the voltage gain is nearly unity, though it is as well to know the following formula in case some badly chosen values for R_E lower the gain to a small fraction.

Voltage gain from V_{in} to $V_{out} = R_E/(r_e + R_E)$.

Since r_e is the internal emitter resistance and will seldom be in excess of 100Ω or so, it is easily seen that the gain will be about 1, providing R_E is in excess of $1\text{k}\Omega$.

2. INPUT RESISTANCE (R_{IN})

This is the same basic formula which has already appeared in connection with the grounded emitter stage

$$R_{IN} = R_1, R_2 \text{ and } r_{in} \text{ in parallel}$$

(remember that $r_{in} = h_{ie}(r_e + R_E)$).

3. OUTPUT RESISTANCE (R_{OUT})

This is a bit complicated unless dealt with in two parts.

$$R_{OUT} = R_s/h_{ie} \text{ in parallel with } R_E$$

where $R_s = R_1, R_2$ and r_s in parallel.

If this is too wearisome to calculate and a very rough equation is all that is needed, then use

$$R_{OUT} = r_s/h_{ie}$$

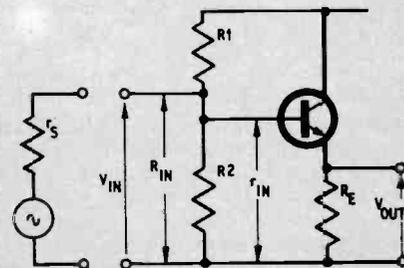


Fig. 4.5 Typical emitter follower with voltage divider for base bias

4.6. D.C. COUPLING

Two stages may be coupled together directly *only* if the d.c. voltage output of the first stage is compatible with the d.c. bias requirements of the second stage.

A typical example which serves to illustrate the system is the circuit of Fig. 4.6 which shows a normal grounded emitter amplifier feeding an emitter follower stage.

Transistor TR1 provides the voltage gain and TR2 provides a low resistance (high current) output.

The gain of the first stage = $R_C / (r_e + R_E) = (84k\Omega / 1k\Omega + 250\Omega) = 67$.

The second stage contributes no further voltage gain.

STAGE INPUT RESISTANCE

The stage input resistance is r_{in} , R1 and R2 in parallel, although it is reasonable to ignore R1.

Now, $r_{in} = h_{ie}(r_e + R_E) = 100(250\Omega + 1k\Omega) = 125k\Omega$, which, in parallel with R1 gives a value for R_{IN} of about $45k\Omega$.

Currents through TR2 would be determined first. 1mA is chosen for collector current, so assuming a pessimistic h_{FE} of 100, the base current of TR2 would be $10\mu A$.

The divider feed for the bias of TR2 is the chain R_C , TR1 and R_E of the first stage which is passing 0.1mA (which is ten times the base current of TR2).

Again taking an h_{FE} of 100 for TR1, the base current would be $1\mu A$, which is fed by a divider chain taking $10\mu A$.

The "rule of ten" has thus been used throughout.

OUTPUT RESISTANCE

The output resistance of the emitter follower is a bit tricky. The equation, as stated previously, is $R_{OUT} = R_S / h_{ie}$ in parallel with R_E . The term R_S is the source resistance of the signal feeding the base, which, in this case, is the output resistance of the first stage.

To a rough approximation this may be taken as the collector resistance, R_C , which is $84k\Omega$. Thus $R_{OUT} = 84k\Omega / 100 = 840\Omega$. (The $9k\Omega$ R_E which strictly is in parallel may be disregarded.)

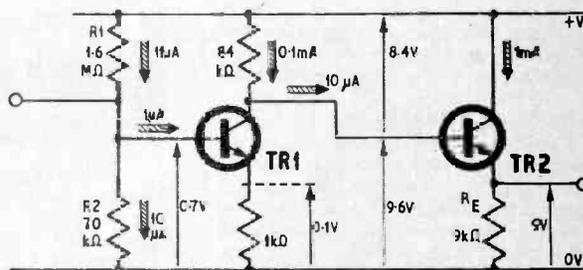


Fig. 4.6 A two stage d.c. coupled amplifier showing typical component values

4.7. D.C. FEEDBACK LOOPS

Leaving the emitter resistor unbypassed has so far been the only example of negative feedback. A more obvious example is frequently used in direct-coupled stages and, to illustrate such a system, the circuit previously discussed will be modified to include a d.c. feedback loop (see Fig. 4.7).

The circuit, including the voltages and currents are exactly the same, apart from the method of biasing the first stage.

Instead of the customary divider across the supply rail, the bias feed is taken from across the output resistor.

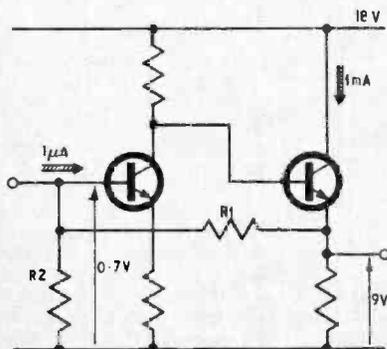


Fig. 4.7 Negative feedback stabilises the output voltage but reduces gain

This is not such a violent change as appears at first sight. After all, there are nine volts available so why not use them and obtain the added advantage of a d.c. feedback loop?

In choosing the values for R1 and R2 we must be careful not to disturb the output circuit too much. It is drawing 1mA so it will hardly be aware of the theft if we divert say $10\mu A$ from R_E to feed a divider.

Since R2 must drop 0.7V, R1 must drop the remaining 8.3V which means that if $10\mu A$ is flowing the values of R1 and R2 are calculated as follows:

$$R_1 = 8.3V / 10\mu A = 830k\Omega$$

$$R_2 = 0.7V / 10\mu A = 70k\Omega$$

STABILITY

Such a circuit has very good stability in spite of wide tolerances in the resistors R1 and R2. In fact, it is astonishing how the output appears to lock at 9V.

Suppose that the output tends to drift downwards: this will pull the base of TR1 down which causes the collector of TR1 and base of TR2 to rise. The output tendency is therefore to rise which, due to the feedback loop is providing a correcting influence on the tendency for the input to fall.

The original gain before feedback is, of course, reduced from its previous value. This is one of the penalties to be paid for the benefits of negative feedback.

Continued next month

THERE must be many PE readers who would never call themselves musicians but who have an interest in music, be it as listeners or as vamping-left-hand pianists. Some of them are no doubt in the throes of building the units which go to make up Mr. Shaw's Synthesiser and are wondering what on earth to do with it when it's completed. Others may not want to begin any musical project because they feel that their creative or re-creative talent is nil.

Yet others may be musicians like myself who have a smattering of electronic theory and practice up their sleeves but are afraid to launch any large-scale project because they fear they may never get the finished article to function. I hope this feature may allay the fears of all these people and, indeed, offer some constructive help.

Facilities in the U.K.

Until quite recently the musician, particularly the composer and/or arranger has had to sit on the periphery of technological progress, using a small amount of electronic equipment in a limited kind of way, unable, through lack of know-how, to extend his innate creativity.

In this country it is not just know-how that has been lacking, but the facilities needed to acquire expertise. Although there has been a tremendous surge of interest in electronically produced or processed sound over the past decade or so we still have not managed to produce a chain of national studios where the musician can work with first-rate equipment and expert technical assistance.

It is true that we have the BBC Radiophonic Workshop, well-equipped and staffed by experts, but, alas, Auntie Beeb tends to hog the show by restricting its output to broadcast material in the shape of incidental music and sound effects and a few (all too rare) commissions from composers outside the Corporation.

Numerous private studios exist too — those of Tristram Cary, Daphne Oram and Peter Zinovieff immediately spring to mind, along with such institutions as the University of York and Goldsmith's College, London—yet most of us cannot hope to experience this kind of Utopian dream. Those of us who live and work away from the metropolis are, as in many things, particularly poorly off.

A studio at home

However, having said that, there is not too much cause for gloom. Magazines like PE have made it abundantly clear that the imaginative person can build quite a sizeable and versatile studio at home, quite apart from the commercial market.



Over the past few years PE has included in its pages features dealing with some of the electronic equipment available to the musician. More frequently there have appeared constructional projects specifically geared to the amateur musician: Waa Waa, Fuzz, Phase, and Sound Bender effects units; and complete instruments such as the Electronic Organ, Electronic Piano, and the Voltage Controlled Synthesiser.

The time is ripe, then, for the musician to join in and help bring the electronics engineer or experimenter and the creative artist together. As a professional musician whose creative work calls increasingly for more and more electronic equipment, I welcome the appearance of this page as a meeting place for the exchange of information, ideas, and ventilating of nagging questions.

Until projects such as the PE Synthesiser appeared (as far as I know the first design to be published for the home constructor to build from scratch) most of us tended to sink further into the slough of despond in the belief that only a fabulous win on the pools could get us reasonably well-equipped.

By beginning in a modest way, building our equipment module by module, we can now keep pace with our pockets whilst steadily increasing our versatility in the creative music sense.

Getting started

I am often asked, particularly by secondary school music teachers who (quite rightly) feel that there is an honourable place for electronic music in the curriculum, what is necessary by way of basic equipment in order to get started.

Assuming that "canned" rather than "live" electronic music is envisaged, then I would suggest a decent half-track stereo tape machine with three or more speeds, sound-on-sound facilities and a couple (maybe only one, at first) of reasonable quality microphones; this should keep you going for quite some time.

You may be wondering why I recommend a half-track tape machine when the present-day quality of quarter-track machines is very high indeed. It's not a matter of quality in this instance. Amongst the tricks used in the manipulation of recorded sound one of the simplest is reverse playback, and on a standard quarter-track machine, stereo or mono, or a half-track mono machine, reversal of the tape direction merely gives playback of the recorded material on the new channel(s) in a forward direction. On a half-track stereo machine turning the tape over reverses the material on both channels, incidentally reversing the stereo direction too.

Tape manipulation

Strictly speaking, using only microphones, you are not going to produce electronic music, since the microphone will only pick up air-borne sounds, most of which may well be "natural" in origin—dried peas in a can, hand claps, vocal sounds, or the jangle of keys, and maybe acoustic musical instruments. But by varying the tape speeds in recording, superimposition and reverse playback an amazing variety of sounds can be achieved. For the price of an editing block and a reel of splicing tape the sounds can be linked together to form a satisfactory sequence.

Anyone who has persevered with this kind of tape manipulation—and it is, believe me, a time-consuming activity—will tell you that the results can be miraculously electronic in effect.

In case you think this approach to creative sound a bit limiting, then I suggest you go out and buy a recording of "Variations for a door and a sigh" by Pierre Henry (Philips 4 FE 8504). Henry is one of the leading lights in the French movement which began in the early post-war years and produces so-called "musique concrète".

What can be more limiting than the creakings of an old barn door? Yet Pierre Henry manages, through careful handling of the granary door and a bit of superimposition back at the studio, to produce an incredibly wide range of sounds which are as musical as they are amusing.

There is a little paperback, too, by Terence Dwyer entitled "Composing with Tape Recorders" which offers invaluable advice.

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2N490	3.15	2N3708	0.70	AD161	1.00	BC309A	0.10	BFY50	0.23
2N491	3.55	2N3709	0.11	AD162	1.05	BC309B	0.10	BFY51	0.21
2N492	3.99	2N3710	0.12	AF109R	0.40	BC327	0.21	BFY52	0.19
2N493	4.20	2N3711	0.11	AF115	0.24	BC328	0.19	BFY53	0.18
2N696	0.18	2N3712	0.96	AF116	0.25	BC337	0.19	BFY90	0.16
2N697	0.18	2N3713	1.20	AF117	0.20	BC338	0.19	BRY39	0.23
2N698	0.25	2N3714	1.33	AF118	0.50	BCY30	0.43	BU104	1.42
2N699	0.29	2N3715	1.50	AF124	0.24	BCY31	0.52	BU105	2.25
2N706	0.18	2N3716	1.80	AF125	0.20	BCY32	1.15	CI06A	0.48
2N706A	0.18	2N3721	2.20	AF126	0.19	BCY33	0.34	CI06B	0.55
2N708	0.14	2N3722	1.80	AF127	0.20	BCY34	0.37	CI06C	0.65
2N709	0.35	2N3723	2.65	AF139	0.39	BCY38	0.83	CI06E	0.43
2N711	0.30	2N3729	3.15	AF170	0.25	BCY39	1.05	CA3020A	1.80
2N718	0.21	2N3730	2.40	AF172	0.55	BCY40	0.87	CA3046	6.70
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2N720	0.50	2N3792	2.60	AF179	0.65	BCY58	0.22	CA3089E	1.06
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2N916	0.41	2N3820	0.38	AF200	0.35	BCY71	0.22	LM3004A	2.03
2N918	0.47	2N3823	0.42	AF233	0.51	BCY72	0.13	LM309K	1.88
2N929	0.30	2N3900	0.21	AF240	0.72	BCY82	0.42	LM324K	0.75
2N1302	0.19	2N3901	0.32	AF279	0.54	BCY88	0.42	LM709	0.40
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2N1305	0.24	2N3905	0.24	AL103	0.70	BD116	0.75	LD11L	0.38
2N1306	0.33	2N3906	0.27	BC107	0.18	BD121	0.75	LM723C	0.75
2N1307	0.24	2N3907	0.24	BC108	0.18	BD122	0.62	LM729	0.40
2N1308	0.25	2N4037	0.42	BC109	0.19	BD124	0.47	T099	0.40
2N1309	0.36	2N4058	0.16	BC113	0.13	BD131	0.80	BD11L	0.46
2N1671	1.44	2N4059	0.09	BC115	0.15	BD132	0.60	LD11L	0.38
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2N1711	0.45	2N4126	0.23	BC118	0.11	BD138	0.62	LD11L	0.38
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2N2102	0.50	2N4919	0.64	BC121	0.23	BD140	0.87		1.26
2N2147	0.70	2N4920	0.99	BC125	0.15	BDY20	1.05	MC1310	2.92
2N2148	0.94	2N4921	0.73	BC126	0.20	BF115	0.25	MC1458CP1	
2N2160	0.60	2N4922	0.84	BC132	0.30	BF116	0.23		0.78
2N2192	0.40	2N4923	0.85	BC134	0.11	BF117	0.43	MJ480	0.90
2N2192A	0.40	2N5172	0.12	BC135	0.11	BF119	0.58	MJ481	1.14
2N2913	0.40	2N5174	0.22	BC136	0.15	BF121	0.25	MJ490	0.98
2N2193A	0.61	2N5175	0.28	BC137	0.16	BF123	0.27	MJ491	1.38
2N2194	0.73	2N5176	0.32	BC138	0.24	BF125	0.25	MJ493A	0.42
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2N2194B	0.50	2N5191	0.95	BC141	0.29	BF123	0.25	MPSA05	0.28
2N2219	0.45	2N5192	0.24	BC142	0.24	BF124	0.18	MJ496	0.88
2N2219A	0.60	2N5195	1.46	BC143	0.21	BF158	0.23		0.68
2N2220	0.45	2N5245	0.43	BC145	0.21	BF159	0.27	MP8111	0.32
2N2221	0.41	2N5457	0.49	BC147	0.12	BF160	0.23	MP8112	0.40
2N2221A	0.40	2N5458	0.46	BC148	0.13	BF161	0.42	MP8113	0.47
2N2222	0.40	2N5459	0.49	BC149	0.12	BF163	0.32	MPF10	0.59
2N222A	0.50	40361	0.48	BC153	0.18	BF166	0.32	MPSA05	0.28
2N2368	0.21	40362	0.50	BC154	0.18	BF167	0.21	MPSA06	0.28
2N2369	0.37	40363	0.61	BC157	0.14	BF173	0.24	MPSA55	0.28
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2N2646	0.77	40394	0.58	BC159	0.14	BF178	0.35	NE555V	0.90
2N2647	1.12	40395	0.65	BC160	0.37	BF179	0.43	NE560	4.48
2N290	0.50	40406	0.56	BC167	0.15	BF178	0.45	NE561	1.46
2N290A	0.40	40407	0.63	BC168A	0.13	BF181	0.34	NE561A	4.48
2N2905	0.48	40408	0.50	BC168C	0.11	BF182	0.40	OC23	0.56
2N2905A	0.50	40409	0.52	BC169B	0.13	BF183	0.40	OC28	0.76
2N2906	0.31	40410	0.52	BC169C	0.13	BF184	0.30	OC35	0.56
2N2906A	0.37	40411	2.25	BC170	0.11	BF185	0.17	OC42	0.35
2N2907	0.40	40414	0.33	BC168	0.13	BF184	0.16	OC45	0.32
2N2907A	0.45	40430	0.85	BC172	0.11	BF186	0.17	OC71	0.12
2N2924	0.14	40583	0.23	BC182	0.12	BF196	0.15	OC72	0.13
2N2925	0.17	40601	0.67	BC182L	0.12	BF197	0.15	OC81	0.20
2N2926	0.42	40602	0.46	BC183	0.09	BF198	0.18	OC83	0.20
Green	0.12	40603	0.53	BC183L	0.09	BF199	0.18	ORP12	0.50
Yellow	0.11	40604	0.58	BC184	0.11	BF200	0.40	SC35D	1.68
Orange	0.06	40606	1.10	BC185	0.10	BF201	0.11	SC38D	1.46
0.11	40669	1.00	BC186	0.25	BF237	0.22	SC40D	1.89	
2N3053	0.32	40673	0.70	BC187	0.27	BF238	0.22	SC41D	1.32
2N3054	0.60	AC107	0.25	BC207	0.12	BF244	0.16	SC45D	1.89
2N3055	0.75	AC113	0.16	BC208	0.11	BF245	0.33	SC46D	1.98
2N3380	0.26	AC117	0.20	BC212K	0.10	BF246	0.43	SC50D	2.80
2N3391	0.28	AC119	0.27	BC212L	0.10	BF247	0.43	SC51D	2.80
2N3391A	0.29	AC127	0.25	BC211	0.21	BF254	0.18	SL414A	4.80
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2N3394	0.13	AC152V	0.17	BC239	0.09	BF258	0.59	TAA350	2.10
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2N3414	0.10	AC187K	0.23	BC259	0.13	BF229	0.30	TBA271	0.64
2N3415	0.10	AC188K	0.34	BC261	0.20	BFX30	0.25	TBA641B	
2N3416	0.15	ACY18	0.24	BC262	0.18	BFX44	0.33		2.25
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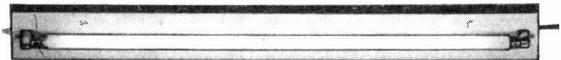
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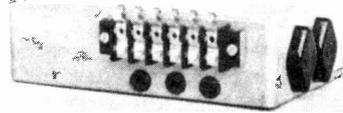
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PATCHBOARDS FOR SYNTHESISER

SYNTHESISER patchboards consist of a matrix of jack sockets by which any combination of input and output signals may be connected by inserting a shorted jack plug into the appropriate socket. A patch board for a medium sized synthesiser would require about 14 inputs and 20 outputs, making a total of 280 jack sockets which at 10p each plus the cost of plugs adds up to around £30.

The system to be described has two advantages: a system as previously described would cost only £6, and this type of patchboard can be used to programme the synthesiser.

The patchboard is made from 20 sixteen-way edge connectors, the 0.15in matrix size being the most practical. Each connector has its first and last pins wired to the output (Fig. 1). The remainder are wired to separate inputs.

In practice a piece of Veroboard also of 0.15in matrix is plugged into the connector. The first and

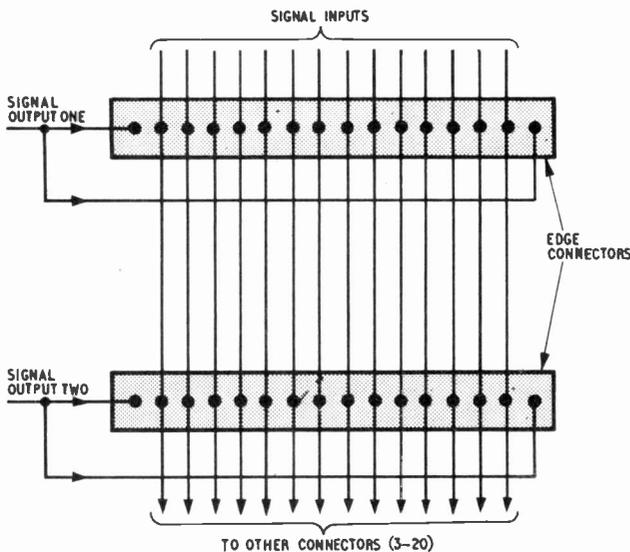


Fig. 1. Suggested wiring for the edge connectors

last copper strips on the board are joined by means of a link wire which also connects to one or more intermediate strips. This forms a link between the output and one or more of the inputs according to how the board is wired.

By removing the board it can be turned over and plugged into the same connector making a completely different link or patch between the inputs and outputs. The opposite end of the board can also be used in this way making a total of four different connections available from each board (see Fig. 2).

The programme cards can be numbered for their particular function, e.g. board No. 5 will connect output 3 to input 7, etc.

J. A. Knife,
Dagenham, Essex.

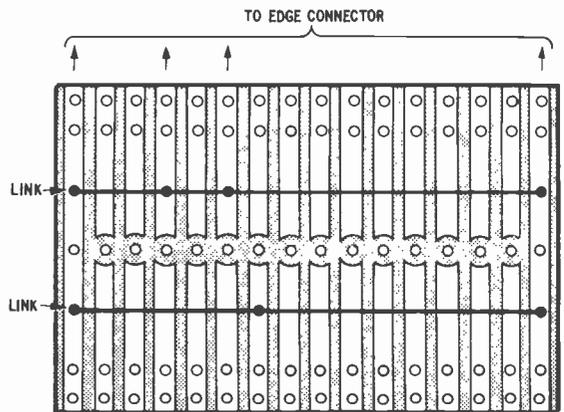


Fig. 2. Wiring details for a programme card

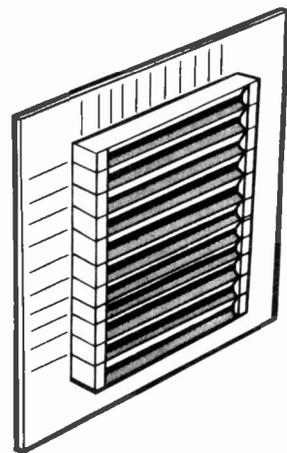


Fig. 3. Typical arrangement of connectors mounted on panel of synthesiser



BOOK REVIEWS

ELECTRONICS — A handbook for Engineers and Scientists

By G. H. Olson

Published by Butterworths

482 pages. Price £7

EVER increasingly the influence of electronics is felt by more and more people whose disciplines would traditionally have been unrelated. Probably the biggest contribution to this has come in the application of electronic techniques to measurement and control in various forms of sophisticated instrumentation. All of this has demanded an understanding of the subject, be it ever so superficial.

As a lecturer with an awareness of the "language" problem of the non-electronic specialist the author has provided a course which is qualitative and informative and will be prized as a valuable reference. The depth of subject treatment is not superficial nor does it lean towards being an examination textbook. In these, usually very little attention is paid to practical details in rigorous analyses. In the handbook these aspects are common and some useful circuits are given with details of the components.

From an introductory chapter on passive components, simple circuits containing them are analysed. Semiconductor devices are then examined (thermionic valves are eschewed throughout) followed by a chapter on indicating instruments. Next comes power supplies, then a massive chapter on the various genre of amplifier.

The concluding chapters embrace oscillators, an introduction to logic and digital circuits and measuring instruments.

Useful references for further reading are included after chapters and appendices provide the means to resolve some of the finer points mathematically.

At £7 pricey, but a good investment for the d.i.y. tyro.

G.G.

RECORDING WITH COMPACT CASSETTES

Published by Agfa-Gavaert

91 pages, 210mm × 150mm. Price 65p

THE THEORY and practice of cassette tape recording are combined in this concise, non-technical, well-illustrated book.

Besides the cassette itself there is an excellent description of the theory behind tape recording, from the conversion of sound into an electronic signal to the actual recording of the signal by the head.

The book is full of hints and suggestions for getting the most out of a cassette recorder.

Many of the illustrations are in full colour, and overall the book seems excellent value for money.

This book is just one of a series on tape recording and photography and can be obtained direct from Agfa-Gavaert Ltd., Great West Road, Brentford, Middlesex.

S.R.L.

QUESTIONS AND ANSWERS ON INTEGRATED CIRCUITS

By R. G. Hibberd

Published by Newnes-Butterworths

96 pages, 6½in × 4½in. Price 75p

AS ANY regular reader of Practical Electronics will realise, the integrated circuit is now a well-established component in modern electronics. However, the development of these devices from the unusual to the commonplace has been so rapid that many people will no doubt be feeling a little left behind.

For anyone in this position, this little book provides an excellent introduction to the field. In the form of questions and answers it gives the reader information about how integrated circuits are made, their advantages and disadvantages over discrete components, and their uses, both in the area of digital and linear electronics.

In the section on Digital Integrated Circuits there is a useful introduction to logic which is essential to the understanding of digital systems.

The book is written for students and technicians who require a simple, mainly non-mathematical, text on this rapidly widening facet of electronics.

S.R.L.

INSTRUMENT TECHNOLOGY (Volume 1)

By E. B. Jones

Published by Newnes-Butterworths Ltd.

402 pages, 9½in × 6½in. Price £5-00

THIS is a new (third) edition of a book which was first published in 1953 and forms the first volume of a three volume set dealing with Instrument Technology. The coverage of this volume is restricted to the measurement of pressure, level, flow and temperature and the treatment uses S.I. units throughout. The presentation is lucid and the mathematics have been kept as simple as possible. Together with the other two volumes of the set, this book should provide a good coverage of much of the material normally found in technician and craftsman level courses dealing with process control and instrument technology and should also prove useful as a reference text for engineers and other personnel who are not experienced in this field.

The text is well illustrated with clear diagrams, photographs and exploded views of numerous instruments which should prove useful to students especially, since they do not normally have access to such a comprehensive range of instrumentation.

Electronic devices and techniques such as the pressure sensitive transistor and the application of lasers to level measurement are not covered and the brief section on transistors, diodes and photocells does not reflect present day technology. In a work such as this the selection of material is difficult due to the wide range of instruments in current use. The author's stated aim has been to give a reasonably complete picture of the more common and more important devices in present use and this has been achieved. It is unfortunate that the price of this book will put it out of the range of the average student's pocket.

P.R.A.

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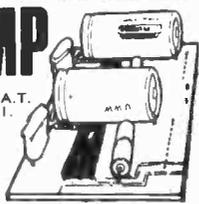


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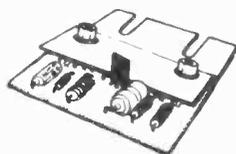
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Wharfedale Dovedale 3 (pair)	£52-00
Richard Allan Twinkit (each)	£8-25
Richard Allan Triple 8 (each)	£13-00
Richard Allan Triple (each)	£18-50
Richard Allan Super Triple (each)	£21-50
Goodmans DIN 20 (each)	£8-75
Fane Mode 1 (each)	£9-90
Peerless 3-15 (3SP.) (each)	£15-00
Kefkit 2 (each)	£23-50
Kefkit 3 (each)	£34-00
Helme XLK25 (pair)	£18-17
Helme XLK50 (pair)	£37-18
Helme XLK30 (pair)	£14-95
Baker Major Module	£10-75
P.A. and Hi-Fi speaker cabinets. Send for Free booklet "Choosing a Speaker". Carr. and Insurance 75p per kit (£1-50 pair).	

PA/Disco Amplifiers

(Carriage and Insurance £1)	
Baker Major 100 watt	£46-00
Linear 30/40	£25-00
Linear 40/60	£30-00
Linear 80/100	£55-00

Radios/Cassettes

Grundig Soio Boy	£16-00
Grundig Top Boy	£17-75
Grundig Party Boy 500	£22-75
Grundig Melody Boy 500	£26-75
Grundig Elite Boy 500	£26-75
Grundig Signal 500	£26-50
Grundig Yacht Boy 210	£34-00
Grundig Melody Boy 1000	£38-75
Grundig Satellite 2000	£121-00
Grundig C410 Cassette	£28-50
Grundig RF430 mains radio	£26-75
Grundig RF310 mains radio	£22-00
Tanberg TP41	£43-00
ITT Weekend Auto	£18-00
ITT Golf Preset	£24-50
ITT Colt	£11-50
ITT Europa	£20-50
ITT SL53 cassette	£25-75
ITT Studio 60M cassette	£32-75
ITT Studio 73 cassette	£48-00
Bush VTR178, 5 band (inc. air)	£29-00
Koyo KTR1770 11 band	£58-95
Koyo KTR1663 or 1664, 8 band	£42-00
Koyo KTR1883, 5 band	£22-00
Murphy BA209 radio/cassette	£32-75
Carriage and Insurance 75p. FREE with each radio—World radio stations book.	

Free with speaker orders over £7—

"Hi-Fi Loudspeaker Enclosures" book. All units guaranteed new and perfect. Prompt despatch.

Carriage 35p per speaker (tweeters and crossovers 20p).

ALL PRICES QUOTED INCLUDE VAT

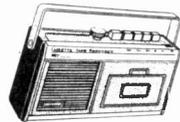
WILMSLOW AUDIO

Dept. PE

Loudspeakers: Swan Works, Bank Square, Wilmslow, Cheshire, SK9 1HF.

Radios, etc.: 10 Swan Street, Wilmslow, Cheshire. Telephone: Wilmslow 29599

The items below are from the April Supplement to our 1974 Catalogue. You can receive this Catalogue and the next 12 supplements by sending 86p.



THIS MONTH'S SNIP Cassette Tape Player Recorder

With dynamic microphone. First class Jap. made tape recorder and player. Pushbutton operated and with automatic level control of recording. Standard cassettes clean jacks for intc. (which has motor stop/start switch) for recording from radio and for being powered by mains. A bargain at £89.95 plus 35p post, etc.

Mullard Unilex. The 4 Mullard modules—2 EP9000, 1 EP9001, 1 EP9002, for £7.50 plus 30p post. The control panel kit, with spun aluminium faced knobs and silk screened front plate cannot be added, but at least we will hold the price at £3.80 despite increases in prices.

Spartan Portable Radio. Long and medium wave band, telescopic pull up aerial, leather carrying case, size approx. 6in x 4in x 2in. 7 transistors ferrite rod aerial. Uses comparatively large speaker, so tone better than average. Brand new in original packing case, untested, only £1.95 each.

Instant Start! Fluorescent Lighting bargains. Starter-less control gear, resin filled, super-silent cool running, by very famous maker. 4ft 40W £1.50, 5ft 65W £1.60, 5ft 80W £1.75, 6ft 85W £1.95. These at about one half of maker's current prices and can't be repeated once stocks are cleared: Add 20p per piece carriage.

Bulk head aerial lead out. 2 cone shaped porcelain insulators with cork wafers for waterproofing and OBA brass rod passing through centre, terminal heads top and bottom. Price 75p each.

Message tapes. 250ft best quality PVC tape (USA made) on a 3in spool. Packed in small mailing box. 30p each. 3 for 75p.

Mains transformer 12V-0-12V 1 amp. Small construction for instruments, size approx. 1in cube, upright mounting with fixing lugs. £1.84.

Output Transformer. Ratio 140:1 midget size 1in x 1 1/2in x 1 1/2in. Primary impedance 450 ohms, connections by flying leads, upright mounting. 46p.

Output Transformer. Ratio 80:1, small size, approx. 1 1/2in x 1in x 1in, printed circuit board connection. 56p.

Light cell. Has almost no resistance in sunlight but increases to over 200k in the dark. Size not much more than the top of a pencil with wire leads. 22p. Clock movement has hour and minute hands which are fairly easy to extend in any length required. Mains operated, has switches but these are easy to remove. The movement made by Smiths, very reliable, price £2.

Planning for your holiday! Don't forget your *mini immersion heater* to make your hot drinks. Room service is usually not all that can be desired in holiday hotels and you will save the cost of your immersion heater on your first holiday, even though they have gone up slightly in price. Post and VAT paid, £1.90 each. If going camping, we have a 12V battery model, 10p more.

Mains induction motor. 1in stack with 1in diameter spindle protruding from each end. This motor is particularly well made and quiet running, good quantities in stock. Price 65p.

0-100 micro amp meter. Large oblong, full vision front, size 4 1/2in x 3 1/2in approx. Good quality Japanese made, moving coil meter. £3.85.

Mains suppressor adaptor for preventing or reducing interference caused by office machines, vacuum cleaners, sewing machines, etc. This plugs into a 3 amp socket and takes a 3 amp plug. Its rating, however, is 4 amps. Limited quantity. 45p each. 50 cycle to 60 cycle inverters. For operating American instruments and other equipment made for 60 cycles 115V from 230/240 50 cycle mains. These units have an output of 115V a.c. and will handle a load of up to 100W. These are precision made and have a reed type frequency meter which vibrates when the frequency is exactly 60 c.p.s. Adjustment of the frequency is by a knob on control panel. Input by 3 core output from 3 pin socket. Original cost of this in excess of £60. A limited quantity available £25 each.

Reed Relay. Glass encapsulated reed switch in 24V solenoid, neatly enclosed in neat metal case, size 2 1/2in x 1 1/2in x 1 1/2in. Operates from 24V d.c. or from a.c. mains. Price 35p each.

Battery Model, Balfour Auto-charger. As mains model but for 24V operation, also these are new ex-factory stock not returned export. Less carriage £6 each plus £1 post and insurance.

TERMS: Add 10% V.A.T.

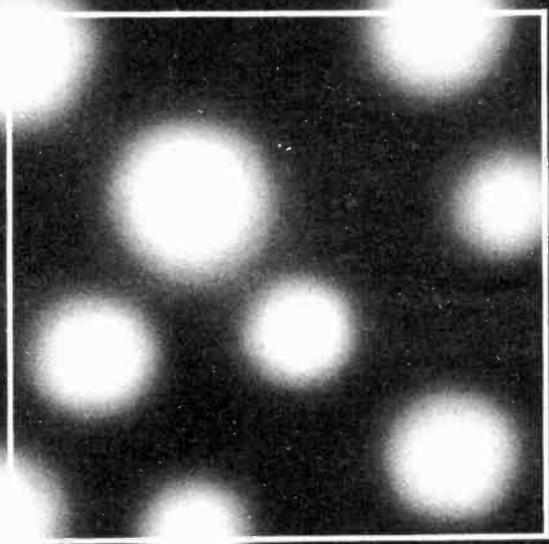
Send postage where quoted—other terms, post free if order for these items is £6.00, otherwise add 20p.

J. BULL (ELECTRICAL) LTD.

(Dept. PE), 7 Park Street
Croydon CR0 1YD Callers to:
102/103 Tamworth Road, Croydon

RANDOM LIGHT DISPLAY

By K.L. SPENCE



THIS article describes a Random Light Display which, unlike most light displays, is not driven by an audio signal.

The unit consists of nine or more coloured lamps positioned behind a semi-transparent screen. Each lamp flashes on and off in an apparently random manner, without an overall fixed sequence. The resulting effect is to fill the screen with a blaze of mixing and changing colours forming a fascinating display.

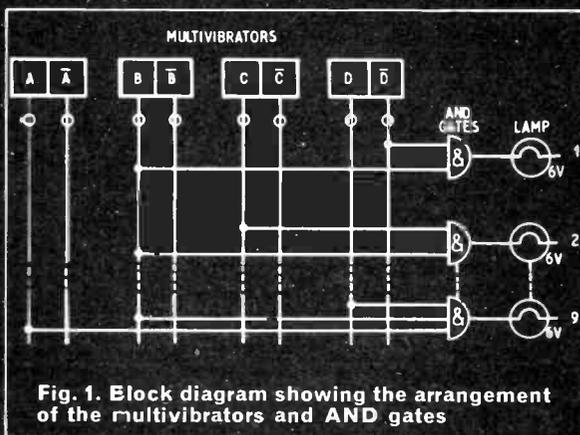


Fig. 1. Block diagram showing the arrangement of the multivibrators and AND gates

METHOD OF OPERATION

The apparent random effect is achieved by using four slow-running multivibrators each with different frequencies and mark-space ratios.

Each lamp is driven by gating together the outputs of two or more multivibrators using a logic AND gate. The system is illustrated in Fig. 1, which shows the overall arrangement of the multivibrators and AND gates.

It can be seen that lamp LP1 will only light when multivibrator outputs B and D are high, i.e. logic 1; lamp LP2 requires outputs B and C high, and lamp LP9 requires A, B and D high.

CIRCUIT DETAILS

The circuit diagram of a multivibrator is shown in Fig. 2. Four of these are required, the values of the timing capacitors C1 and C2 being given in the table.

The AND gate and lamp driver circuit is shown in Fig. 3.

The gate may have two, three or four diode inputs. If any of the inputs is taken to 0V by a multivibrator output then current will flow down resistor

COMPONENTS . . .

MULTIVIBRATORS—4 OFF REQUIRED

Resistors

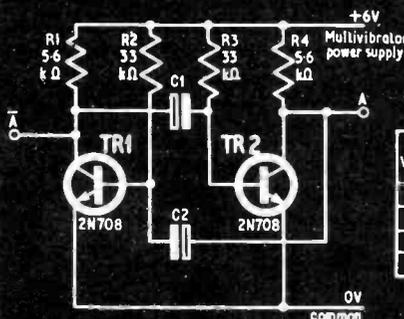
R1, R4 5.6k Ω (2 off)
R2, R3 33k Ω (2 off) } 1/4W 10% carbon

Capacitors

C1, C2 see table

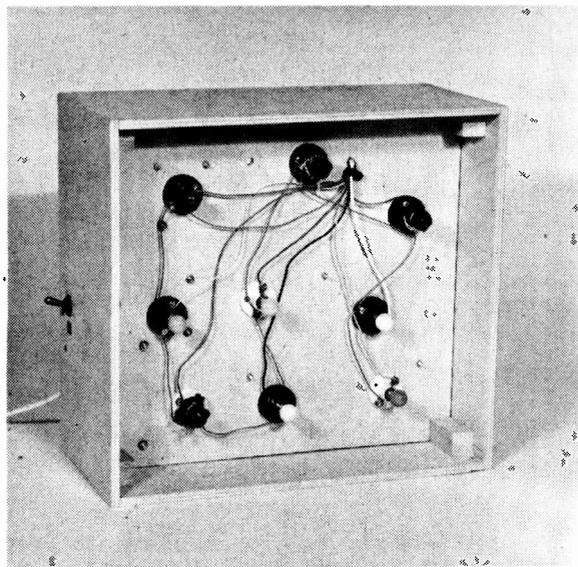
Transistors

TR1, TR2 2N708 (2 off)



MULTI VIBRATOR	C1 μ F	C2 μ F	CYCLE TIME SECS
A	100	50	3 1/2
B	250	150	9
C	50	25	2
D	250	100	8

Fig. 2. Circuit diagram of a single multivibrator circuit. The table shows the values of the timing capacitors for the four multivibrators required



Photograph showing a front view of the completed unit with the cover removed

R1 and the voltage at TR1 base will not be sufficient to switch on transistors TR1 and TR2 which need about 1.4V to be forward biased.

However, if all inputs are at 6V then the diodes will be reverse biased and the current through R1 will flow into the base of TR1 causing it and TR2 to conduct and the lamp to light.

COMPONENTS . . .

AND GATE/LAMP DRIVERS—9 OFF REQUIRED

Resistors

R1 8.2kΩ ½W 10% carbon

Diodes

D1-D4 OA200 (4 off, or as required)

Transistors

TR1 2N708

TR2 BFY52

Lamps

LP1 6V 0.3A m.e.s. with lampholder

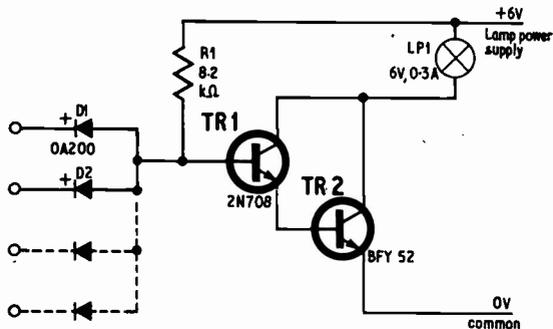


Fig. 3. Circuit diagram of a single AND gate/lamp driver circuit. Nine of these are required. The number of diode inputs may be two, three or four

COMPONENTS . . .

POWER SUPPLY

Resistors

R1 82Ω ½W 10% carbon

Capacitors

C1 500μF 12V elect.

C2 250μF 12V elect.

Diodes

D1-D4 50V 5A bridge rectifier

D5-D8 50V ½A bridge rectifier

D9 6.2V 400mW Zener

Transformer

T1 Mains primary, 6.3V 3.6A secondary

T2 Mains primary, 6.3V ½A secondary

Miscellaneous

S1 2 pole mains on/off

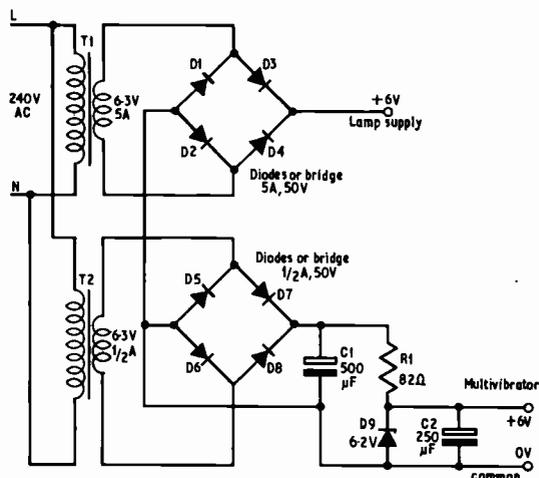


Fig. 4. Circuit diagram of the power supply. This provides a smoothed supply for the multivibrators and unsmoothed supply for the lamps

POWER SUPPLY

The power supply is shown in Fig. 4. It has two 6V outputs, one is smoothed for the multivibrators and the other is unsmoothed for the lamps.

The components specified are widely available, though discrete diodes instead of a bridge may be used if desired.

CONSTRUCTION

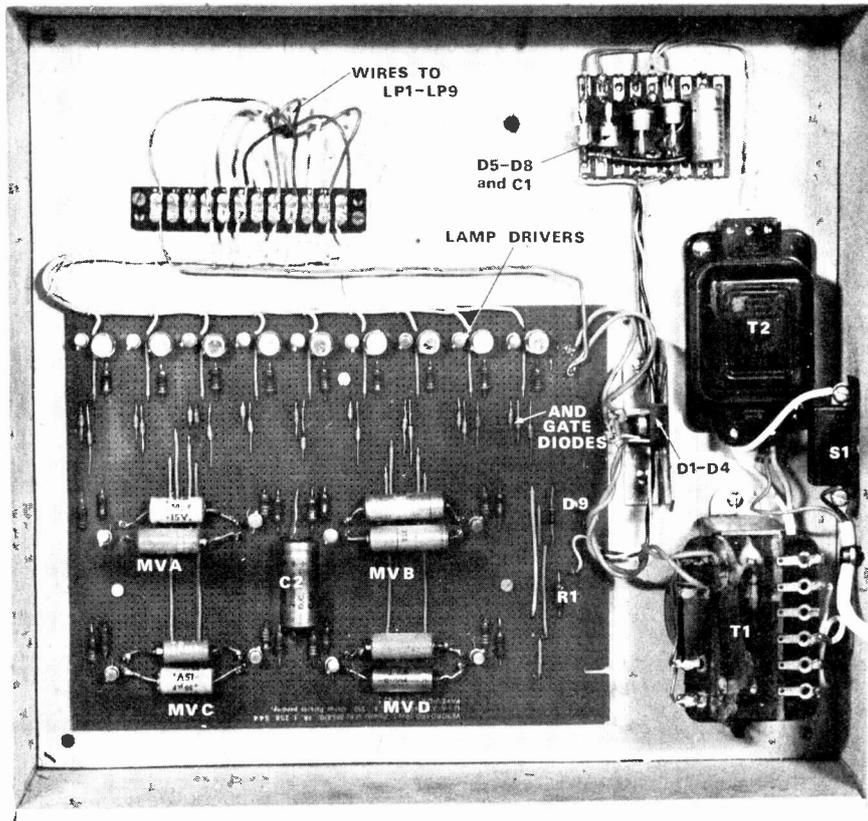
Component layout is not at all critical and the circuits may be built on any type of wiring board.

The author used a large piece of 0.1in Veroboard, the general arrangement being seen in the photograph. Fig. 5 shows the multivibrator circuits and the lamp driver circuits in more detail. Four of the multivibrators and nine lamp drivers are required.

It is useful to provide a wiring pin for every multivibrator output and gate input as this greatly simplifies the cross-connections.

It is advisable to first construct and test all the multivibrators and gates and then make the connections between them.

The constructor is free to choose for himself which outputs to connect to each gate, the only restriction being that both the outputs of a particular

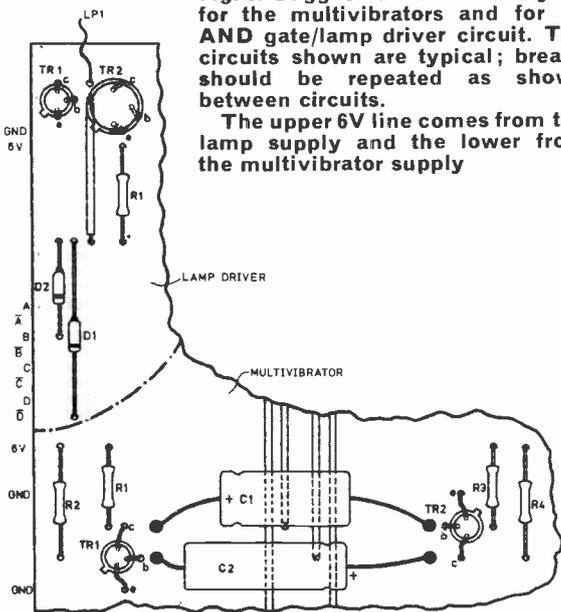


Photograph showing the general arrangement of the components at the rear of the box. The power supply Zener diode, resistor R1 and capacitor C2 are mounted on the Veroboard which carries four multivibrators (MVA to MVD) and nine AND gate/lamp drivers

multivibrator must not be connected to the same gate, as this would mean the lamp would never light.

Fig. 5. Suggested Veroboard layout for the multivibrators and for an AND gate/lamp driver circuit. The circuits shown are typical; breaks should be repeated as shown between circuits.

The upper 6V line comes from the lamp supply and the lower from the multivibrator supply



The gates may have two, three or four inputs but it should be remembered that gates with four inputs will only be enabled very infrequently compared with the two-input gates.

Photographs illustrate the general manner of construction with lamps in the front of the box and the circuits behind.

The overall size is governed by the number of lamps the constructor decides to use. The prototype measured 15in × 15in × 6in and had nine lamps.

FRONT SCREEN

The front screen consists of a wooden frame covered with thin white cloth or tracing paper. A sheet of Perspex is then fixed on the front for protection.

The lamps may be any 6V types and they may be covered with coloured Cellophane or painted.

MODIFICATIONS

The unit described in this article may be extended to many more lamps and multivibrators providing the transformer can handle the power output.

Higher wattage lamps could be used by incorporating thyristors in the lamp driver circuits. It could also be interesting to have a mixture of AND and OR gates instead of only AND gates.

The values of the timing capacitors can be changed to give more rapid or slower changes as the constructor desires.

F.M. STEREO TUNER

BY R.A. COLE

THE Rondo system is designed specifically to accept a variety of inputs to suit individual constructor's tastes. However, the initial design concept included the basic idea of providing as many facilities as possible within the one unit. One of the most important to many constructors will of course be the stereo tuner and associated decoder and Part 8 will initiate the discussion of these two items.

GENERAL CIRCUIT

The basic system for an f.m. tuner and decoder is shown in block form in the accompanying Fig. 8.1 and the complete circuit in Fig. 8.2. A varicap-tuned head feeds its output to a wide-band amplifier, a ceramic filter, a further i.f. amplifier and finally to the stereo decoder. Movement of the varicap potentiometer VR1 is indicated on a suitable tuning dial and a tuning meter indicates signal level.

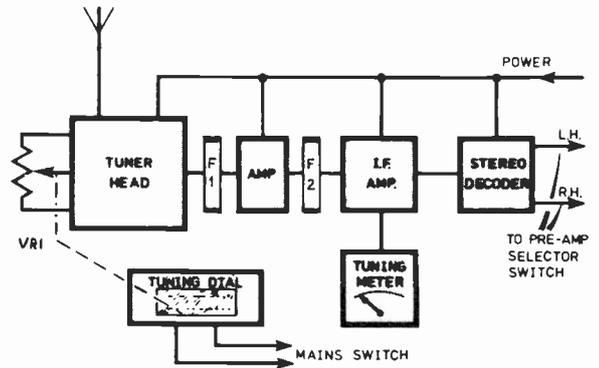


Fig. 8.1. Block diagram of the f.m. stereo tuner/decoder arrangement for the Rondo system

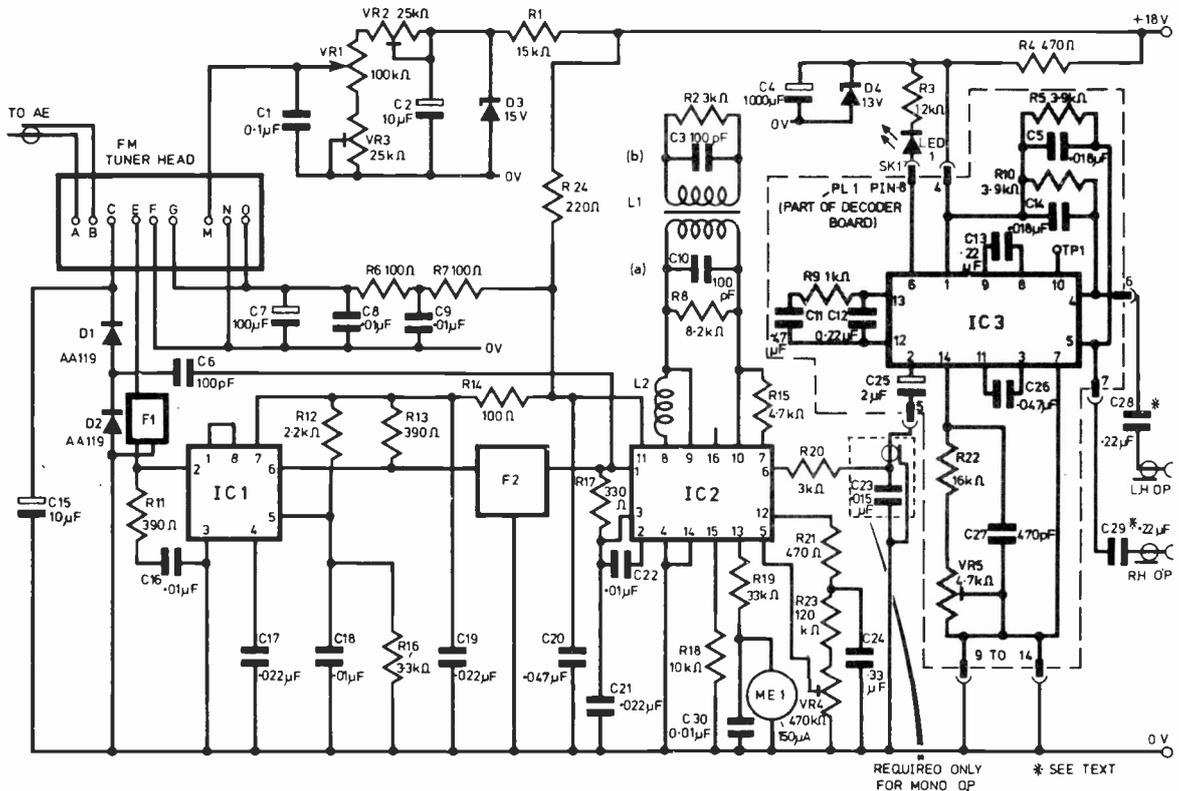


Fig. 8.2. Full circuit diagram of the tuner and decoder with the decoder board shown shaded

STEREO DECODER

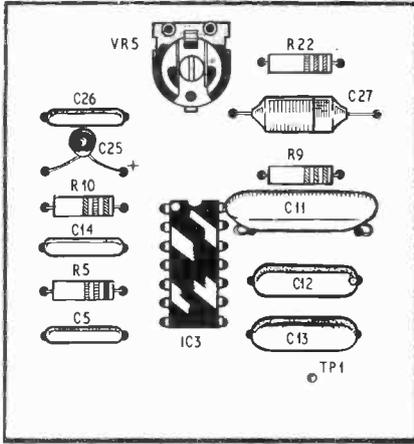


Fig. 8.4. Component layout on p.c.b. for the stereo decoder



Fig. 8.5. Master p.c.b. copper layout for the decoder board

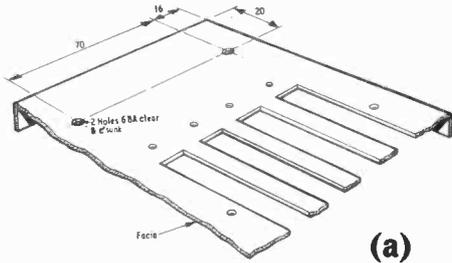
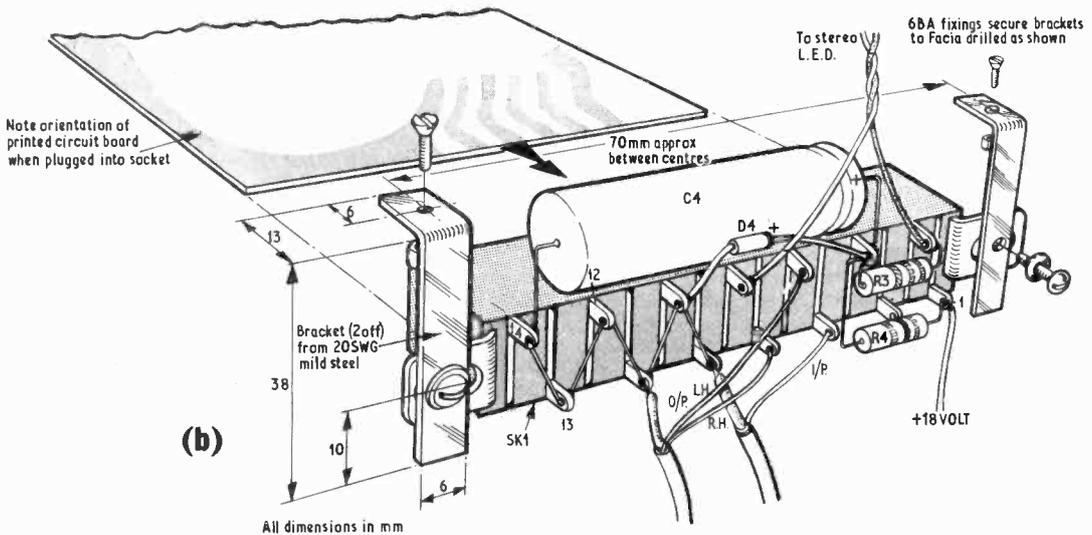


Fig. 8.6. (a) Rear right-hand corner of fascia panel (see Fig. 4.1). (b) Details for the mounting of the decoder board edge connector and associated carrying brackets, their location in the main assembly, and the positioning of some off-board components



PE RORDO

COMPONENTS . . .

Resistors

R1	15k Ω	R13	390 Ω
R2	3k Ω	R14	100 Ω
R3	1.2k Ω	R15	4.7k Ω
R4	470 Ω	R16	3.3k Ω
R5	3.9k Ω	R17	330 Ω
R6	100 Ω	R18	10k Ω
R7	100 Ω	R19	33k Ω
R8	8.2k Ω	R20	3k Ω
R9	1k Ω	R21	470 Ω
R10	3.9k Ω	R22	16k Ω , $\frac{1}{2}$ W, 2%
R11	390 Ω	R23	120k Ω
R12	2.2k Ω	R24	220 Ω

All $\frac{1}{2}$ W, 5% except where stated

Capacitors

C1	0.1 μ F	C18	0.01 μ F
C2	10 μ F, 25V	C19	0.022 μ F
C3	100pF Polystyrene	C20	0.047 μ F
C4	1,000 μ F	C21	0.022 μ F
C5	0.018 μ F	C22	0.01 μ F
C6	100pF Polystyrene	C23	0.015 μ F, De-emphasis
C7	100 μ F, 16V	C24	0.33 μ F
C8	0.01 μ F	C25	2 μ F or greater, Tantalum bead preferred
C9	0.01 μ F	C26	0.047 μ F
C10	100pF	C27	470pF, 2% Polystyrene
C11	0.47 μ F	C28	0.22 μ F
C12	0.22 μ F	C29	0.22 μ F
C13	0.22 μ F	C30	0.01 μ F
C14	0.018 μ F		
C15	10 μ F, 25V		
C16	0.01 μ F		
C17	0.022 μ F		

Potentiometers

VR1	100k Ω Lin
VR2	25k Ω Lin preset
VR3	25k Ω Lin preset
VR4	470k Ω Lin. preset
VR5	4.7k Ω Lin. preset

Diodes

D1	AA119
D2	AA119
D3	BZY88, 15V Zener, 400mW
D4	BZY88, 13V Zener, 400mW
LED1	Light emitting diode

Integrated Circuits

IC1	CA 3053
IC2	CA 3089E or TDA 1200
IC3	MC1310P or CA1310E

Inductors

L1	Single quadrature, KACS K586 HM or Double quadrature TKACS 34343 AVO and TKACS 34342 AVO from Toko U.K.
L2	R.F. Choke, 22 μ H

Miscellaneous

Head	Larsholt 8317-501 stereo tuner head, f.m.
Tuning meter ME1	0-150 μ A Full-View panel meter
Ceramic Filters F1, F2	CFS 107M (Toko)
Assorted wire, co-axial cable, p.c.b., 14-way edge connector, metalwork brackets, nuts and screws etc.	

decoder switching to stereo mode when the audio is too weak to give good signal-to-noise ratio.

Indication of stereo presence is given by the light emitting diode LED1 which is wired in series with a 1.2k Ω resistor. This latter drops the voltage across the diode to around 1.6V at 20mA. As most diodes give adequate light emission at this current this seems sensible even though the i.c. is capable of driving up to 100mA if necessary.

The decoder and associated de-emphasis components are mounted on one board as shown in Fig. 8.4. The master negative for this board is shown in Fig. 8.5 and two combined scrap views show the orientation of the board in its edge connector and the mounting of this latter under the master tone control board in Fig. 8.6.

Assembly of the decoder board follows normal p.c.b. assembly procedure although it will be noted that several components from the decoder and tuner-associated circuitry are in fact mounted in the wiring, as it were. Thus R3 and R4, C4 and D4 are all mounted on the edge connector carrying the decoder board. The l.e.d. is mounted in the tuner fascia just above the tuning meter. C28 and C29 can be mounted on the pre-amplifier board.

Wiring from the decoder board is passed down the side of the fascia to the fanning-strip/switch assembly described in the last part for interconnection to the remainder of the looming.

OSCILLATOR ALIGNMENT

When the tuner/decoder system has been completed it is necessary to set the decoder oscillator. This is a simple procedure requiring that one tunes to a known broadcast and then adjusts VR5 until the pilot light illuminates. This of course assumes a stereo broadcast is taking place.

Stereo output should now be heard from the loudspeakers.

If an oscilloscope is to hand the adjustment can be made perhaps more accurately by connecting the scope to the v.c.o. test point TP1 (pin 10 of the i.c.) and adjusting VR5 until a 19kHz waveform (55 μ s cycle time) appears. Equally, a counter/timer could be used to register 19kHz.

Tolerance of this value is ± 3 per cent or 580Hz either side of 19kHz.

I.C. HOLDERS

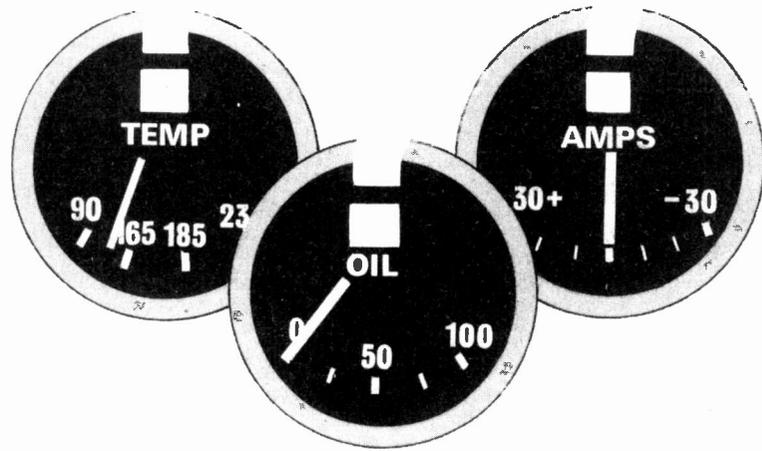
An important point is the use of i.c. holders with these types of i.c.s. It is always advisable to use holders since this gives the obvious advantage of being able to remove the i.c. later and in any case some manufacturers revoke their guarantee if their particular products have been soldered in position as there is always the risk of thermal damage occurring.

It will be appreciated that each additional item of equipment inserted in the Rondo is an extra load applied to the power supply. In general terms this is no problem since the p.s.u. is well able to deal with the demand placed on it. However, the problem is easily overcome if it does arise by simply turning TR6 of Fig. 3.1 in Part 3 "on" a little more. This can be achieved by simply lowering the value of R32 in the same figure to 470 Ω .

Next month: Construction details for the tuner board and mechanical assembly

CAR SYSTEMS MONITOR

BY J.P. PERRY



EVEN in this day and age it is not unusual to find cars stranded at the side of a motorway after having suffered boiling perhaps through loss of a fan belt or a burst hose.

Remembering that most vehicles are fitted with some form of temperature indicator for water temperature this sort of event only serves to indicate just how little attention is paid to the various dials by a driver, particularly when coping with things like motorways.

Oil, water and indeed battery charge, are all indicated visually and their loss, which can occur quietly and seemingly unnoticed, can have very damaging results including seized engine bearings or the like. So clearly what is needed is some form of audible indication in the event of failure of these parameters.

The present circuit was designed to give an instantaneous audible alarm if water temperature, oil pressure or generator output assume a fault condition.

The circuit is fairly simple and would probably cost in the region of £3 which is cheap in comparison with the cost of replacing a damaged engine or even carrying out a minor repair with labour costs in the £3 per hour region.

PRACTICAL CIRCUIT

A circuit is shown in Fig. 1. Three inputs can be connected to detect the presence or absence of voltage at for example the car temperature gauge, the ignition warning light and the oil pressure switch. In each case if the respective point is connected to chassis (earth) an alarm condition can be said to exist.

If this occurs current is taken by the associated one of the three diodes D1, D2 or D4. TR3 becomes saturated and 12V is applied to the astable TR4/TR5. Protection diodes D6 and D7 prevent the breakdown of the base/emitter junctions of these latter devices.

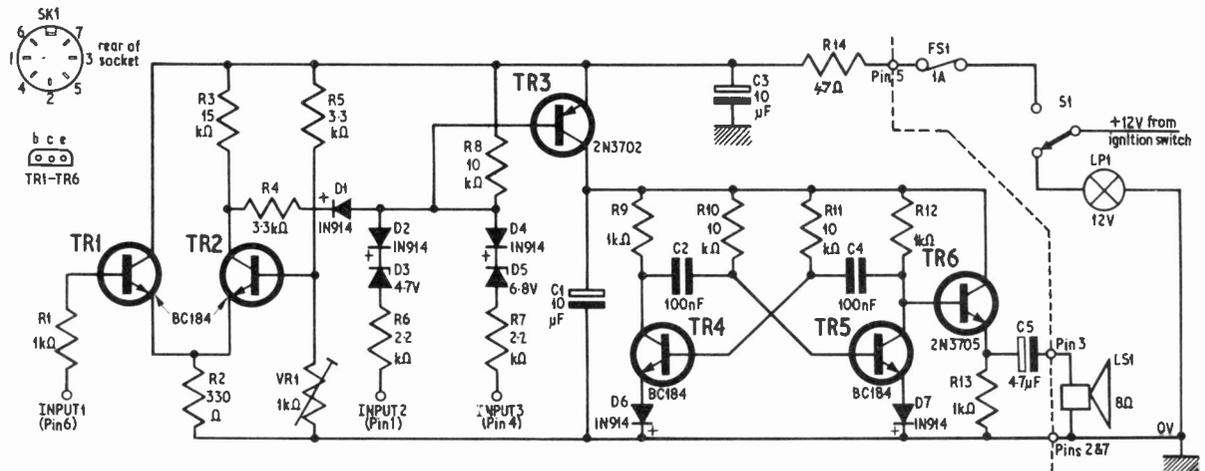


Fig. 1. Circuit diagram of Monitor

The astable is connected to a final transistor TR6 to drive a loudspeaker which may be any 2 to 3 inch 3 to 30 ohm device. The level of output is variable by choice of a suitable value for R13, 1k Ω being a suitable value to start with.

LAYOUT

Veroboard is used for the layout and cutting pattern and component locations are shown in Fig. 2.

No particular problems exist as far as the board is concerned except perhaps with the diodes with which care should be taken when bending the leads to avoid cracking the glass bead.

Whilst the circuit is shown for negative earth vehicles, the positive earth version can be catered for quite simply. It only requires that the *nnp* transistors be replaced with *pnp* and the *pnp* with *nnp*, that the diodes be reversed and the electrolytic capacitors similarly turned round.

Whilst BC184's are specified together with 2N3702's and 1N914's almost any small signal transistors and diodes can be used.

TESTING

Before wiring in to a vehicle it is best to check that all is functioning properly. Simply apply the 12 to 15V supply and temporarily connect input 1, the water temperature gauge input, to +12V. There should be no output.

If now any one of the inputs are connected to ground, an output should be obtained at the loudspeaker.

The volume of this buzz can be varied by selecting R13 to suit requirements.

CASE

Thus far we have only discussed a Veroboard assembly which, for use in a vehicle, should obviously

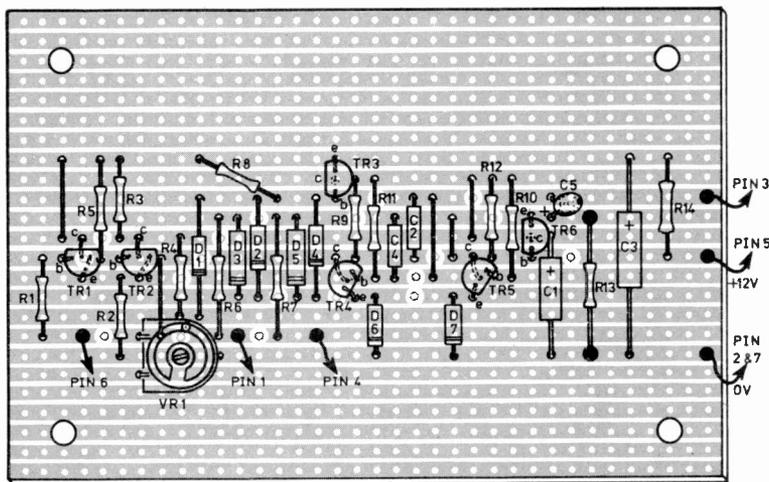


Fig. 2. Component layout on Veroboard, the copper track cuts being shown as white cut-outs

COMPONENTS . . .

Resistors

R1	1k Ω	R8	10k Ω
R2	330 Ω	R9	1k Ω
R3	15k Ω	R10	10k Ω
R4	3.3k Ω	R11	10k Ω
R5	3.3k Ω	R12	1k Ω
R6	2.2k Ω	R13	1k Ω (see text)
R7	2.2k Ω	R14	47 Ω

All $\frac{1}{4}$ W carbon film

Potentiometers

VR1 1k Ω preset

Capacitors

C1	10 μ F electrolytic 16V
C2	100nF ceramic
C3	10 μ F electrolytic 16V
C4	100nF ceramic
C5	4.7 μ F Tant. bead. 35V

Transistors

TR1, TR2, TR4, TR5	BC184 or BC182, BC183, BC107, BC108, BC109
TR3	2N3702 or 2N3703
TR6	2N3705 or 2N3704, BC182, BC183, BC184, "L" types

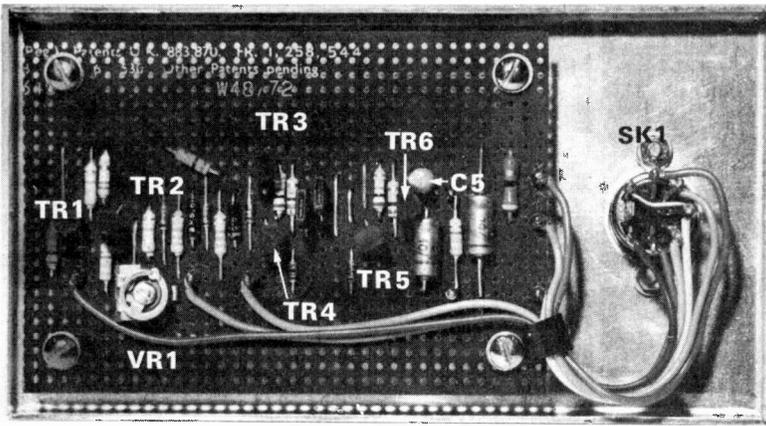
Note that when selecting alternatives care should be taken with the pin connections.

Diodes

D1, D2, D4, D6, D7	1N914 or 1S914, 1S44, 1N4148
D3	BZY88 4.7V Zener, 400mW
D5	BZY88 6.8V Zener, 400mW

Miscellaneous

SK1 6-pin DIN.
Veroboard, Veropins, aluminium box, connecting wire, fuseholders, switch and lamp if required, solder, etc.



Interior view of Systems Monitor showing completed unit

be cased in some form of protective box. In the prototype this took the form of a simple aluminium case and lid, with the Veroboard mounted on support pillars in the lid.

Wiring access to and from the circuit is provided via a 6-pin DIN socket SK1 mounted in the lid. As the whole assembly of lid and board is only a matter of an inch deep clearly the box can be quite shallow but it is best to use a box which can be screwed up and properly sealed against ingress of moisture from the engine compartment or wherever it is located on the vehicle.

INSTALLATION

It is probably wisest when installing any equipment in a vehicle to first of all disconnect the battery so as to avoid any damage from inadvertent shorts. Power supply to the unit is connected from the ignition switch, switched side and the inputs 1, 2 and 3 are connected respectively to the water temperature warning light or thermometer, the oil pressure warning light or block switch and the

generator output terminal or terminal "A" on the ignition light.

The battery may now be reconnected and no output should be obtained.

If the constructor has wired in the extra components S1, FS1 and LP1, then when the ignition is switched on LP1 should come on but there should still be no output. Switching S1 to the "on" position should extinguish LP1 and the unit is now "armed" for operation. In fact an output should be obtained because of course there is no oil pressure or generator output.

Starting the car should silence the output but if this fails it may be necessary to adjust VR1.

The vehicle should now be driven round for a while till engine temperature reaches its normal level and VR1 is again adjusted till the output buzz is just extinguished. This is all the setting up required with the possible exception of small adjustment to make up for the difference between summer and winter temperatures.



BOOK REVIEWS

I.E.E. REGULATIONS FOR THE ELECTRICAL EQUIPMENT FOR BUILDINGS
224 pages. Price £1.50

IN Great Britain, the Institute of Electrical Engineers has, since 1882, issued rules and regulations relating to electrical installations in general.

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They are completely accepted by the Electricity Board, Local Authorities, Insurance Companies and consulting engineers as standard practice in the industry.

Issues are available from I.E.E., P.O. Box 8, Southgate House, Stevenage.

NEWS BRIEFS

OBITUARY

THE name Bulgin must be one of the best-known in the electronics field in Britain. Certainly every follower must have used plugs, sockets and so on bearing this name.

Thus it is with great sadness that we mourn the passing of Arthur F. Bulgin, O.B.E. the founder of the company bearing his name. He has served our industry for 51 years and, indeed, his country as well, and it is a mark of his astute judgement that the A. F. Bulgin company is the only one in the industry to show a steady rate of growth since the last war.

Chairmanship of the company continues in Mr Bulgin's son, Mr Ronald Bulgin, M.A., C.Eng., M.I.E.E., who also shares joint managing directorship with A.F.B.'s brother, Mr Stanley Bulgin.

.....tuning in to ESP

Our correspondent, Peter Verwig, recently attended the IEEE Intercon show in New York. Among the usual mass of technical and marketing papers read at the conference was a session on "New Advances in Parapsychology".

The chairman of the technical programme committee, Jack Raper, was one of the doubters on the advisability of including a parapsychology session in the International Convention and Exposition of the Institute of Electrical and Electronic Engineers in New York. In the end, the session went ahead and, if not exactly a sensation, it certainly caused a stir among the coolly-calculating, logically-minded scientists and engineers who formed the audience.

LECTURERS

The one aspect in favour of the session was that though the speakers may have had odd ideas, some of which might be classified as kinky, they did at least have the credibility of being engineers with normal levels of engineering objectivity and were clearly not the crankier type of mystic living on emotion rather than scientific fact.

Two of the speakers, E. Douglas Dean and John Mihalasky were from the Newark College of Engineering and the third, James B. Beal, hails from NASA, Huntsville, though he was careful to point out that he was speaking as a private person and NASA was in no way involved.

All three speakers were firmly convinced that such phenomena as extrasensory perception (ESP), precognition and telepathy were not only possible but also capable of detection and measurement in the scientific sense although much remains to be done.

TELEPATHY

The main practical work of E. Douglas Dean has been in telepathy. For his experiments he uses the plethysmograph, an instrument used in medicine for over a hundred years. It records a change in volume with correlation against blood circulation in the extremities of the body, for example the finger tip.

In the ordinary way a person has no control over any variations, but it has been shown that what we might loosely term "emotion" causes involuntary vaso-constriction leading to a lowering of blood volume in the measured part of the body. Dean's apparatus is considerably more sensitive than the old medical

plethysmograph and incorporates a pressure capacitance diaphragm pick-up and a continuous chart recorder which records the normal pulse of the heartbeat and any vaso-constriction as a pronounced dip below the average baseline.

The "subject" lies on a couch with a finger connected to the instrument and in an adjacent room the "agent" picks up a card on which is inscribed a name which may or may not have significance for the subject. Some cards are blank. The subject doesn't know what is on the cards, or the order in which they are shuffled.

The agent looks at each card for twenty seconds. Blank cards showed no response and cards with names only showed subject response on the recording pen when they had some emotional significance, for example a close relative, and the pen deflection was most pronounced when there had been recent anxiety or other strong emotion in connection with the name.

In one test the subject's two-day old new-born baby's name was on the card and the resulting vaso-constriction was so severe it took over a minute for the recorder to return to baseline.

The experiments were repeated with the agent enclosed in a fully electrically screened room and this had no effect, indicating that whatever the communication medium between agent and subject it was not affected by screening. Long distance tests have been completed north to south from New York to Florida, a distance of 1,200 miles, and east-to-west from Newark, New Jersey, to Bordeaux, France. Amazingly, the effect was also recorded with the agent 35ft under water in Florida and the subject 4,000 miles away in Zurich, Switzerland.

The underwater test opens up the possibility of communicating with submarines submerged at great depth, of greatest potential value in the event of disabling disaster. The technique would involve the use of pre-arranged time slots and the Morse code with stimulus, for example, representing a dot and non-stimulus being a dash. The data rate would be very slow but over a period of hours it is thought that comprehensible communication could be possible.

An important finding by Déan is that using electronic equipment to establish emotional response shows scientifically that one person in every four has some level of ESP ability.

FIELD EFFECTS

James B. Beal maintains that electric fields have important effects on the body. He has gone as far as to fit a 500V positive field generator in his car to alleviate fatigue. He has also reared beans in a 2,000V positive electrostatic field and recorded a four-day earlier germination compared with a control group outside the field.

The same apparatus was used on a badly asthmatic child with beneficial results. Tests on typists showed an enormously lowered error-rate if they sat in a strong field.

Beal recalls that the ancient Chinese knew, perhaps instinctively, that beneficial health, mental and spiritual qualities could be obtained by proper geophysical orientation of homes and religious shrines in relation to the earth's magnetic poles, subterranean streams, geology and topology. It is even suggested that many mental patients are not ill but merely hypersensitive to field effects and, of course, it is well established that natural phenomena such as hot winds containing an excess of positive ions, especially in the Middle East, induce both physical and mental maladies in the population.

It was also suggested by Beal that ESP can be developed in suitable subjects by teaching machines. One such is commercially available.

SEEING THE FUTURE

Working on precognition (seeing into the future), especially in the realm of creative ideas in engineering and business has been studied for many years by Dr. John Mihalasky.

The successful engineer or businessman is often said to have intuition or insight in addition to ordinary levels of logical thought. The brilliant solution to a problem is often conceived "in a flash" from the unconscious mind spontaneously and frequently at very odd times and in peculiar circumstances.

SOLAR POWER AND ITS APPLICATIONS FOR TODAY

BY P. S. WOODCOCK*

THE oldest known power source is the sun and there have been many ways devised to use its energy. Until very recently none have withstood the march of technological progress. Modern technology is now able to provide ways of making use of a very small fraction of that power that is always available.

The utilisation of solar energy has also been limited by economic reasons; the techniques for many applications have been known and fully proven but the cost of using them has made it totally uneconomic.

PHOTOCELLS AND SATELLITES

The basic component for the conversion of solar power into electrical power is the photocell and this was introduced, as a production device, in 1957.

This cell, in the form of a silicon photovoltaic semiconductor diode, has been the prime power source on earth orbiting satellites since the first was launched in 1957. It is therefore not surprising that industry is now using this well established, fully proven space technology as a source of pollutionless terrestrial power.

GROWING SILICON CRYSTALS

The photovoltaic cell is produced from silicon, the second most abundant element on earth.

A seed of pure single crystal silicon is dipped into a bath of molten silicon and rotated and slowly withdrawn, in an inert atmosphere, producing a bar of almost pure single crystal silicon.

The silicon is required to be doped with small quantities of impurities to control its conductivity. These impurities are introduced into the bath of molten silicon so that the withdrawn bar contains the correct level of dopants.

Early technology imposed a limit on the diameter of bar that could be pulled of about one inch, but recent developments have seen this increased very significantly, and it is now usual for 2½in diameter bars to be used.

The bar of silicon is then cut so that circular slices of defined thickness are produced. The majority of cells produced for satellite applications have used silicon slices 300 micron (one micron = 10^{-6} metre) thick but a new generation requires cells of 200 micron thick. The thickness of silicon used does not affect production processing.

Almost all silicon produced for cell applications is boron doped so that it will conduct by means of positive charges or holes, and for this reason is called *p*-type.

PHOTOCELL PRODUCTION

The production of a photocell involves several basic steps and these may be listed as follows:

1. Diffusion of *pn* junction
2. Contact formation
3. Coating

The creation of the *pn* junction is achieved by the controlled diffusion of an impurity into the *p*-type silicon slice. The impurity used is phosphorus which is introduced into the diffusion furnace as a vapour, the depth of the diffusion being a function of time and temperature.

The basis of operation of the photocell is such that when photons (light particles) strike the cell surface, close to the *pn* junction, positive charges (holes) and negative charges (electrons) are produced. The electrons will tend to travel towards the *n*-type silicon and the holes towards the *p*-type silicon. If connections are made to the *n*- and *p*-regions electric current can flow into an external load.

METALLISED CONTACTS

The next vital production stage is thus the deposition of a metallised contact structure. The *p*-contact, on the rear face of the cell, can cover the total cell area, but the design of the *n*-contact, on the front or active surface, is critical to the performance of the cell.

*Electronic Components Division, Ferranti Ltd.

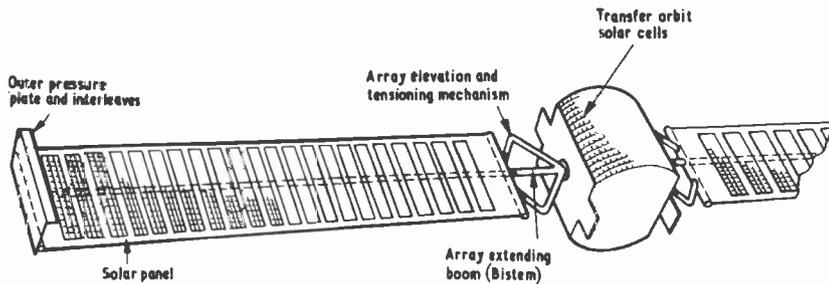


Fig. 2. Drawing of a flexible fold-up solar array. Each paddle is about one metre wide by five metres long

The requirements are many and varied and, in some cases, conflicting. For maximum cell output the contact must mask minimum cell area but must have sufficient cross-sectional area to handle the photon generated current.

Thick metallisation must be avoided as severe stresses can be set up on thermal cycling and, in the extreme, this stress could be sufficient to break the silicon. The metallisation must have good electrical and thermal conductivity, must be easily contactable, and should not degrade or cause degradation in any encountered environment.

The process by which the metallisation pattern is defined must also be of sufficient accuracy that overall pattern tolerances are maintained. Pattern definition is achieved by a photographic mask and the metallisation used on the satellite cell is a composite structure of nickel, copper and gold.

The nickel gives the ohmic contact to the cell, the copper gives the electrical conductivity and the gold prevents contact tarnishing.

The pattern defined on the satellite cell is a narrow top contact bar and then 24 narrow fingers running down the length of the cell. These fingers are typically 25 microns wide and five microns thick. The multiplicity of these fingers optimises the collection efficiency of the photon generated electric current.

OPTIMISING CELL PERFORMANCE

On bare silicon, light striking the active cell surface will be partially absorbed but a certain percentage will be lost due to reflection. This percentage can be significantly reduced if a quarter wavelength thick transparent dielectric layer is deposited on the cell surface.

The refractive index of this layer is chosen to optimise cell performance. Early cells used either silicon monoxide or dioxide but the latest technology uses titanium oxide.

The almost universally used cell size for satellite applications has been 2 cm sq and the output power from a cell of this type is typically 62mW at 25°C when illuminated with air mass zero sunlight at 140mW/cm². This gives an overall power conversion efficiency of 11 per cent.

Fig. 1 shows the output characteristics of a typical solar cell.

The power requirements for a satellite have always demanded a cell of maximum power, from minimum area, at minimum weight and this has dictated that the cell produced to satisfy this requirement is of the highest possible performance.

SATELLITE SOLAR ARRAYS

Satellite solar array design has followed two distinct channels, both of which offer advantages and disadvantages in the satisfying of an overall system requirement.

In one case the cells are mounted on a cylindrical body which spins with its axis perpendicular to the sun. In the other case the cells are mounted on deployed paddles which are sun orientated.

To give some idea of sizes involved, the recently launched communications satellites designated *Intelsat 4*, each carry 50,000 cells mounted on a cylindrical body, nine feet in diameter and ten feet high.

This initially will provide almost 900W of power and will provide power for 5,000 simultaneous telephone channels or ten colour television transmissions. To provide 1kW of power from a deployable array would require approximately 17,000 cells and, using two paddles, each paddle being typically one metre wide and five metres long (see Fig. 2).

THE ADVANTAGES OF SILICON

The justification for the choice of silicon is simple. As previously stated it is the second most abundant element and it has been the foundation of the semiconductor industry. As such it has seen an investment in its technology many orders greater than all other basic semiconductor materials.

The basis of using the experience gained from developing and producing solar cells for satellite

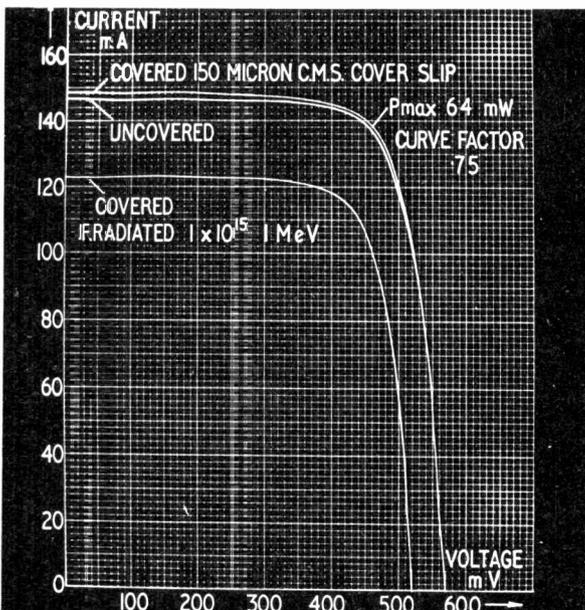


Fig. 1. Power output characteristics of a typical solar cell

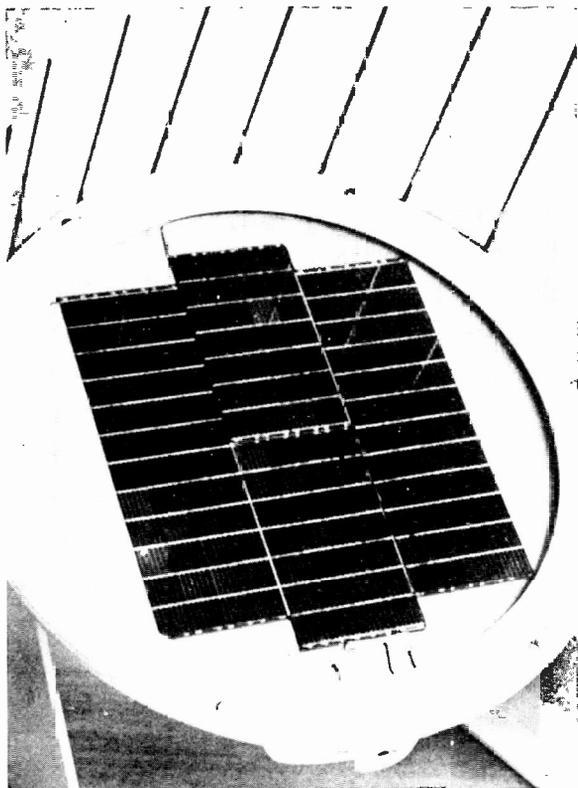


Fig. 3. A terrestrial solar panel as used for marine applications

applications is that the silicon voltaic cell has been the prime power service in over 700 American and some 500 Russian spacecraft of varying type.

From this background the selection of a silicon photovoltaic cell as a design start point for terrestrial power applications was inevitable and inarguable.

POSSIBLE ALTERNATIVES TO SILICON

It should not be thought that silicon is the only material suitable, and some effort has been devoted to other semiconductors.

The most notable of these have been gallium arsenide and cadmium sulphide. The former is able to withstand high temperatures and thus is able to generate at intensities 1,000 times greater than sunlight. The problems of heat dissipation must still be solved, however, before it can be considered to be technically competitive, but on cost it must be extremely doubtful if it can ever be considered to be an economic alternative.

Cadmium sulphide offers a cheap means of producing a photocell of considerable area in a flexible sheet form. It does, however, suffer the disadvantage of much lower conversion efficiency, and hence will only ever be able to be suitable for that market segment that can accept no restrictions on area.

TERRESTRIAL SOLAR POWER

The initial choice of cell for terrestrial use was dictated by availability, and 2×2 cm reject satellite cells were used. These were cells that failed to fully satisfy the most stringent electrical and physical requirements of a space satellite specification but

which would work quite happily when mounted on a terrestrial panel.

The panel was designed to provide 400mA at 15V in the equivalent of bright sunlight, and required for this output 156 cells interconnected as 39 cells in series with four cell strings in parallel.

MARINE ELECTRONICS

The design and construction of this panel, ideal for off-shore repeater or navigation aids, is not really suitable for the larger volume commercial business. A fast expanding market is that of marine power generation. The use of instrumentation and electronics on yachts and power boats is ever increasing with very little regard for the state of the onboard battery.

A small solar panel permanently mounted on the boat is extremely attractive from an economical and environmental standpoint. The use of solar panels in marine applications will, however, be limited by price considerations and only when a panel can be produced at a low enough price will full market penetration be achieved.

LARGER SLICES

The techniques for the production of refined single crystal silicon have not stayed stationary and manufacturers now have readily available large area slices. This realises a slice diameter of typically 6cm and allows the use of cells of this size and proportional power rating.

Based upon expected conversion efficiencies the output from a circular cell of diameter 6cm should be 500mA at 470mV when measured under $100\text{mW}/\text{cm}^2$ simulated sunlight at 25°C .

The front active cell surface will have a simple metallised contact pattern and the back face will be fully metallised. The interconnection of cells must be performed simply, easily and reliably, to permit the building of the basic power modules.

Based upon the major market requirement for recharging nominal 12V batteries the voltage capability of the module is defined as greater than 13.8V. Thus a basic power module can be defined as 30 cells interconnected in series.

The expected output from the package under simulated bright sunlight conditions will be 500mA at 12V. The calculation for overall charging rate must be subject to some hypothesis as to expected weekly hours of sunlight and at what illumination intensity.

AVERAGE SUNLIGHT

The average daily hours of daylight during summer can be considered to be 15 hours. The Meteorological Office estimate for hours of sunshine on the South coast of England is a daily average of 7 hours. Assuming this to be at 75 per cent intensity, this is equivalent to 5.25 hours at full sun.

Thus the daily output charge from the panel will be 2.6amp-hours. Based upon a five-day week for charging and the boat being in use the other two days this gives an average weekly charging capability of 13amp-hours, neglecting any charging that can still take place during the time the boat is in use.

The expected current drain, based upon estimated usage of electronics and ancillary electrical equipment, is of this same order, 10 to 15amp-hours, so the projected panel size would seem suitable for this market.

OTHER APPLICATIONS

Usage of this type of panel is by no means limited to marine applications. A similar application, and one that is being studied closely, is for use with caravan trailers.

The power output requirements for a solar panel in this application are almost the same as on board a boat and hence the market can, hopefully, be catered for with an identically produced product.

Remote or unmanned automatic operation of road signs is receiving great attention, especially in the use of danger signs for such hazards as road works. The often seen flashing amber lights denoting road repairs could be easily solar powered.

Built-in rechargeable batteries could be charged during daylight hours for operation at night. The use of this type of power source could easily be extended to cover motorway hazard lights, emergency telephone systems and many monitoring devices.

Solar power gives to these applications the advantage of freedom from main power links and must improve their suitability for utilisation in many more wide ranging areas.

FORESTRY AND METEOROLOGY

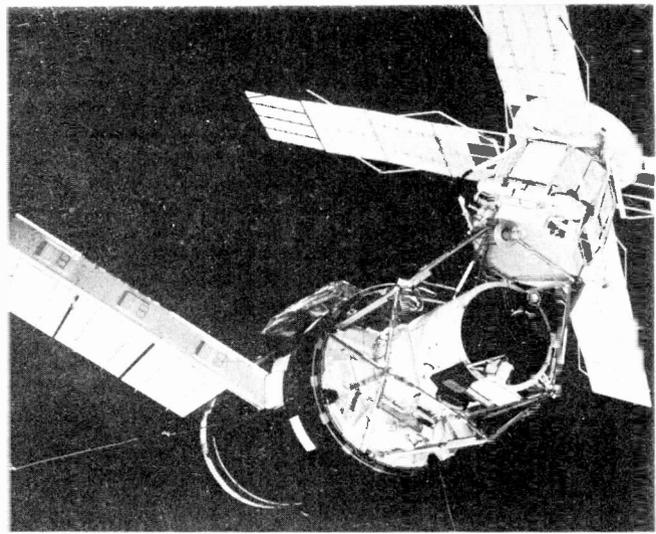
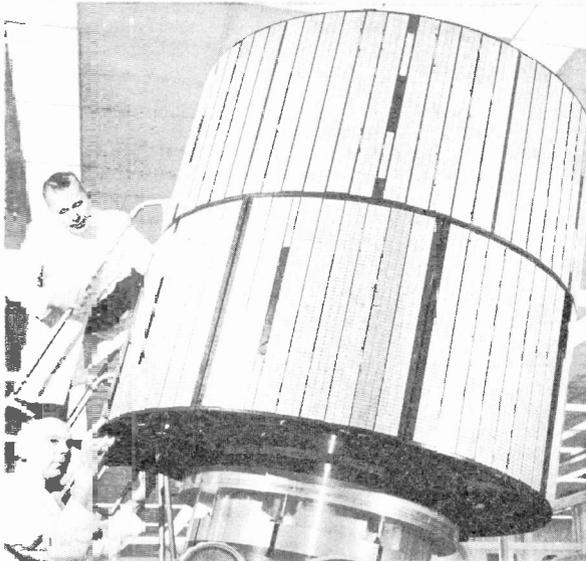
These applications are ones that are commonly encountered by a wide cross section of the public but extensive markets exist in less well known areas. Forestry requires extensive use of remote automatic equipment for such applications as fire warning and portable or remote communications. The use of this type of power source is also available for weather monitoring, rain gauges, flood warning, seismic detection. The list can be almost endless.

Two application areas that will demand a high reliability factor are those of remote area repeater links for communications and off-shore navigation aids.

REPEATER STATIONS

Microwave relay stations and telephone repeater stations are often situated in some of the remotest parts of the world and are required to remain in unattended trouble-free operation for periods of a year or longer. It can cost a great deal of money to transport people and spares to these sites for servicing and repair and it is therefore essential that frequency of visits is as low as possible.

Photograph of a satellite built by the Hughes Aircraft Company for NASA and launched in 1966



Photograph taken from Skylab 3 showing the deployed solar arrays

POWER PRODUCTION

The present major energy crisis has spurred even greater discussion and thought towards ways of producing, economically, consumer electrical power, such that it can be considered a realistic alternative to power produced from fossil fuels.

Two ideas, once considered close to science fiction, are being discussed. One involves a large solar farm in a flat desert region and the other a large solar array in synchronous orbit above the earth beaming r.f. power to a terrestrial station.

Power would be taken away on a National Grid type system. The problems of maintaining the solar blankets can be imagined and no acceptable solution has been found.

ORBITING SOLAR ARRAYS

The orbital power station having two large arrays, totalling 7.3×2.7 miles, is the current design thought and these would flank a microwave transmitting antenna that would be 0.63 miles in diameter.

It is intended to try and fly a prototype satellite in 1990 and a commercial version could be flying at the end of the century.

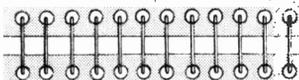
THE SOLAR POWER AGE

The world markets for small commercial systems currently demand a high technology product in large volume at low cost but this is only the smallest tip of some vast technological iceberg. A technological miracle is in the making and it is one that could revolutionise our outlooks.

The photovoltaic cell and the solar array will become everyday commodities known to all. They offer a method of saving our precious and dwindling stocks of fossil fuels for processes that require these and they will provide an economic pollution free energy solution based upon a natural power source that will never be diminished.

We have seen the Stone Age, the Iron Age, the Industrial Revolution, the Space Age. The possibility of a Solar Power Age must not be dismissed or taken lightly.





INDUSTRY NOTEBOOK

By Nexus



WHAT'S IN A NAME?

We are all certain to be subjected during the next few months to growlings, grumbings, even open hostility directed towards the so-called multinational companies. In fact the very word multinational has now joined other political jargon words like racist, fascist, red, speculator, capitalist, terrorist in a fully emotive sense.

Multinational, in short, has become a word of abuse. Nothing to do with injection of capital and creating employment and wealth in underdeveloped or otherwise needy areas, and everything to do with faceless (indeed, probably heartless as well) exploiters counting their gold in plush offices thousands of miles away. No wonder some of the great multinational companies are keeping a low profile and, for one or two of them, with very good reasons.

Most of the outcry is directed against US-based multinationals but it has to be remembered that nearly all the great British companies operate multinationally, as do those of France, Germany and Italy.

I rather liked the argument put forward recently by the German Siemens group to an American audience in defence of their penetration of the US market by acquisition of US companies as well as direct sales from Germany. Siemens, said their spokesman Bernard Mayer, is a World Company and this has been true ever since the company was founded by Werner von Siemens, 126 years ago. He quoted the installation by Siemens of the 7,000 mile London to Calcutta telegraph completed in 1870 as an example of operating on a world scale. And he pointed

out that Siemens' advanced technology products, which demand two million dollars R and D expenditure alone every working day, could not be supported by domestic sales alone.

In the United States, Siemens has now grown from a handful of market research men 20 years ago to a sales and production force of 2,000. Steady, rather than dynamic growth, and still only a drop in the vast ocean of the US electronics and telecommunications industry.

My own rough guide lines for goodness factor in multinationals operating in Britain are that they should be British-managed, have good export potential, have some element of in-house R and D (i.e. not be just an overseas production unit), and make a genuine contribution to the economic and social life of the country. Fortunately, there are more companies like this than of any other sort.

I suppose Mullard (Dutch-owned) is the most notable example and of the more recently established companies, Hewlett-Packard (US-owned) has an impeccable record. But there are many others and it will do us all good when confronted with mindless political slogans to pause and think.

CUTTING THE COST

Electronics, because of its steady advance in solid-state technology, is uniquely running against the tide of rising world prices. You get more value per unit cost every year. The electronic watch which last year cost £100 will cost you £30 by 1978 according to industry forecasts.

It's all to do with volume. Last year solid-state watch sales were 250,000 in a world market of 185 million watches, only 0.14 per cent. But by 1978, say the pundits, in a projected market of 227 million watches, the solid state watch will have 51 million sales or 22.46 per cent of the total market. By that time the cost of the C/MOS LSI chip will have dropped from 10 US dollars to 2.50 dollars, the digital display from 9 US dollars to 2 dollars, the quartz crystal from 3 US dollars to 2 dollars and even labour (presumably through automation) from 5 US dollars to 2 dollars.

Take a single-chip electronic calculator. In 1970 the semiconductor manufacturers made an "introductory offer" at 30 US dollars per chip. Last year, the price of the chip had plummeted to 5 dollars. This year the price is 4.50 dollars and the l.e.d. display is now 50 cents a digit instead of a dollar. The complete handheld calculator, albeit of the simplest type, is expected to fall

in cost to 20 US dollars by 1975, well under £10 at UK prices, the limiting factor being promotional costs because intense competition encourages heavy expenditure on advertising.

The cost of a single planar transistor in 1959 was 50 US dollars. By 1976, when it should be possible to buy the cheapest calculator chip of some 3,000 transistors for 3 US dollars, the cost per transistor will work out at 0.001 of a US dollar. That's not the end of the story because if all these transistors were discrete and had to be hand-wired with external wiring at a cost, say, of 10 US cents a wire installed, then the total cost would be astronomical.

The big question now is whether the semiconductor wizards can achieve the same order of cost reductions in solar cells for commercial and domestic use to alleviate the energy crisis? One line of research is to fabricate the cells in continuous ribbons instead of individually, but even the optimists concede that it may be another ten years before a hundredfold reduction in cost is achieved. This is the order of cost reduction needed to make economic the direct conversion from solar to electrical energy.

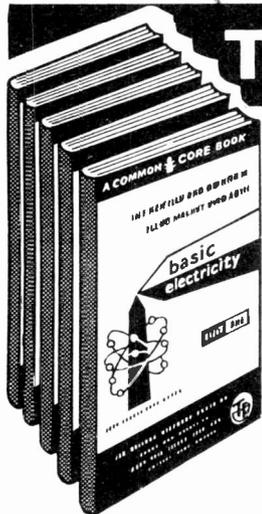
INSPIRATION

We could all kick ourselves at times for not spotting the obvious. The trembler bell in a telephone has been around ever since the telephone was patented by Alexander Graham Bell in 1876. If ever a mechanism needed up-dating it's that "oldy" in the base of your phone.

Mitel Canada Ltd. have come across with the answer, and it's an answer with enormous market potential. A replacement panel incorporating a 2-inch loudspeaker, amplifier and control circuits.

The all-electronic bell gives a pleasant ringing tone, as good or better than any electro-mechanical bell, and it has the advantage that it can also be used for ordinary loud-speaking messages. On a PABX system in a hotel, for example, the operator can make an emergency announcement to all rooms simultaneously or individual announcements to selected guests without the receiver being off its rest. If you are using the phone at the time, then the announcement automatically breaks into your conversation.

It is claimed that the Mitel "Mitone" signalling system can be manufactured to sell at the same cost as the old-fashioned single-purpose bell. Another advantage is that drive voltage is much lower and more in line with the requirements of modern electronic switchboards.



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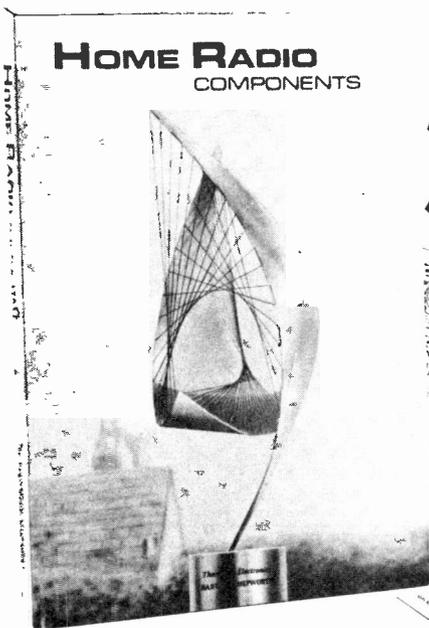
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NEWS BRIEFS

MARCONI CENTENARY EXHIBITION

TO MARK the centenary of Guglielmo Marconi's birth, the Science Museum in Exhibition Road, London, is holding a special exhibition which will run throughout the summer to about October.

The exhibition consists of a large selection of documents, and a display of early apparatus together with many of Marconi's personalia and commemorative material.

Experiments with radio waves were carried out in 1888 by Hertz and were extended by various physicists in following years. It was not until 1894 when Hertz died, that the young Marconi, 20 years of age, appeared on the scene.

After reading a commemorative article on Hertz he began experimenting in the attic of his parents' large villa near Bologna, Italy. By the summer of 1895 he had transmitted a signal over a few yards using a simple spark gap transmitter, and coherer type detector.

By August 1895 Marconi had achieved transmission over 1½ miles. The Italian government remained unimpressed and so Marconi set sail for England.

Following preliminary demonstrations in his laboratory the chief engineer of the Post Office, William Preece, to whom Marconi had been introduced by his cousin, arranged formal demonstrations to Post Office officials.

Observers were suitably impressed and in a second demonstration six months later the range was extended to seven kilometres. An historic lecture at Toynbee Hall followed this and Marconi soon became a celebrity.

The scientific community was, however, less enthusiastic suspecting Marconi of plagiarism. In particular, Professor Oliver Lodge, who first developed the coherer and had in fact transmitted Morse signals over 60 metres before Marconi began his experiments, was deeply offended.

In 1897 Marconi established "The Wireless Telegraph and Signal Company Limited" much to the disgust of the Post Office who did not favour experiments being carried out without their involvement.

In 1899 cross-channel transmissions were successfully achieved and the possibility of transatlantic radio was soon realised.

On the 12th December, 1901 the first transatlantic message, a single Morse letter S, was transmitted from England to Newfoundland giving Marconi success against all the odds.

Photograph of Marconi in London in 1896, showing the original apparatus brought by him from Italy. (Marconi Company Ltd.)



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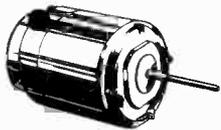
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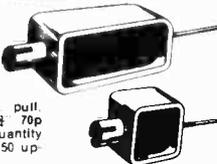
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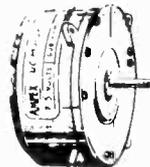
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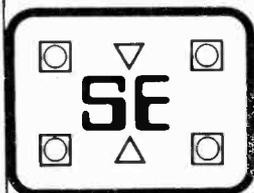
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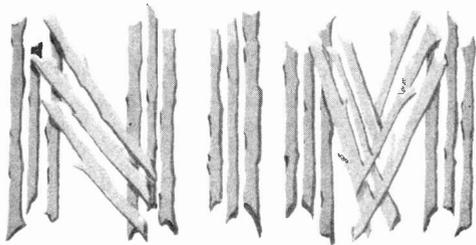
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NIM is a game for two players. At each move a player may take any number of sticks from one, and only one, of several piles. He must remove at least one stick and the winner is the person to take the last stick. In an alternative form of the game it is the loser who is forced to take the last stick.

The game reputedly comes from ancient China, but was first analysed at the beginning of this century at Harvard, U.S.A. Clearly one or other of the players must win—there can be no draw—and it transpires that the winning strategy is closely related to the binary representation of the number of sticks in the piles.

Various designs for Nim playing machines have appeared over the years since the development of the digital computer and this article presents a contemporary one using readily available TTL digital integrated circuits.

WINNING STRATEGY

The prescription for winning at Nim relies on the fact that any arrangement of piles may be categorised as either a winning or a losing position. Further, if the arrangement represents a winning position the next move is certain to create a losing position, whilst it is always possible to play so that a losing combination is converted to a winning one again.

Thus if player A starts with a winning position, player B is bound to leave a losing one after his move. At this point A is able to convert the position to a winning one by making the correct move. The game is now back where we started and will continue to cycle in this way until A finally wins.

Should A make a wrong move at any stage the way is open for B to take over the winning strategy. As there are many more losing combinations than winning ones it is unlikely that even a player who commences with a winning position in his favour should make all the moves appropriate to his being sure of winning.

BINARY REPRESENTATION

To discover whether a given arrangement represents a winning position or not we must first write down the numbers in the piles in the binary notation. For example, suppose that there are three piles containing 3, 6 and 7 sticks then we can write these numbers in binary form as three columns

3	0	1	1
6	1	1	0
7	1	1	1
	2	3	2

Each column of this binary set should now be summed so that in this case we find the numbers 2, 3, 2, as shown. Now, a winning combination is one in which each power of two is represented an even number of times. Hence our example is a losing position because the second column, indicating the number of times that 2^1 occurs, adds up to 3 which is an odd number.

To convert such a losing position to a winning one a player must remove sticks from any pile containing the highest unpaired power of 2. In this example the highest unpaired power is 2^1 , the middle column, and as each pile contains this power it is possible to produce a winning combination by taking sticks from any pile. In fact the combinations 1,6,7 3,4,7 and 3,6,5 are all winning positions.

Should the players choose the alternative game in which the last player loses, then the above strategy follows through unchanged until no pile contains more than one stick. In this case a winning position is one in which there is an *odd* number of piles of one match each. It will be seen that this is the opposite condition to that imposed by the normal game in this case.

BASIC DESIGN

Fig. 1 presents a block diagram for a machine which will implement the principles outlined. Rotary wafer switches represent the numbers of sticks in

four piles 1 to 4, containing up to seven sticks each. These switches give outputs in binary coded form, so that, for example, if switch S1 is set to 5 then A₀ will be a logical 1 representing 2⁰, A₁ will be a logical 0 representing 2¹ and A₂ will be a logical 1 representing 2². For each power of 2 the four outputs from the four switches are taken to a Summer which produces an output equal to logical 0 if the sum is even and logical 1 if it is odd.

The Analyser takes these outputs and decides whether a winning or a losing position is set. In the former case the win output goes low and the 'Your Move' indicator lights. In the latter case the 'My Move' indicator lights and the Analyser initiates a search of the switches to find one which has the highest unpaired power of two present at its output. When this switch is found the appropriate lamp indicator lights.

The last-to-play (L.T.P.) circuitry simply tests for the simultaneous occurrence of no pile containing more than one stick and S5 being set to 'Loser'. In such a situation the control line L goes to logical 1 and the quantity NOT Σ₀ is presented to the Analyser in place of Σ₀. A little thought will show that this fits the prescription outlined above.

METHOD OF PLAY

The challenger is free to set any initial combination on the switches S1 to S4. The machine should now be switched on and one of the move indicators

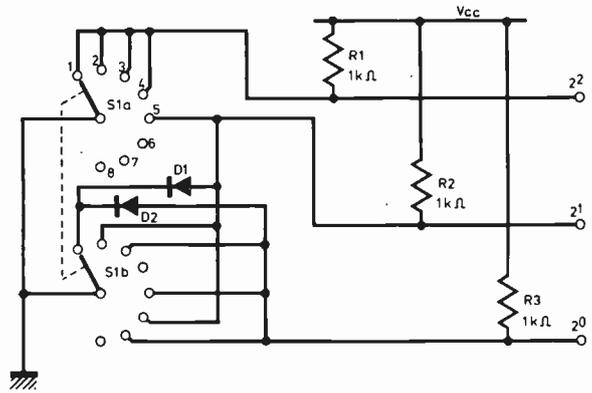


Fig. 2. Wiring detail for one of the decimal to binary switch encoders. Four such arrangements are needed

will immediately light. If 'Your Move' lights the challenger should make some legal Nim move. If the 'My Move' indicator lights then one of the lamps will also be lit and the player should turn the corresponding switch back until the 'Your Move' lamp lights. This represents the machine's move. By continuing in this way, the challenger will invariably lose.

Fig. 2 shows the suggested arrangements of one of the four Encoders S1 to S4, all of which are wired in the same way.

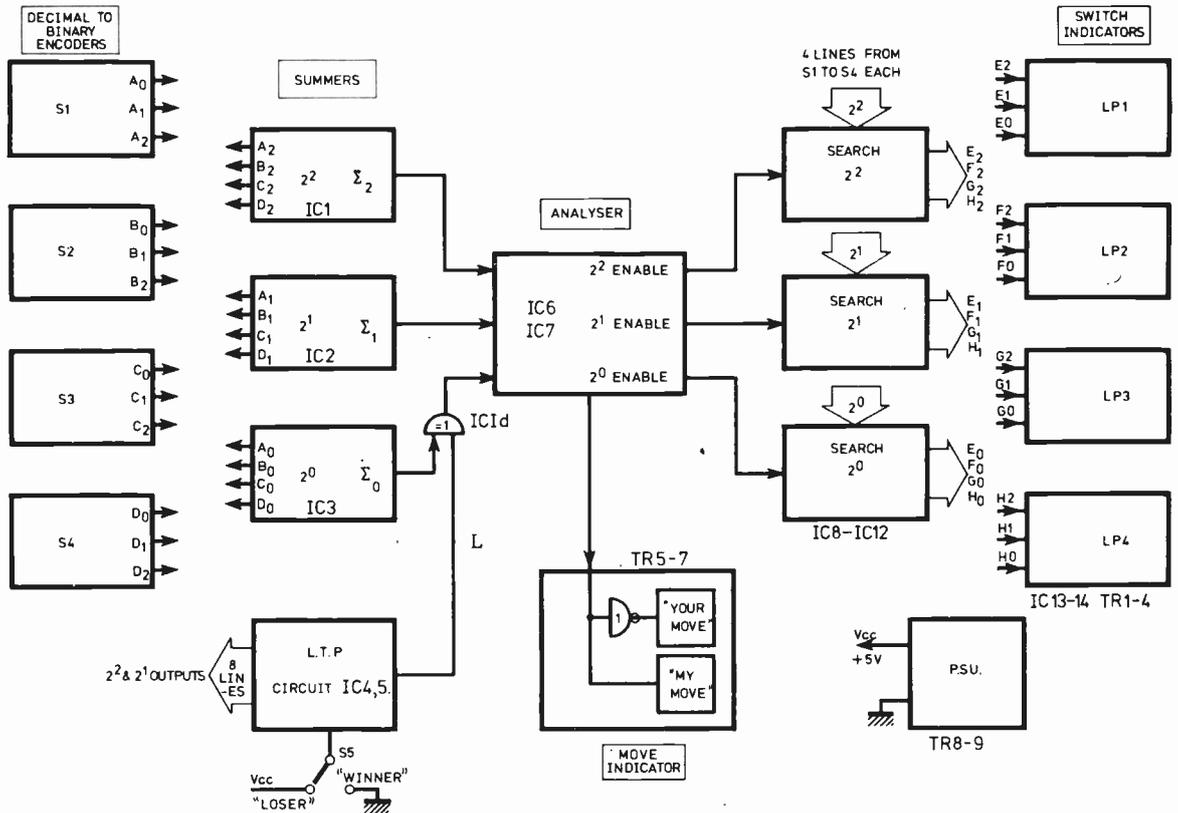


Fig. 1. Block diagram of NIM machine. For detailed wiring of sub-assemblies, see following figures

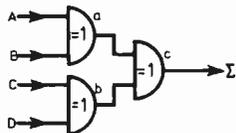


Fig. 3. Three exclusive OR gates make up each Summer. Three such circuits are required

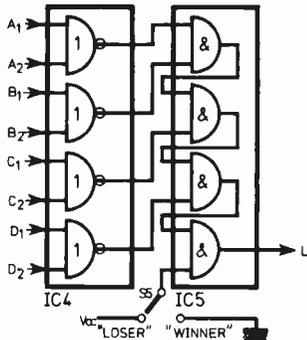


Fig. 4. Arrangement for last-to-play (L.T.P.) circuitry. See Fig. 1 for interwiring detail

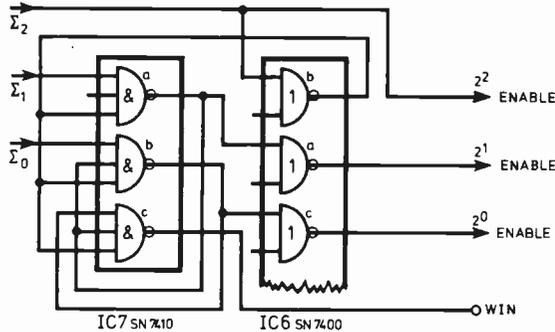


Fig. 5. Circuit diagram of Analyser gates

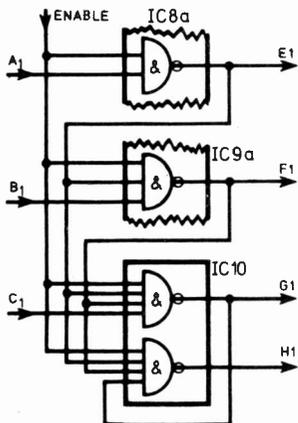


Fig. 6. The Search circuit. Three of these are required

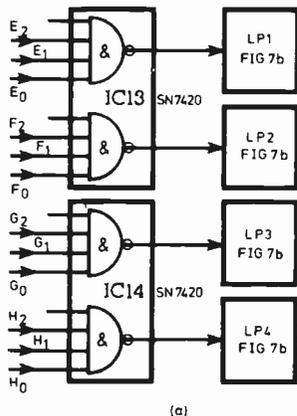


Fig. 7. Switch Indicator circuit (a) output lamp logic (b) lamp driver circuit

SUMMER

It will be seen from Fig. 3 that the Summer is a very simple circuit block. Each gate employed here is the exclusive OR gate, or half adder. Whenever the inputs are identical, the output is 0 but when the inputs differ the output is 1. That this is the function we need may be seen by realising that for our purposes all even numbers are equivalent to 0 and all odd numbers to 1.

Repeated application of the truth table to this arrangement of three gates will show that the final output is 1 if the power of 2 is represented an odd number of times and 0 otherwise.

L.T.P. CIRCUITRY

The control line output, L, of the L.T.P. circuit comes from IC5 which is wired as a five input AND gate (Fig. 4) needs only to invert Σ_0 when no pile contains more than one stick and the last person to play is deemed the loser. IC4 recognises the former condition by testing the 2^2 and 2^1 outputs from each switch. Only if these are simultaneously zero can that switch be displaying nought or one, and in this case the NOR output is a logical 1.

When the output from each of the NOR gates is 1 and the selector is set to "Loser" a control level 1 is produced which causes IC1d (Fig. 1) to invert the Σ_0 output.

ANALYSER

The purpose of the Analyser circuit (Fig. 5) is to find the highest unpaired power of 2. If all powers are paired then the game is set in a winning position, and the Analyser indicates accordingly.

Working from the top we see that if Σ_2 is high then the 2^2 enable line is high also, but IC6b inverts this level which forces both the other enable lines to stay low and forces the 'Win' output high. Similarly if Σ_2 is low but Σ_1 is high the 2^1 enable line is high but the 2^2 and 2^0 enable lines are low and the 'Win' output is high. Only if Σ_2 , Σ_1 and Σ_0 are all low does the 'Win' output go low and, in this case, all the enable lines are also low. Thus a logical 0 at the 'Win' output corresponds to a winning arrangement.

The Win output controls the Move Indicator directly.

SEARCH CIRCUITS

Suppose that the 2^1 enable line is high (this explanation follows in the same way for both of the other enable lines) then one of the three search circuits in Fig. 1 will be activated. These work in much the same way as the Analyser circuit once they are enabled.

Consider one search circuit in Fig. 6. If the A_1 level is high then E1 goes low and the other gates in the circuit are disabled forcing a high condition

COMPONENTS . . .

Resistors

R1-R17	1k Ω (17 off)	R20	68 Ω
R18	6.8k Ω	R21	1k Ω
R19	2.7k Ω		

Capacitors

C1-C3	0.1 μ F (line supply decoupling capacitors for every five i.c.s)
C4	3,300 μ F elect. 16V

Potentiometer

VR1	1k Ω preset
-----	--------------------

Diodes

D1-D8	OA81 (8 off)
D9-D12	W005 full wave rectifier (50 p.i.v., 1A)
D13	ZL3-3, 3.3V, 1.5W Zener

Transistors

TR1-TR7	BC108 (7 off)	TR8	2N3054	TR9	BC109
---------	---------------	-----	--------	-----	-------

Integrated Circuits

IC1-IC3	SN7486 (3 off)	IC8	SN7400
IC4	SN7402	IC9	SN7410
IC5	SN7408	IC10-IC14	SN7420 (5 off)
IC6	SN7400		
IC7	SN7410		

Switches

S1-S4	2 pole, 8 way rotary wafer switches (4 off)
S5	Single pole change-over
S6	Double pole mains on/off toggle

Transformer

T1	Mains transformer—primary 240V; secondary 6.3V, 1A
----	--

Lamps

LP1-LP6	6V, 0.04A filament lamps (6 off)
---------	----------------------------------

Miscellaneous

Contil Case No. 975—West Hyde Developments

at each of the other outputs F1, G1 and H1. This will cause lamp LP1 to light. Similarly, if B₁ is high then F1 goes low and the other outputs are forced to stay high so that only LP2 will light.

If A₁, B₁ and C₁ are all low then H1 goes low and LP4 lights, since the enable line tells us that one of the switches must be presenting a 2¹ contribution.

SWITCH INDICATORS

Each Switch Indicator comprises a NAND gate coupled to a lamp driver and lamp as in Fig. 7. When all three inputs are high the output of the NAND gate is low and the lamp stays off. When a low condition is received from one of the search circuits the output of the NAND gate goes high, and so the lamp lights up. So long as no fault exists, only one lamp can be lit at any one time.

The driver transistors should have a current gain of at least 50—the higher the better—and should be capable of passing up to 100mA. The power dissipation is very small, however, since each transistor is either fully conducting or completely off.

MOVE INDICATOR

The Move Indicator (Fig. 8) consists of two lamp driver circuits coupled by an inverter. The philosophy here is that if it isn't your go, it must be mine!

A discrete circuit is used for the inverter in the prototype, but one of the odd unused gates from the main circuit would work just as well.

The same comments as above apply to the characteristics of the driver transistors used here.

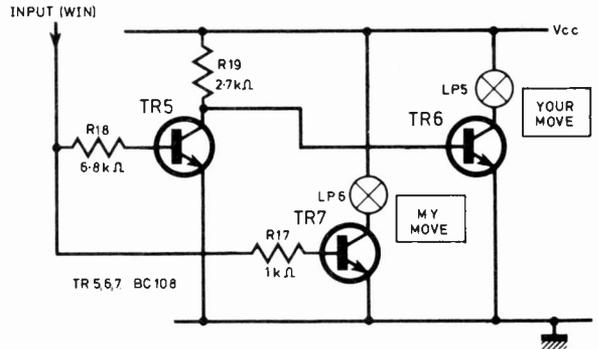


Fig. 8. The Move Indicator consists of two lamp drivers coupled by an inverter

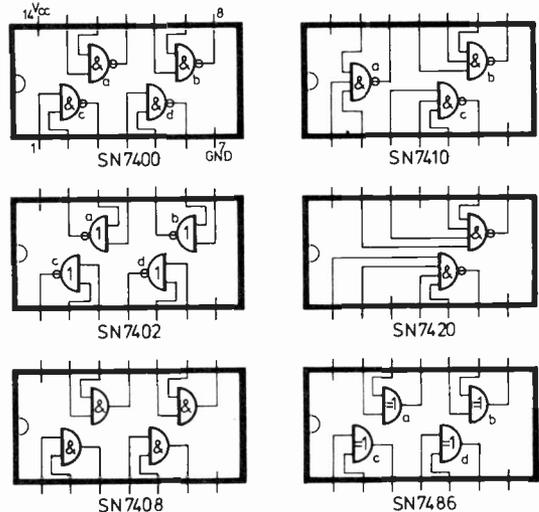


Fig. 9. Pin diagrams for the i.c.s used

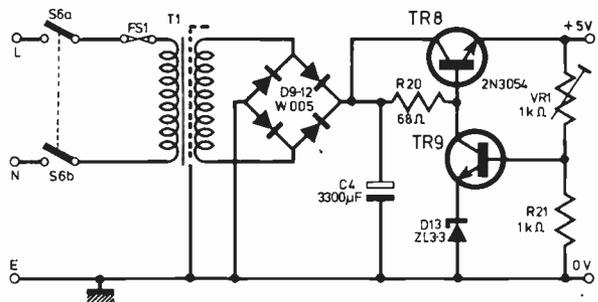


Fig. 10. Suitable power supply for the NIM machine

CONSTRUCTION

Providing all interconnecting leads are kept below 10in component layout is not critical. The sub-assemblies given in the figures should be individually assembled and checked electrically before interwiring the complete machine according to Fig. 1.

The pin wiring for the i.c.s is given in Fig. 9 and a suitable power supply in Fig. 10.

The normal i.c. practice of decoupling every 5 to 10 packages with a capacitor of about 0.1 microfarads should be followed.

The use of i.c. holders is not recommended on grounds of cost. The simple gates used in these circuits are available very cheaply, often at prices comparable with the cost of holders. ★

PATENTS REVIEW

PATENTS LIBRARY

Some remarks and reminders on general patent matters bear making. As most readers will understand, the British Patents reported in these columns are selected from the latest batches published (at the rate of around 4,000 a month) by the British Patent Office.

Once a week a new issue of patent specifications is laid out for public inspection in the library attached to the British Patent Office in Southampton Buildings, just off London's Chancery Lane. Similarly, issues are laid out at other libraries round the country. At the same time copies of the specifications are made available for purchase from the Patent Office Sales Branch by any member of the public at 25p each, post free.

At first sight this publishing of protected ideas seems a contradiction in terms. A patent application is made by an inventor who wishes to protect or monopolise his idea for a number of years. While the application is examined by the British Patent Office it is kept rigidly secret from the public; only the title, name and application date are listed in the public card indexes kept in the library. But when the application has been accepted and is published, its content is there for all to read. So what protection is a patent providing for the inventor? And would it not have been better for them simply to keep the details of his invention secret and not involve himself in the expense of securing a patent (likely to be at least £100 if handled by a Patent Agent)?

PATENT CONTENTS

A patent specification is worded in a language which many people regard as an incomprehensible mixture of legal and technical jargon. After a legally worded preamble, every specification launches into a general description of the invention and then moves on to a specific description (usually with drawings) which explains in detail how one or more practical embodiments of the invention actually work.

Every patent specification ends with a set of claims which are the

most important part when monopoly and infringement are considered. The claims define the scope of monopoly which the Patent Office has agreed to allow the inventor, having carried out searches through previously published patents.

If a claim is too broad, it may "catch" a large number of "infringing" articles, but it may also embrace articles that are known to be old. So the claim is in practice invalid. And anyone concerned and believing that the claims of a freshly published patent are obviously invalid can either ignore them or legally oppose them at a Patent Office Hearing.

ADVANTAGES OF PUBLISHING

Publishing patents also serves to enhance the richness of human knowledge and once a patent has expired (even if the full £300 worth of annual renewal fees are paid, a British patent can only last 16 years) all that it discloses and claims becomes part of the public domain. The basic reasoning is that the inventor is granted a limited monopoly in return for disclosing his idea rather than keeping it secret. Incidentally, laying open the details of an invention to the public also serves as something of an advertisement for the owner of the patent, who may be approached by manufacturers who wish to make what he claims under a licence.

It is a basic canon of patent law throughout the world that (subject to a very few exceptions) no one can patent an invention once it has been disclosed to the public. Thus, usually, once an invention has been published (e.g. in a book or magazine, or offered for sale) no one, the inventor included, can subsequently patent it. But it is perfectly safe for an inventor to lodge an application (even if it is accompanied only by a Provisional Specification, which simply lies fallow at the Patent Office for a year) and then immediately publish his invention. Making the patent application generates a priority date which safeguards subsequent disclosure.

Where details of a circuit or construction are given in a magazine with d-i-y slant, e.g. Practical Electronics or Everyday Electronics, it would not normally be possible for anyone to apply for a patent,

for anything disclosed, after publication. However, if a contributor had already applied for a patent before the appearance of the article describing his design, then the appearance of that article would not in itself invalidate any patent subsequently granted.

LEGAL ACTION

Because the long arm of patent law moves slowly, there is often a gap of several years between original application and final acceptance and grant. Thus it is perfectly possible that a circuit or design published in a magazine such as this could already be the subject of a pending patent application which will not come into legal force until months or even years after the appearance of the relevant magazine issue.

Usually no action for infringement can ever be taken on a pending patent application (remember, they are kept secret so it would be grossly unreasonable if such action could be taken) this could under certain circumstances mean that designs to be found in some back numbers are only now protected by patents.

In practice these circumstances have never presented problems and are unlikely ever to do so, largely because the law is not often an ass. For instance, it is so unlikely as to be inconceivable that the owner of a patent would ever be in a position to know who was making a "one-off" model of his design in the privacy of his own home or garden shed.

But anyone considering an expensive production run of any construction should always try and discover whether or not patent rights (perhaps owned by some completely different third party) are involved before embarking on such a project. For this reason it would seem in the interests of everyone if contributors with d-i-y projects included a reference by number to any relevant patents or patent applications.

Finally, readers believing that they have a patent problem on their hands should seek advice from a Patent Agent; no one on Practical Electronics can enter into correspondence on such matters.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 25p each

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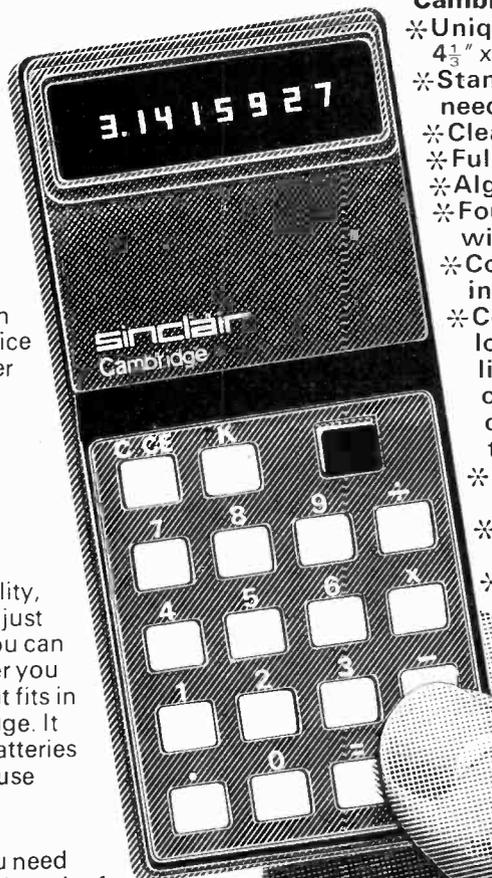
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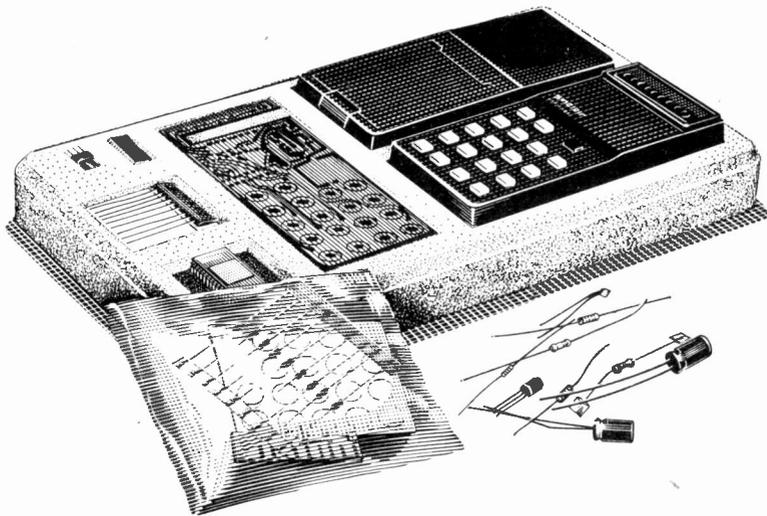
- * Uniquely handy package. $4\frac{1}{3}'' \times 2'' \times \frac{1}{16}''$, weight $3\frac{1}{2}$ oz.
- * Standard keyboard. All you need for complex calculations.
- * Clear-last-entry feature.
- * Fully-floating decimal point.
- * Algebraic logic.
- * Four operators (+, -, x, ÷), with constant on all four.
- * Constant acts as last entry in a calculation.
- * Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £17.
- * Calculates to 8 significant digits.
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A complete kit!

The kit comes to you packaged in a heavy-duty polystyrene container. It contains all you need to assemble your Sinclair Cambridge. Assembly time is about 3 hours.

Contents:

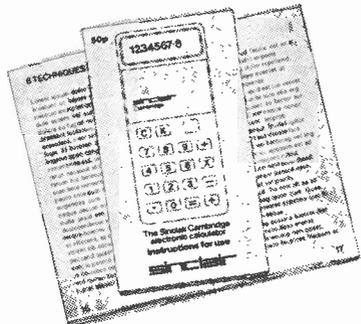
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



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Readout —

A SELECTION FROM OUR POSTBAG

Good olde days!

For over twenty years, I have been an inveterate constructor. In my early days they were the designs of people more clever than myself. Then, with increasing knowledge and experience, I began to try my hand at designing my "own" circuits.

An essential part of my apprenticeship was acquiring the expertise essential if one was to become a skilful "chassis basher", out of aluminium, mild steel or tin plate. A chassis was an essential prerequisite for use with valves, which were, for the benefit of those who haven't seen one, made of glass with bits of metal inside them. The valves usually glowed dull red (that's the filament, son), sometimes got very hot, and sometimes "bit" hard if one got careless. I ended up in hospital once when I got careless whilst working on high power transmitters.

A well laid out, and carefully constructed chassis, imbued its constructor with a feeling of euphoria, whilst he sniffed at the delicate aroma of hot valves, warm Bakelite and warm transformer impregnant, occasionally enlivened by over heated resistors.—What joy! What contentment!

Then along came the transistor. I had to discard most of my painfully acquired wisdom and start learning again. Early results were most discouraging, but I persevered, and, slowly, success came my way. But some of the pleasure had gone. A tag board here, a turret tag there. The resulting rat's nest on an s.r.b.p. board possibly worked, but it looked ghastly and meant that one less skill to be exercised.

To cap it all, along came i.c.s. and, again, less skill was required on the part of the constructor. A few i.c.s. and sundry components mounted on a bit of "holey" s.r.b.p. board (Veroboard) and there it was. It may have worked, but did it really take much "constructing"?—I personally don't think so.

Over the period of time since I first entered the world of electronics, the individual constructor has had to exercise less and less skill, more and more is done for him. In this world of "instant" instants, who has the time to learn a new set of skills to really build or construct something different, something unique?

It is a chastening thought, and, I think, a saddening one, to reflect on the electronics constructors lot in, say, ten years' time. You want to "build" a radio, son? You'd like to build a 50W stereo amplifier? Here are three "cubular modules", press the top of that one, there's the radio you built. Plug the other two into the mains, plug in your sound source and there's the stereo amplifier you built.

Where's the fun? Where's the pleasure of actually constructing something with your own hands? Fun? Pleasure? I for one, mourn the passing of the valve; the passing of the early transistor days.—Those were the days.

H. T. Kitchen,
Bulkington, Warks.

Fog warning system

Sir,—With the perennial concern for Motorway safety I feel you should know about a fog warning system I have devised after a considerable period of experimentation.

In principle it monitors the whole of the Motorway, is automatically triggered by fog or smoke and provides advance warning to motorists 300m prior to the affected area.

The basic system is as follows (See Fig. 1). A light beam is directed along the Motorway verge in the direction of oncoming traffic to an optical receiver 300m away. While the beam is maintained a relay controls another signal lamp directed to a receiver a further 300m along the Motorway verge and so on. Such a chain is optically possible since Motorways are practically

straight and level and there are no obstructions along the verges.

If the beam is interrupted by fog, heavy rain, snow or smoke the receiver causes the relay to change over and transfer power from the following signal lamp to multivibrator controlled warning lamps. The net result is that all lamps in the chain are cancelled and warning lamps are left to flash warning of danger.

The optical receiver consists of a long collimator tube, matt black inside, which directs the light beam from the lamp to a 4½in concave mirror and light dependent resistor which almost forms the focus. Similarly the transmitter has a 4½in concave mirror fed from a 10V, 1A bulb. This supply is obtained from a tapped car battery (older kind) which also sources two groups of six 3.5V, 0.3A bulbs in a series parallel arrangement making up the collector loads to a multivibrator circuit.

A modification to the system is the inclusion of a lamp pulser (multivibrator). This permits the system to be used over long distances. If, say, fog were only affecting a section of the Motorway the closing of the relay would operate the warning lamps and the pulser. For that transmitter path where there was no fog the pulser would cause the lamp to flash, this would restore the "all-clear" to the other units along the Motorway.

By carefully timing the pulses and adding a suitable delay to each receiver it is possible to have two fog affected units showing a warning and the rest of the chain showing "all-clear."

From the circuits devised, field trials have been encouraging. Some further experiments have been conducted using modulated light, but it is a matter for further study as to which of these ideas is the most suitable, but the writer believes that it should not be beyond the abilities of, say, students working for A level physics to devise a practical solution, working on these lines, to a national problem.

G. Cozens,
Bartley,
Southampton

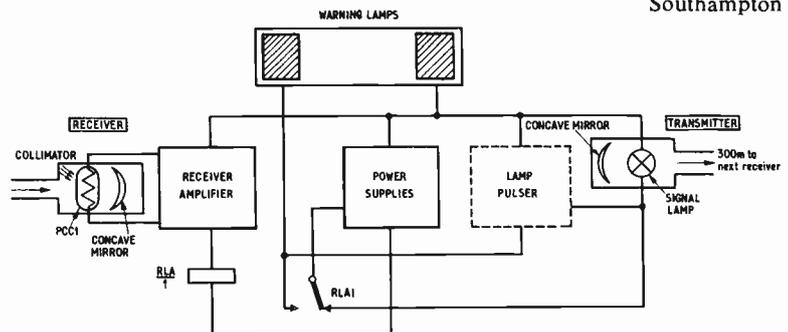


Fig. 1. Basic receiver/transmitter unit for controlling fog warning lamps on the Motorway

Psycho-sensitive semiconductors ?

Sir—With reference to Mr. Brian Baily's article in P.E. April '74 about ESP I should like to propose the following explanation of the results he obtained from his experiments on plants. I wish to point out that this is merely a hypothesis and that I have no evidence other than that which I state:

In one of the programmes in the recent BBC T.V. series "Young Scientist of the Year!" the results of a group of boys' experiments on growing plants in magnetic fields, were presented. They found that plants grown in a magnetic field bent and grew along the lines of force. Could this not be something to do with the fact that there is an atom of iron at the core of the chlorophyll molecule, which may render it magnetically sensitive?

It is possible that the molecules align themselves along the lines of force, presenting a coherent chain of electrically resistive molecules, whereas normally they would be in an amorphous distribution. This migration of the vital chlorophyll towards one point would explain the tropic response of the plants in the magnetic fields.

Is it not possible then, that if a large, strong field is enough to cause the plant to change its direction of growth, the weak field surrounding an electrically active brain would be sufficient to align one or two

chains of molecules and thus cause a change in the cells' resistance?

The shrimps' nervous system on contact with the boiling water would radiate a field of far greater strength than normal, this would be selected by the plant and the appropriate change in resistance would occur. I propose that a concentrating mind, regardless of the subject of that concentration, produces a field strong enough for the plant to detect.

Assuming this theory to be correct, there must be other chemicals possessing the same property, in which case it is not hard to imagine, in the not-too-distant future, the invention of a psycho-sensitive semiconductor device. This would be a boon for handicapped people who would be able to turn on equipment merely by thinking about it, no physical help required.

P. Watson,
Bedfordshire.

Hot line

Sir—A short while ago, my wife and I decided to change the position of the furniture in our lounge. The arrangement we chose meant that the colour television would not plug directly into the socket, so I decided to use an extension cable. The only one which was available was a 150ft cable which I use with the electric lawn mower.

Being the cautious type I checked that the television would not overload the cable and as the cable

was rated at 5A and the television consumption 245W, which is just over 1A at 240V, I decided that it would be safe. As you can imagine, 150ft of cable across a lounge leaves quite a lot to spare so I coiled it neatly and put it behind the television.

I offered a neighbour of mine the use of my lawn mower as he was having trouble coping with a thick growth. As the cable on the machine was not long enough I also offered the extension cable, this was when I found to my horror that the neatly coiled cable had welded itself together, it had apparently acted as a heating coil with 1A being sufficient to create enough heat to ruin all but 15ft of the cable. During this time the cable has not short circuited or failed but it has left a nasty burn mark on the carpet.

I had wondered why the cat had taken to sleeping under the television, she usually finds the warmest position to curl up.

R. F. Burgin,
Witham,
Essex.

According to I.E.E. regulations current ratings for cable are based on a fixed ambient air temperature. Any heat arising from the cable caused through coiling must derate this figure. The combination of heat generated in a long cable magnified by coiling and the cat probably contributed to the thermoplastic insulation deteriorating.—Ed

SOUND SYNTHESIS FOR THE AMATEUR

Due to the unprecedented number of letters we have received from readers stating their disappointment at not being able to attend the P.E. Audio Fair lectures, and more recently the lecture given at Essex University, we have decided to make available (at a small fee) to Clubs, Schools and Universities a taped recording and colour slides of the lecture.

Entitled "SOUND SYNTHESIS FOR THE AMATEUR" the tape runs for approximately 45 minutes at 7½ i.p.s. and was recorded on a Philips N4450 domestic recorder. The colour slides contain waveforms, block diagrams and circuits on the various sections of the P.E. Synthesiser. Only two sets of tapes and slides are available and requests will be dealt with in strict rotation of receipt.

It is regretted that this service can only be offered to CLUBS, SCHOOLS, and UNIVERSITIES. The charge is £1 to cover handling and postal charges. A refundable deposit of £5, to cover any damage to tapes or slides, is also required.

Requests for the tape and slides (with date of proposed use) should be addressed to:

The Editor, Practical Electronics, Fleetway House, Farringdon Street, London, E.C.4.

It is regretted that we can only handle postal requests.

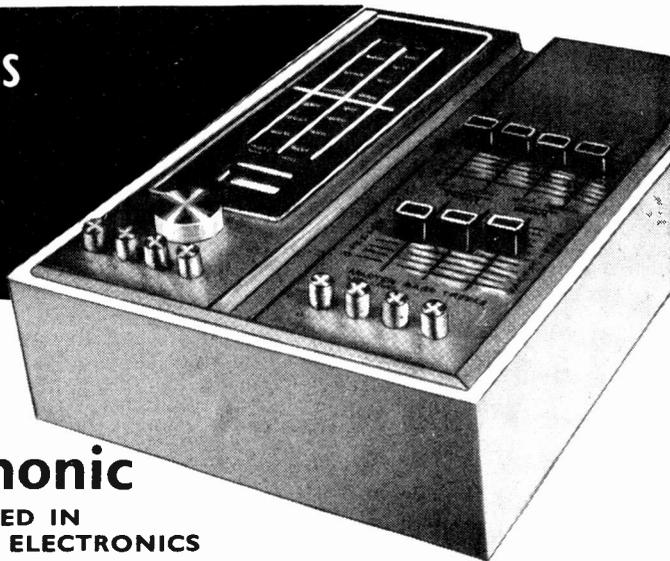
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SPEAKER KITS All components parts for "Rondo" loudspeaker assemblies are available, including special precision machined wrapround cabinets for very easy construction and perfect professional finish—as shown in fig. 7.9 of January 1974 issue.

COMPLETE SPEAKER KIT WITH 4 DRIVE UNITS, CROSSOVER WADDING, ETC. INCLUDING CABINETS
Price Per Pair **£34.50**
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SPECIAL OFFER - SAVE £7

4 Speaker kits (as required for Rondo) **£62.00**
Post £2. + VAT £6.40

Comprising 16 loudspeaker drive units, FOUR 5 element crossover networks including 12 prewound coils, four fully machined and polished wrap-round cabinets, four routed front and four routed back panels. 72 feet of coded coloured wire, four recess panels containing din and 4mm sockets, 24 lengths of 2" thick special acoustic wadding and latest acoustically transparent Declon fronts to complete the finish.

MONEY ENCLOSED £

NAME

ADDRESS

POST TO:

SONAX ELECTRONICS, Spencer House, Brettenham Rd., Edmonton, London, N.18

BASS DRIVE UNITS (2 per cabinet) **£4.25**
Post Free. + VAT 42p

TWEETERS (2 per cabinet) **£1.20**
Post Free. + VAT 12p

CROSSOVER KIT (1 per cabinet) **£2.75**
Post Free. + VAT 27p

DETAILS OF ANCILLARY KITS

We apologize to our customers for any inconvenience caused by delay in delivery. This is due to tremendous demand for our products and we are endeavouring to clear back-log with all possible speed.

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CHEQUE/P.O./MONEY ORDER**

RST

VALVE MAIL ORDER CO.

16a WELLFIELD ROAD, LONDON SW16 2BS
SPECIAL EXPRESS MAIL ORDER SERVICE
Express postage 3p for first transistor, 1p thereafter, over ten post free. INTEGRATED CIRCUITS 5p + 1p each added

Ref. No.	VA (Watts)	Weight lb oz	Size cm.	P & P		
1N21	0-17	FAZ11	1-15	BY213 0-25	0AZ206 0-25	ES170 0-18
1N23	0-25	AFZ12	2-00	BY210 0-45	0AZ206 0-45	ZS271 0-18
1N85	0-50	ASB28	0-25	BYZ11 0-40	0AZ207 0-45	ZT21 0-25
1N293	0-50	ASB27	0-20	BYZ12 0-40	0AZ208 0-40	ZT43 0-25
1N265	0-50	ASB28	0-25	BYZ13 0-25	0AZ209 0-40	ZTX107 0-18
1N645	0-16	ASB29	0-20	BYZ15 1-25	0AZ210 0-40	ZTX108 0-10
1N725A	0-20	ASB36	0-25	BZ116 0-40	0AZ211 0-40	ZTX300 0-14
1N914	0-06	ASB51	0-40	BZY88 0-10	0AZ222 0-45	ZTX304 0-24
1N4007	0-12	ASB53	0-20	CL11 0-55	0AZ224 0-45	ZTX503 0-18
1B131	0-25	ASB55	0-20	CR81/05 0-80	0AZ241 0-25	ZTX531 0-25
1B131	0-18	ASB55	0-20	CR81/40 0-45	0AZ242 0-15	
1B202	0-25	ASB62	0-25	CR84B 1-90	0AZ244 0-25	
2G371	0-40	ASB66	0-25	CB10B 0-80	0AZ246 0-15	
2G381	0-22	ASB221	1-00	DD000 0-15	0AZ290 0-25	
2G414	0-30	AU101	1-50	DD003 0-15	OC16 1-00	
2G417	0-25	AUY10	1-00	DD006 0-25	OC16T 1-00	
2N404	0-25	BC107	0-12	DD007 0-40	OC19 0-20	
2N897	0-15	BC108	0-12	DD008 0-25	OC20 0-20	
2N898	0-20	BC109	0-12	DD008 0-25	OC22 1-00	
2N706	0-10	BC110	0-18	GD 4 0-10	OC24 1-20	
2N706A	0-12	BC113	0-16	GD5 0-10	OC28 1-10	
2N708	0-15	BC116	0-20	GD8 0-25	OC29 0-40	
2N709	0-40	BC116A	0-22	GD12 0-10	OC28 0-40	
2N1091	0-20	BC118	0-20	GET102 0-20	OC28 0-70	
2N1131	0-25	BC121	0-20	GET103 0-40	OC29 0-25	
2N1132	0-25	BC122	0-20	GET113 0-25	OC30 0-40	
2N1303	0-18	BC126	0-25	GET114 0-20	OC36 0-25	
2N1304	0-22	BC128	0-25	GET118 0-25	OC38 0-25	
2N1306	0-22	BC147	0-12	GET120 0-50	OC42 0-70	
2N1307	0-25	BC148	0-10	GET872 0-20	OC43 0-70	
2N1308	0-22	BC149	0-12	GET875 0-40	OC44 0-18	
2N2147	0-75	BC167	0-14	GET880 0-55	OC44M 0-17	
2N2148	0-60	BC168	0-12	GET881 0-25	OC45 0-18	
2N2160	1-00	BC180	0-22	GET882 0-25	OC45M 0-18	
2N2218	0-22	BC189	0-22	GET885 0-25	OC46 0-27	
2N2219	0-25	BCY31	0-45	GEX44 0-08	OC57 0-20	
2N2369A	0-10	BCY32	1-20	GEX45/1 0-45	OC58 0-20	
2N2444	1-00	BCY33	0-25	GEX941 0-45	OC59 0-20	
2N2613	0-25	BCY34	0-45	GJ3M 0-50	OC68 0-50	
2N2646	0-50	BCY38	0-55	GJ4M 0-25	OC70 0-18	
2N2904	0-20	BCY39	1-00	GJ5M 0-25	OC71 0-15	
2N2904A	0-25	BCY42	0-20	HG1005 0-50	OC72 0-25	
2N2906	0-20	BCY70	0-15	H8100A 0-20	OC74 0-20	
2N2907	0-20	BCY71	0-20	MAT100 0-20	OC75 0-20	
2N2924	0-18	BCZ10	0-20	MAT101 0-25	OC76 0-20	
2N2925	0-15	BCZ11	0-65	MAT120 0-20	OC77 0-55	
2N2926	0-10	BD121	1-00	MAT121 0-25	OC78 0-25	
2N3054	0-50	BD123	1-00	MJ220 0-20	OC79 0-20	
2N3055	0-20	BD124	0-80	MJ2205 1-10	OC81 0-20	
2N3702	0-11	BDY11	1-45	MJ2305 0-75	OC81D 0-20	
2N3708	0-18	BF115	0-22	MJ2340 0-50	OC81M 0-20	
2N3706	0-11	BF117	0-50	MPP102 0-40	OC81DM 0-18	
2N3707	0-18	BF167	0-25	MPP103 0-20	OC81Z 0-25	
2N3709	0-10	BF173	0-22	MPP104 0-25	OC82 0-22	
2N3711	0-11	BF181	0-22	MPP105 0-45	OC82D 0-25	
2N3819	0-20	BF184	0-25	NKT129 0-45	OC83 0-20	
2N3819	0-20	BF185	0-25	NKT129 0-20	OC84 0-20	
2N3819	0-20	BF186	0-25	NKT211 0-25	OC84 0-20	
2N3819	0-20	BF187	0-25	NKT212 0-25	OC85 0-20	
2N3819	0-20	BF188	0-25	NKT213 0-25	OC86 0-20	
2N3819	0-20	BF189	0-25	NKT214 0-25	OC87 0-20	
2N3819	0-20	BF190	0-25	NKT215 0-25	OC88 0-20	
2N3819	0-20	BF191	0-25	NKT216 0-25	OC89 0-20	
2N3819	0-20	BF192	0-25	NKT217 0-25	OC90 0-20	
2N3819	0-20	BF193	0-25	NKT218 0-25	OC91 0-20	
2N3819	0-20	BF194	0-25	NKT219 0-25	OC92 0-20	
2N3819	0-20	BF195	0-25	NKT220 0-25	OC93 0-20	
2N3819	0-20	BF196	0-25	NKT221 0-25	OC94 0-20	
2N3819	0-20	BF197	0-25	NKT222 0-25	OC95 0-20	
2N3819	0-20	BF198	0-25	NKT223 0-25	OC96 0-20	
2N3819	0-20	BF199	0-25	NKT224 0-25	OC97 0-20	
2N3819	0-20	BF200	0-25	NKT225 0-25	OC98 0-20	
2N3819	0-20	BF201	0-25	NKT226 0-25	OC99 0-20	
2N3819	0-20	BF202	0-25	NKT227 0-25	OC100 0-20	
2N3819	0-20	BF203	0-25	NKT228 0-25	OC101 0-20	
2N3819	0-20	BF204	0-25	NKT229 0-25	OC102 0-20	
2N3819	0-20	BF205	0-25	NKT230 0-25	OC103 0-20	
2N3819	0-20	BF206	0-25	NKT231 0-25	OC104 0-20	
2N3819	0-20	BF207	0-25	NKT232 0-25	OC105 0-20	
2N3819	0-20	BF208	0-25	NKT233 0-25	OC106 0-20	
2N3819	0-20	BF209	0-25	NKT234 0-25	OC107 0-20	
2N3819	0-20	BF210	0-25	NKT235 0-25	OC108 0-20	
2N3819	0-20	BF211	0-25	NKT236 0-25	OC109 0-20	
2N3819	0-20	BF212	0-25	NKT237 0-25	OC110 0-20	
2N3819	0-20	BF213	0-25	NKT238 0-25	OC111 0-20	
2N3819	0-20	BF214	0-25	NKT239 0-25	OC112 0-20	
2N3819	0-20	BF215	0-25	NKT240 0-25	OC113 0-20	
2N3819	0-20	BF216	0-25	NKT241 0-25	OC114 0-20	
2N3819	0-20	BF217	0-25	NKT242 0-25	OC115 0-20	
2N3819	0-20	BF218	0-25	NKT243 0-25	OC116 0-20	
2N3819	0-20	BF219	0-25	NKT244 0-25	OC117 0-20	
2N3819	0-20	BF220	0-25	NKT245 0-25	OC118 0-20	
2N3819	0-20	BF221	0-25	NKT246 0-25	OC119 0-20	
2N3819	0-20	BF222	0-25	NKT247 0-25	OC120 0-20	
2N3819	0-20	BF223	0-25	NKT248 0-25	OC121 0-20	
2N3819	0-20	BF224	0-25	NKT249 0-25	OC122 0-20	
2N3819	0-20	BF225	0-25	NKT250 0-25	OC123 0-20	
2N3819	0-20	BF226	0-25	NKT251 0-25	OC124 0-20	
2N3819	0-20	BF227	0-25	NKT252 0-25	OC125 0-20	
2N3819	0-20	BF228	0-25	NKT253 0-25	OC126 0-20	
2N3819	0-20	BF229	0-25	NKT254 0-25	OC127 0-20	
2N3819	0-20	BF230	0-25	NKT255 0-25	OC128 0-20	
2N3819	0-20	BF231	0-25	NKT256 0-25	OC129 0-20	
2N3819	0-20	BF232	0-25	NKT257 0-25	OC130 0-20	
2N3819	0-20	BF233	0-25	NKT258 0-25	OC131 0-20	
2N3819	0-20	BF234	0-25	NKT259 0-25	OC132 0-20	
2N3819	0-20	BF235	0-25	NKT260 0-25	OC133 0-20	
2N3819	0-20	BF236	0-25	NKT261 0-25	OC134 0-20	
2N3819	0-20	BF237	0-25	NKT262 0-25	OC135 0-20	
2N3819	0-20	BF238	0-25	NKT263 0-25	OC136 0-20	
2N3819	0-20	BF239	0-25	NKT264 0-25	OC137 0-20	
2N3819	0-20	BF240	0-25	NKT265 0-25	OC138 0-20	
2N3819	0-20	BF241	0-25	NKT266 0-25	OC139 0-20	
2N3819	0-20	BF242	0-25	NKT267 0-25	OC140 0-20	
2N3819	0-20	BF243	0-25	NKT268 0-25	OC141 0-20	
2N3819	0-20	BF244	0-25	NKT269 0-25	OC142 0-20	
2N3819	0-20	BF245	0-25	NKT270 0-25	OC143 0-20	
2N3819	0-20	BF246	0-25	NKT271 0-25	OC144 0-20	
2N3819	0-20	BF247	0-25	NKT272 0-25	OC145 0-20	
2N3819	0-20	BF248	0-25	NKT273 0-25	OC146 0-20	
2N3819	0-20	BF249	0-25	NKT274 0-25	OC147 0-20	
2N3819	0-20	BF250	0-25	NKT275 0-25	OC148 0-20	
2N3819	0-20	BF251	0-25	NKT276 0-25	OC149 0-20	
2N3819	0-20	BF252	0-25	NKT277 0-25	OC150 0-20	
2N3819	0-20	BF253	0-25	NKT278 0-25	OC151 0-20	
2N3819	0-20	BF254	0-25	NKT279 0-25	OC152 0-20	
2N3819	0-20	BF255	0-25	NKT280 0-25	OC153 0-20	
2N3819	0-20	BF256	0-25	NKT281 0-25	OC154 0-20	
2N3819	0-20	BF257	0-25	NKT282 0-25	OC155 0-20	
2N3819	0-20	BF258	0-25	NKT283 0-25	OC156 0-20	
2N3819	0-20	BF259	0-25	NKT284 0-25	OC157 0-20	
2N3819	0-20	BF260	0-25	NKT285 0-25	OC158 0-20	
2N3819	0-20	BF261	0-25	NKT286 0-25	OC159 0-20	
2N3819	0-20	BF262	0-25	NKT287 0-25	OC160 0-20	
2N3819	0-20	BF263	0-25	NKT288 0-25	OC161 0-20	
2N3819	0-20	BF264	0-25	NKT289 0-25	OC162 0-20	
2N3819	0-20	BF265	0-25	NKT290 0-25	OC163 0-20	
2N3819	0-20	BF266	0-25	NKT291 0-25	OC164 0-20	
2N3819	0-20	BF267	0-25	NKT292 0-25	OC165 0-20	
2N3819	0-20	BF268	0-25	NKT293 0-25	OC166 0-20	
2N3819	0-20	BF269	0-25	NKT294 0-25	OC167 0-20	
2N3819	0-20	BF270	0-25	NKT295 0-25	OC168 0-20	
2N3819	0-20	BF271	0-25	NKT296 0-25	OC169 0-20	
2N3819	0-20	BF272	0-25	NKT297 0-25	OC170 0-20	
2N3819	0-20	BF273	0-25	NKT298 0-25	OC171 0-20	
2N3819	0-20	BF274	0-25	NKT299 0-25	OC172 0-20	
2N3819	0-20	BF275	0-25	NKT300 0-25	OC173 0-20	
2N3819	0-20	BF276	0-25	NKT301 0-25	OC174 0-20	
2N3819	0-20	BF277	0-25	NKT302 0-25	OC175 0-20	
2N3819	0-20	BF278	0-25	NKT303 0-25	OC176 0-20	
2N3819	0-20	BF279	0-25	NKT304 0-25	OC177 0-20	
2N3819	0-20	BF280	0-25	NKT305 0-25	OC178 0-20	
2N3819	0-20	BF281	0-25	NKT306 0-25	OC179 0-20	
2N3819	0-20	BF282	0-25	NKT307 0-25	OC180 0-20	
2N3819	0-20	BF283	0-25	NKT308 0-25	OC181 0-20	
2N3819	0-20	BF284	0-25	NKT309 0-25	OC182 0-20	
2N3819	0-20	BF285	0-25	NKT310 0-25	OC183 0-20	
2N3819	0-20	BF286	0-25	NKT311 0-25	OC184 0-20	
2N3819	0-20	BF287	0-25	NKT312 0-25	OC185 0-20	
2N3819	0-20	BF288	0-25	NKT313 0-25	OC186 0-20	
2N3819	0-20	BF289	0-25	NKT314 0-25	OC187 0-20	
2N3819	0-20	BF29				

44p ?

Trannies

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- * PRICES INCLUSIVE OF V.A.T.
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- Includes
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OR COMPLETE SYSTEM £189.97, carriage £5.00. Terms available, no deposit. £10.16 monthly for 24 months.

We stock a full range of Disco Equipment. Send for list or pay a visit.

£1 BARGAIN PACKS

- £1 10 Silicon NPN Power transistors (like 2N3055). Below spec.
- £1 30 Plastic FET's unmarked/untested, similar to 2N3819 (random test showed good yield).
- £1 20 TO5 transistors NPN or PNP, state which, 2 to 5 amp w/tested.
- £1 20 TO18 transistors PNP like BC178, BC179, etc. U/tested.
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- £1 10 General Purpose fully tested FET's.
- £1 200 mixed capacitors
- £1 250 mixed resistors.
- * Any 5 packs £4.50 *

SEMICONDUCTORS	BRIDGE RECTIFIERS	THYRISTORS	TUBES
AC126 14p	OC44 16p		
AC127 16p	OC45 10p	1 Amp	
AC128 15p	OC71 11p	100V	22p
AC141K 26p	OC81 12p	200V	24p
AC142K 26p	2N706 14p	600V	27p
AC176 18p	2N1131 24p		
AC187 24p	2N1132 28p		
AC188 24p	2N304 20p	1 Amp	
AC187K 23k	2N2926 11p	50V	29p
AC188K 23p	2N3053 26p	100V	32p
AD149 49p	2N3054 55p	200V	34p
AD161 33p	2N3055 49p	400V	44p
AD162 40p	2N3702 14p	3 Amp	
AF114 20p	2N3703 13p	50V	39p
AF115 20p	2N3704 14p	100V	44p
AF116 20p	2N3705 13p	200V	48p
AF117 20p	2N3706 12p	400V	66p
BC107 13p	2N3707 13p	5 Amp	
BC108 12p	2N3708 11p	50V	46p
BC109 13p	2N3709 12p	100V	57p
BC147 13p	2N3710 12p	200V	66p
BC148 13p	2N3711 12p	400V	77p
BC149 13p	2N3819 35p		
BC182 13p	40361 55p	2 Amp	
BC183 11p	40362 55p	100V	33p
BC184 14p	40363 69p	200V	55p
BC212 13p	1N914 8p	400V	77p
BC213 13p	1N916 8p	6 Amp	
BC214 13p	1N4001 7p	100V	66p
BD131 68p	1N4002 8p	200V	88p
BD132 90p	1N4003 10p	400V	99p
BF194 16p	1N4004 10p	10 Amp	
BF195 17p	1N4006 15p	100V	99p
BF244 27p	1N4148 6p	200V	1.32
BFY50 18p	1N5400 16p	400V	1.43
BFY51 18p	1N5401 17p	400mW	
BFY52 17p	1N5402 19p	ZENER	
MP8111 36p	1N5404 24p	DIOIDES	
OC28 50p	1N5406 28p	3.3 to 33	
OC26 50p		volt 11p each	

Resistors

- 1/2 watt 5% carbon 1p
- 1 watt 5% carbon 3p
- 1 watt 10% carbon 1p
- range 10 ohms to 4.7 megohms.
- 1/2 watt m/o 2% 4p
- range 10 ohms to 1 megohms.

VEROBOARD

0-1	0.15
2 1/2 x 3 1/2	24p 19p
2 1/2 x 5	27p 23p
3 1/2 x 3 1/2	27p 23p
3 1/2 x 5	31p 31p
17 x 2 1/2	82p 63p
17 x 3 1/2	£1.10 87p
17 x 5 (Plain)	80p
Pin insertion tool	57p 57p
Spot face cutter	46p 46p
Pk. 36 Pins	20p 20p

Electrolytic Capacitors

6.3 VOLT	220µF	9p	40 VOLT
68µF	64p	680µF	17p
150µF	64p	1000µF	17p
170µF	11p	1500µF	25p
680µF	13p	2000µF	43p
1500µF	18p		
1500µF	18p		
3300µF	26p		
		25 VOLT	
		10µF	64p
		22µF	64p
		47µF	64p
		100µF	8p
		150µF	8p
		220µF	10p
		470µF	13p
		470µF	10p
		1000µF	11p
		1500µF	20p
		2200µF	24p
		5000µF	68p
		16 VOLT	
		15µF	64p
		33µF	64p
		150µF	64p
		150µF	8p
		40 VOLT	
		6.8µF	64p
		15µF	64p
		33µF	64p

VOLUME CONTROLS

Potentiometers
Carbon track 500Ω to 2.2MΩ.
Log or Linear.
Single 13p. Dual gang (stereo) 44p.
Single-type with D.P. switch 13p extra.

CARBON SKELETON PRESETS

Small high quality type (linear only). All valves 100-5 meg ohms.
- 1 watt 6p each
- 2.5 watt 64p each

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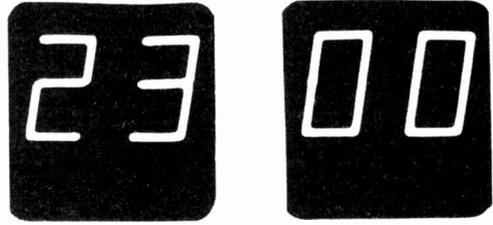
SLIDE SWITCH SPST 11p each D.P.D.T. 13p each.

MINIATURE NEON LAMPS 240V or 110V 1.4 Sp. 5 plus 44p each.

Mullard Polyester Capacitors

C280 SERIES
250V P.C. mounting: 0.01µF, 0.015, 0.022 34p, 0.033, 0.047, 0.068 4p, 0.1 44p, 0.15, 0.22 54p, 0.33 7p, 0.47 94p, 0.68 12p, 1µF 14p, 1.5µF 22p, 2.2µF 27p.

C296 SERIES
400V: 0.001µF, 0.0015, 0.0022, 0.0033, 0.0047 3p, 0.0068, 0.01, 0.015, 0.022, 0.033 34p, 0.047, 0.068, 0.1 44p, 0.15 64p, 0.22 84p, 0.33 12p, 0.47 144p, 0.68 34p, 0.1 4p, 0.15 4p, 0.1 44p, 0.15, 0.22 54p, 0.33 7p, 0.47 94p, 0.68 12p, 1µF 14p, 1.5µF 22p, 2.2µF 24p.



SP352

SP352

MK50250N—NEW MOSTEK ALARM CLOCK IC £6.00 + VAT = £6.60
24hr format—Alarm—Snooze—Multiplexed 4 to 6 digit display—etc. This is a high performance clock IC from Mostek Corporation at a break-through price.

BUILD AN ATTRACTIVE DIGITAL ALARM CLOCK WITH RADIO TURN-ON
A kit of all parts except case and switches for a digital alarm clock with radio turn-on using the MK5020N and highly attractive SP352 0.55in displays (see above). The kits include: Building instructions, MK50250N, SP352 displays, all semiconductors, resistors and capacitors, radio turn-on relay, miniature loudspeaker for alarm, soldercon pins for IC socket, main PCB and digit mounting PCB. Both PCBs have been designed so that constructors of the 4 digit clock may easily expand their unit to 6 digits at a later date.

4 digit Kit £26.00 + VAT = £28.60
6 digit Kit £31.40 + VAT = £34.54
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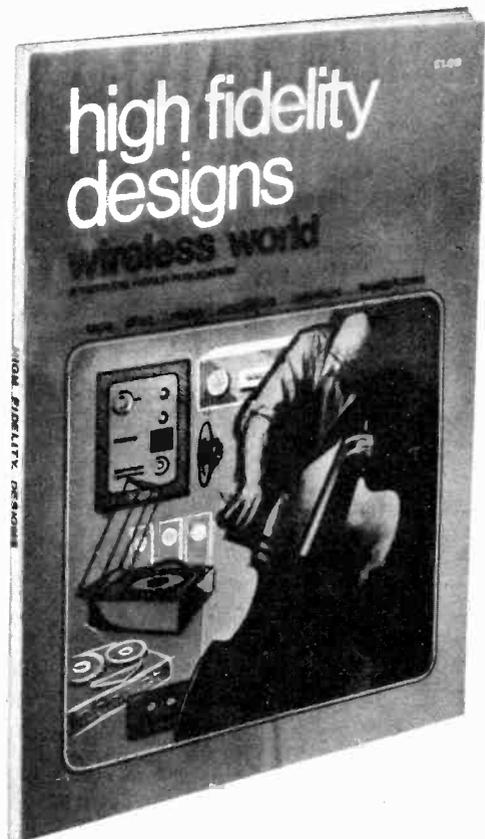
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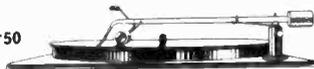
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Bits No.

102 For model CN240 ½"

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1102 For model CCN240 1"

1020 For model G240 ½"

1021 For model G240 ¾"

1022 For model G240 1"

50 For model X25 ½"

51 For model X25 ¾"

52 For model X25 1"

ELEMENTS

ECN 240 £1.16 ECCN 240 £1.32

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C4 75	1/4 W Resistors mixed preferred values	0.55
C5 5	Pieces assorted Ferrite Rods	0.55
C6 2	Tuning Gangs, MW/LW VHF	0.55
C7 7	Pack Wire 50 metres assorted colours	0.55
C8 10	Reed Switches	0.55
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C11 5	Jack Sockets 3 x 3.5m Standard Switch Type	2 x 0.55
C12 40	Paper Condensers preferred types mixed values	0.55
C13 20	Electrolytics Trans. types	0.55
C14 1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0.55
C15 4	Mains Slide Switches	0.55
C16 20	Assorted Tag Strips & Panels	0.55
C17 10	Assorted Control Knobs	0.55
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C19 3	Relays 6—24V Operating	0.55
C20 4	Sheets Copper Laminate approx. 10" x 7"	0.55

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P8 37 DIN	5 Pin 180°	0.10
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P8 39	Jack 2.5mm Switched	0.09
P8 40	Jack 3.5mm Switched	0.10
P8 41	Jack 1" Switched	0.17
P8 42	Jack Stereo Switched	0.28
P8 43	Phono Single	0.08
P8 44	Phono Double	0.10
P8 45	Car Aerial	0.08
P8 46	Co-Axial Surface	0.09
P8 47	Co-Axial Flush	0.14

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P8 21	D.I.N. 2 Pin (Speaker)	0.13
P8 22	D.I.N. 3 Pin	0.17
P8 23	D.I.N. 5 Pin 180°	0.17
P8 24	D.I.N. 5 Pin 240°	0.17
P8 25	Jack 2.5mm Plastic	0.10
P8 26	Jack 3.5mm Plastic	0.12
P8 27	Jack 1" Plastic	0.24
P8 28	Jack 1" Screened	0.28
P8 29	Jack Stereo Plastic	0.22
P8 30	Jack Stereo Screened	0.28
P8 31	Phono Screened	0.14
P8 32	Car Aerial	0.15
P8 33	Co-Axial	0.17

PLUGS

P8 1	D.I.N. 2 Pin (Speaker)	0.11
P8 2	D.I.N. 3 Pin	0.12
P8 3	D.I.N. 4 Pin	0.15
P8 4	D.I.N. 5 Pin 180°	0.14
P8 5	D.I.N. 5 Pin 240°	0.15
P8 6	D.I.N. 6 Pin	0.15
P8 7	D.I.N. 7 Pin	0.10
P8 8	Jack 2.5mm Screened	0.09
P8 9	Jack 3.5mm Plastic	0.12
P8 10	Jack 3.5mm Screened	0.13
P8 11	Jack 1" Plastic	0.18
P8 12	Jack 1" Screened	0.18
P8 13	Jack Stereo Screened	0.28
P8 14	Phono	0.06
P8 15	Car Aerial	0.15
P8 16	Co-Axial	0.10

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CP 2	Twin Common Screen	0.08
CP 3	Stereo Screened	0.23
CP 4	Four Core Common Screen	0.08
CP 5	Four Core Individually Screened	0.30
CP 6	Microphone Fully Braided Cable	0.10
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CP 9	Speaker Cable	0.04
CP 10	Low Loss Co-Axial	0.10

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Log and Lin		
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VC2	Single D.P. Switch	0.28
VC3	Tandem Less Switch	0.44
VC4	1K Lin Less Switch	0.14
VC5	100K Log anti-Log	0.44

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Holds 14, 13in x 5in x 6in. Lock and handle, £1.95
 Holds 24, 13½in x 8in x 5½in. Lock and handle, £2.70.

COLOURS: Red, black and tan, please state preference

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240V. Primary. Secondary voltages available from selected tapings 4V, 7V, 8V, 10V, 14V, 15V, 17V, 19V, 21V, 23V, 31V, 33V, 40, 50 and 25V 0-25V.

Type	Amps	Price	P. & P.
MT60/1	1	£1.93	30p
MT50/1	1	£2.42	35p
MT50/2	2	£3.20	40p

CARTRIDGES

ACOS GP91-18C, 200mV at 1.2cm/sec £1.16
 ACOS GP93-1, 280mV at 1cm/sec £1.65
 ACOS GP96-1, 100mV at 1cm/sec £2.65
 TTC J-2005, Crystal/Hi Output 99p
 TTC J-20 100 Crystal/Hi Output Compatible £1.10
 TTC J-200 CS Stereo/Hi Output £1.60
 TTC J-2105 Ceramic/Med. Output £1.64

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The E12 Range of Carbon Film Resistors, ½ watt available in PAK 8 of 50 pieces, assorted into the following groups:—

R1	50 Mixed 100 ohms-820 ohms	40p
R2	50 Mixed 1K ohms-8.2K ohms	40p
R3	50 Mixed 10K ohms-82K ohms	40p
R4	50 Mixed 100K ohms-1 Meg. ohms	40p

THESE ARE UNBEATABLE PRICES—LESS THAN 1p EACH INCL. V.A.T.

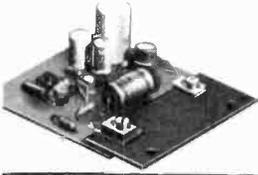
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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f = 1KHz	0.25%
LOAD IMPEDANCE	—	8-16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE -3dB	Po = 2 WATTS	50 Hz-20KHz
SENSITIVITY for RATED O/P	Vs=25V, R1=8 Ω f=1KHz	75mV, RMS
DIMENSIONS	—	3" x 2 1/2" x 1"

The above table relates to the AL10, AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power out for 2% T.H.D. (RL = 8 Ω f = 1KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL 10. 3 watts	£2-19
AL 20. 5 watts	£2-59
AL 30. 10 watts	£3-01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20)	85p
PSM 80. (Use with also AL30 & AL50)	£3-25
FRONT PANELS PA 12 with Knobs	£1-00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4-35
PA 100. (Use with AL30 & AL50)	£13-15

TRANSFORMERS

T461 (Use with AL10)	£1-38 P & P 15p
T538 (Use with AL20)	£1-93 P & P 15p
BMT80 (Use with AL30 & AL50)	£2-15 P & P 25p

PA12 PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most ↑Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 35mm.

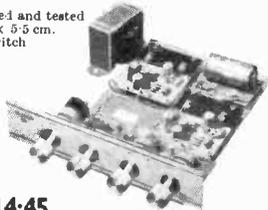
Frequency response—	20Hz-50KHz (-3dB)
Bass control—	± 12dB at 60Hz
Treble control—	± 14dB at 14KHz
*Input 1. Impedance	1 Meg. ohm
Sensitivity 300mV	
†Input 2. Impedance	30 K ohms
Sensitivity 4mV	

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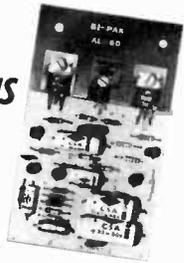
The STEREO 20

The "Stereo 20" amplifier is mounted, ready wired and tested in a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls, transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The "Stereo 20" has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 0.0mV into 1M. Freq. res. 20Hz-50KHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ± 12dB at 60Hz typically 0.25% at 1 watt. Treble con. ± 14dB at 14KHz.



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THERMAL PROTECTION!
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FOR ONLY £3.95

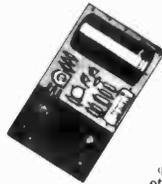


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- Thermal Feedback
- Latest Design Improvements
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TRANSFORMER BMT80 £2-15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages. Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz—20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1.5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.	
Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than -60dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm x 82mm x 35mm

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"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT
This fantastic little box

approx. 4" x 3" x 2" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts. Complete with a sensitive level control the unit is fused and cannot harm your amplifier. A Bargain at £7-50 plus 10p.

"CRESCENT" BUBBLE LIGHT SHOW

A new and exciting feature for the professional disc jockey or to give the private party an electric atmosphere, a projected kaleidoscope of colour.

Specification—Projector: 100W. convection cooled, at 30ft the projected image = 16ft; Motor: 1 rev per 2 min. Liquid Wheel: 6in diameter multicolour.

The Motor is fitted to the Projector and can only be purchased as a single unit. The Liquid Wheel, however, is our very popular standard model & may be purchased separately. A bargain—Projector with Motor ready for instant use, £15-6in Liquid Wheel, £5-£20 + 75p cart.

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Enables you to work your Transistor Radio, Amplifier or Cassette, etc., from the a.c. mains through this compact Eliminator. Just by moving a plug you can select the voltage you require, 6, 7 or 9 volt. This means all your transistor power pack applications can be handled by this one unit. Approx. size 2 1/2in x 2 1/2in x 3 1/2in. Our Price **£2-75** plus 10p P. & P. Same model suitably wired for the Phillips Cassette £3 plus 10p P. & P.

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A top quality speaker ideal where small size is important. Manufactured by E.M.I. for a well-known hi-fi set maker. Size: 7in x 4in. Impedance: 8 ohms. Flux: 38,000. Max. Free range: 90Hz to 12kHz. Power handling: 5W. Unbeatable. Price: **£1-60**. Free postage on this item.



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| UK65 | Transistor Tester | £1-86 |
| UK92 | Telephone Amp | £2-26 |
| UK115 | Hi-Fi Amp—8W | £4-50 |
| UK130 | Mono Control Unit | £4-15 |
| UK145 | Amp—1-5W | £3-81 |
| UK165 | RIAA Equalised Stereo Amp | £5-30 |
| UK195 | Mini-Amp—2W | £3-86 |
| UK220 | Signal Injector | £2-65 |
| UK230 | AM-FM Aer. Amp | £3-29 |
| UK275 | Mike Pre-Amp | £2-98 |
| UK300 | 4 Channel Radio Control T.X. | £6-61 |
| UK310 | Radio Control Receiver | £3-29 |
| UK515 | MW Radio Receiver | £7-92 |
| UK520 | AM Tuner | £4-60 |
| UK710 | 4 Channel A.F. Mixer | £12-59 |
| UK715 | Photoelectric Cell Switch | £9-97 |
| UK835 | Guitar Pre-Amp | £4-98 |
| UK875 | Cap. Discharge Ignition | £13-19 |
| UK915 | R.F. Amp 12-170MHz | £2-86 |
| UK935 | Wide Band Amp 20Hz to 150MHz | £2-86 |

TRI-VOLT CAR SUPPLY

Enables you to work your Transistor Radio, Amplifier or Cassette, etc. from the 12 volt car supply. Positive or negative earth. Approx. size = 2in x 3 1/2in x 1 1/2in. This converter supplies 6, 7 or 9 volts and is transistor regulated. A real money saving device for **£2-50**. 10p P. & P.

"C.300" DISCO CONTROL PACK

A control unit which when connected to twin decks makes a disc of professional quality. We supply a smart front panel which incorporates controls, switch and input sockets. The control module, I.C. construction incorporating mixing, pre-amp and headphone listening amplifier. The power pack enables this unit to work from the standard mains. * Inputs include Mic, Tape/Cassette and Twin Decks. * Controls include Mic, Tape, Each Deck, Mono, £14. Stereo, £17 plus 20p cart.

3 KILOWATTS PSYCHEDELIC LIGHT CONTROL UNIT



Three Channel: Bass—Middle—Treble. Each channel has its own sensitivity control. Just connect the input of this unit to the loudspeaker terminals of an amplifier, and connect three 250V up to 1000W lamps to the output terminals of the unit, and you produce a fascinating sound-light display. (All guaranteed) **£18-50** plus 38p P. & P.

LOW VOLTAGE AMPLIFIER

5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output. With high IMP input this amplifier will work as a record player, baby alarm, etc., amplifier. **£1-75** plus 13p P. & P.

200/250V MAINS RELAY

Heavy duty contacts. 2,500Ω coil. All new and unused D.P.D.T. Mains relays 50p + V.A.T. Carr. Free. Special quantity price: **£40** per 100 relays.

MINI LOUDSPEAKERS

2 1/2in 80 ohm, 50p; 2 1/2in 40 ohm, 50p. Please include 5p P. & P. on each L.S.

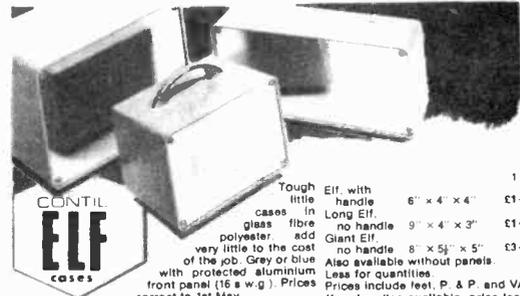
EnCase ENVIRONMENTAL HOUSING

A cleverly designed protected polycarbonate enclosure... weatherproof, hoseproof and damp and dust protecting. It's high impact strength will withstand rough handling. The seven sizes can interconnect and any case will extend vertically or horizontally or both while maintaining full protection. Send for new catalogue. Many extras available incl hinges, etc.

EnCase includes chassis, retaining screws, cover, gasket and cover retaining screws, price includes P. & P and VAT.

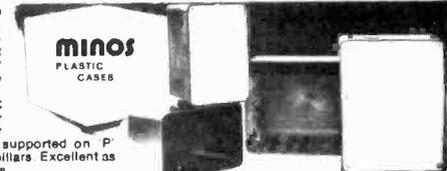
ENA	7 1/2" x 7 1/2" x 5"	£4-93
ENB	11" x 7 1/2" x 5"	£6-33
ENC	15" x 7 1/2" x 5"	£8-43
END	11" x 11" x 5"	£8-62
ENE	15" x 11" x 5"	£11-05
ENF	22" x 11" x 5"	£15-30
ENG	22" x 15" x 7"	£21-18

Prices correct to 1st May



Tough Elf, with little handle 6" x 4" x 4" **£1-92** **£1-76**
cases in Long Elf.
glass fibre no handle 9" x 4" x 3" **£1-98** **£1-92**
polyester add Giant Elf.
very little to the no handle 8" x 5 1/2" x 5" **£3-19** **£3-08**
of the job. Grey or blue with protected aluminium front panel (16 g w g). Prices correct to 1st May. Also available without panels. Less for quantities. Prices include test, P. & P. and VAT. If no handles available, price less 9p.

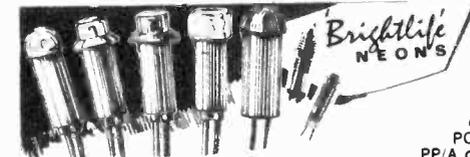
A smart miniature case in tough, rigid, high-gloss black A.B.S. Front panels in either aluminium or white PVC/Steel.



Built-in slots for PC cards, dividers, or screens. Chassis or PC boards can be supported on P clips from internal pillars. Excellent as encapsulation boxes.

M2	65mm x 100mm x 50mm 2 1/2" x 3 1/2" x 2"	51p 45p
M3	100mm x 130mm x 50mm 3 1/2" x 5" x 2"	67p 58p

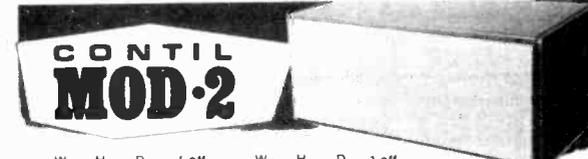
Prices include P. & P. and VAT. Less for quantities. Also available without panel and screws. Minimum order £1. Prices correct to 1st May.



Brightlife neons, illustrated are PC/A or C, PC/G or P, PP/A or B, Q & S, are brighter and give an average of 25,000 hrs. life. The 0.375" dia. are red or white. The 0.375" dia. are red, amber or white; these have 3 cap shapes and all may be supplied for 115, 240V or the PP neons in 110, 240 and 440V with 6" or 30" leads. Send for details in new catalogue.

dia	leads	volts	10 off	100 off
PC/A to 1	6"	110 or 160-260	17 1/2p	16 1/2p
PC/A to 1	30"	110 or 160-260	19 1/2p	18 1/2p
PP/A	6"	110 or 160-260	17 1/2p	16 1/2p
PP/A	30"	110 or 160-260	19 1/2p	18 1/2p
Q type	none	110 or 160-260	29p	27p
S type	none	160-260	23p	21p

P. & P. inc. any quantity, then add 10% VAT. Minimum quantity each type 10 off. Prices correct to 1st May.



A	4.5"	3"	6.5"	£3-60	M	4.5"	3"	13"	£4-44
B	4.5"	7"	6.5"	£4-44	N	4.5"	7"	13"	£5-44
C	4.5"	10"	6.5"	£4-91	O	4.5"	10"	13"	£6-91
D	9"	3"	6.5"	£4-91	P	9"	3"	13"	£5-44
E	9"	7"	6.5"	£5-44	Q	9"	7"	13"	£6-91
F	9"	10"	6.5"	£6-28	R	9"	10"	13"	£8-41
G	13"	3"	6.5"	£5-44	S	13"	3"	13"	£6-91
H	13"	7"	6.5"	£6-28	T	13"	7"	13"	£8-41
I	13"	10"	6.5"	£6-91	U	13"	10"	13"	£10-20
J	18"	3"	6.5"	£6-28	V	18"	3"	13"	£8-41
K	18"	7"	6.5"	£8-41	W	18"	7"	13"	£10-20
L	18"	10"	6.5"	£10-20	X	18"	10"	13"	£12-21

Woodgrain D at £5-44, E & G at £6-28, H at £6-91. Includes screws, feet, chassis, according to size, and P. & P. and VAT. Prices correct to 1st May.

WEST HYDE

WEST HYDE DEVELOPMENTS LTD., RYEFIELD CRES., NORTHWOOD HILLS, MIDD. HA8 1NN. Tel: Northwood 24941 or 28732 Telex: 923231

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If you construct you should own one. Send 20p inc. carriage.

VAT

★ Please include 10% VAT on goods plus carriage.

PRICES INCLUDE VAT
SUPERSOUND 13 HI-FI
MONO AMPLIFIER

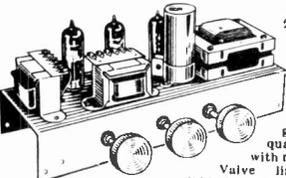


A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13W r.m.s. into 8 ohm. Frequency response 12Hz-30KHz \pm 9db. Fully integrated pre-amplifier stage with

separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3in high x 6in wide x 7in deep. A.C. 200/250V.

PRICE £12.00 P. & P. 60p.

DE LUXE STEREO AMPLIFIER



A.c. mains 200-240 volts. Using heavy duty fully integrated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up—2 ECL86 Triode Pentodes.

1 x EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate "balance" control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11in. w x 4in. x. Overall height including valves 5in. Ready built and tested to a high standard. **Price £10.40.** P. & P. 50p.

NEW! POWER SUPPLY UNIT

200/240V A.C. input. Four switched fully smoothed D.C. outputs giving 6V and 7.1V and 9V and 12V at 1 amp on load.

Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case, overall size 6" x 3 1/4" x 2 1/4". Suitable for Transistor Radios, Tape Recorders, Amplifiers, etc., etc. Ready built and tested.

PRICE £5 P. & P. 35p.

HI-GRADE COPPER LAMINATE BOARDS. 8" x 6". Five for 60p plus 30p P. & P.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0-210-240V. Secondary combinations: 0-5-10-15-20-25-30-35-40-60V half wave at 1 amp or 10-10-10-20-30-30-30, at 2 amps full wave. Size 3inL x 3 1/2inW x 3inD. **Price £2.31.** P. & P. 40p

FEW ONLY. High grade mains transformers with grain orientated lamination. Primary 200/240 secondary 18-5 volts at 0-5 amps and 4-6 volts at 0-3 amps. Size 2 1/2" x 2 1/4" W. x 2 1/2" overall. **£1.25 plus 25p P. & P.**

MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240V Sec. 9-0-9 at 500mA. **£1.10 P. & P. 25p.** Pri. 200/240V Sec. 12-0-12 at 1 amp. **£1.21 P. & P. 25p.** Pri. 200/240V Sec. 10-0-10 at 2 amp. **£1.82 P. & P. 25p.**

GENERAL PURPOSE HIGH STABILITY TRANSISTOR PRE-AMPLIFIER. For P.U., Tape, Mike, Guitar, etc., and suitable for use with valve or transistor equipment. 9-18V. Battery or from H.T. line 200/300V. Frequency response 15Hz-25KHz. Gain 26dB. Solid encapsulation size 1 1/2 x 1 1/4 in. Brand new—complete with instructions. **Price £1.** P. & P. 15p.

3 REFERENCE ENCYCLOPEDIAS FOR ELECTRONIC ENGINEERS AND DESIGNERS, covering theory, transistor characteristics, diode and transistor equivalents. Many thousands of up-to-date European types listed. Diode Equivalents 80p
 Transistor Equivalents 90p
 Transistor Characteristics **£1.20**
 All three together **£2.90** **POST FREE**

HANDBOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES

A must for servicemen and home constructors. Including many 1000's of British, U.S.A., European and Japanese transistors. **ONLY 40p.** Post 5p.

NEW ISSUE—Thyristor, Triac, Diac, etc. encyclopedias 95p Post Free.

Open 9.30-5.30 Mon. to Fri.
 9.30-5.30 Sat. Closed Wed.

A few minutes from South Wimbledon Tube Station.

FOR PERSONAL CALLERS ONLY! Limited number of Stereo Radiogram chassis covering LW/MW/FM bands. Mono radio and stereo gram. Overall size approx. 16 1/2" W. 6 1/4" H. 8" D. 4 Watts per channel output. **ONLY £16.50.**

SPECIAL BARGAIN OFFER!

Limited number of BSR C123 Auto Changer De Luxe with lightweight tubular arm and stereo cartridge. Brand new. **ONLY £8.00** plus P. & P. 60p.

PRECISION ENGINEERED PLINTHS

Beautifully constructed in heavy gauge "Colorcoat" plastic coated steel. Resonance free. Designed to take Garrard 1025, 2000, 2025TC, 2500, 3000, 3500, 5100, SP25 II and III, EL86B, AT80, etc. or B.S.R. C123, C109, C129, A21, etc. Black leatherette finish. Size 12 1/2in x 14 1/2in x 3 1/2in high (approx. 7 1/2in high, including rigid smoked acrylic cover). P. & P. 70p. **Now only £4-95**

8 pole 3 way 2 bank low loss Xaley type switches 14" sections. Standard spindle. 2 switches 86p + 10p P. & P.

LATEST ACOS GP91/180 Mono Compatible Cartridge with 1/6 stylus for LP/EP/78. Universal mounting bracket. **£1.50.** P. & P. 15p.

SONOTONE STEREO COMPATIBLE STEREO CARTRIDGE T/O stylus. Diamond Stereo LP and Sapphire 78. **ONLY £2-30.** P. & P. 10p. Also available fitted with twin Diamond T/O stylus for Stereo LP. **£2-30.** P. & P. 15p.

LATEST RONETTE T/O Stereo Compatible Cartridge for EP/LP/Stereo/78. **£1-63.** P. & P. 15p.

LATEST RONETTE T/O Mono Compatible Cartridge for EP/LP/78 mono/stereo records on mono equipment **£1-50.** P. & P. 15p.

QUALITY RECORD PLAYER AMPLIFIER MK II

A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 3 d. x 6 h. Ready built and tested. **PRICE £5-00.** P. & P. 50p. **ALSO AVAILABLE** mounted on board with output transformer and speaker. **PRICE £8-30.** P. & P. 60p.

SPECIAL OFFER!!
HI-FI LOUSPEAKER SYSTEM

Beautifully made teak finish enclosure with most attractive Tygan-Vynair front. Size 16in high x 10in wide x 6in deep. Fitted with E.M.I. Ceramic Magnet 13in x 8in bass unit, two H.F. tweeter units and crossover. Max. power handling 10W. Available 3, 8 or 16 ohm impedance.

Our Price £9-25 Carr. 75p

CABINET AVAIL. SEPARATELY £4-95. Carr. 65p. Also available in 8 ohm with EMI 13in x 8in. bass speaker with parasitic tweeter. **£7-15.** Carr. 75p.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3-5 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep x 6in. high overall. AC mains 200/240V. Supplied absolutely BRAND NEW, completely wired and tested with good quality output transformer.

OUR ROCK BOTTOM BARGAIN PRICE **£3-85** P. & P. 40p

LOUDSPEAKER BARGAINS

5in 3 ohm £1-25. P. & P. 15p. 7 x 4in 3 ohm £1-40. P. & P. 20p. 10 x 6in 3 or 15 ohm £2-10. P. & P. 30p. E.M.I. 8 x 3in 3 ohm with high flux magnet £1-70. P. & P. 20p. E.M.I. 12 1/2 x 8in with high flux ceramic magnet with parasitic tweeter 3, 8, or 15 ohm £3-50. P. & P. 30p. E.M.I. 13 x 8in, 3 or 8 or 15 ohm with two built-in tweeters and crossover network £4-65. P. & P. 30p.

EMI CERAMIC MAGNET HEAVY DUTY TWEETER. approx. 3in. Av. 3 or 8 or 15 ohms. **£1-25 plus 20p P. & P.**
BRAND NEW. 12in 15W H/D Speakers, 3, 8 or 15 ohm (state which). Current production by well-known British maker. Now with HiLux ceramic ferrobar magnet assembly **£9-90.** Guitar models: 25w **£9-90.** 35w **£11-00.** P. & P. 45p each.



SPECIAL OFFER!

LIMITED NUMBER OF BRAND NEW ELAC 10" TWIN CONE LOUSPEAKERS. With large ceramic magnet and plasticised cone surround, 8 ohm impedance. **£3-70.** P. & P. 35p.

Also available specification as above but size 10" x 6" **£2-70 P. & P. 35p.**

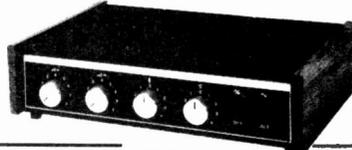
12in "RA" TWIN CONE LOUSPEAKER 10 watts peak handling, 3 or 8 or 15 ohm (state which). **£2-95.** P. & P. 35p.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER. Size 1 1/2in x 1 1/2in deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz-20KHz. Can be mounted on ceilings, walls, doors, under tables, etc., and used with or without baffle. Send S.A.E. for full details. **Only £6-55 each.** P. & P. 34p.

HI-FI STEREO HEADPHONES

Adjustable headband with comfortable flexifoam ear-muffs. Wired and fitted with standard stereo 3in jack plug. Frequency response 30-16,000Hz. Matching impedance 8-16 ohms. Easily converted for mono. **PRICE £3-30.** P. & P. 25p.

HARVERSONIC SUPER SOUND
10 + 10 STEREO AMPLIFIER KIT



NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EASIER CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. (Very simple to modify to suit magnetic cartridge—instructions included). Output stage for any speakers from 5 to 15 ohms. Compact Design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, smart brushed anodized aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output 14W r.m.s. per channel into 6 ohms. Frequency response \pm 3dB 12-30,000Hz. Sensitivity better than 80mV into 1M Ω . Full power bandwidth \pm 3dB 12-15,000Hz. Bass boost approx. to \pm 12dB. Treble cut approx. to -16dB. Negative feedback 18dB over main amp. Power requirements 35V at 1-0 amp. Overall size—12" wide x 8" deep x 2 1/2" high.

Fully detailed 7-page construction manual and parts list free with kit or send 18p plus large S.A.E.

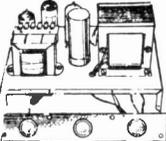
PRICES AMPLIFIER KIT, £11-55 P. & P. 125p. (Magnetic input components 33p extra)
POWER PACK KIT, £3-50 P. & P. 35p.
CABINET, £3-50 P. & P. 35p.

(Post Free if all units purchased at same time). Full after sales service. Also available ready built and tested, **£25-10.** Post Free.

Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

3-VALVE AUDIO AMP. HA34 MK II

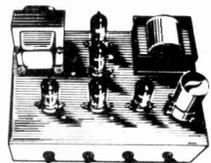
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7 1/2in. w. x 4in. d. x 4 1/2in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4 1/2 watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£8-00.** P. & P. 45p.



HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **£5-00.** P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT

A stylishly finished non-aerial amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other.



Fully shrouded section wound output transformer to match 3-15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving loud lift and cut. Valve line-up 2 EL84s, ECC83, E868 and EZ80 rectifier. Simple instruction booklet 15p plus S.A.E. (Free with parts). All parts sold separately. **ONLY £9-00.** P. & P. 60p. Also available ready built and tested **£13-00.** P. & P. 70p.

VYNAIR & BEXINE SPEAKERS & CABINET FABRICS app. 5 1/2in. wide. Our price £1-10 yd length. P. & P. 10p per yd. (min. 1 yd.). S.A.E. for samples.

HARVERSON SURPLUS CO. LTD.

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INPUT 230/240V a.c. 50/60 OUTPUT VARIABLE 0-260V

SHROUDED TYPE
 0.5 KVA (21 amp) (MAX) £10 00
 1 KVA (5 amp) (MAX) £14 70
 2 KVA (10 amp) (MAX) £28 10
 3 KVA (15 amp) (MAX) £31 25
 4 KVA (20 amp) (MAX) £32 50
 37.5 amp (MAX) £102 50
CARRIAGE AND PACKING EXTRA



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All primaries 220-240V

Type No.	Sec. Taps	Price Post
1	30, 32, 34, 36V at 5A	£6.90 + 45p
2	30, 40, 50V at 5A	£9.15 + 60p
3	10, 17, 18V at 10A	£7.30 + 50p
4	6, 12V at 20A	£8.60 + 60p
5	17, 18, 20V at 20A	£9.15 + 60p
6	6, 12, 20V at 20A	£8.65 + 60p
7	12, 20, 24V at 10A	£6.75 + 50p
8	4, 6, 24, 32V at 12A	£8.60 + 60p
9	6 and 12V at 10A	£4.30 + 40p

VOLTAGE CHANGING TRANSFORMER

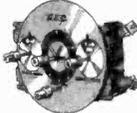
M.f.g. to highest W.D. spec. Auto wound, and tapped 0-130-160-200-250 at least 2kVA. Can also be used as 230-240V input, 115V out for U.S.A. equipment, or reverse to obtain 240V from 115V. The ideal transformer for making up solid state constant voltage unit, by use of taps the following voltages may be obtained 30-40-50-70-90V at 10 amps. Weight 40lb, length, 260mm, height 190mm, width 230mm. In original maker's wooden case, £8. Carr. £1.

300 VA ISOLATING TRANSFORMER

115/230-230V isolating. Screened. Primary two separate 0-115V for 115 or 230 volts. Secondary two 115V at 150 VA each for 115 or 230 volt output. Can be used in series or parallel connections. Fully tropicalised. Length 13.5 cm. Width 11 cm. Height 13.5 cm. Weight 15 lb.
SPECIAL OFFER PRICE £5. Carr. 80p.

A.C. MAINS TIMER UNIT

Based on an electric clock, with 25 amp. single pole switch, which can be preset for any period up to 12 hrs. ahead to switch on for any length of time, from 10 mins. to 6 hrs. then switch off. An additional 60 min. audible timer is also incorporated. Ideal for Tape Recorders, Lights, Electric Blankets, etc. Attractive satin copper finish. Size 135 mm x 130 mm x 60 mm. Price £2. Post 20p. (Total incl. VAT and Post £2.42).



VENNER TIME SWITCH TYPE MSQP

200/250 Volt 2-ON/2-OFF every 24 hours at any manually pre-set time. 20 amp contacts. Fitted diecast case. Tested and in perfect condition £4.75. Post 25p.



FOOT SWITCH

Suitable for Motors, Drills, etc., etc. 5 amp. 250 volt. Price 75p. Post 15p.



A.C. MOTOR 'Mfg. by AEI'

Smooth running, powerful, continuously rated, reversible motor. 230/250V a.c., 50 cycle 1/50 H.P., RPM 900, 0.25A. £3.50 post 50p.



METERS NEW! 2 1/2 in.

Flush round. Available in D.C. Amps 1, 5, 10, 15, 20 or A.C. Amps 1, 5, 10, 15, 20, Voltmeter 0-300V A.C. All types £2. Post 15p.



230/240 VOLT A.C. EXTRACTOR FAN KIT

Comprising of impeller, continuously rated motor, motor housing and fixings as illustrated. Price £1.75. Post 25p. (Total incl. VAT and Post £2.20).



MINIATURE UNISELECTOR SWITCHES

2 Bank, 12 position, 24 volt D.C. operation, full wiper with ancillary contacts. NEW Price £2.50. Post 20p. As above but with 5 Bank, 12 position. Price £3.50. Post 20p.



Build a Strobe Unit, using the latest type Xenon white light flash tube. Solid state timing and triggering circuit. 230/250V a.c. operation.

EXPERIMENTERS' ECONOMY KIT
 Speed adjustable 1 to 30 flash per sec. All electronic components including Xenon Tube and instructions £6.30. Post 30p.

INDUSTRIAL KIT
 Ideally suitable for schools, laboratories, etc. Speed adjustable 1-80 f.p.s. Approx. 1/2 output of Hy-Light. Price £12.00. Post 50p.

HY-LIGHT STROBE MK III
 For use in large rooms, halls and utilises a silica tube. Printed circuit. Speed adjustable 0-20 f.p.s. Light output greater than many (so called 4 Joule) strobes. £12. Post 50p.

THE 'SUPER' HY-LIGHT KIT

Approx. four times the light output of our well proven Hy-Light strobe.

● Variable speed from 1-13 flash per sec.
 ● Reactor control circuit producing an intense white light. ONLY £20. Post 75p.

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Ideally suited for above Strobe kits. Price 55p. Post 15p.

COLOUR WHEEL PROJECTOR

Complete with oil-filled colour wheel, 100 watt lamp, 200/240V A.C. Features extremely efficient optical system. £18.50. Post 50p.
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 As used for Disco lighting effects, etc. Price £4.50. Post 30p.



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400Watt. Mercury vapour ultra violet lamp. Powerful source of u.v. Innumerable industrial applications also ideal for stage, display, discos, etc. P.F. ballast is essential with these bulbs. Price of matched ballast and bulb £16. Post £1.
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BLACK LIGHT FLUORESCENT U.V. TUBES
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AUTO FADE COLOUR BLEND MODULE

Will control up to 750V. of lighting. Automatic fade-up, fade-down at a manually pre-selected timing, which may be varied between 1 second to 1 minute. Based on 10 amp triac for maximum reliability. Ready built with switch and Time Control, on 4 1/2 x 5 1/2 glass P.C. board. Three modules or more can be sequenced to obtain fantastic colour blending effects. Price £12.50. Post 30p per module.

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 6 cam model. £3.25 post 30p.
 12 cam model. £4.00 post 35p.
 6 cam model. 3 r.p.m. £3.25 post 30p.



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GENERAL ELECTRIC POWER-GLAS TRIACS
 10 amp. Glass passivated plastic triac. Latest device from U.S.A. Long term reliability. Type SCI46D 10 amp, 400 PIV, £1. Post 5p. Type SCI46E 10 amp, 500 PIV, £1.30. Post 5p. (Inclusive of data and application sheet.) Suitable Base 18p.

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New ceramic construction, vitreous enamel embedded winding, heavy duty brush assembly, continuously rated.

25 WATT 10/25/50/100/250/300/500/1k/ohm £1-15. Post 10p.
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Black Silver, Skirted knob calibrated in Nos. 1-9. 1 1/2 in. dia. brass bush. Ideal for above Rheostats, 22p each.

RELAYS SIEMENS, PLESSEY, Etc. MINIATURE RELAYS

Col.(1) Coil ohms	1	2	3	4
Col. (2)	52	4-6	6M	60p*
Working d.c. volts	58	5-9	6 c/o	80p*
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Contracts	185	8-12	6M	60p*
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Price	700	16-24	4M/4B	60p*
HD =	700	16-24	4 c/o	80p*
Heavy duty	700	6-12	1 c/o HD	70p*
	700	20-30	6 c/o	50p*
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6 VOLT D.C. 1 make contacts 35p. Post 5p.
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12 VOLT D.C. RELAY
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24 VOLT D.C. 3 c/o 75p. Post 5p.



ITT LOW PROFILE RELAY
 500 ohm coil, 12-24 volts D.C., 4 c/o. Price 85p. Post 5p each.

CLARE-ELLIOTT TYPE RP7641 G8

Miniature relay. 675 ohm coil. 24 Volt D.C. 2 c/o, 70p post paid.
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24 VOLT A.C. Mfg. by ITT. 2 h.d. c/o contacts. 55p. Post 5p.

240 VOLT A.C. RELAY. Mfg. by ITT. 240V A.C. 10 amp h.d. c/o contacts. Octal pin base. (Similar to illustration below). Price 75p. Post 5p.

HEAVY DUTY A.C. SEALED RELAYS
 230/240 V. 2 c/o. 20 amp contacts. 110 Volt. 2 c/o 20 amp contacts. Either type £1-25. Post 10p.



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Mfg. by ERG, 12 volt d.c. encapsulated. Single c/o 65p, post paid. 2 c/o 85p, post paid. STC 280 ohm coil/6/12V d.c. 3 make metal shrouded. 60p post paid. Other types available, state your requirement.

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Each bank comprises a c/o rated at 10 amp/240V A.C. Black knob in. Fixing hole 1/2 in. ONE bank 40p; TWO bank 40p; THREE bank 50p. Quote for quantity.



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Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L.8in, W.4in, H.6in, weight 6lb. 1,000V, 1,000 megohms, £34. Post 60p. 500V, 500 megohms, £28. Post 60p.



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UNIT containing 1 heavy duty solenoid approx. 25lb pull 1 inch travel. Two approx. 1lb pull 1 inch travel. 6 x approx. 4oz. pull 1 inch travel. One 24 volt d.c., 1 heavy duty single make relay. Price £2.50 P + p 60p. **ABSOLUTE BARGAIN.**

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Top value 1,000 opv pocket multi-meter. Ranges: 0/10/50/250/1,000 volt AC and DC. DC current 0.1mA/100mA. Resistance: 0/150k ohms. Decibels: -10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

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Jewel movement, attractively moulded case with edgewise ohms adjustment. Ranges: 0/3/15/150/300/1200V AC. (2500 opv). 0.6/30/300/600V DC. (5000 opv). 0.300 uA/0.300mA DC. Resistance: x 10 & x 100. -10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

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20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/100uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. -20 to +50dB.

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HIOKI Model 720X VOM
A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10/50/250/1000V AC. 0.5/50uA/250mA. 0.20k/2 Megohms.

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20,000 opv DC. 8000 opv AC. Mirror scale. 0/1/12/30/120/60V DC. 3/30/120/600V DC. 50/600uA/60/600mA. 10/100k/1 Meg/10 Meg Ohm. -20 to +46dB.

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U4323 MULTIMETER
20,000 opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance x 10, x 100, x 1,000, x 10,000 (50k). 50k(1, 50k)(2) centre scale. Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

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MODEL HIOKI 730X
30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/1200V AC. 60 uA. 30mA/300mA. 2K/200K. 2 Meg Ohm. -10 to +63dB.

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MODEL TE300
30,000 opv. Mirror scale. Overload protection. 0/0.5/3/15/60/300/1200V DC. 0/6/30/120/600/1200V AC. 0/300uA/60mA/60mA/300mA/600mA. 0/8k/80k/800k/8 Meg ohms. -20 to +63dB.

OUR PRICE £7.50 P&P 15p

U4324 MULTIMETER
High sensitivity, overload protected. 20,000 opv. Ranges: 0.6/1/2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistance: 25/500 ohms/0.5/5/50/500k ohms/5 Megohms. Decibels: -10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £8.00 P&P 20p

U435 MULTIMETER
20,000 opv. Overload protected. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

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U91 Clamp VOLT AMMETER
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500mA. Accuracy 4%. Size 283 x 34 x 36mm. Complete with carrying case, leads and fuses.

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46 ranges, mirror scale. 50kV DC. 50kV AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000V AC. AC Volts: 1.5/3/5/10/25/50/125/250/500/1000V DC. DC current: 25/50/100/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohm. -20 to +81.5dB.

OUR PRICE £12.50 P&P 17p

U4312 MULTIMETER
extremely sturdy instrument for general electrical use. 66700V. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV/0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/50/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA. 1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.

OUR PRICE £9.75 P&P 25p

MODEL 500
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/5/10/50/100/250/500mA/500mA. 12A DC. 0/60k/6 meg/60 megohms.

OUR PRICE £13.95 Carr. paid
Leather case for above £1.75

HIOKI 750X VOLT-OHM-MILLIAMETER
43 ranges. 0-0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0.0/0.1/0.2/0.5/1/2/5/10/20/300/600/1,200V AC. Current: 0.30/600mA/1.5/3/15/30/150/300mA/6A/12A. Resistance: 0-3/300k/3/30Megohms. Decibels: -10 to +17dB. Output: -0.3/6/15/30/60/120/300V. Accuracy: 3% DC. ± 4% AC. Sensitivity: 50,000 opv DC. 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.

OUR PRICE £11.95 P&P 40p

HIOKI Model 700X
100,000 opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/50/150/300mA/6/12A DC. 2k/20k/200/20M Ohms -20 to +63dB.

OUR PRICE £14.95 P&P 20p

Model HT10084 MULTIMETER
Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1.5/5/25/500/1,000V DC. 2.5/10/50/250/1,000V AC. DC resistance: 0-20/200k/2/20 Meg. ohms. DC current: 10/250mA/2.5/25/250 mA/10A. AC current: 0-10A. -20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.

OUR PRICE £17.50 P&P 40p

MODEL AS.1000 VOM
100,000 opv. Mirror scale. Built-in meter protection. 0.3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10uA/6/60/300mA. 12 Amp. 0.2K. 200K/2M/200 Meg Ohm. -20 to 17dB.

OUR PRICE £17.50 P&P 20p.

TMK 100K LAB TESTER
100,000 opv. 6 1/2" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5kV AC. DC Volts: 0.5/2.5/10/50/250/1000V AC. 1/10/50/250/500/1000V DC. current 10/100uA/10/100/500mA/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: -10 to +89dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 25p

370WTR MULTIMETER
Features AC current ranges. 20,000 opv. 0/0.5/2.5/10/50/250/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: -20 to +62dB.

OUR PRICE £19.95 P&P 25p

KAMODEN 72.200 Multitester
High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges: 0/0.6/3/30/120/600/1200V DC. 0/3/12/60/300/1120V V AC. 0/6uA/1.2mA/12A DC. 600mA/1/2A DC. 0/12A AC. -20 to +63dB. 0.2k/200k/2 Meg/200 Megohms.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER
High sensitivity instrument for field and laboratory work. Knife edge pointer. 86mm. mirror scale. Ranges: 100mV/0.5/1/5/10/25/100/250/500/1000V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: -5 to +10dB. Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

OUR PRICE £15.00 P&P 20p

MODEL U4311 Sub-standard Multi-range Volt-Ammeter
Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1/1.5/3/7.5/15/30/75V. 7.5A AC. 0/3/7.5/15/30/75/150/300/750mA. 1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3/7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

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TE65 VALVE VOLT METER
28 ranges. DC volts 1.5-1500V. AC volts 1.5-1500V. AC Resistance up to 1000 Megohms. 200/240V AC operation. Complete with probe and instructions.

OUR PRICE £17.50 P&P 30p
Additional probes available: RF £2.12, HV £2.50

MODEL AF.105 VOM
50,000 opv Mirror scale Meter protection 0 3 12 60 120 300 600 1200V DC. 0 6 30 120 300 600 1200V AC. 0.30uA 6 60 300 mA 12 Amp. 0.1k 1m 10m 100 Meg Ohms -20 to 17dB.

OUR PRICE £12.50 P&P 20p.

L83 TRANSISTOR TESTER
Tests ICO and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

L84 TRANSISTOR TESTER
Tests PNP or NPN transistors. Auto indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

U4341 Multimeter & Transistor Tester
27 ranges. 16,700 opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/600V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.08/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 90mm.

OUR PRICE £10.50 P&P 20p

S100TR MULTIMETER TRANSISTOR TESTER
100,000 opv. Mirror scale. Overload protected. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/6/30/120/600/1200V AC. 0/12/600uA/12/300mA/6/12A DC. 0/10k/1 Meg/100 Meg. -20 to +50dB. 0.01-0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

OUR PRICE £19.95 P&P 25p

KAMODEN HMG500 insulation resistance tester
Range 0-1,000 Megohms. 500V. Battery operated. Wide range clear meter 4" x 4". COME with deluxe carrying case, batteries and instructions.

OUR PRICE £19.95 P&P 30p

C15 PULSE OSCILLOSCOPE
For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1-25; HORIZ. AMP. Bandwidth: 500kHz. Sensitivity at 100kHz VRMS/mm: 0.3-25. Preset triggered sweep 1-3000uscc. Free running 20-200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115-230V AC.

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5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2uscc. to 100 milli-sec/cm. Free running time base. 50Hz-1MHz. Built-in time base. Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

OUR PRICE £87.00 Carr. paid

MODEL TE15 GRID OIP METER
Transistorised. Operates at Grid Dip. Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440kHz-280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £19.95 P&P 20p

Also see following pages

ALL PRICES EXCLUDE VAT

SWR METER Model SWR3
Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedance 52 Ω . Input current 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.
OUR PRICE £4.25 P&P 25p

AT201 Decade ATTENUATOR
Frequency range 0-200kHz. Attenuator 0-111dB, 0.1dB steps. Impedance 600 ohms. Input power maximum 30dBm. Size: 180 x 90 x 55mm.
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TRANSISTORISED L.C.R. A.C. BR. 8 MEASURING BRIDGE
A new portable bridge offering excellent range and accuracy at low cost. Resistance 0.1 ohm-11.1 megohm \pm 1% inductance: 6 ranges. 1 microhenry-111 henries \pm 2%. Capacity: 6 ranges. 10pF-1110 mfd \pm 2%. Turns Ratio: 6 ranges. 1:1-1000:1 11100 \pm 1%. Bridge Voltage at 1.000cps. Operated from 9-volt battery. 100 microamp meter indication. Size 7 1/2" x 5" x 2".
OUR PRICE £25.00 P&P 25p

TE16A TRANSISTORISED SIGNAL GENERATOR
5 ranges, 400kHz to 30 MHz. An inexpensive instrument for the handy-man. Operates on 9V battery. Wide easy to read scale. 800kHz modulation. Size: 149 x 149 x 92mm. Complete with instructions and leads.
OUR PRICE £8.97 P&P 25p

MODEL TE20 RF SIGNAL GENERATOR
Six bands, 120kHz-260MHz. Dual output RF terminals. Separate variable audio output. Accuracy \pm 2%. Audio output to 8V. Power requirements: 105-125V, 220-240V AC. Size: 193 x 265 x 150mm. Complete with test leads etc.
OUR PRICE £17.50 P&P 40p

TE-200 RF SIGNAL GENERATOR
Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable RF attenuator audio output. Xtal socket for calibration. 220/240V a.c. Brand new with instructions.
Size 140mm x 215mm x 170mm.
OUR PRICE £17.50 P&P 30p

TE22 SINE SQUARE WAVE AUDIO GENERATOR
Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedance 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.
OUR PRICE £24.95 P&P 37p

ARF 300 AF/RF SIGNAL GENERATOR
All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100kHz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.
OUR PRICE £37.50 P&P 50p

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR
Range 19 220,000Hz Sine Wave 19-100,000 Hz Square Wave Output Sine or Square wave 10V p.p. to P. Size 180 x 90 x 90mm Operation 220/240V a.c.
OUR PRICE £19.95 P&P 37p

PS200 Regulated POWER SUPPLY UNIT
Solid state. Variable output 5-20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size 190 x 136 x 98mm.
OUR PRICE £19.95 P&P 25p

POWER RHEOSTATS
High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wear. Continuous rating. Wide range available ex stock. Single hole fixing. 1/4" diameter shafts. Bulk quantities available.
25 WATT 10/50/100/250/500/1000 Ohms **£1.15** P&P 10p
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100 WATT 1/10/25/50/100/250/500/1000/2500 Ohms **£2.34** P&P 15p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS
Excellent quality at low cost. Input 230V 50/60Hz. Output 0-260V. **MODEL S260 BENCH MOUNTING**
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5A £17.50 37p
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10A £33.75 75p
12A £29.50 75p
20A £85.00 125p
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App. 7:1 ratio planetary drive vernier dial. Log scale 0-180 degrees. Blank scales 1-5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. 1/4" diam. shaft.
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OUR PRICE £71.25 per pair
P&P 50p per pair
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Features 24 hour alarm setting, on/off switch and auto alarm 'sleep' switch. Illuminated rotary dial with hours, minutes and seconds. Automatically turns off radio, TV, light etc. and with auto-switching will turn on again when required. 240V AC operation. Switch rating 250V-3 Amp.
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complete with printed circuit mounting board
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Light weight head phones with padded ear pieces, 4/16 ohms 20-20,000Hz. Complete with 6' lead and plug.
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Sensitive magnetic headset with soft ear pads. Impedance 2,600 ohms (600 ohms DCI). Frequency response: 200-4,000Hz.
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8 ohms 30 watt Heavy duty, ideal for Hi-Fi. P.A. Group
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High quality 2 way speaker systems. 25 Watts, 4-8 ohms. 40Hz-18kHz. Size: 560 x 340 x 225mm. Approx. Wood grain finish with black fronts.
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Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.
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6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88-108MHz. Ready built, ready for use. Fantastic value for money.
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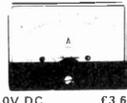
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500uA	£3.65	100-0-100uA	£3.75
50-0-50uA	£3.75	1mA	£3.65
100-0-100uA	£3.70	5mA	£3.65
1mA	£3.65	10mA	£3.65
5mA	£3.65	50mA	£3.65
10mA	£3.65	100mA	£3.65
500mA	£3.65	50V DC	£3.65
1A DC	£3.65	300V AC	£3.65
5A DC	£3.65	15V AC	£3.75
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15V DC	£3.65	VU Meter	£3.90



*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD830

Size: 110 x 83mm

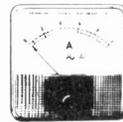
50uA	£4.30	10V DC	£4.10
100uA	£4.25	20V DC	£4.10
200uA	£4.20	50V DC	£4.10
500uA	£4.15	100-0-100uA	£4.25
50-0-50uA	£4.25	1mA	£4.10
100-0-100uA	£4.20	5mA	£4.10
1mA	£4.10	10mA	£4.10
5mA	£4.10	50mA	£4.10
10mA	£4.10	100mA	£4.10
500mA	£4.10	50V DC	£4.10
1A DC	£4.10	300V DC	£4.10
5A DC	£4.10	15V AC	£4.20
10A DC	£4.10	300V AC	£4.20
15V DC	£4.10	VU Meter	£4.40



CLEAR PLASTIC MODEL MR 65P

Size: 86 x 78mm

50uA	£3.95	10V DC	£3.80
100uA	£3.85	20V DC	£3.80
200uA	£3.80	50V DC	£3.80
500uA	£3.75	100-0-100uA	£3.85
50-0-50uA	£3.85	1mA	£3.70
100-0-100uA	£3.80	5mA	£3.70
1mA	£3.70	10mA	£3.70
5mA	£3.70	50mA	£3.70
10mA	£3.70	100mA	£3.70
500mA	£3.70	50V AC	£3.80
1A DC	£3.70	150V AC	£3.80
5A DC	£3.70	300V AC	£3.90
10A DC	£3.70	500V AC	£3.80
15A DC	£3.70	S Meter 1mA	£4.10
20A DC	£3.70	VU Meter	£3.70
30A DC	£3.70	1A AC	£3.70
40A DC	£3.70	5A AC	£3.70
50A DC	£4.05	10A AC	£3.70
5V DC	£3.70	20A AC	£3.70
10V DC	£3.70	30A AC	£3.70
20V DC	£3.70	100mA AC	£3.70
50V DC	£3.70	200mA AC	£3.70
150V DC	£3.70	500mA AC	£3.70



CLEAR PLASTIC MODEL SW100

Size: 100 x 80mm

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100uA	£4.50	300V AC	£4.45
500uA	£4.40	VU Meter	£4.90
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100-0-100uA	£4.45		
1mA	£4.30		
1A DC	£4.30		
5A DC	£4.30		
20V DC	£4.30		
50V DC	£4.30		
300V DC	£4.30		



CLEAR PLASTIC MODEL MR 45P

Size: 50 x 50mm

50uA	£3.20	300V AC	£3.05
100uA	£3.15	S Meter 1mA	£3.40
200uA	£3.10	VU Meter	£3.40
500uA	£3.00	1A AC	£2.95
100-0-100uA	£3.15	5A AC	£2.95
100-0-100uA	£3.10	10A AC	£2.95
500-0-500uA	£2.95	20A AC	£2.95
1mA	£2.95	30A AC	£2.95
5mA	£2.95		
10mA	£2.95		
50mA	£2.95		
100mA	£2.95		
500mA	£2.95		
1A DC	£2.95		
5A DC	£2.95		
20V DC	£2.95		
20V DC	£2.95		
300V DC	£2.95		
15V AC	£3.05		



BAKELITE MODEL S80 Enlarged Window

Size: 80 x 80mm

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100uA	£4.45	VU Meter	£3.80
500uA	£4.20	1A AC	£3.30
100-0-100uA	£4.20	5A AC	£3.30
1mA	£4.20	10A AC	£3.30
5mA	£4.20	20V DC	£4.20
10mA	£4.20	50V DC	£4.20
50mA	£4.20	300V DC	£4.20
100mA	£4.20	300V AC	£4.30
500mA	£4.20	VU Meter	£4.70



EDGWISE MODEL PE70

Size: 90 x 34mm

50uA	£4.15	100-0-100uA	£4.05
100uA	£4.10	50-0-50uA	£4.10
200uA	£4.05	1mA	£4.05
500uA	£3.90	10mA	£4.05
50-0-50uA	£4.10	50mA	£4.05
100-0-100uA	£4.05	100mA	£4.05
1mA	£4.05	500mA	£4.05
10mA	£3.95	1A DC	£4.30
300V AC	£3.95	5A DC	£4.30
VU Meter	£4.30	20V DC	£4.30



CLEAR PLASTIC MODEL MR 38P

Size: 42 x 42mm

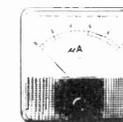
50uA	£3.10	20V DC	£2.80
100uA	£3.05	50V DC	£2.80
200uA	£3.00	100V DC	£2.80
500uA	£2.85	150V DC	£2.80
50-0-50uA	£3.05	300V DC	£2.80
100-0-100uA	£3.00	500V DC	£2.80
100-0-100uA	£2.80	750V DC	£2.80
1mA	£2.80	1A DC	£2.80
10-1mA	£2.80	2A DC	£2.80
2mA	£2.80	5A DC	£2.80
5mA	£2.80	10A DC	£2.80
10mA	£2.80	20A DC	£2.80
20mA	£2.80	50V AC	£2.90
50mA	£2.80	100V AC	£2.90
100mA	£2.80	150V AC	£2.90
150mA	£2.80	300V AC	£2.90
200mA	£2.80	500V AC	£2.90
300mA	£2.80	S Meter 1mA	£2.80
500mA	£2.80	VU Meter	£3.20
750mA	£2.80		
1A DC	£2.80		
2A DC	£2.80		
5A DC	£2.80		
10A DC	£2.80		
20A DC	£2.80		
50V DC	£2.80		
10V DC	£2.80		
15V DC	£2.80		



CLEAR PLASTIC MODEL MR 52P

Size: 60 x 60mm

50uA	£3.70	S Meter 1mA	£3.30
100uA	£3.50	VU Meter	£3.80
500uA	£3.35	1A AC	£3.30
50-0-50uA	£3.50	5A AC	£3.30
100-0-100uA	£3.45	10A AC	£3.30
1mA	£3.30	20V DC	£4.20
5mA	£3.30	50V DC	£4.20
10mA	£3.30	300V DC	£4.20
50mA	£3.30	300V AC	£4.30
100mA	£3.30		
500mA	£3.30		
1A DC	£3.30		
5A DC	£3.30		
10V DC	£3.30		
20V DC	£3.30		
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1mA	£7.60	500mA/5A DC	£7.60
10-1mA	£7.60	5V/50V DC	£7.60
1A DC	£7.60	5V/15V DC	£7.60
5A DC	£7.60	1/5A DC	£7.60
5V DC	£7.60		
10V DC	£7.60		
15V DC	£7.60		



CLEAR PLASTIC MODEL SD460

Size: 59 x 46mm

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100uA	£3.45	20V DC	£3.30
200uA	£3.40	50V DC	£3.30
500uA	£3.35	100V DC	£3.30
50-0-50uA	£3.45	150V DC	£3.30
100-0-100uA	£3.40	300V DC	£3.30
1mA	£3.30	500V DC	£3.30
10mA	£3.30	750V DC	£3.30
50mA	£3.30	1A DC	£3.30
100mA	£3.30	2A DC	£3.30
500mA	£3.30	5A DC	£3.30
1A DC	£3.30	10A DC	£3.30
5A DC	£3.30	20A DC	£3.30
10A DC	£3.30	50V AC	£3.45
15V DC	£3.30	100V AC	£3.45
		150V AC	£3.45
		300V AC	£3.45
		VU Meter	£3.65



BAKELITE MODEL MR 65A

Size: 80 x 80mm

25uA	£5.25	300V DC	£3.60
50uA	£4.00	30V AC	£3.60
100uA	£3.95	50V AC	£3.60
500uA	£3.60	150V AC	£3.60
50-0-50uA	£3.95	300V AC	£3.60
100-0-100uA	£3.90	500V AC	£3.60
500-0-500uA	£3.60	1A DC	£3.60
1mA	£3.60	2A DC	£3.60
10-1mA	£3.60	5A DC	£3.60
5mA	£3.60	10A DC	£3.60
10mA	£3.60	20A DC	£3.60
50mA	£3.60	50V AC	£3.60
100mA	£3.60	100V AC	£3.60
500mA	£3.60	150V AC	£3.60
1A DC	£3.60	300V AC	£3.60
2A DC	£3.60	500V AC	£3.60
5A DC	£3.60	S Meter 1mA	£3.60
10A DC	£3.60	VU Meter	£4.10
15A DC	£3.60		
30A DC	£3.60		
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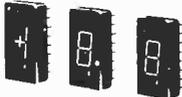
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2N5777

V_{ceo}, V_{ceo} 25v, V_{ebo} 5v

V_{ceo}, V_{ceo} 25v, V_{ebo} 5v

Hg 2500; I_c 250 MA

OPTOELECTRONICS

Monsanto

Xalim

litronix



Red
Green
Yellow

Seven Segment
MAN 71
MAN 51
MAN 81

Overflow
(±1)
MAN 73
MAN 53
MAN 83

DL 707
0.3" high character
14 pin DIL

DL 747
0.6" high character
L.H. Dec Ph

DL 701
(±1)

Common Anode
Red Only

Common Anode
Red Only

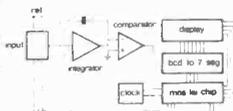
All Common Anode; Left Hand Decimal Point
Character Height 0.3"

OUR PRICE £2.65 each

£2.19

£2.89

3 1/2 DECADE DIGITAL VOLTMETER (INTEGRATED CIRCUIT)



This state-of-the-art MOS LSI chip contains all the logic necessary for a 3 1/2 decade, dual slope integrating, automatic polarity detecting DVM. Supplied with free data and circuit booklet.

OUR PRICE ONLY £7.79

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SIEMENS



LIQUID CRYSTAL DISPLAY complete with socket and removable reflective backing. Ref AN41308 13mm character height. Can be directly driven by National Semiconductor Alarm Clock chip MMS316

OUR PRICE £14.37

LIGHT EMITTING DIODES



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Red 24p each, Yellow 99p each,
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0.125" dia
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RED (Led 7)
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2N 3055	53p	2N 3707	13p	1N 5401	16p

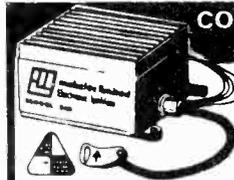
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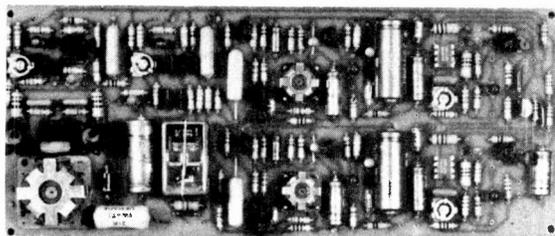
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HI-FI TAPE LINK

(PE Mar./Apr. 73) S/c's, i.c's, Rs, Cs, Relay and pc-base, Pot Cores and pc-bases, Sw's, Pots, Panel Lamp—Mono, £12.78; Stereo, £20.41. PSU, £3.58. Main Circuit PCB (3½in x 9in) Stereo (also holds relay and stereo), £2.10. Sub-assembly PCB (2½in x 6½in), Stereo 80p.

BIOLOGICAL AMPLIFIER

(PE Jan./Feb. 73) P/A Set—S/c's, i.c's, Rs, Cs, Pots, PCB, £3.46. Output Stages—S/c's, Rs, Cs, Pots, Rotary Sw's and PCBs for Alphaphone, Cardio, Freq-Meter, Vis-Feed, £4.96. Audio Amps: PC7, £5.20; EA1000, £3.30.

ENLARGER EXPOSURE METER AND THERMOMETER

(PE Sept 73) S/c's, Thermistor, LDR, Rs, Pots, PCB, £3.90.

ELECTRONIC PIANO

(PE Sept. 72/Jan. 73) Details in lists

GEMINI STEREO AMPLIFIER

(PE Nov 70/Mar 71) Stereo Sets and PCBs Pre-amp—Rs, Cs, Pots, Sw's—with 1W MO Rs £14.18—with ½W CF Rs, £10.40. PCB as published, £2.20. Main Amp—Rs, Cs, Pots, £5.88. PCB (3½in x 5in), £1.28. Power supply—Rs, Cs, Pot, £4.56. PCB (2in x 4in), 65p.

AUDIO MILLIVOLTMETER

(PE Feb 74) S/c's, Rs, Cs, Pots, Sw's PCBs, £4.95.

MICROPHONE MIXER

(PE Apr. 69) S/c's, Rs, Cs, Pots, PCB (also holds pots), £4.12. While Stocks Last

8 WATT AMPLIFIER

(PW Nov./Dec. 72) Pre-amp—S/c's Rs Cs Pots, Sw—Mono, £2.50; Stereo, £6.03. PCB (3½in x 7½in) (Stereo) also holds rotary or slider pots and Sw, £1.66. Main Amp—S/c's, Rs, Cs, Pot—Mono, £4.18; Stereo, £8.36. PCB (2½in x 3in) (Mono), 72p. PSU, £3.90.

SOUND SYNTHESISER

(PE Feb. 73/Feb. 74)

RHYTHM GENERATOR

(PE Mar./June 74)

SOUND BENDER

(PE May 74)

Details of all these in List

REVERBERATION UNIT

(PW Nov./Dec. 72) S/c's, Rs, Cs, T/ormer—with Rotary Pots, £6.44 PCB (2in x 1½in), £1.40. 9in Spring Unit, £4.50.

LOUDHAILER AND SIREN

(PW Dec 72) Pre-amp and Siren Generator—S/c's, Rs, Cs, Pot, PCB (2½in x 2½in), £2.20. While Stocks Last. Main Amp Module PCB, £6.25.

MISCELLANEOUS PCBs (While Stocks Last)

LOGICAL RADIO CONTROL (PE Dec 71/Jan 72) PCBs '2A', '2B', 50p each
 MODEL SERVO CONTROL (PE Feb./Mar. 72) PCBs 'B', Fail-safe, 33p each
 DIGITAL PSU PCB (PE Aug 72), 50p. OSCILLOSCOPE P/A PCB (PE Aug 72) 33p.
 GEMINI STEREO TUNER PCB (PE Apr 72), £1.50. TRIFFID PCB (PE Feb 73) 60p.
 (The above PCBs are as published)
 DIGITRONIC (PW Mar. 73) Read-out PCB (1½in x 3½in), 50p. CALLERCORD (PE Jul 72) Main Control PCB (4in x 7½in)

RESISTORS

½W and ¼W
 CARBON FILM
 MANUFACTURED BY
 AEI TO DEF 6112A
 E24 SERIES
 ½W 5% 4E7 to 1M
 ¼W 5% 4E7
 to 2M2 then 10% to
 10M
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 STOCKS
 FACILITATE RAPID
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SEMICONDUCTORS

AC128	20p	2N2905	27p
AC176	20p	2N2907	27p
AD181	48p	2N3702	12p
BC107	13p	2N3703	12p
BC108	13p	2N3704	12p
BC109	13p	2N3819	35p
BC147	12p	2N3823E	35p
BC148	12p	2N4871	35p
BC149	12p		
BC157	12p		
BC158	12p		
BC159	12p		
BC182L	12p		
BC204	14p		
BC209c	14p		
BC212L	15p		
BCY71	22p		
BFY50	22p		
BFY52	22p		
BSY95A	12p		
MJE2955	115p		
MJE3055	75p		
NKT0033	112p		
OC2	65p		
OC71	14p		
OC84	25p		
ORP12	55p		
TIS43	30p		
2N706	22p		
2N914	22p		
2N1304	22p		
2N2219	27p		

INTEGRATED CIRCUITS

709	TO5	40p
723	TO5	95p
741	8P DIL	40p
747	14P DIL	115p
748	TO5	83p
7400		28p
7402		28p
7420		28p

ELECTROLYTIC (µF/V)

0 47 63	6p	100 10	6p
1 0 63	6p	100 25	6p
2 2 63	6p	100 40	7p
4 7 35	6p	100 63	12p
4 7 63	6p	150 16	6p
6 8 40	6p	150 63	12p
10 25	6p	220 10	6p
10 63	6p	220 16	6p
15 40	6p	220 25	10p
22 10	6p	220 40	14p
22 25	6p	220 63	21p
33 6 3	6p	330 10	6p
33 16	6p	470 6 3	6p
33 40	6p	470 10	10p
33 50	6p	470 25	14p
47 25	6p	470 40	20p
47 40	6p	500 64	40p
47 63	6p	680 6 3	35p
50 6 4	6p	680 25	20p
		680 40	25p
		1000 10	14p
		1000 16	20p
		1000 25	25p
		1000 40	35p
		1000 63	50p
		2200 25	45p
		2200 40	60p
		2200 63	80p
		3300 63	133p
		3300 100	350p
		4700 16	60p
		4700 25	75p
		4700 40	93p

POLYESTER (µF)

0 01	3p
0 015	3p
0 022	3p
0 033	31p
0 047	31p
0 068	31p
0 1	4p
0 15	5p
0 22	5p
0 33	7p
0 47	9p
0 68	11p
1 0	14p

TANTALUM BEAD (µF/V)

0 1 35	12p
0 22 35	12p
0 47 35	12p
1 0 35	12p
1 5 35	16p
2 2 35	12p
4 7 35	12p
10 16	12p
10 25	16p
15 6 3	16p
22 16	16p
47 6 3	16p
100 3	16p

ADD 15p P. & P.
 ADD 10% VAT to total cost (including P. & P.)
 SEND S.A.E. (Stamped Addressed envelope) for Free Itemised List (and with all enquiries please)
 OVERSEAS COSTS: P. & P. will be charged at cost (most kit weights and postal rates are shown in list). Send International Reply Coupon for Free List & with all enquiries. VAT does not apply to exports. EXPORT ORDERS ARE ALWAYS WELCOME.
 MAILING LIST SERVICE—details with list
 COLOUR CODE identification supplied with most kits and as part of list
 PCBs are Fibreglass, Drilled, Tinned, and designed by Phonosonics unless stated as published.
 PCB Layout and Circuit Diagram supplied free with Phonosonics-designed PCBs
 POTS are rotary unless stated as slider.
 PRICES correct at time of press E & OE
 DELIVERIES subject to availability

PHONOSONICS PCB's AND KITS

PHOTOPRINT PROCESS CONTROL

(PE Jan./Feb. 72) For Colour and B & W—finds exposure, controls timing, stabilises mains voltage. S/c's, SCR, LDR, Rs, Cs, Pots, Relay, Keywitch, T/frm, £7.98. PCB (3½in x 5½in) also holds pots, Sw, relay, £1.60.

RONDO

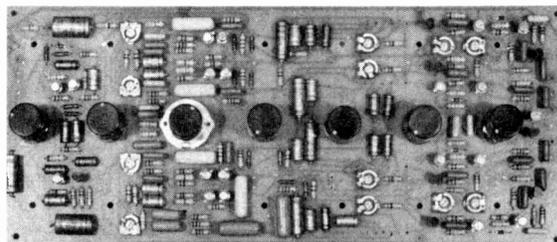
(PE Sept 73/Feb 74) Details in List

PROJECT Q4

(PW Oct 73/Jan 74) Multisystem Quadraphonic Decoder. S/c's, i.c's, Rs, Cs, Pots, Makeswitches, £12.48 PSU, £3.17. Set of PCBs, £2.60.

PHASING UNIT

(PE Sept 73) S/c's, Rs, Cs, Pots, PCB (1½in x 2½in), £2.20.



AURORA

(PE Apr./Aug 71) Multichannel Sound Controlled Light S/c's (Excl. SCRs), Rs, Cs, Pots, Cores—Pre-amp, Sync Generator and 4 Chans., £10.97; 4 extra chans., £8.35. Reg PSU, £4.32. PCB (4½in x 10½in) for Pre-amp and 4 Chans (also holds pots), £2.50. PCB (4½in x 5in) for Sync. Gen PSU, 8 Cores, 8 SCRs, £1.25.

AURORA AUXILIARY CONTROL UNIT

2 Variable Frequency Strobe Generators and 4 Variable Amplitude Frequency Generators S/c's, Rs, Cs, Pots, PCB (3½in x 5½in), £4.87.

SEMICONDUCTOR TESTER

(PE Oct 73) S/c's, Rs, Cs, Pots, Make-switches, Sub-assembly PCB, £5.30.

TAPE NOISE LIMITER

(PE Feb 72) S/c's, Rs, Cs, Pot, Sw, PCB (1½in x 3in), £2.30. Reg PSU and PCB (1½in x 2½in), £3.40.

ULTRASONIC TRANSMITTER-RECEIVER

(PE May 72) S/c's, Rs, Cs, Pot, Relay, Dual PCB (2in x 5½in), £4.40. Transducers excluded.

VERSATILE LIGHT EFFECTS UNIT

Single Channel Sound Controlled Light with built-in variable strobe. (PE Jun 72). S/c's, Rs, Cs, Pots, T/frm, Keywitch, £11.28. PCB (3½in x 7½in) also holds pots and switch, £1.70. SCRs excluded

VIBRASONIC GUITAR PRE-AMP

(PW Sept 70) Incl. Mic P/A, 2-Guitar P/A, Trem and Tone Controls, Master Volume S/c's, Rs, Cs, LDR, Rotary Pots, Lamps. Coupling T/frm, £7.64. PCB (3½in x 10½in) also holds pots, £1.92. Power Supply, £3.90.

VOICE OPERATED FADER

(PE Dec 73) S/c's, Rs, Cs, Pot, PCB (PE Dec 73) £2.95.

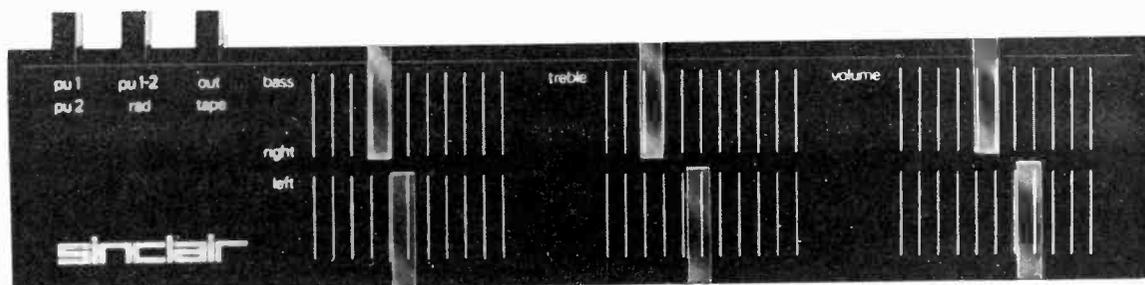
WIND AND RAIN EFFECTS

(PE Oct 73) S/c's (incl. special noise diode), Rs, Cs, Pots, £1.95.

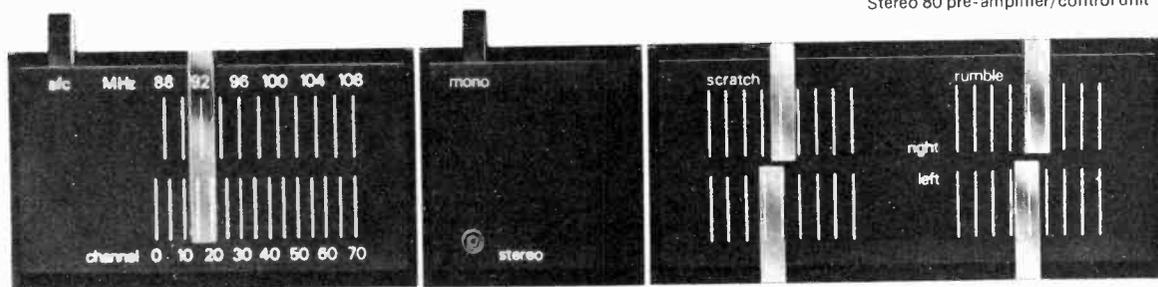
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MAIL ORDER ONLY

Sinclair Project 80

exciting



Stereo 80 pre-amplifier/control unit



Project 80 tuner

Stereo decoder

Project 80 Active Filter Unit (AFU)

only $\frac{3}{4}$ " deep x 2" high

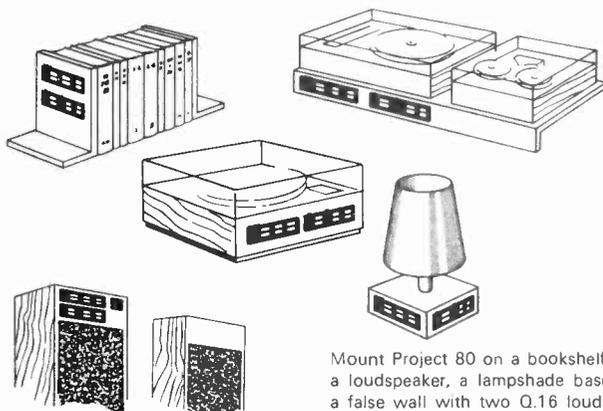
Living with hi-fi takes on new meaning with Sinclair Project 80. The electronics of these revolutionary new modules are all contained within elegantly designed matching cases no more than three-quarters of an inch deep. They are designed for mounting on any appropriate flat surface by means of 6BA bolts extending from the rear of each module and which pass through suitably drilled holes. Connections are taken away out of sight in a similar manner. The possibilities opened up by Project 80 are endless – superb hi-fi systems can be installed in ways hitherto only dreamed about and never before made practical. No more cutting out and shaping to put modules in position. A few holes drilled with the aid of templates supplied and the job is done. Now you need never again be faced with problems of keeping the hi-fi from clashing with carefully thought-out furnishing schemes. (That will surely please wives!) Slider controls have been introduced in place of knobs and all modules in the range incorporate new up-dated circuitry with emphasis on performance standards and built-in protection against overload and shorting. The aim was to re-think modular construction completely – to make it infinitely more versatile, even simpler and more reliable – the result – Project 80 – another triumph for Sinclair, and the most exciting construction modules ever.

the slimmest, most elegant hi-fi modules ever made

Typical Project 80 applications

System	The Units to use	Units cost
Simple battery record player	Z.40	£5.45 +54p V.A.T.
Mains powered record player	Z.40, PZ.5	£10.43 +£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	2 x Z.40s, Stereo 80; PZ.6	£30.83 +£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	2 x Z.60s, Stereo 80; PZ.8	£33.83 +£3.38 V.A.T.
Indoor P.A.	Z.60, PZ.8	£14.93 +£1.49 V.A.T.

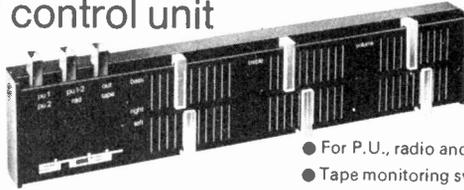
Project 80 FM tuner, decoder, and A.F.U. may be added as required



Mount Project 80 on a bookshelf, a loudspeaker, a lampshade base a false wall with two Q.16 loudspeakers... almost anywhere.

new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



- For P.U., radio and tape
- Tape monitoring switch
- Simplest ever fixing

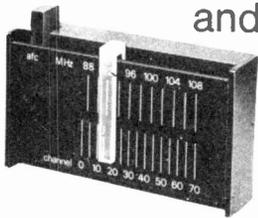
Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS

Size - 260 x 50 x 20mm (10 1/4 x 2 x 3/8 ins)
 Finish - Black with white indicators and transparent Sliders
 Inputs - Magnetic pick-up 3mV RIAA corrected; Ceramic pick-up 300mV
 Radio 300mV; Tape 30mV
 Signal/noise ratio - 60dB
 Frequency range - 20Hz to 15KHz \pm 1dB, 10Hz to 25KHz \pm 3dB
 Power requirements - 20 to 35 volts
 Outputs - 100mV \rightarrow AB monitoring for tape
 Controls - Press button for tape, radio and P.U. Sliders for volume, bass (\pm 12dB to \pm 14dB at 100Hz) treble (\pm 11dB to \pm 12dB at 10KHz)

R.R.P. **£11.95** +£1.19 V.A.T.

Project 80 FM tuner and stereo decoder



- Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
- On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER

Size - 85 x 50 x 20mm (3 1/4 x 2 x 3/8 ins)
 Tuning range - 87.5 to 108 MHz
 Detector - I.C. balanced coincidence for good A.M. rejection
 One I.C. equal to 26 transistors
 Distortion - 0.2% at 1 KHz for 30% modulation
 4 pole ceramic filter in I.F. section
 Aerial impedance - 75 Ω or 240-300 Ω
 Sensitivity - 4 microvolts for 30dB quieting
 Output - 300 mV for 30% modulation
 Power requirements - 23 to 33 volts

DECODER
 Size - 47 x 50 x 20mm (1 7/8 x 2 x 3/8 ins)
 One 19 transistor I.C.

R.R.P. **£11.95** +£1.19 V.A.T.

R.R.P. **£7.45** +0.74 V.A.T.

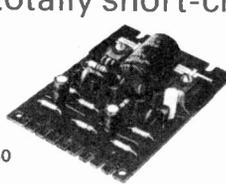
Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge.

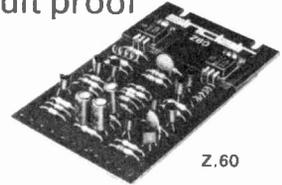
sinclair

Sinclair Radionics Ltd. London Road, St. Ives, Huntingdon PE17 4HJ
 Telephone St. Ives (0480) 64646

Z.40 & Z.60 power amplifiers totally short-circuit proof



Z.40



Z.60

Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS

Size - 55 x 80 x 20mm (2 1/4 x 3 1/4 x 3/8 ins) 9 transistors
 Input sensitivity - 100mV
 Output - 15 watts RMS continuous into 8 Ω (35V)
 Frequency response - 10Hz - 100KHz \pm 1dB
 Signal/noise ratio - 64dB
 Distortion - at 10 watts into 8 Ω less than 0.1%
 Power requirements - 12 to 35 volts

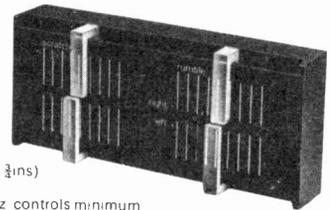
Z.60 TECHNICAL SPECIFICATIONS

Size - 55 x 98 x 15mm (2 1/4 x 3 3/4 x 3/8 ins) 12 transistors
 Input sensitivity - 100-250mV
 Output - 25 watts RMS continuous into 8 Ω (45V).
 Distortion - typically 0.03%
 Frequency response - 10Hz to more than 200KHz \pm 1dB
 Signal/noise ratio - better than 70dB
 Built-in protection against transient overload and short circuiting
 Load impedance - 4 Ω min. max safe on open circuit

Z.40 R.R.P. **£5.45** + 0.54 V.A.T. Z.60 R.R.P. **£6.95** + 0.69 V.A.T.

Project 80 active filter unit

Makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls applied to each channel make it easier to obtain ideal stereo balance.



TECHNICAL SPECIFICATIONS

Size - 108 x 50 x 20mm (4 1/4 x 2 x 3/8 ins)
 Voltage gain - minus 0.2dB
 Frequency response - 36Hz to 22KHz controls minimum
 Distortion - at 1 KHz - 0.03% using 30V supply
 HF cut off (scratch) - 22KHz to 5.5KHz, 12dB/oct. slope
 L.F. cut off (rumble) - 28dB at 20Hz, 9dB/oct slope

- For scratch and rumble control
- Transistorised active circuitry

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Power supply units

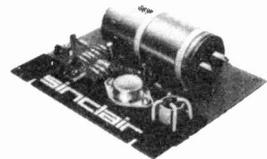
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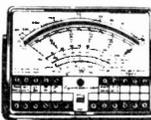
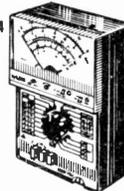
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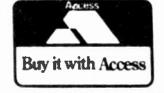
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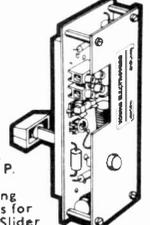
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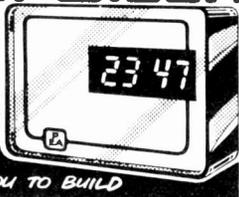
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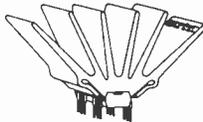
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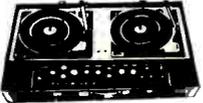


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