PRACTICAL

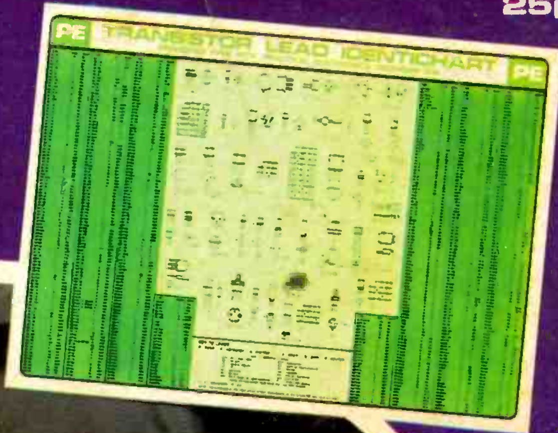
ELECTRONICS

DECEMBER 1974

25p

FREE! *in this issue*

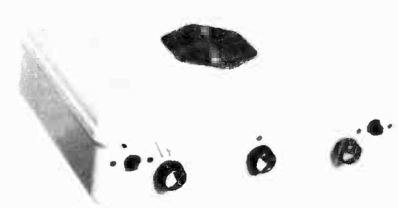
TRANSISTOR LEAD IDENTICHART



CORRECT SETTING WITH OUR

DWELL METER

FOR IMPROVED ENGINE PERFORMANCE



NEW EDU-KIT MAJOR

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

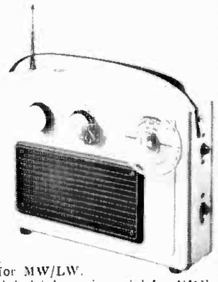
- 4 Transistor Earpiece Radio
- Signal Tracer
- Signal Injector
- Transistor Tester NPN —PNP
- 4 Transistor Push Pull Amplifier
- 5 Transistor Push Pull Amplifier
- 7 Transistor Loudspeaker Radio MW/LW
- 5 Transistor Short Wave Radio
- Electronic Metronome
- Electronic Noise Generator
- Batteryless Crystal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

TOTAL BUILDING COSTS

£7·23 (+8% VAT 57p) **P.P. & INS. 44p (Overseas P.P. £1·85p)**

Components include:
- 24 Resistors
- 21 Capacitors
- 10 Transistors
- 3½" Loudspeaker
- Earpiece
- Mica Baseboard
- 3 12-way Connectors
- 2 Volume Controls
- 2 Slider Switches
- 1 Tuning Condenser
- 3 Knobs
- Ready Wound MW/LW/SW Coils
- Ferrite Rod
- 6½ yards of wire
- 1 yard of sleeving, etc.
- 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 wavechange controls. Attractive all white case with red grille and carrying strap. Size 9¼in × 7in × 2¾in approx. Parts price list and plans 30p (FREE with parts).

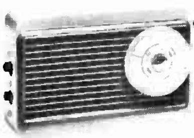
TOTAL BUILDING COSTS £6·95 (+8% VAT 55p) **P.P. & INS. 44p (OVERSEAS P. & P. £1·85)**

POCKET FIVE

NOW WITH 3" LOUDSPEAKER

3 Tunable wavebands. MW/LW and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, attractive Black and Gold Case. Size 5½in × 1¼in × 3½in approx. Plans and parts price list 15p (FREE with parts).

Total Building Costs £2·50 (+8% VAT 20p) **P.P. & Ins. 26p (Overseas P. P. £1·25)**



TRANSONA FIVE NOW WITH 3" LOUDSPEAKER

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).

Total Building Costs £2·75 **P.P. & Ins. 26p** (+8% VAT 21p) **(Overseas P. & P. £1·25)**

NEW EVERYDAY SERIES

Build this exciting New series of designs

EV5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3" loudspeaker. Attractive case with red speaker grille. Size 9in × 5½in × 2½in approx. Parts price list and plans 15p (FREE with parts).

TOTAL BUILDING COSTS £2·95 (+8% VAT 23p) **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 (+8% VAT 29p) **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 build plans 20p. Free with parts.

TOTAL BUILDING COSTS £4·08 (+8% VAT 32p) **P.P. & INS. 31p (OVERSEAS P. & P. £1·85p)**

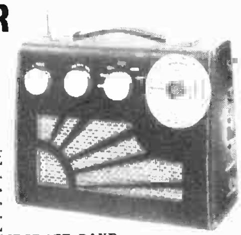
ROAMER EIGHT Mk. I

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. Chrome plated telescopic aerial can be angled and rotated for peak short-wave listening. 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 controls. Attractive case in rich chestnut shade with gold blocking. Size 9in × 7in × 4in approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

TOTAL BUILDING COSTS £6·98 (+8% VAT 56p) **P.P. & INS. 47p (OVERSEAS P. & P. £1·85)**

ROAMER TEN



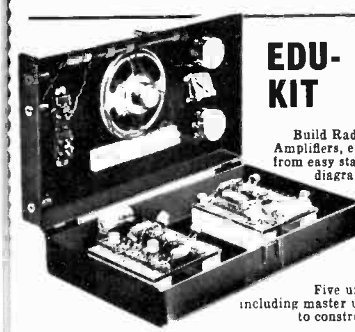
WITH VHF INCLUDING AIRCRAFT

10 TRANSISTORS. 9 TUNABLE WAVEBANDS. 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. 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 × 7in × 4in. Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

TOTAL BUILDING COSTS £8·50 (+8% VAT 68p) **P.P. & INS. 52p (OVERSEAS P. & P. £1·85)**

EDU-KIT



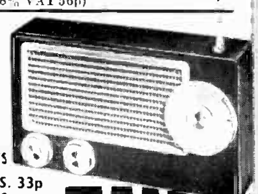
Build Radios Amplifiers, etc., from easy stage, diagrams.

Five units including master unit to construct.

Components include: Tuning Condenser: 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 ¼in 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 (+8% VAT 44p) **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 × 5½in × 2½in 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 (+8% VAT 36p) **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 FOR EASIER TUNING OF LUXEMBOURG, ETC. 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 × 5½in × 2½in approx. Plans and parts price list 25p (FREE with parts).

TOTAL BUILDING COSTS £3·98 (+8% VAT 32p) **P.P. & IN. 31p (OVERSEAS P. & P. £1·85)**

RADIO EXCHANGE LTD

*Callers side entrance "Lavells" shop
*Open 10-1. 2.30-4.30. Mon.-Fri. 9-12 Sat.

To RADIO EXCHANGE CO., 61a HIGH STREET, BEDFORD MK40 1SA
Tel. 0234 52367 Reg. No. 788372

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PE12

PRACTICAL
ELECTRONICS

VOLUME 10 No. 12 DECEMBER 1974

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL DATA SHEET FREE INSIDE THIS ISSUE

TRANSISTOR LEAD IDENTICHART

At-a-glance details on over 700 transistors

Our January 1975 issue will be published on Friday, December 13, 1974

 Publisher's Subscription Rate including postage for one year, Inland £3·25, Overseas £4·10. International Giro facilities Account No. 5122007. Please state reason for payment, "message to payee".

CRESCENT RADIO LTD.

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(also) 13 SOUTH MALL, EDMONTON, N.9

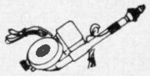
MAIL ORDER DEPT.
11 MAYES ROAD, LONDON N22 6TL
Phone 888 3206 & (EDM.) 803 1685

ADD LUXURY TO YOUR CAR

WITH A MOTOR DRIVEN CAR AERIAL

Spec.: 5 Section
Extended Length 100cm
Length under Fender 40cm
Cable Length 120cm

Supplied complete with Fixing Bracket and Control Switch. **£7·50** plus 25p P. & P.



"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT

This fantastic little box approx. 4" × 3" × 2½" when connected to the output of a sound source from 1 to 100 watts produces a psychcdelic 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.

MINIATURE RELAYS

Brand new range of British made relays, size: 1¼in × 1in × ¾in.
All two changeovers with 250V 1·5A contacts and suitable for fitting on 0·1m veroboard.

Type	Volts	Current	Ohms	
27/A	12V	17M/A	700	All
21/A	12V	28M/A	430	£1·30
12/A	6V	33M/A	185	each

200/250V Mains Relay

Heavy duty contacts 2,500 ohm coil. All new and unused D.P.D.T. mains relays 50p, Carr. free. Special quantity £40 per 100 off.

MIDGET MAINS TRANSFORMER

Varnish Impregnated

Size 45mm × 36mm × 31mm

PRI 240V

Sec	3.0·3	100mA
Sec	6·0·6	100mA
Sec	9·0·9	100mA
Sec	12·0·12	100mA
Sec	20·0·20	100mA

£1·23 10p P. & P.

CRESCENT BUBBLE LIGHT SHOW

This budget system compares very favourably with more sophisticated and higher priced models.
Specification:
Projector—150W convection cooled. At 30ft the projected image is 16ft.
Motor—1 rev. per 2 min.
Liquid Wheel—6in diameter multi colour.
The motor is fitted to the projector and can only be purchased as a single unit.
The liquid wheel is our standard model and may be purchased separately.
A bargain at: Projector, £15; Wheel, £5; Total £20. Plus 75p carr.

7in × 4in LOUDSPEAKER

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 × 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.

"CRESCENT" 100 WATT R.M.S. ALL PURPOSE AMPLIFIER U. BUILD. IT

We supply the three modules for you to build this Disco-Group-P.A. amplifier into the cabinet of your choice.

★ THE POWER AMP MODULE

170W r.m.s. sq. wave 300W instantaneous peak into 8 ohm (60W into 16 ohm).

★ THE PRE-AMP MODULE

Four control pre-amp, Vol. Bass, Treble. Middle controls. Designed to drive most amplifiers using F.E.T. first stage.

★ THE POWER SUPPLY

Is supplied complete with the mains transformer. Complete fixing instructions are supplied and no technical knowledge is required to connect the three ready wired modules. A fantastic bargain. £25, carr. 75p. Send S.A.E. for further details on this or our ready built amplifiers.

12-0-12V 500M/A

240V primary transformer bargain. Approx. size: 60mm × 40mm × 50mm; fixing centres: 75mm. Our price £1·20.

18V 500M/A

240V tapped 120V with screen. Approx. size: 60mm × 40mm × 50mm: fixing centres: 75mm. Our Price £1 each.

BARGAIN BOX

Loud buzzer mounted in a metal box complete with two U2 battery size holder.
Designed and can be used as a fire alarm but is ideal as a door or morse code practise buzzer.
Approx. size: 2¾in × 6¼in × 1½in.
OUR PRICE 50p

ABS PLASTIC BOXES

Handy boxes for construction projects. Moulded extrusion rails for P.C. or chassis panels. Fitted with 1mm front panels. 1005, 105mm × 73mm × 45mm **51p**; 1006, 150mm × 75mm × 47mm **66p**; 1007, 184mm × 124mm × 60mm **96p**; 1021, 106mm × 74mm × 45mm (sloping front) **50p.**

BARGAIN BOARDS

Components galore for the experimenter. Ex-Computer boards with resistors, capacitors and useful transistors—at least 4 transistors per board. Five boards £1.

2in. PANEL METERS

Size 59mm × 46mm

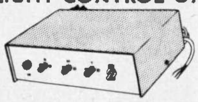
0·50µA —ME6	0·100mA—ME13
0·100µA—ME7	0·500mA—ME14
0·500µA—ME8	0·1A —ME15
0·1mA —ME9	0·50V a.c. —ME16
0·5mA —ME10	0·300V a.c.—ME17
0·10mA—ME11	S meter —ME18
0·50mA—ME12	V.U. meter—ME19

£3 each. 10p P. & P.

POWER PACKS

PP1 Switched 3·6·7½-9V 400M/A Transistor and Zener Stabilised On/Off switch and Polarity Reversal switch, in a black metal case, £5·25 each.
PP2 Switched 6-7½·9V Battery Eliminator. Approx. size 2¾in × 2¼in × 3¼in. Ideal for cassette recorders, £2·75 each (Philips type £3·00).
PP3 Car converter. From 12V Pos. or Neg. to * 6-7½-9V. Easy to fit and transistor regulated, £2·50 each.

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.

MINI LOUDSPEAKERS

2½in 80 ohm, 50p; 2½in 40 ohm, 50p. Please include 5p P. & P. on each L.S.

U.K. CARRIAGE 15p UNLESS OTHERWISE STATED	VAT 8% VAT TO BE ADDED TO ALL ORDERS	SEND 20p FOR A CRESCENT CATALOGUE

RST VALVE MAIL ORDER CO.

16a WELLFIELD ROAD, LONDON SW16 2BS

SPECIAL EXPRESS MAIL ORDER SERVICE

Express postage 5p for first transistor, 1p thereafter, over ten post free. INTEGRATED CIRCUITS 6p + 1p each added

	£p
1N21	0·17
1N23	0·35
1N85	0·88
1N253	0·50
1N256	0·50
1N645	0·16
1N725A	0·20
1N914	0·06
1N4007	0·12
1S113	0·25
1S131	0·13
1S202	0·23
2G371	0·40
2G381	0·22
2G414	0·30
2G417	0·25
2N404	0·22
2N697	0·15
2N698	0·30
2N706	0·10
2N706A	0·12
2N708	0·15
2N709	0·40
2N1091	0·55
2N1131	0·25
2N1132	0·25
2N1302	0·18
2N1303	0·18
2N1304	0·22
2N1305	0·22
2N1306	0·28
2N1307	0·28
2N1308	0·28
2N2147	0·75
2N2148	0·60
2N2160	1·00
2N2218	0·23
2N2219	0·25
2N2369A	0·16
2N2444	1·99
2N2613	0·28
2N2646	0·50
2N2904	0·20
2N2904A	0·25
2N2906	0·20
2N2907	0·23
2N2924	0·13
2N2925	0·15
2N2926	0·10
2N3054	0·50
2N3055	0·60
2N3702	0·11
2N3705	0·15
2N3706	0·11
2N3707	0·13
2N3709	0·10
2N3710	0·11
2N3711	0·11
2N3819	0·35
2N4289	0·20
2N5027	0·53
2N5088	0·33
2S301	0·59
2S304	1·15
2S501	0·75
2S703	1·00
AA129	0·20
AAZ12	0·75
AAZ13	0·10
AC107	0·35
AC126	0·25
AC127	0·25
AC128	0·20
AC187	0·20
AC188	0·20
ACY17	0·35
ACY18	0·27
ACY19	0·27
ACY20	0·22
ACY21	0·22
ACY22	0·16
ACY27	0·25
ACY28	0·25
ACY39	0·65
ACY40	0·22
ACY41	0·22
ACY44	0·82
AD140	0·50
AD149	0·50
AD161	0·39
AD162	0·39
AF106	0·30
AF114	0·25
AF115	0·25
AF116	0·25
AF117	0·20
AF118	0·50
AF119	0·30
AF124	0·30
AF125	0·30
AF126	0·30
AF127	0·30
AF139	0·33
AF178	0·55
AF179	0·65
AF180	0·55
AF181	0·50
AF186	0·40
AFY19	1·13

	£p
FAZ11	1·15
AFZ12	2·00
ASY26	0·25
ASY27	0·30
ASY28	0·25
ASY29	0·30
ASY36	0·25
ASY50	0·20
ASY51	0·40
ASY53	0·20
ASY55	0·20
ASY62	0·25
ASY66	0·33
ASZ21	1·00
ASZ23	0·75
AU101	1·50
AUY10	1·00
BC107	0·12
BC108	0·12
BC109	0·12
BC113	0·16
BC115	0·20
BC116	0·20
BC116A	0·23
BC118	0·20
BC121	0·20
BC122	0·20
BC125	0·68
BC126	0·65
BC140	0·55
BC147	0·12
BC148	0·10
BC149	0·12
BC157	0·14
BC158	0·12
BC160	0·63
BC169	0·14
BCY31	0·45
BCY32	1·20
BCY33	0·38
BCY34	0·45
BCY38	0·55
BCY39	1·00
BCY40	0·80
BCY42	0·30
BCY70	0·15
BCY71	0·20
BCZ10	0·60
BCZ11	0·65
BD121	1·00
BD123	1·00
BD124	0·80
BDY11	1·45
BF115	0·22
BF117	0·50
BF167	0·25
BF173	0·28
BF181	0·35
BF184	0·22
BF185	0·22
BF194	0·13
BF195	0·13
BF196	0·15
BF197	0·15
BF861	0·25
BF898	0·25
BFX12	0·20
BFX13	0·25
BFX29	0·28
BFX30	0·28
BFX35	0·98
BFX63	0·50
BFX84	0·25
BFX85	0·28
BFX86	0·25
BFX87	0·25
BFX88	0·22
BFY10	1·00
BFY11	0·50
BFY17	0·40
BFY18	0·45
BFY19	0·55
BFY24	0·45
BFY44	1·00
BFY50	0·20
BFY51	0·20
BFY52	0·20
BFY53	0·17
BFY64	0·45
BFY90	0·75
BSX27	0·50
BSX60	0·93
BSX76	0·18
BSY26	0·17
BSY27	0·20
BSY51	0·50
BSY95A	0·12
BSY95	0·12
BT102/500R	0·75
BTY42	0·92
BTY79/100R	0·75
BTY79/400R	1·10
BY100	0·15
BY126	0·14
BY127	0·15
BY182	0·85

	£p
BY213	0·25
BYZ10	0·45
BYZ11	0·40
BYZ12	0·40
BYZ13	0·35
BYZ15	1·25
BYZ16	0·60
BZY88	0·10
C111	0·55
CRS1/05	0·30
CRS1/40	0·45
CS4B	1·90
CS10B	3·50
DD000	0·15
DD003	0·15
DD006	0·25
DD007	0·40
DD008	0·38
GD3	0·33
GD4	0·10
GD5	0·33
GD8	0·25
GD12	0·10
GET102	0·50
GET103	0·40
GET113	0·35
GET114	0·30
GET115	0·75
GET116	0·85
GET120	0·50
GET872	0·30
GET875	0·40
GET880	0·55
GET881	0·25
GET882	0·85
GET885	0·40
GEX44	0·08
GEX45/1	0·45
GEX941	0·45
GJ3M	0·50
GJ4M	0·50
GJ5M	0·25
GJ7M	0·50
HG1005	0·50
HS100A	0·20
MAT100	0·20
MAT101	0·25
MAT120	0·20
MAT121	0·25
MJE520	0·65
MJE2955	1·10
MJE3055	0·75
MJE340	0·50
MPF102	0·40
MPF103	0·36
MPF104	0·35
MPF105	0·46
NKT128	0·45
NKT129	0·30
NKT211	0·25
NKT213	0·25
NKT214	0·24
NKT216	0·40
NKT217	0·45
NKT218	1·13
NKT219	0·33
NKT222	0·30
NKT224	0·25
NKT251	0·24
NKT271	0·20
NKT272	0·20
NKT273	0·20
NKT274	0·20
NKT275	0·25
NKT277	0·20
NKT278	0·25
NKT301	0·85
NKT304	0·75
NKT403	0·70
NKT404	0·60
NKT678	0·30
NKT713	0·30
NKT773	0·25
NKT777	0·38
O78B	0·38
OA5	0·60
OA6	0·12
OA47	0·08
OA70	0·10
OA71	0·20
OA73	0·15
OA74	0·15
OA79	0·10
OA81	0·10
OA85	0·15
OA86	0·15
OA90	0·07
OA91	0·07
OA95	0·07
OA200	0·08
OA202	0·10
OA210	0·20
OA211	0·25
OAZ200	0·50
OAZ201	0·45
OAZ202	0·45
OAZ203	0·45
OAZ204	0·45

	£p
OAZ205	0·45
OAZ206	0·45
OAZ207	0·45
OAZ208	0·40
OAZ209	0·40
OAZ210	0·40
OAZ211	0·40
OAZ222	0·45
OAZ223	0·45
OAZ224	0·45
OAZ241	0·25
OAZ242	0·15
OAZ244	0·25
OAZ246	0·15
OAZ290	0·38
OC16	1·00
OC16T	1·00
OC19	0·50
OC20	2·00
OC22	1·00
OC23	1·25
OC24	1·10
OC25	0·40
OC26	0·40
OC28	0·70
OC29	0·65
OC30	0·40
OC35	0·55
OC36	0·65
OC41	0·35
OC42	0·40
OC43	0·70
OC44	0·18
OC44M	0·17
OC45	0·18
OC45M	0·18
OC46	0·27
OC57	0·60
OC58	0·60
OC59	0·60
OC66	0·50
OC70	0·18
OC71	0·15
OC72	0·25
OC73	0·50
OC74	0·30
OC75	0·30
OC76	0·30
OC77	0·55
OC78	0·25
OC79	0·30
OC81	0·28
OC81D	0·28
OC81M	0·20
OC81DM	0·18
OC81Z	0·45
OC82	0·28
OC82D	0·25
OC83	0·25
OC84	0·30
OC114	0·38
OC122	1·00
OC123	1·10
OC139	0·40
OC140	0·65
OC141	0·80
OC169	0·20
OC170	0·25
OC171	0·30
OC200	0·55
OC201	0·80
OC202	0·90
OC203	0·55
OC204	0·65
OC205	1·00
OC206	1·10
OC207	1·00
OC460	0·20
OC470	0·30
OCP71	1·00
ORP12	0·55
ORP60	0·45
ORP61	0·48
SX68	0·20
SX631	0·45
SX635	0·55
SX640	0·75
SX641	0·75
SX642	0·60
SX644	0·85
SX645	0·85
TIC44	0·29
V15/30P	0·75
V30/201P	0·75
V60/201	0·50
V60/201P	0·75
XA101	0·10
XA102	0·18
XA151	0·15
XA152	0·15
XA161	0·25
XA162	0·25
XB101	0·43
XB102	0·30
XB103	0·35
XB113	0·30
XB121	0·43

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ZS170	0·10
ZS271	0·18
ZT21	0·25
ZT43	0·25
ZTX107	0·12
ZTX108	0·10
ZTX300	0·14
ZTX304	0·24
ZTX500	0·15
ZTX503	0·16
ZTX531	0·25

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7402	0·20
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7404	0·20
7405	0·20
7406	0·40
7407	0·40
7408	0·25
7409	0·33
7410	0·20
7411	0·23
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7417	0·30
7420	0·20
7422	0·28
7423	0·40
7425	0·37
7427	0·37
7428	0·43
7430	0·20
7432	0·37
7433	0·43
7437	0·43
7438	0·43
7440	0·20
7441AN	0·85
7442	0·85
7450	0·20
7451	0·20
7453	0·20
7454	0·20
7460	0·20
7470	0·33
7472	0·38
7473	0·44
7474	0·48
7475	0·59
7476	0·45
7480	0·80
7482	0·87
7483	1·20
7484	1·00
7486	0·50
7490	0·75
7491A	1·10
7492	0·75
7493	0·75
7494	0·85
7495	0·85
7496	1·00
7497	4·32
74100	2·16
74107	0·51
74110	0·57
74111	0·86
74118	1·00
74119	1·92
74121	0·57
74122	0·80
74123	1·44
74141	1·00
74145	1·44
74150	2·30
74151	1·15
74154	2·30
74155	1·15
74156	1·15
74157	1·09
74170	2·88
74174	1·80
74175	1·29
74176	1·44
74190	2·30
74191	2·30
74192	2·30
74193	2·30
74194	1·72
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74197	1·58
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Specification: Deck Inputs—50mV into 1MΩ; Deck Tone Controls—treble + 20 − 10dB at 12kHz, Bass + 22 − 15dB at 40Hz; Mic Input—200 ohms upwards, 2mV into 10kΩ; Mic Tone Control—Total Variation Treble 15dB, Total Variation Bass 10dB; Tape Input —30mV into 47kΩ; Power Requirements—30–45 volts at 100mA.

£26·50

PANEL SIZE
18 × 4½in.
DEPTH 3in.

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- 1000W per channel
- Each channel fully suppressed and fused
- Master control to operate from 1W to 100W
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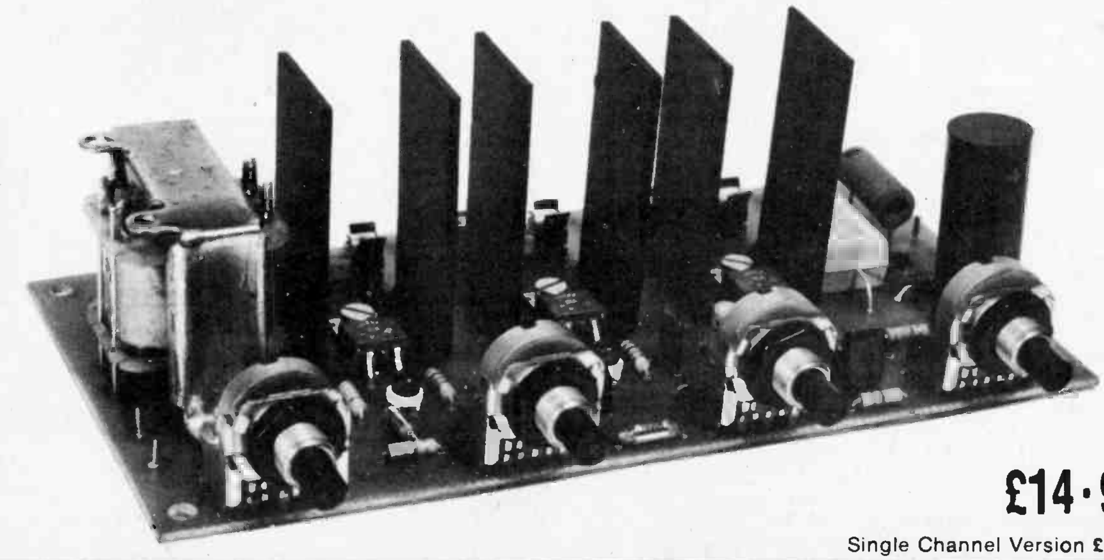

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PE SCORPIO Mk2 ignition system kit new from ELECTRO SPARES

* 6 OR 12 VOLT
* + VE AND – VE GROUND

Here's the new, improved version of the original PE Scorpio Electronic Ignition System – with a big plus over all the other kits – the PE Scorpio Kit is designed for *both* positive and negative ground automotive electrical systems. Not just +ve ground. Nor just —ve ground. But both! So if you change cars, you can be almost certain that you can change over your PE Scorpio Mk. 2 as well.

Containing all the components you need, this Electro Spares PE Scorpio Mk. 2 Kit is simply built, using our easy to follow instructions. Each component is a branded unit by a reputable manufacturer and carries the manufacturer's guarantee. Ready drilled for fast assembly. Quickly fitted to any car.

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★ Easier starting from cold ★ Firing even with wet or oiled-up plugs ★ Smoother running at high speed ★ Fuel saving ★ More power from your engine ★ Longer spark plug life ★ No more contact-breaker burn.

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As featured in the May 1973 issue of 'Practical Electronics'. Superb Hi-Fi tuner Kit now available from Electro Spares. Including cabinet and all components – pre-set Mullard modules for R.F. and I.F. circuits. Motorola I.C. Phase Lock Loop Decoder for perfect stereo reception. No alignment needed. Guaranteed first time results – or send it back, and we'll return it in perfect order (for a nominal handling charge). Electro Spares price only **£28.50 inc. VAT and p & p.**

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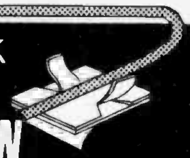

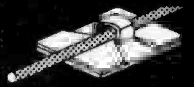

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*QUICK AND EASY TO APPLY – EVEN IN AWKWARD PLACES
*SAVES DAMAGE TO WOOD AND PAINTWORK
*STICKS ON INSTANTLY : HOLDS WIRE FIRMLY

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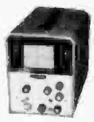
ITT METRIX
Model 101B miniature oscilloscope. D.C. 10mHz. Sensitivity 100mV. Single-beam. Dimensions 20cm × 14cm × 13cm. Weight 5½lb. **Sold brand new** at nearly one half maker's list price. **Only £50.**



AVO VALVE TESTERS
Brief-case type 160. Full working condition throughout. **£65.**

DIGITAL FREQUENCY METER
Type 'FT300'
Reads as frequency meter up to 99·99 kHz in three ranges or as tachometer, 99.990 r.p.m. Solid-state instrument. Clear read-out. Size only 8in × 5in × 2¼in. Weight 4½lb. BCD outputs. Operating voltage 110/240V a.c. Made by famous manufacturer. These units are brand new in original makers cartons. Price **£55.**

EDDYSTONE 770R RECEIVER
Range 19–165mHz. As new. £125.

AERIAL CHANGE-OVER RELAYS
of current manufacture designed especially for mobile equipments, coil voltage 12V, frequency up to 250MHz at 50 watts. Small size only. 2in × ⅞in. Offered brand new, boxed. Price £1·50, inc. P. & P.

TV WOBBULATOR Type '210'
Technical characteristics
Frequency: 5 to 220Mc/s in one range.
Accuracy: That of the marker generator (e.g. METRIX 936).
Output: Not less than 100 mV attenuable in steps of 10 down to 10μV.
Sweep width: 1–2–5–10–20Mc/s.
Linearity: 10% at sweep width 10Mc/s.
Amplitude modulation: Less than 10% at sweep width 10Mc/s.
Power supply: 110–130–220V, 50–60c/s. 130V may be replaced by 160V, 220V may be replaced by 240V on demand.
Power Input: 35VA approx.
Tubes used: 2 × EC81, 1 × 6J6, 1 × 6X4.
Weight: 20lb 8oz (9·300kg).
Dimensions: 20 × 11½ × 7¾in. (510 × 295 × 195mm) overall. Price £48·50 inc. VAT.

Large selection of
RF PLUGS AND SOCKETS
Available ex-stock: BNC plugs 50 **30p**; BNC sockets 50 **25p**; N. type plug 50 **50p**; Burndept plugs 40p; Burndept sockets 20p; All plugs and sockets are brand new. Please add appropriate amount for postage.

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Type 100L. 230V input. 0–230V a.c. output. 8 amps. Brand new minus control knobs. Price only **£15,** carriage £1.

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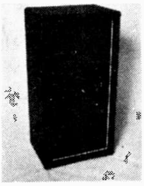
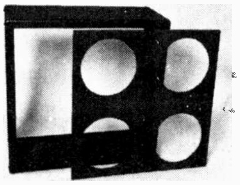
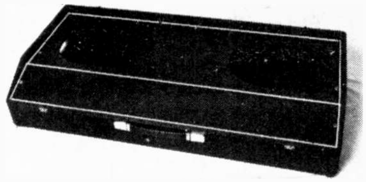
SPEAKER CABINETS IN KIT FORM REPRESENT HUGE SAVINGS



2' x 12" Cabinet



4' x 12" Cabinet



Disco Console (includes lid not shown)
Takes two slaves

For a long time now a large number of customers have asked us to produce cabinets in kit form, and above we show examples of cabinet styles and these are now available either fully built or in kit form ready for you to produce a professional finish in a very short time !

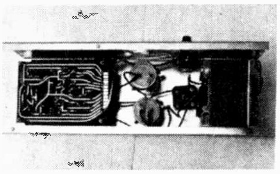
Kits are available in all specifications and all the kits contain everything you need as follows :-

1) 4 sides with handle cutouts, front edges rounded, 1 back with jack socket hole, and1 baffleboard with speaker cutout
2) P.V.C. cut to size for frame and back, plus false front and back timbers, white front piping and speaker cloth
3) Recessed handles with fixing screws, jack socket, all fixing screws, corner plates, glue, and full instructions !

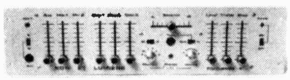
PRICE & TYPE LIST

Type	*Size*	*Price manufactured*	*Kit price*
2 x 12" (illustrated above)	36" x 18" x 13" x ¾	£19.50	£12.50
4 x 12" (illustrated above)	31" x 31" x 13" x ¾	£24.50	£17.50
4 x 12" P.A. Column	48" x 27" x 13" x ¾	£30.00	£21.50
1 x 18"	31" x 31" x 13" x ¾	£24.50	£17.50
1 x 15" with two top horn cutouts	36" x 20" x 13" x ¾	£21.00	£13.50
Mini Disco (state deck cutout BSR, GARRARD etc.)	33" x 20" x 8" x ½	£20.00	£13.00
Maxi Disco (illustrated) (state deck cutout BSR, GARRARD etc.)	42" x 20" x 10" x ½	£25.00	£18.50

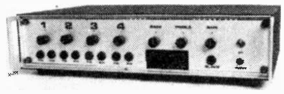
Please ask for quotation on any other type or size of cabinet you may require.



* 100w RMS slave amp for Disco
* 100w RMS continuous sine wave output
* Short and open circuit protection
* Built to highest industrial spec.
* Price £37.00 complete



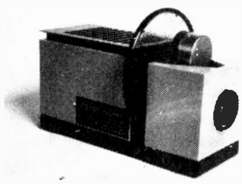
* Stereo studio disco mixer
* Full PFL and Monitor facilities
* As used by John Peel, Mark Wesley, Paul Burnett, DLT, Dave Christian, Tony Prince
* Price £120.00



ERC 100w power amplifier
* Electrolytic capacitors and second generation ICs
* Fully protected against short or open circuit
* Less than 0·1% distortion at all powers
* Rise time 4muS-stability-Unconditional Price £66.50

ALL OUR PRICES INCLUDE VAT AND UK DELIVERY

VALUE!!



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Disco imp projector 150 watt tungsten
unbeatable price £19.75
Includes liquid wheel and postage
Normally £24–£27.50

UNBEATABLE NOW ONLY £18

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R T V C FOR AUDIO ON A BUDGET

PUSH BUTTON CAR RADIO KIT

The Tourist II

NO SOLDERING REQUIRED!

NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly.
Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.

Car Radio Kit £7.70 + 55p p & p

The Tourist I Kit For the experienced constructor
If you can solder on a printed circuit board you can build this model.
Same technical specification as Tourist II
Price £6.60 + 55p p & p.

Technical specification:
(1) **Output** 4 watts R.M.S. output. For 12 volt operation on negative or positive earth.
(2) **Integrated circuit** output stage, pre-built three stage IF Module.

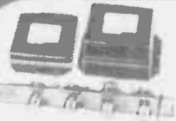
Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands.
Size chassis 7" wide, 2" high and 4¾" deep approx

Speaker including baffle and fixing strip **£1.65+23p. p&p.**
Car Aerial Recommended — fully retractable
£1.37+20p. postage & packing

*STEREO 21 QUALITY SOUND FOR LESS THAN £20·00

Stereo 21, easy to assemble audio system kit. No soldering required. The unit is finished in white P.V.C. and the acrylic top presents an unusually interesting variation on the modern deck plinth.

Includes:– **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.
Specifications: For the technically minded:—
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. 15½" × 8" × 4". Complete deck and cover in closed position approx. 15½" × 12" × 6".
Complete only **£19·95** + £1.60 p & p. Extras if required. Optional Diamond Styli **£1.37.**
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance. **£3.85.**



BUILD YOUR OWN* STEREO AMPLIFIER

For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.
240V. AC only. **£7·64 + 55p p&p**

8 TRACK HOME CARTRIDGE PLAYER*

Elegant self selector push button player for use with your stereo system. Compatible with Viscount III system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV Comparable unit sold eleswhere at £24.00 approx. Yours for only
£11.95 + 90p p & p.

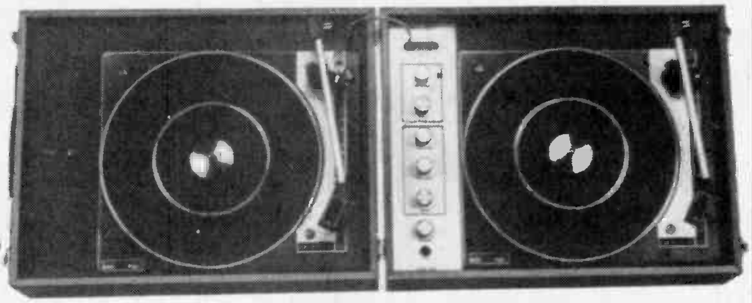
FOR DISCO PAGE AND DETAILS OF HOW TO ORDER – TURN OVER...

PORTABLE DISCO CONSOLE

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables.

Two B.S.R. single play professional series decks, fitted with crystal cartridges.

The turntables are designed and precision engineered. They combine clean modern styling with superb reproduction. Their many special features include square section aluminium tonearms, (high precision low mass design fully counterbalanced, with calibrated stylus pressure control for perfect tracking), and conveniently grouped easy to read linear controls. The turntables have viscous cueing devices which allows the tonearms to be placed or lifted at any point on the record.
The two lightweight cartridge shells have slide-in-holders to facilitate easy inspection of needles and cartridges.



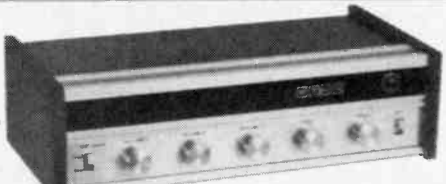
TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV. Auxiliary inputs – 200mV and 750mV into 1 meg. Mic input – 6mV into 100K. 240 volt operation.
Turntables capacity – 7", 10" or 12" records.
Rumble, wow and flutter – Rumble – Better than –35dB. Wow – Better than 0.2%. Flutter – Better than 0.06% (Gaumont kalee meter).
Finish – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size – Unit Closed – $17\frac{3}{4}$"×$13\frac{3}{4}$"×$8\frac{3}{4}$" (approx.)
Unit Open – $35\frac{3}{4}$"×$13\frac{3}{4}$"×$4\frac{5}{8}$" (approx.)
This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging diamond spun control knobs with matching control panel.

Yours for only £45.00 + £3.50 P. & P.

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 470 K
Size: $19\frac{1}{4}$"×$10\frac{1}{2}$"×8" (approx.) Amplifier **£27.50 + £1.50 p. & p.**



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49	Cassette recorder mic. (2½mm & 3½mm plugs)	1·85
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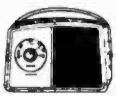

MW/LW portable radio £7·98 (P. & P. 32p). MW/LW radio tuner £5·25 (P. & P. 20p). 9V regulated power supply £2·15 (P. & P. 15p). 15W inverter £5·20 (P. & P. 30p). 40W inverter £6·80 (P. & P. 40p). Sinclair micromatic radio £2·25 (P. & P. 15p)

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IC Clock
MM 5314 single chip clock with CCT £9.

Radio IC Chip
ZN414 Radio IC with circuit £1·20.

Ultrasonic transducers
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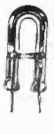

Strobe tubes
ZFT8A (similar to 4A) £4.
ZFT12A £5.

7 segment indicators
3015F with data £1·70 each

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(Post, etc. 15p any quantity.)

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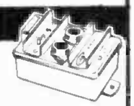
AMTRON KITS



Model No		£ p
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707	Windscreen wiper timer	£7·97
157	Private TV loop trans	£4·95
525C	120–160 mHz VHF tuner	£11·31

		£ p
310	Radio control receiver	£3·29
300	4-channel R/C transmitter	6·61
345	Superhet R/C receiver	6·61
65	Simple transistor tester	1·66
115	8 watt amplifier	4·50
120	12 watt amplifier	4·73
125	Stereo control unit	6·61
130	Mono control unit	4·16
605	Power supply for 115	5·31
610	Power supply for 120	5·31
615	Power supply for 2 x 120	6·64
230	AM/FM aerial amplifier	3·29
240	Auto packing light	6·90
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590	SWR meter	9·47
630	STAB Power supply 6–12V 0·25–0·1A	9·24
690	DC motor speed Gov.	3·31
700	Electronic Chaffinch	7·92
760	Acoustic switch	12·57
780	Metal Detector (electronics only)	10·91
790	Capacitive Burglar alarm	7·92
835	Guitar preamp	4·99
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390	VOX	13·62
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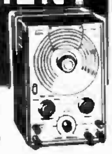
670	Buffer Battery Charger	7·59
850	Electronic Keyer	16·37

TEST EQUIPMENT

MULTI-METERS



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	£
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U4313 20k/V with steel case	12·50
U4317 20k/V with case	16·50
U4341 33k/V plus transistor tester steel case	10·50
U4323 20k/V plus 1kHz 465kHz OSC with case	7·70
ITI-2 20k/V slim type	5·95
THL33D (L33DX) 2k/V Robust	7·50
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TP10S 2k/V	6·25
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EP10KN 10k/V	9·95
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S100TR 100k/V Plus transistor tester	22·50

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(† Carr. packing 50p.
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680R Multi-tester £18·50

NEW REVOLUTIONARY SUPERTESTER 680R

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680R Multi-tester	18·50
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†3100 IMA Strip chart recorder	44·00
†Tk40 AC Multivoltmeter	19·75
†Tk15 Grid dip meter 440kHz–28mHz	19·50
†Tk65 28 Range valve voltmeter	22·50
†Tk20D RF Generator 120kHz–500mHz	18·95
†Tk22D AF Generator 20Hz–200kHz	19·95
*HM350 In circuit transistor tester	19·50
*C3025 Deluxe meter 1–300mHz	6·95
*TT145 Compact transistor tester	14·75
†G3-36 R/C osc. 20Hz–200kHz	19·75
*C3042 SWR Meter	5·75
*SE350A Deluxe signal tracer	12·95
*SE400 Mini-lab. all in one tester	15·50
C1–5 Scope 500,000kHz (carr. £1)	43·00
*C3043 5 CH F/A meter 1–300mHz	5·75
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AC113	20
AC115	22
AC117K	32
AC122	13
AC125	19
AC126	19
AC127	20
AC128	20
AC132	16
AC134	16
AC137	16
AC141	20
AC141K	32
AC142	20
AC142K	28
AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	24
AC188K	25
ACY17	28
ACY18	22
ACY19	22
ACY20	22
ACY21	22
ACY22	18
ACY27	20
ACY28	21
ACY29	39
ACY30	31
ACY31	31
ACY34	23
ACY35	23
ACY36	31
ACY40	19
ACY41	20
ACY44	39
AD130	42
AD140	53
AD142	53
AD143	42
AD149	55
AD161	39

Type	Price p
AD162	39
AD161 and AD162MP	75
ADT140	55
AF114	27
AF115	27
AF116	27
AF117	27
AF118	39
AF124	33
AF125	33
AF126	31
AF127	31
AF139	33
AF178	55
AF179	55
AF180	55
AF181	55
AF186	55
AF239	41
AL102	72
AL103	72
ASY26	28
ASY27	33
ASY28	28
ASY29	28
ASY50	28
ASY51	28
ASY52	28
ASY54	28
ASY55	28
ASY56	28
ASY57	28
ASY58	28
ASY73	28
ASZ21	44
BC107	14
BC108	14
BC109	15
BC113	11
BC114	17
BC115	17
BC116	17
BC117	20
BC118	11
BC119	33
BC120	88
BC125	13
BC126	20
BC132	13
BC134	20
BC135	13
BC136	17
BC137	17
BC139	44
BC140	33
BC141	33
BC142	33
BC143	33
BC145	50
BC147	11

Type	Price p
BC148	11
BC149	13
BC150	20
BC151	22
BC152	19
BC153	31
BC154	33
BC157	20
BC158	13
BC159	13
BC160	50
BC161	55
BC167	13
BC168	13
BC169	13
BC170	13
BC171	16
BC172	16
BC173	16
BC174	16
BC175	24
BC177	21
BC178	21
BC179	21
BC180	27
BC181	27
BC182	16
BC182L	16
BC183	16
BC183L	16
BC184	22
BC184L	22
BC186	31
BC187	31
BC207	12
BC208	12
BC209	13
BC212L	14
BC213L	14
BC214L	18
BC225	28
BC226	39
BC301	30
BC302	27
BC303	35
BC304	40
BC440	34
BC460	40
BCY30	27
BCY31	29
BCY32	33
BCY33	24
BCY34	28
BCY70	16
BCY71	22
BCY72	16
BCZ10	22
BCZ11	28
BCZ12	28
BD115	68
BD116	88

Type	Price p
BD121	66
BD123	72
BD124	76
BD131	55
BD132	66
BD133	72
BD135	44
BD136	44
BD137	50
BD138	55
BD139	61
BD140	66
BD155	88
BD175	66
BD176	66
BD177	72
BD178	72
BD179	72
BD180	77
BD185	72
BD186	72
BD187	77
BD188	77
BD189	83
BD190	83
BD195	94
BD196	94
BD197	99
BD198	99
BD199	£1·05
BD199	£1·05
BD200	£1·05
BD205	88
BD206	88
BD207	£1·05
BD208	£1·05
BDY20	£1·10
BDY20	£1·10
BF115	27
BF117	50
BF118	77
BF119	77
BF121	50
BF123	55
BF125	50
BF127	55
BF152	61
BF153	50
BF154	50
BF155	77
BF156	53
BF157	61
BF158	61
BF159	66
BF160	44
BF162	44
BF163	44
BF164	44
BF165	44
BF167	24
BF173	24

Type	Price p
BF176	39
BF177	39
BF148	33
BF179	33
BF180	33
BF181	33
BF182	44
BF183	44
BF184	28
BF185	33
BF187	30
BF188	44
BF194	18
BF195	18
BF196	16
BF197	16
BF200	50
BF222	£1·05
BF257	50
BF258	66
BF259	94
BF262	61
BF263	61
BF270	39
BF271	33
BF272	88
BF273	39
BF274	39
BFW10	66
BFX29	30
BFX84	24
BFX85	33
BFX86	24
BFX87	27
BFX88	24
BFY50	22
BFY51	22
BFY52	22
BFY53	19
BSX19	17
BSX20	17
BSY25	17
BSY26	17
BSY27	17
BSY28	17
BSY29	17
BSY38	20
BSY39	20
BSY40	31
BSY41	31
BSY95	14
BSY95A	14
Bu105	£2·20
C111E	55
C400	33
C407	28
C424	28
C425	55
C426	39
C428	22
C441	33

Type	Price p
C442	33
C444	39
C450	24
MAT100	21
MAT101	22
MAT120	21
MAT121	22
MJE2955	95
MJE3055	62
MJE3440	55
MPF102	46
MPF104	41
MPF105	41
OC19	39
OC20	70
OC22	52
OC23	54
OC24	62
OC25	42
OC26	32
OC28	55
OC29	55
OC35	46
OC36	55
OC41	22
OC42	27
OC44	17
OC45	14
OC70	11
OC71	11
OC72	16
OC74	16
OC75	17
OC76	17
OC77	28
OC81	17
OC81D	17
OC82	17
OC82D	17
OC83	22
OC139	22
OC140	22
OC169	28
OC170	28
OC171	28
OC200	28
OC201	31
OC202	31
OC203	28
OC204	28
OC205	39
OC309	44
OCP71	48
ORP12	48
ORP60	44
ORP61	44
P20	55
P346A	22
P397	46
ST140	14
ST141	19

Type	Price p
TI843	33
UT46	30
ZN414	£1·20
2G301	21
2G302	21
2G303	21
2G304	27
2G306	44
2G308	39
2G309	39
2G339	22
2G339A	18
2G344	20
2G345	18
2G371	18
2G371B	13
2G373	19
2G374	19
2G377	33
2G378	18
2G381	18
2G382	18
2G401	33
2G414	33
2G417	28
2N388	39
2N388A	61
2N404	22
2N404A	31
2N524	46
2N527	54
2N598	46
2N599	50
2N696	14
2N697	15
2N698	27
2N699	39
2N706	09
2N706A	10
2N708	18
2N711	33
2N717	39
2N718	27
2N718A	55
2N726	31
2N727	31
2N743	22
2N744	22
2N914	16
2N918	33
2N929	23
2N930	23
2N1131	22
2N1132	24
2N1302	16
2N1303	16
2N1304	19
2N1305	19
2N1306	23
2N1307	23
2N1308	26

Type	Price p
2N1309	26
2N1613	22
2N1711	22
2N1889	35
2N1890	50
2N1893	41
2N2147	79
2N2148	63
2N2160	66
2N2192	39
2N2193	39
2N2194	39
2N2217	24
2N2218	22
2N2219	22
2N2220	24
2N2221	22
2N2222	22
2N2368	19
2N2369	16
2N2369A	16
2N2411	27
2N2412	27
2N2646	52
2N2711	23
2N2712	23
2N2714	23
2N2904	19
2N2904A	23
2N2905	23
2N2905A	23
2N2906	17
2N2906A	20
2N2907	22
2N2907A	24
2N2923	16
2N2924	16
2N2925	16
2N2926G	14
2N2926Y	12
2N2926O	11
2N2926R	11

Type	Price p
2N2926B	11
2N3010	77
2N3011	16
2N3053	19
2N3054	51
2N3055	55
2N3391	16
2N3391A	18
2N3392	16
2N3393	16
2N3394	16
2N3395	19
2N3402	23
2N3403	23
2N3404	31
2N3405	46
2N3414	17
2N3415	17
2N3416	31
2N3417	31
2N3525	83
2N3614	74
2N3615	82
2N3616	82
2N3646	10
2N3702	13
2N3703	13
2N3704	14
2N3705	13
2N3706	13
2N3707	14
2N3708	09
2N3709	10
2N3710	10
2N3711	10
2N3819	31
2N3820	55
2N3821	39
2N3823	31
2N3903	31
2N3904	33
2N3905	31

Type	Price p
2N3906	30
2N4058	13
2N4059	11
2N4060	13
2N4061	13
2N4062	13
2N4284	19
2N4285	19
2N4286	19
2N4287	19
2N4288	19
2N4289	19
2N4290	19
2N4291	19
2N4292	19
2N4293	19
2N5172	13
2N5294	60
2N5457	35
2N5458	35
2N5459	44
2N6121	75
28301	55
28302A	46
28302	46
28303	61
28304	77
28305	86
28306	86
28307	86
28321	62
28322	46
28322A	46
28323	62
28324	77
28325	77
28326	77
28327	77
28701	46
40361	44
40362	50

DIODES AND RECTIFIERS

AA119	9
AA120	9
AA129	9
AAY30	10
AAZ13	11
BA100	11
BA116	23
BA126	24
BA148	16
BA154	13
BA155	16
BA156	15
BA173	16
BY100	17
BY101	13
BY105	19
BY114	13

BY124	13
BY126	16
BY127	17
BY128	17
BY130	18
BY133	23
BY164	55
BYX38/30	46
BYZ10	39
BYZ11	33
BYZ12	33
BYZ13	28
BYZ16	44
BYZ17	39
BYZ18	39
BYZ19	31

CG62 (OA91Eq)	6
CG651 (OA70-OA79)	7
OA5	39
OA5 short leads	23
OA10	15
OA47	8
OA70	8
OA79	8
OA81	8
OA85	10
OA90	7
OA91	7
OA95	8

LINEAR INTEGRATED CIRCUITS

Type No.	1	25	100+
72702	50p	48p	45p
72709	35p	33p	30p
72710	45p	43p	40p
72741	40p	38p	35p
72741C	45p	43p	40p
72741P	38p	36p	34p
72748P	38p	36p	34p
SL201C	50p	45p	40p
SL701C	50p	45p	40p
SL702C	50p	45p	40p
TAA263	80p	70p	60p
TAA293	£1·00	95p	90p
TAA350A	£1·85	£1·80	£1·70
μA703C	28p	26p	24p
μA709C	35p	33p	30p
μA711	45p	43p	40p

NUMERICAL INDICATOR TUBES

CD66	£1·87
GR116	£1·70
3015F Minitron	£1·50
MAN 3M. L.E.D. 7-segment 0·127"	£1·90

All indicators 0·9 + Decimal point. All side viewing. Full data for all types available on request.

ZN414 .. .. .. £1·20 each
I.C. Radio Rec. incl. full cir. data.

DTL 930 SERIES LOGIC I.C's

Type	Price 1	25	100+
BP930	15p	14p	13p
BP932	16p	15p	14p
BP933	16p	15p	14p
BP935	16p	15p	14p
BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
BP9097	45p	43p	40p
BP9099	45p	43p	40p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only.)

VOLTAGE REGULATORS
TO3 Plastic 1·5 Amps

μA 7805/L129 5V (Equiv. to MVR5V) £1·76
μA 7812/L130 12V (Equiv. to MVR15V) £1·76
μA 7815/L131 15V (Equiv. to MVR15V) £1·76

74 Series T.T.L. I.C's

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

Type	Quantities £p 1	£p 25	£p 100+
7406	0·39	0·34	0·31
7407	0·39	0·34	0·31
7408	0·25	0·24	0·23
7409	0·25	0·24	0·23
7411	0·28	0·27	0·26
7412	0·30	0·29	0·28
7413	0·32	0·31	0·30
7416	0·40	0·39	0·38
7417	0·40	0·39	0·38
7422	0·30	0·29	0·28
7423	0·40	0·39	0·38
7425	0·40	0·39	0·38
7426	0·40	0·38	0·36
7427	0·40	0·38	0·36
7428	0·45	0·42	0·40
7432	0·40	0·38	0·36
7433	0·42	0·40	0·38
7437	0·45	0·42	0·40
7438	0·45	0·42	0·40
7441	0·74	0·71	0·64
7442	0·74	0·71	0·64
7443	1·20	1·15	1·10
7444	1·20	1·15	1·10
7445	1·98	1·95	1·90
7446	1·20	1·15	1·10
7447	1·10	1·07	1·05
7448	1·10	1·07	1·05
7470	0·32	0·29	0·27
7472	0·32	0·29	0·27
7473	0·41	0·39	0·35
7474	0·41	0·39	0·35

Type	Quantities £p 1	£p 25	£p 100+
7475	0·60	0·58	0·56
7476	0·44	0·43	0·42
7480	0·74	0·71	0·64
7481	1·30	1·25	1·20
7482	0·90	0·85	0·80
7483	1·20	1·15	1·05
7484	1·10	1·05	1·00
7485	2·00	1·90	1·80
7486	0·35	0·34	0·33
7489	4·00	3·75	3·50
7490	0·74	0·71	0·64
7491	1·10	1·05	1·00
7492	0·74	0·71	0·64
7493	0·74	0·71	0·64
7494	0·85	0·82	0·75
7495	0·85	0·82	0·75
7496	0·96	0·93	0·86
74100	1·50	1·45	1·40
74104	0·70	0·68	0·66
74105	0·70	0·68	0·66
74107	0·44	0·42	0·40
74110	0·60	0·55	0·50
74111	0·95	0·92	0·90
74118	1·10	1·05	1·00
74119	1·50	1·40	1·30
74121	0·50	0·48	0·45
74122	0·88	0·86	0·84
74123	1·58	1·54	1·50
74141	0·85	0·82	0·79
74145	1·58	1·54	1·50
74150	2·50	2·40	2·30

Type	Quantities £p 1	£p 25	£p 100+
74151	1·10	1·05	1·00
74153	1·20	1·10	1·00
74154	1·98	1·90	1·75
74155	1·20	1·15	1·10
74156	1·20	1·15	1·10
74157	1·20	1·15	1·10
74160	1·73	1·70	1·65
74161	1·73	1·70	1·65
74162	1·73	1·70	1·65
74163	1·73	1·70	1·65
74164	2·20	2·10	2·00
74165	2·20	2·10	2·00
74166	2·35	2·30	2·25
74174	2·00	1·95	1·90
74175	1·40	1·35	1·30
74176	1·60	1·55	1·50
74177	1·60	1·55	1·50
74180	1·60	1·55	1·50
74181	5·00	4·50	4·00
74182	1·50	1·45	1·40
74184	2·40	2·30	2·20
74190	2·15	2·10	2·00
74191	2·15	2·10	2·00
74192	2·15	2·10	2·00
74193	2·15	2·10	2·00
74194	1·90	1·80	1·70
74195	1·60	1·50	1·40
74196	1·73	1·70	1·65
74197	1·73	1·70	1·65
74198	3·45	3·35	3·20
74199	3·10	3·00	2·90

Devices may be mixed to qualify for quantity price. (TTL 74 series only) data is available for the above series of I.C.s in booklet form. Price 35p.

TRIPLE 66-bit DYNAMIC SHIFT REGISTER EDSR3166

Comprises three 66-bit 20 dynamic shift registers with independent inputs and outputs. TTL compatibility and buffered clock lines to reduce the capacitive load presented at the clock pins. A bootstrapped buffer ensures a full logic swing at the output. **£2·50** each

DUAL-IN-LINE SOCKETS

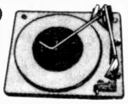
14 & 16 Lead Sockets for use with DUAL-IN-LINE I.C's. TWO Ranges PROFESSIONAL & NEW LOW COST.

PROF.	TYPE No.	1-24	25-99	100 up
TSO14	14 pin type	33p	30p	27p
TSO16	16 pin type	38p	35p	32p
BP814	14 pin type (low cost)	16p	14p	12p
BP816	16 pin type (low cost)	17p	15p	13p

ALL PRICES INCLUDE V.A.T.

ALL OUR PRICES INCLUDE V.A.T.

BSR HI-FI AUTOCHANGER
STEREO AND MONO



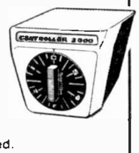
Plays 12", 10" or 7" records. Auto or Manual. A high quality unit backed by BSR reliability with 12 months' guarantee. A.C. 200/250V Size 13¼ × 11¼in. Above motor board 3¼in. below motor board 2½in.
with STEREO and MONO CARTRIDGE **£6·95** Post 45p.

PORTABLE PLAYER CABINET
Modern design. Rexine covered. Vynair front grille. Chrome fittings. Size: 17 × 15 × 8in approx.
Motor board cut for BSR deck **£4·50** Post 45p.

COMPACT PORTABLE STEREO HI-FI
Two full size loudspeakers 13¼ × 10 × 3½in. Player unit clips to loudspeakers making it extremely compact, overall size only 13¼ × 10 × 8½in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls 240V a.c. mains.

Attractive Teak finish Weight 13 lb.
Bargain Price **£25** 85p carriage

SPECIAL OFFER!
SMITH'S CLOCKWORK 15 AMP TIME SWITCH
0–60 MINUTES **£1·95** Post 25p
Single pole two-way. Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights, etc. Variable knob. Turn on or off at full or intermediate settings. Brand new and full guaranteed.



TEAKWOOD LOUDSPEAKER GRILLES will easily fit to baffle board. Size 18⅞ × 10⅞in—75p. 10½ × 7⅞in—45p

WEYRAD P50 — TRANSISTOR COILS

RA2W Ferrite Aerial	85p	Driver Trans. LFDT4	65p
I.F. P50/2CC 470 kc/s	40p	Printed Circuit, PCA1	85p
3rd I.F. P50/3CC	40p	J.B. Tuning Gang	£1·20
Spares Cores	3p	Weyrad Booklet	10p
P50/1AC	60p	OPT1	65p

Mullard Ferrite Rod 8 × ⅜in., 20p. 6 × $\frac{5}{16}$in. 20p. 3 × ⅜in. 10p.

VOLUME CONTROLS
5 K. ohms to 2 Meg. LOG or LIN. L/S 20p. D.P. 35p. STEREO L/S 55p. D.P. 75p. Edge 5K.S.P.Transistor 25p

80 Ohm Coax 5p yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £2; 60 yd. £3
FRINGE LOW LOSS Ideal 625 and colour **10p yd**

8in. or 10×6in. ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50–16,000 c/s. Bass resonance 55 c/s, 8 ohm impedance, 10 watts. music power. **£3·75** Post 25p

E.M.I. 13½ × 8in. SPEAKER SALE!

With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. Post 25p **£4·50**

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45–60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 25p **£2·75**

Bookshelf Cabinet Teak finish 16 × 10 × 9in.
13in × 8in. Bass Woofer, 20 watts, £5·50 **£6·60** Post 45p

SET OF 3 MOTORS FOR COLLARO STUDIO 115 VOLT TAPE DECK
£1·50 Post 50p

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in. sides 6 × 4in 45p; 8 × 6in 53p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1.
ALUMINIUM BOXES, 3 × 3 × 3in 60p; 4 × 4 × 4in 70p; 6 × 4 × 4in 80p; 9 × 4 × 4in £1; 12 × 4 × 4in £1·30.
ALUMINIUM PANELS 18 s.w.g. 6 × 4in 12p; 8 × 6in 19p; 14 × 3in 20p; 10 × 7in 24p; 12 × 5in 25p; 12 × 8in 34p; 16 × 6in 34p; 14 × 9in 40p; 12 × 12in 47p; 16 × 10in 60p.
S.R.P.B. PAXOLIN PANEL 10 × 8in 30p.

ANOTHER R.C.S. BARGAIN!
ELAC 9× 5in HI-FI SPEAKER TYPE 59RN
This famous unit now available, 10 watts, 8 ohm.
Price **£2·95** Post 25p

R.C.S. STABILISED POWER PACK KITS
All parts and instructions with Zener Diode, Printed Circuit, Bridge Rectifiers and Double Wound Mains Transformer Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less
PLEASE STATE VOLTAGE REQUIRED Details S.A.E. Size 3½ × 1½ × 1½in. **£2·20** Post 25p

RCS POWER PACK KIT
12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£2·95** Post 25p
12 VOLT 300mA KIT, £2·75. 9 VOLT 1 AMP KIT, £2·95.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE
Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9–12V or H.T. line 200–300V d.c. operation. Size: 1½ × 1½ × ½ in. Response 25 c/s to 25 kc/s. 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **99p** Post 20p

ELECTRO MAGNETIC PENDULUM MECHANISM
1·5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. **95p** Post 20p

BRITISH FM/VHF TUNING HEART
88 to 108 M/CS British made. 2 Transistors ready aligned requires 10·7 M/CS I.F. Complete with tuning gang. Connections supplied but some technical experience essential. **Our price £3·95** Post 20p
10·7 M/CS I.F. strip £4·95 DECODER £4·95

MAINS TRANSFORMERS
ALL POST 25p each

250–0–250V 70mA, 6·3V 2A	£2·00
250–0–250 80 mA, 6·3V 3·5A 6·3V 1A or 5V 2A	£2·50
350–0–350 80 mA, 6·3V 3·5A, 6·3V 1A or 5V 2A	£3·00
300–0–300V 120 mA, 6·3V 4A C.T.; 6·3V 2A	£4·25
MINIATURE 200V 20 mA, 6·3V 1A 2½ × 2½ × 2in	95p
MIDGET 220V 45 mA, 6·3V 2A 2½ × 2½ × 2in	£1·10
HEATER TRANS. 6·3V ½ amp 85p, 3 amp	£1·20

GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £3·00
1 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £3·00
2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·00
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £6·00
5 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £9·75
3, 5, 8, 10, 13 or 5–0–5V 5 amp. £1·50, 6–0–6V 500mA 90p, 9V 1 amp. 95p, 12V 300mA 75p, 12V 500 mA 85p, 12V 750 mA 95p, 12V, 36V, 48V, 2 amp. £2·20, 20V 3 amp. £2.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £3·00; 500W £6·25; 750W £10; 1000W £15
CHARGER TRANSFORMERS. Input 200/250V, for 6 or 12V, 1½ amp £1·50; 2 amp £1·80; 4 amp £2·50.
BATTERY CHARGERS. Ready built with leads and clips 1½ amp £2; 4 amp £4; 5 amp £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs, 1½ amp 40p; 2 amp 55p; 4 amp 85p.

MAINS ISOLATING TRANSFORMER
Primary 0–110–240V. Secondary 0–240V. 3A. 720W. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £19). OUR PRICE **£12** Carr. 95p.
Can be used as 800W auto transformers 240–110V. IDEAL FOR COLOUR T.V. OR GARDEN TOOLS.

NEW ELECTROLYTIC CONDENSERS

2/350V	14p	250/25V	14p	50 + 50/300V	50p
4/350V	14p	500/25V	20p	900/350V	95p
8/350V	22p	1000/25V	35p	32 + 32/250V	20p
16/350V	25p	1000/50V	47p	32 + 32/450V	60p
32/500V	50p	8 + 8/450V	22p	350 + 50/325V	85p
25/25V	10p	8 + 16/450V	25p	100 + 50 + 50/350V	85p
50/50V	10p	16 + 16/450V	40p	32 + 32 + 32/350V	65p
100/25V	10p	32 + 32/350V	40p	4700/63V	95p

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.

TRIMMERS 10pF, 30pF, 50pF, 5p. 100pF, 150pF, 15p.
CERAMIC, 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V–0·1 4p, 0·5 13p; 1mF 150V 15p; 2mF 150V 15p.
500V–0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.
MICRO SWITCH LEVER ACTION 20p.
SUB-MIN MICRO SWITCH 25p. Single pole change over.
TWIN GANG("0-0" 208pF + 176pF £1·20; 500pF standard 75p
365pF + 365pF with 25pF + 25pF, Slow motion drive 50p.
SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p.
NEON PANEL INDICATORS 250V AC/DC. Amber 30p.
RESISTORS. ⅓W, ¼W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each.
TAPE OSCILLATOR COIL Valve type 35p.

NEW MODEL "BAKER LOUDSPEAKER", 12IN 50 WATT. GROUP 50/12. 8 OR 15 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. **£12·95**

BAKER MAJOR 12" £8·50

30–14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 20W. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30–17,000 c/s with tweeter, crossover, baffle and instructions. **£10·95**
Please state 3 or 8 or 15 ohms.

BAKER "BIG-SOUND" SPEAKERS

'Group 25'	'Group 35'	'Group 50/12'
12in. 25W £7·75	12in. 35W £8·50	12in. 50W £12·95
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER AND CABINETS

For 12in or 10in dia. speaker	20 × 13 × 9in, £10·50, Post 75p
For 13 × 8in or 8in speaker	16 × 10 × 9in, £6·60, Post 45p
For 8 × 5in speaker	16 × 8 × 6in, £5·00, Post 25p
For 6in and Tweeter	12 × 8 × 6in, £4·00, Post 25p

LOUDSPEAKER CABINET WADDING 18in wide. 20p ft

GOODMANS 6½in. HI-FI WOOFER
4 ohm or 8 ohm. 10W. Large ceramic magnet. Special Cambric cone surround. Twin cone. Frequency response, 30–12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**
Suitable Cabinet 12x8x6 £4. Suitable Tweeter £2

ELAC CONE TWEETER

The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3¼ × 3¼ × 2in deep. Rating 10W. 3 ohm. Crossover £1·25 **£1·90** Post 20p.

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £2·25.
De Luxe Horn Tweeters 2-18kc/s, 15W, 15 ohm £4.
CROSSOVERS, TWO-WAY 3,000 c/s 3 or 8 or 15 ohm £1·25.
LOUDSPEAKERS P.M. 3 OHMS. 7x4in., £1·25; 6½in., £1·50; 8x5in., £1·60; 10in., £2·00; 8in., £1·75; 10x6in., £1·90.
SPECIAL OFFER: 80 ohm, 2½in, 2½in, 35 ohm, 2in., 3in., 25 ohm, 2½in dia., 3in dia., 5in dia.
15 ohm, 3½in dia, 6x4in., 7x4in., 8x5in., **£1 each**
3 ohm, 2½in., 2½in., 3½in., 5in. dia. (6x4in 8 ohms £1·50).
RICHARD ALLAN TWIN CONE LOUDSPEAKERS,
8in. diameter 4W £2·50. 10in. diameter 5W £2·50;
12in. diameter 6W £2·95. 3/8/15 ohms, please state.
VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1 40p.
Mike trans. mu metal 100:1 £1·25.

Loudspeaker Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting. ¼in spindle. 65p each, Post 15p.

MAJOR 100 WATT ALL PURPOSE GROUP AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. **£49** Carr. £1·00
NEW MODEL MAJOR—50 watt. 4 input. 2 vol. controls. treble and bass £39·95.

BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9V. **£4·50**
TWO CHANNEL STEREO VERSION **£5·95**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built, with volume. Treble and bass controls. 18 volt d.c. **£4·50**

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p.
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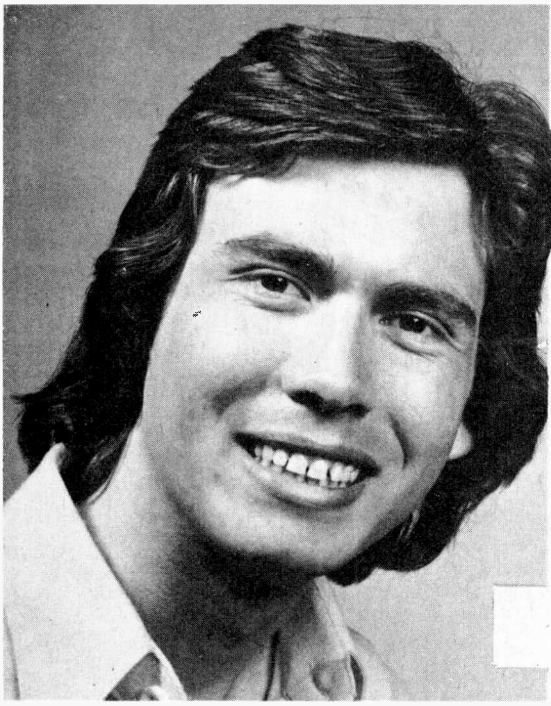

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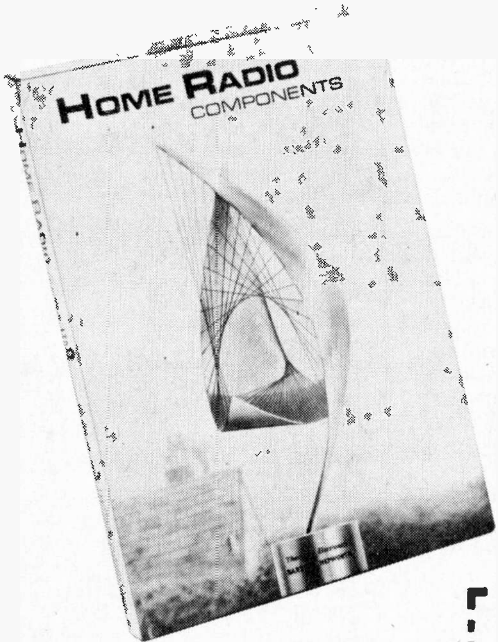

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SELF SERVICE

It is a healthy sign that the throw-away philosophy which has pervaded so many aspects of life is now being questioned, mainly because of the disregard for conservation of natural resources it encourages. The uncontrolled and thoughtless exploitation of irreplaceable materials has finally become a major concern, throughout the world.

In this connection, the role of electronics cannot escape some censure. The vast growth of electronic products has been paralleled by a fall-off in servicing facilities generally available. Clearly many of the cheaper consumer products are not intended to receive any drastic servicing treatment in the course of their normal life. When they prove troublesome their destination, all too commonly, is the dustbin. On a commercial basis this makes sense, it must be admitted, for the cost of a skilled repairman's time would very quickly exceed the market value of the article. It is only the non-profit orientated private enthusiast who is likely to undertake such uneconomical work.

With larger and more expensive equipment, e.g. colour television sets, servicing still remains an indispensable feature during the normal working life of the product. Modular construction aids rapid on-the-spot servicing, although an element of the throw-away philosophy undoubtedly persists at the individual module level.

It has always been claimed that the increased use of i.c.'s will enhance the reliability factor and so reduce the number of failures in electronic equipment. This should help ease the demand upon the overtaxed service technicians. Yet, as in other branches of engineering, the supply of competent service technicians is likely to continue to lag far behind the demand.

One consequence of this shortage of skilled professionals and the accompanying rise in labour charges is the growth of do-it-yourself enterprise, in many different fields. The private motorist offers perhaps the most obvious example of the greatly increasing application of "self service". Car maintenance depends upon specialist knowledge and working experience. It is also a field where electronic instruments can play quite an important part—not least for the amateur. In many instances the electronics constructor can apply his interest in this subject to help out if or when he is compelled to undertake his own car maintenance. The Dwell Meter described in this issue is another valuable instrument that seems destined to repay its cost over and over again in the austere times which we have been warned lay immediately ahead.

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DWELL METER

BY S. JONES

This dwell meter was designed to facilitate automobile contact breaker adjustments without the use of feeler gauges. In this way worn contact breaker points can be adjusted, a task not otherwise possible.

Distributor mechanical wear and vacuum advance operation can also be checked. The prototype was checked against the most expensive commercial dwell meters available and no variation between them could be detected.

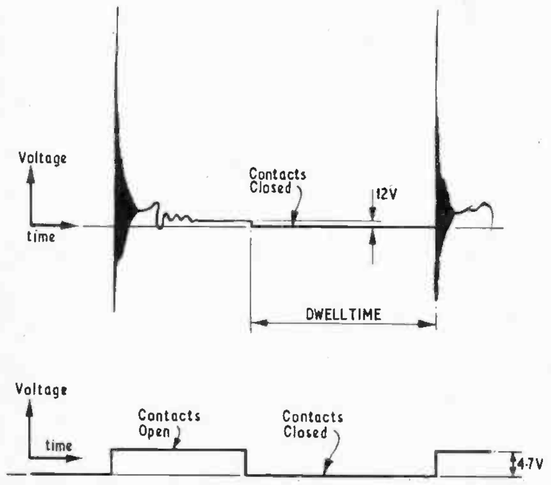


Fig. 1. The waveform at the contact breaker points shown here in the upper graph. The voltage level during the closed-points period is only 12V just to give an idea of scale. The lower graph shows the output from the bridge rectifier used in the following circuit diagram

WHAT IS DWELL ANGLE?

During the time when the points are closed, called the dwell time, the primary current through the coil builds up producing a magnetic field around the coil. If this magnetic field does not reach sufficient strength, due to too short a dwell time, its collapse when the points open may not produce sufficient voltage to cause a spark at the plug.

Dwell time is therefore very important. However, measuring it is difficult as obviously it decreases with increasing engine speed. Thus the angle for which the points remain closed is used and this remains constant through the speed range provided that the points are not moved.

This measurement can be made by examining the potential across the points during their operation.

DESIGN PROBLEMS

Although most ignition systems work on a 6V or 12V supply, an alternating voltage with a peak of up to 300V is produced across the points when they open (see Fig. 1). If this 300V were applied to a transistorised circuit without some modification it is unlikely that the transistors would survive the voltage peaks and for this reason the voltage across the contacts is first rectified and stabilised to produce a voltage suitable for transistor switching as in Fig. 1, lower curve.

CIRCUIT

A full wave rectifier formed by diodes D1 to 4 (Fig. 2) is fed with the signal from the points under test; this rectifies the oscillations shown in the upper part of Fig. 1 to give the lower waveform. R1 limits the current flow to Zener D5 which stabilises the output from the rectifier at 4·7V.

The voltage developed across R3 when the contacts are open makes the base of TR1 positive, turning it on. This in turn switches off TR2 and no current flows through the meter ME1.

COMPONENTS . . .

Resistors
R1 1kΩ
R2 1kΩ
R3 1kΩ
R4 3·3kΩ
All 10% $\frac{1}{10}$W carbon

Potentiometer
VR1 4·7kΩ Lin

Diodes
D1 1N4001
D2 1N4001
D3 1N4001
D4 1N4001
D5 4·7V, 1W Zener

Transistors
TR1 2N2926 (Orange)
TR2 2N2926 (Orange)

Miscellaneous
ME1 1mA or see text
S1 SPST on/off
B1 1·5V battery (Alkaline cell size AA preferable)
Veroboard, 0·1in matrix, 29 × 24 hole rows. Case, 4 × 6 × 1·5in.
Wire, solder, nuts, screws etc.

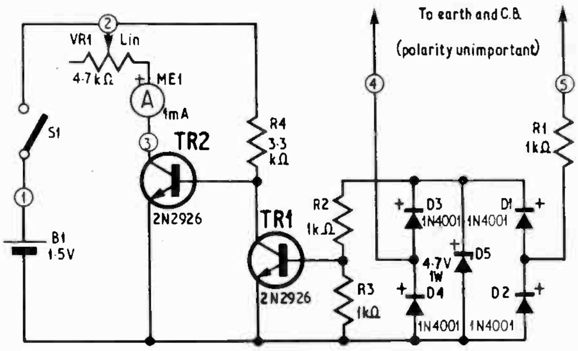


Fig. 2. The circuit diagram of the dwell meter showing the simplicity of the arrangement

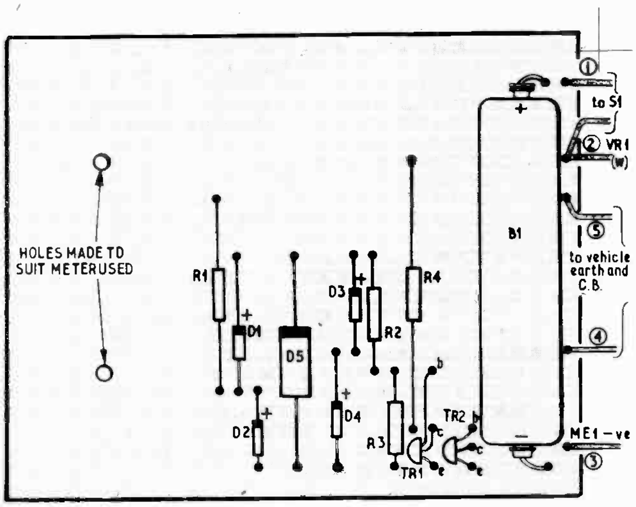


Fig. 3. Component layout and Veroboard cut details for the dwell meter

The Dwell Meter together with the starter switch push unit. Of course, they are not connected electrically, one going to the starter solenoid whilst the other goes to the points

When the contacts close the input to the rectifier is short-circuited by the contacts and the voltage across R3 falls, causing TR1 to be turned off and TR2 on. Current now flows through the meter via VR1.

The "earth" of the vehicle is unimportant as the input to the dwell meter is via a full wave rectifier and for the same reason it is unimportant which way round the input wires are connected across the contacts.

The ratio of on to off periods of TR2 determines the average current through ME1 and this is used to assess the actual dwell angle.

The use of the vehicle battery as a power source, even if stabilised, has been found unsatisfactory and so a 1·5V alkaline cell is recommended. This has a shelf life of 2 years and is totally leak-proof. A standard pen cell could be used, but leakage could be a problem.

The meter ME1 can be almost any value, both 1mA and 100μA have been used and VR1 set accordingly.

CONSTRUCTION

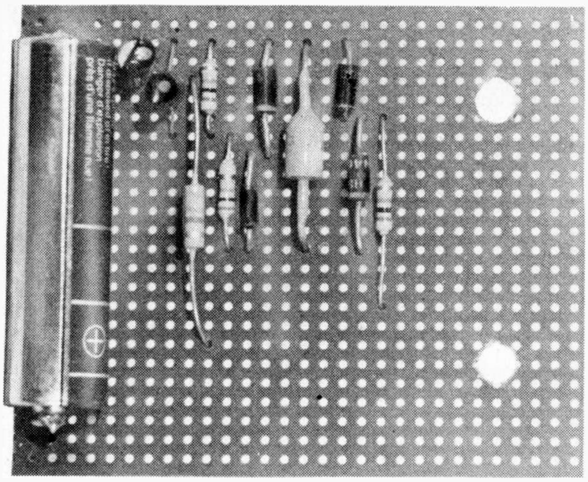
All components are mounted on 0·1in matrix Veroboard 3in × 2·5in which can, if desired, be mounted direct onto the meter terminals. A board layout is shown in Fig. 3. Holes may be drilled anywhere in the last inch of the board as this has been isolated from the rest of the circuit.

The board can be mounted with the copper side outwards if a shallow case is to be used, but the case itself, if metal, must not be connected to the circuitry as the case will no doubt come into contact with the vehicle chassis during normal use.

The battery is soldered direct to the Veroboard though if preferred small clips could be used, or the battery mounted separately.

CALIBRATION

With a normal 0 to 10 scaled meter, all that is required is to change the figures to 0° to 100°. Then zero the meter needle on to 90° for a 4-cylinder engine using VR1. The meter is then ready for use reading dwell angle from 0 to 90° with a linear scale. For 6-cylinder engines set the needle to 60°, 8-cylinder to 45°, 12-cylinder to 30°, i.e. 360 divided by the number of cylinders. These zero marks can be put onto the scale for future reference as can be seen in the photographs.



Component layout on the Veroboard used in the prototype. Note the use of the alkaline cell power source

USING THE DWELL METER

Switch on and zero the dwell meter as explained above to suit the engine being examined. Connect one of the input cables to a good earth and the other to the terminal on the coil which is connected to the distributor contacts; this may be marked CB, positive or negative, depending on the age and "earth" of the vehicle.

Remove the distributor cap and rotor arm and loosen the contact breaker fixing screws so that with a screwdriver in the adjusting slot the points can be adjusted but are not loose. Switch on the ignition and while the starter motor turns over the engine, move the contact breakers with the screwdriver in the adjusting slot until the dwell is correct for your vehicle.

Tighten the screws, replace the rotor arm and distributor cap. The points are now adjusted. It is now advisable to time the engine using the timing lamp in the January issue. Always dwell then time, not the other way about.

Whilst this is a normal procedure in commercial workshops, some owners might prefer to remove the spark-plugs before turning the engine over so as to reduce the load on the starter.

DWELL ANGLES

If the dwell angle only requires checking then connect the dwell meter as described above, but run the engine at idle speed and read the dwell angle in the normal way.

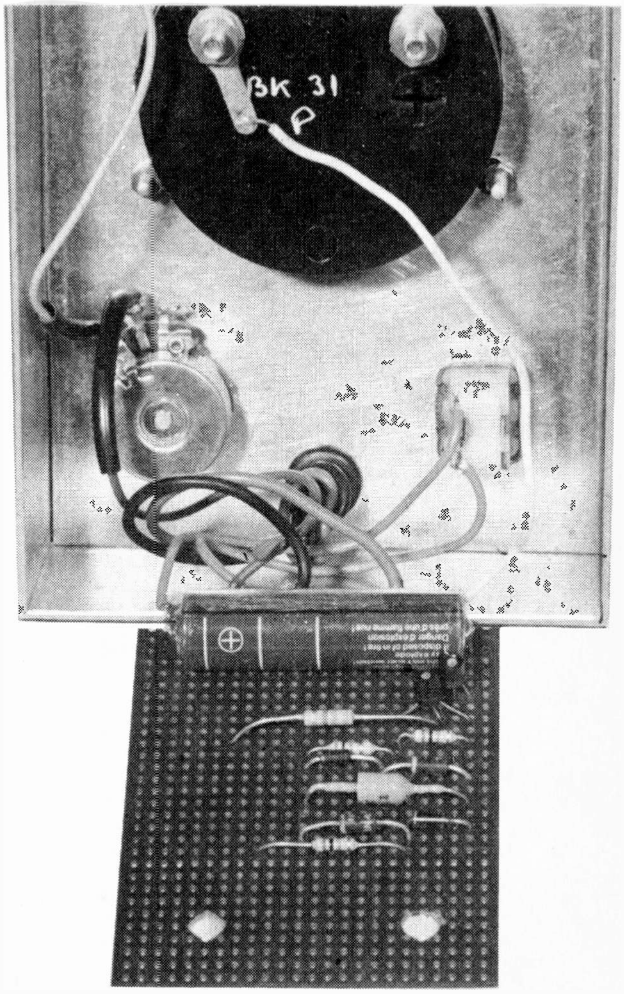
The dwell angles for 4-cylinder engines are as follows:

Autolite distributor	40°	Vauxhall/Bedford
Lucas distributor	60	B.L.M.C.
A.C. Delco distributor	37°	Ford

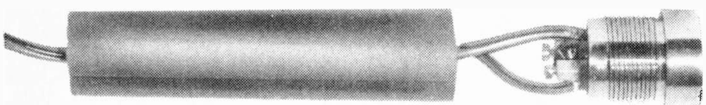
With the Autolite and Delco 4-cylinder distributors the dwell angle will increase when the vacuum advance mechanism operates. This is normal.

The great variety of distributors fitted to 6, 8 and 12-cylinder engines makes listing dwell angles difficult, but most libraries now carry a good selection of manuals as do book shops and they will be only too glad to let you peruse the relevant pages.

To check distributor wear, disconnect the vacuum unit and note the dwell angle at idle speed. Increase speed to 3,000 r.p.m., noting the dwell angle again. A variation of more than 3 indicates distributor bearing wear which may, depending on the exact nature of the wear, affect the running of the engine.



View inside the prototype Dwell Meter showing the simple interwiring between the meter, board and external vehicle circuit



The manual starter switch is simply a push-switch which is itself a push fit in a length of plastic tube to make a comfortable handle. The cable can be locked in position using wax or sealing compound

REMOTE STARTER

Some readers may have considerable difficulty in operating the starter, as in the case where it is actuated by the ignition switch, and at the same time moving the contacts. Where the starter solenoid is not operable mechanically, a remote starter overcomes the problem.

Obtain a length of stout cable, to one end fit a crocodile clip and to the other a ¼in Lucar connector. At the centre break the cable and fit a push-to-make switch rated at at least 5A. In the version shown here a Bulgin switch was pushed into a length of plastic tube for convenience.

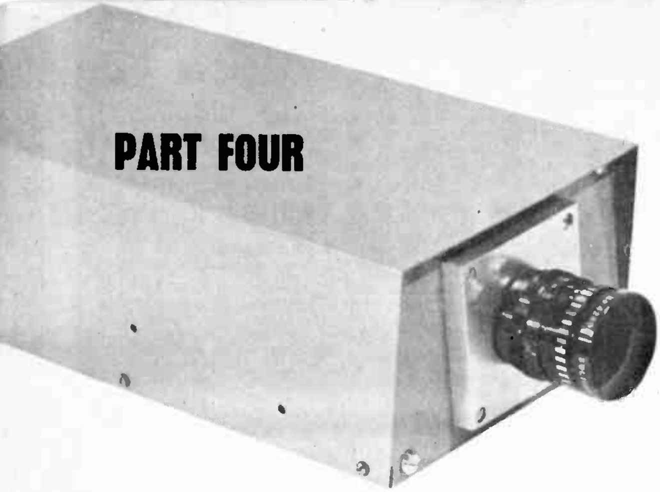
Locate the starter motor solenoid, which may be mounted on top of the starter motor or elsewhere in the engine compartment, and look for a single wire feeding to an isolated Lucar spade. Remove the distributor cap and then have someone turn the engine over briefly with the ignition key and disconnect this cable, the starter motor should stop if the correct cable has been selected.

If you are confronted by two small Lucar spades, one on either side of the solenoid, remove each in turn until the starter motor stops. The other forms part of the ignition system and should be left in place.

Now attach the crocodile clip to the unearthed battery terminal and the Lucar connector to the solenoid operating terminal previously located. Push the button and the starter will operate. On no account remove or make a connection to the two bolt connections of the solenoid or any wire attached to them.

Turning the engine over with the starter for what may seem quite lengthy periods to some readers is normal in the garage trade when setting tappets for instance. No damage will be caused unless the time taken for adjustment is excessive, but for those who wish, the load may be considerably lightened by removing the spark plugs. ★

PART FOUR



PE CCTV MONOCHROME CAMERA

By G. D. BISHOP

U.H.F. MODULATORS: *A CHOICE OF TWO*

A CCTV system normally consists of a camera or group of cameras connected via a fade or switch unit to a CCTV monitor. The monitor is merely a cathode ray tube which is driven by a video amplifier and the normal scan coils and timebase circuits as would be found in a domestic television receiver. A domestic TV set can, therefore, be used as a monitor in one of two ways; the CCTV camera signal can be fed to the video amplifier input direct necessitating internal modifications to the TV set, or the camera signal can be modulated onto the normal u.h.f. carrier frequencies and applied to the usual aerial socket.

No modifications to the receiver are needed if the latter method is adopted and this article describes the construction of such a modulator using a standard domestic receiver u.h.f. tuner as the modulating circuit. The CCTV signal could be applied direct to the modulator but to avoid any distortion of the signal a small video amplifier is included, together with a low voltage power supply.

For those constructors who would prefer to build from a simple kit with instructions, an excellent modulator is available from Crofton Electronics for £7·30. Details are given in Fig. 4.5.

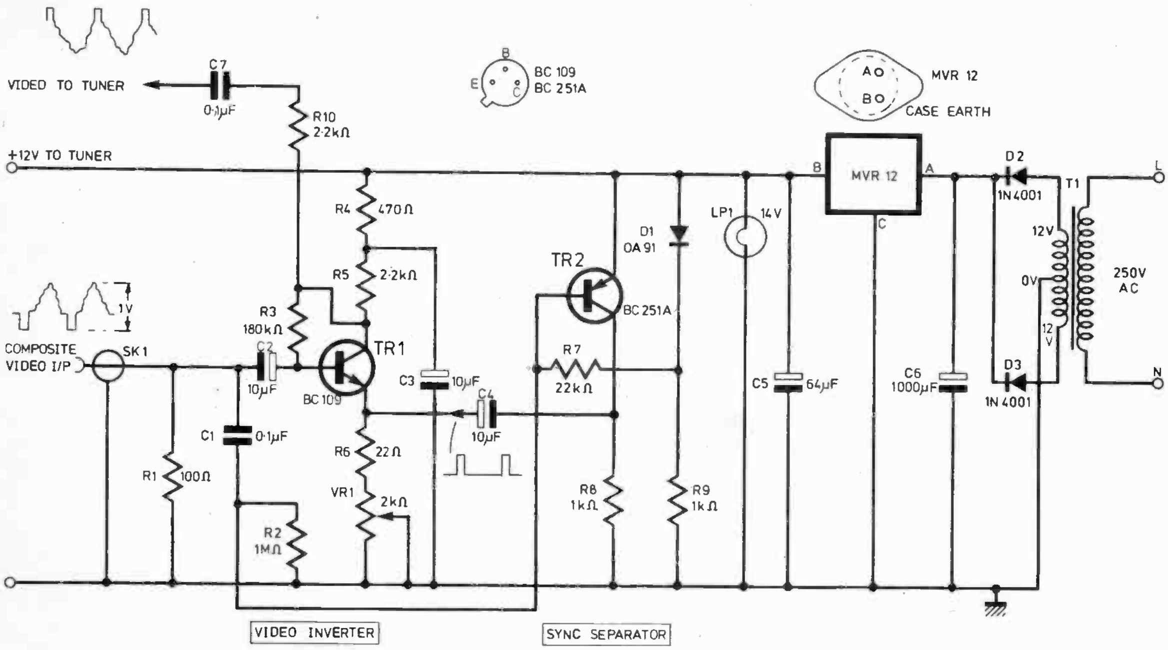


Fig. 4.1. Circuit diagram of sync separator and video inverter

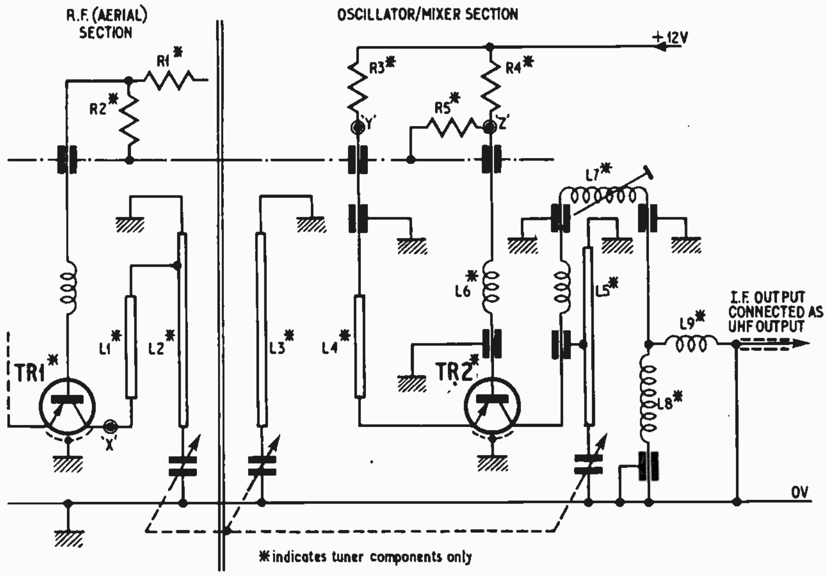


Fig. 4.2. Showing modifications and connections to typical u.h.f. tuner. All straight line inductances are lecher bars

BASIC PRINCIPLES

Part of the modulator (the modified oscillator section of a u.h.f. tuner) comprises a grounded base *pnp* or *npn* transistor connected as a regenerative ultra-high-frequency oscillator and mixer circuit. In this design the aerial signal which would normally be fed to this transistor to mix with the oscillator sinewave is disconnected and replaced by the CCTV signal. The signal is applied to the transistor emitter (grounded base input) and in order to generate negative modulation, identical with normal u.h.f. transmissions an inverted signal must be provided. Camera signal outputs are usually positive video signals and so a single transistor inverter precedes the tuner input.

THE CIRCUIT

Fig. 4.1 shows the video inverter and sync separator with a conventional power supply centred around a 12 volt regulator unit MVR-12, providing +12V to the tuner, TR1, TR2 and an indicator lamp. The input CCTV signal is correctly matched at 75 ohms by R1 and the transistor input impedance and is amplified with approximately unity gain in TR1. The video gain can be adjusted with VR1, a front-panel control, which with R6 provides negative feedback to increase the bandwidth. R4 and C3 decouple TR1 and the output signal is taken via R10 and C7 to the tuner.

The input signal is also taken via C1 to TR2, connected as a sync separator which is switched on only by the negative sync pulses at its base, this being a *pnp* transistor in common emitter connection. D1 provides constant bias to the base and the amplified inverted sync pulses are fed through C4 to TR1 emitter where they add to the video signal at the collector. Any *pnp* transistor which is silicon planar will suffice.

TUNER MODIFICATIONS

Before any u.h.f. tuner modifications are undertaken a few words on general tuner construction might enable prospective constructors to approach this task with more confidence.

The tuner, like many other radio/TV tuners comprises an r.f. section where the aerial signal is selected and amplified, and an oscillator/mixer stage where a generated sinewave is mixed with the r.f. to produce a constant carrier frequency i.f. of 39·5MHz in the case of 625-line TV.

Tuning is carried out with very small inductances called lecher bars which are strips of metal as seen in Fig. 4.3. Each lecher bar is tuned with one section of the tuning gang capacitance in parallel with a small trimmer capacitor. The tuner casing is split into four or five mechanical sections, each of which is a resonant cavity and which is critically tuned to the required frequency. The placing of every component is critical and no component other than those indicated must be touched.

The r.f. section is disconnected by cutting TR1 collector at point X in Fig 4.2. The next step is to

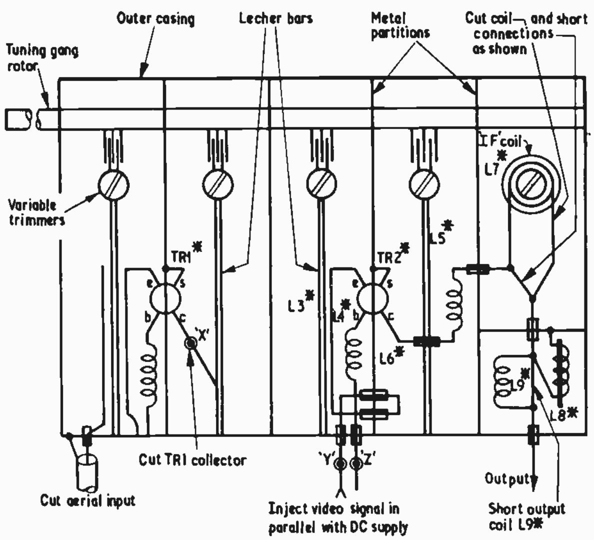
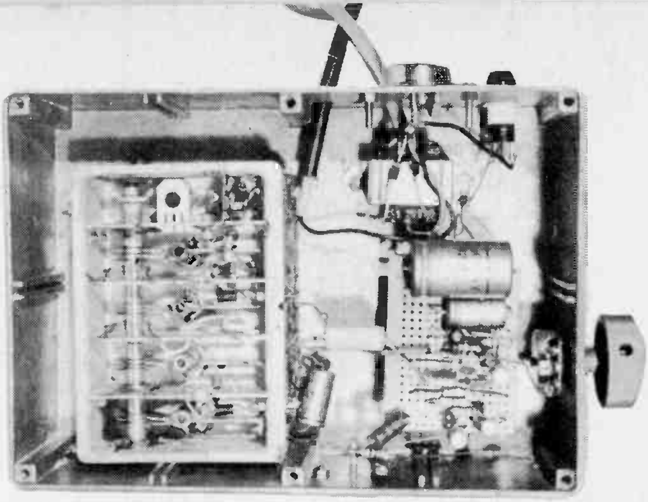


Fig. 4.3. Physical details of modifications and connections to typical tuners

disconnect the output tuned circuits which, if still tuned to 39·5MHz, would attenuate the u.h.f. signal on 450 to 850MHz approximately. The i.f. coil L7 is cut and its place taken by a shorting link. Similarly the output coil L9 is shorted out. No other modifications are necessary inside the tuner casing.

The shorting links are of tinned 20s.w.g. or 22s.w.g. copper wire and are as short as possible and not grounding to chassis.

The aerial input coaxial lead is cut or desoldered and a coaxial lead is soldered on the output connection where the i.f. lead was situated, making the braiding as short as possible. Position Y is then located on the circuit diagram and on the component layout as in Fig. 4.2 and 4.3, this being the point which is to be connected to the video amplifier of Fig. 4.3. There will be d.c. voltage on this point of about 6 volts from R3*. If difficulty is experienced in



COMPONENTS . . .

Resistors
- R1 100Ω
- R2 1MΩ
- R3 180kΩ
- R4 470Ω
- R5 2·2kΩ
- R6 22Ω
- R7 22kΩ
- R8, R9 1kΩ
- R10 2·2kΩ
- All ¼ watt 10% carbon

Capacitors
- C1 0·1μF polyester
- C2–C4 10μF elect. 10V (3 off)
- C5 64μF elect. 25V
- C6 1,000μF elect. 25V

Potentiometer
- VR1 2kΩ lin.

Transistors
- TR1 BC109
- TR2 BC251A *or* BC477

Diodes
- D1 OA91
- D2, D3 IN4001

Transformer
- T1 Mains transformer 240V pri. 12–0–12V, 50mA sec.

Miscellaneous
- Transistor u.h.f. tuner assembly (type immaterial) SK1—75Ω coaxial chassis mounting socket LP1—14V miniature indicator lamp, Veroboard 0·1in matrix, 4cm × 5cm, metal case 12cm × 17cm × 4cm.

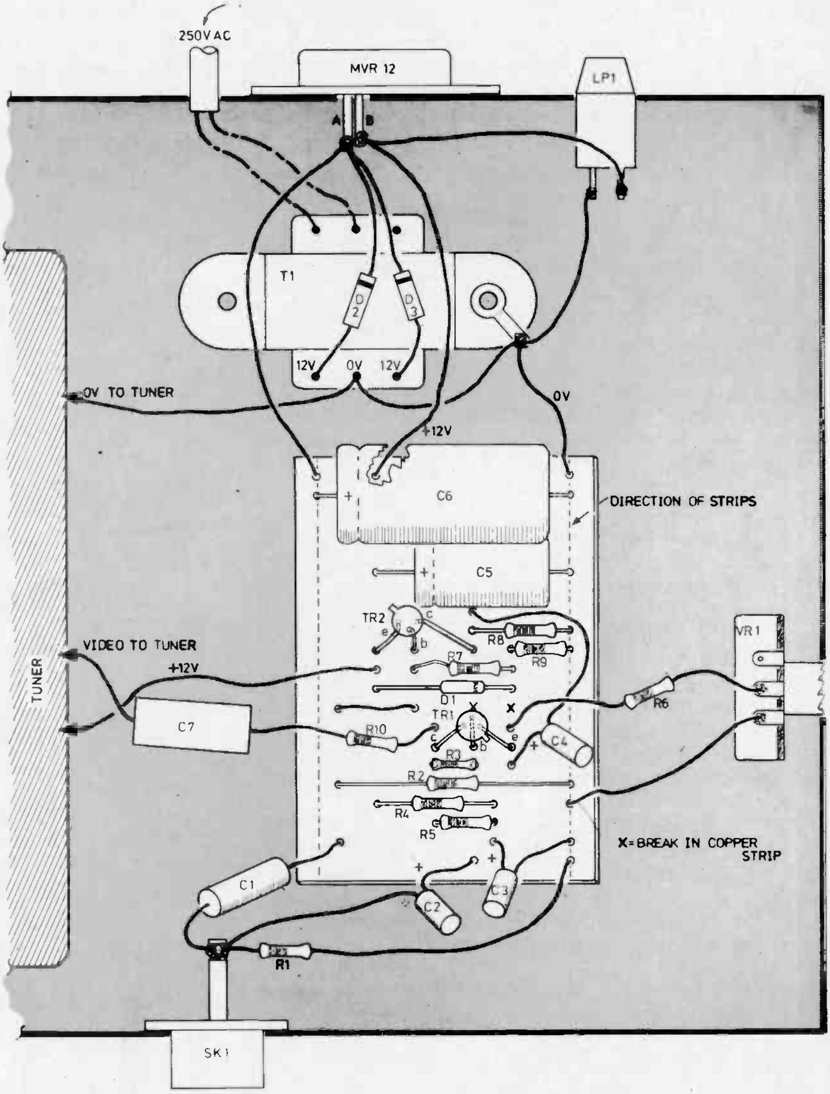


Fig. 4.4. Component layout of sync separator, video inverter and power supply. Tuner unit is adjacent

obtaining good results from point Y, point Z can be substituted this time there being phase inversion in TR2*, (components with an asterisk merely refer to those components in a typical tuner). The cause of the trouble possibly being the fact that the tuner chosen has a negative supply voltage or the CCTV input is inverted.

SCREENING ESSENTIAL

The push-button switch assembly is not required for the tuner but the copper screening cover is essential to avoid interference pick-up. Most transistor tuners require a 12 volt supply with the casing connected to the negative (earth) potential as in Fig 4.2. Location of this 12 volt rail must be carried out with reference to the circuit diagram of the tuner used.

On many receivers, this is obtained via a suitable dropper resistor (10 kilohms or thereabouts) from the 200V valve supply in the i.f. strip. If this is the case then bypass this dropper resistor together with any r.f. gain control, a.f.c. connection or a.g.c. connections which can be ignored or disconnected.

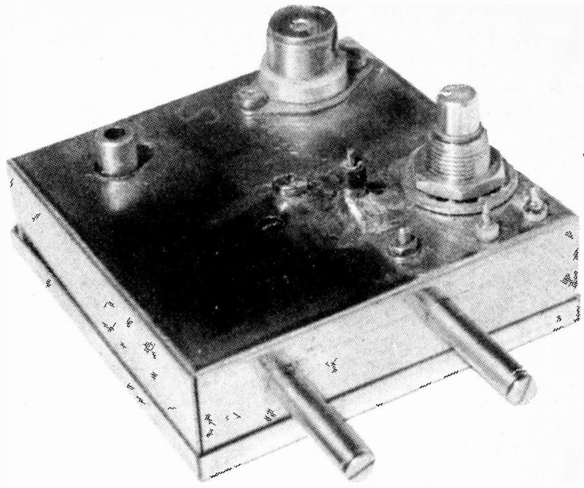
A varicap tuner can also be used as a modulator, similar modifications being necessary using the correct circuit diagram. Two points to mention on varicap tuners are the absence of mechanical tuning gang capacitors and small internal size. If a carrier frequency control is used therefore a potentiometer must be taken to the outside case which will vary the varicap tuning voltage. Due to the small size, great care must be taken when shorting the coils L7* and L9*.

Finally, all TV transistor tuners are different in appearance and their circuits are not identical, their operations, however, are similar and it is not a difficult task for the experienced electronics constructor to relate the circuit and layout of Fig 4.2 and 4.3 to the tuner in question.

Any tuner from a monochrome or colour receiver, single standard in preference, will be suitable. Integrated tuners with u.h.f./v.h.f. combined are too complex and cannot be used, also valve tuners cannot be used.

CONSTRUCTION

The tuner, video printed veroboard panel and power supply will fit into a metal case of dimensions 12cm by 17cm by 4cm deep and are laid out as



The completed Crofton unit

seen in Fig. 4.4. The power supply leads must be kept as short as possible to prevent hum pick-up and the video leads to and from the video panel should be short to avoid interference pick-up. The tuner spindle is passed through a hole in the case so that a knob can be screwed on for carrier frequency adjustment, similarly the video gain potentiometer is screwed onto the case as shown. The power supply regulator is screwed to the chassis after drilling 4mm holes for the input and output leads, the case of the MVR-12 is earthed.

TESTING

The camera is connected to the input socket and the output plugged into a TV aerial socket. A picture should appear on the screen when the carrier frequencies are adjusted to be the same. Adjustment of the gain control will give 'contrast' control and loss of sync when very high or very low. If trouble is experienced in obtaining good results it might be advisable to check the tuner modifications, the polarity of the input video signal or move the carrier frequency up or down the band since the

continued on page 1074

CROFTON MODULATOR.

Kit available from Crofton Electronics, 124, Colne Road, Twickenham, Middlesex, TW2 6QZ. Price £7·30 including p.p. and VAT.

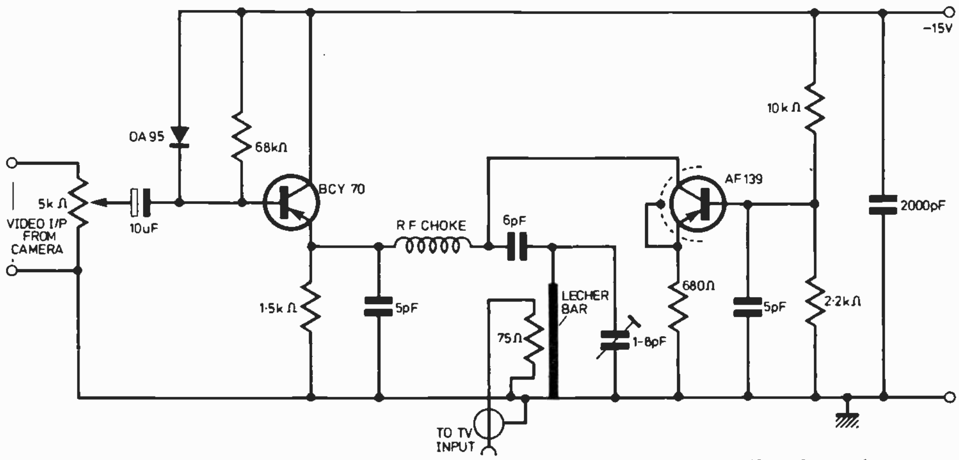
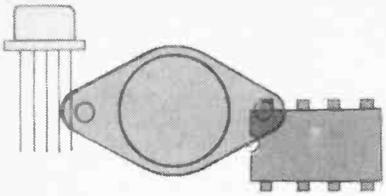


Fig. 4.5. Circuit of Crofton Modulator. For effective operation layout is critical



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Tomorrow's world of electronics as our readers see it . . .

PULSING AHEAD

IT IS the cheapness of integrated circuits and their ability to produce and manipulate pulses that has given the filip to computers and produced the calculator market. Coded systems (pulse code modulation) have already started taking over the telephone system and we shall see the existing network used for other purposes: vision phones, document transmission, remote reading of gas and electricity meters, etc. An inexpensive print-out device would add a new dimension to the phone service and then amateurs would send photos and letters to each other by phone and P.E. will print the results!

Nor are we limited to telephone lines. The national grid could also be used to carry additional information. A start might be made by having an extension speaker system that simply plugs into any mains outlet in the home. This is feasible now.

We could well see sound and vision broadcasts change to a pulse code system so that our receivers will be minicomputers receiving and decoding pulses. This will keep us busy so we may first have time to build our own video tape recorder using present techniques before it becomes obsolete!

In the home those unreliable timing devices on washing machines, etc. will be replaced by an electronic package. Any mechanical function that can be performed electronically will be fair game and this leads us to motor cars, where manufacturers have already made a start. The lighting harness could be replaced by a ring main operated by pulses. An l.e.d. display could give a direct indication of speed, braking, fuel consumption, visibility and other hazards ahead. Scope here for the enthusiastic constructor to keep his banger up to the same standard (electronically) as the most expensive in the land!

William A. L. Smith

BUY BRITISH

THE increasing use of quadraphonic high fidelity sound reproduction and the decreasing quality of the contents so that we end up listening to quadraphonic silence.

The first Megawatt discotheque amplifier goes on sale. A computer process is developed to produce colour information from monochrome films of video recordings enabling all television programmes ever made to be repeated in pseudo-colour.

TV personalities and recording stars are elected Gods by electronic vote counting. Suits are made with more pockets to cater for pocket telephone, pocket television, pocket computer, pocket stereo/quadraphonic receiver, pocket aspirin dispenser.

The BBC announces that the experimental octophonic broadcasts will not become a regular feature.

A new electronic timer is developed for sports events and is adopted for the 1984 Olympics. It enables timing to a nanosecond.

I.c. chips become so small that Mullard issue a photograph of one being engulfed by a bacterium.

British viewers now have a choice of six television channels during the 1984 Olympics; this enables them to watch a different event on each channel.

Sony, National Panasonic, Hitachi, having built factories in this country, urge people to "buy British".

January 1984 issue of Practical Electronics carries the announcement that with effect from February 1984 price will go up to £2·50.

R. N. Soar

GOOD HEALTH

THE following indicates an approach to good health which is positive, as compared with the present system which treats lack of good health, i.e. illness, as the positive factor. When an electrical machine is regularly monitored for its insulation resistance, a progressive lowering of the resistance figure (taking the weather into account) can indicate approaching trouble before disaster actually occurs, and suggest the need for inspection and repair.

It is reasonable to suppose that human beings could be monitored in a similar manner, not for their insulation resistance, but as regards temperature, pulse rate, weight, and as many other biological parameters as are quickly measurable by today's techniques, many of which employ electronic means. These measurements could be fed into a computer, say once a month, and changes over a period compared with the changes expected for a standard person of the age, sex, weight and blood group concerned, probably also taking into account such factors as environment, weight, food intake and type of occupation.

Any unexpected changes developing over the period would then indicate the approach of trouble. After enough experience has been gained with the technique, and if enough biological factors were included in the measurements, it might even be possible to indicate the imminent susceptibility of an individual to a particular disease, and steps taken to counter this.

The great advantage of this method of treatment would be that the patient need not actually become "ill" before treatment is undertaken, and so treatment should be that much easier. Another point is that the biological measurements referred to could be made by technicians, thereby freeing doctors for more urgent tasks. On the one hand, whilst subjects would hopefully be kept in peak condition, on the other the cost of the nation's medical service would be reduced.

W. Higson

OLD AND NEW

POSSIBLY the one sure thing that anyone could predict for electronics in the next ten years would be that the production of valves will cease. Although even the home constructor uses i.c.'s it is suprising to know that valves are still moderately common. When the transistor was first released professional men stuck to the valve. For this reason the valve has hung on and on and so too will the transistor now, and in its turn the i.c.

I would like to see massive efforts (particularly from the Government) in the direction of solar energy control. Alas it will be 50 years or so before the householder hires his "solar energy generator" from the M.E.B. instead of his two-part tarrifmeter!

Could it be that periodicals will act as an interface between the old and new, providing the "old timer" with information to help him understand the new techniques and provide food for thought and ideas for the more advanced readers.

I would like to see more modern test equipment being designed, giving top priority to producing an oscilloscope with the capability of a Tektronix or Hewlett Packard, which might be able to deal with the more advanced projects that you might come up with.

G. R. Wates

NO BOUNDARIES

WHEN making auguries for the next decade, one's imagination must take flight because of what has been born from l.s.i. electronics. Solid state TV is a reality with large scale chip miniaturisations now replacing discretes. Plausibly one could predict a standardised chip TV in the near future just like the standard a.m. discrete superhet of today. Predictions in this area include three dimensional pictures using laser display techniques. This is not just pie-in-the-sky but a possibility raised in a recent RTRA/RRI Conference.

Ceefax and Oracle are words which have insinuated themselves into the language now bristling with electronic acronyms. The U.K. leads the world in this field and recent Government approval of a two year experimental period promises much. This would mean up-to-the-minute print-outs of national and international news providing continuously revised news items, blow-by-blow accounts of stock market dealing, sports news, local news and weather forecasts, all displayed in page form on the screen at the flick of a switch.

In radio, quadraphonic reception will be a certainty since pioneering spadework is already underway.

As a sop to the inevitable neurosis all this surfeit of goodies will cause, electronics will slavishly function as an unpaid locum with the dial-a-complaint computer; another feasibility which will take the mundane work load from the G.P., returning him to his true role of family counsellor and N.H.S. clerk.

In automobiles, digital metering of fuel, temperature, speed, etc. is a certainty since l.e.d. displays are becoming cheaper than their analogue counterparts.

Electronics is a science which has, of necessity, crossed the boundaries of so many disciplines, such as medicine, chemistry, automobile engineering, etc. that it is inevitable that its effects or spin-off in ideas must increase to the benefit of humanity.

G. Rapson

INFORMATION DESK

THE public's requirement to be kept up to date with such things as public services, entertainment and general information creates a market for message systems and information retrieval.

To enable this market to be satisfied the minicomputer in the form of a desk top model completely self-contained will supply the service. The computer will be fully programmable by either cassette tape or disposable read only memories (ROM) with visual display output (VDU) and or permanent copy by thermal printing for availability of users' information.

In order that the public can make use of the service the computers will be located at such places as libraries and railway stations and the service will work in the following way.

As the computer is completely pre-programmed by use of either disposable ROM's or cassette tapes programmed at a central bureau, the programme material will include such things as the entertainment available in the area served by the library, updated monthly on the basis of disposable programmed devices.

Other services offered could be timetables of buses, trains serving that area, hours of opening for public buildings, half day shopping, hotels and many other services.

For more than one user a number of displays will be available driven from the computer using time sharing techniques; also a number of inquiry points will be accommodated. The systems can be further extended to such places as large supermarkets giving information on best buys, present prices and availability of items.

R. Cepa

IT'S ALL CHEMISTRY

WHEN thinking of the future one must take into consideration, that although a decade is not long, it is sufficient time for major development or cultivation of a revolutionary idea.

For example, ten years ago the transistor was making its debut for home constructors; now it is an indispensible component. Similarly the laser was invented a little over ten years ago; now it holds a definite place in industry and technology.

Although not fully conversant with the intricacies of modern electronics, I feel that changes are inevitable and possibly will involve chemistry, where the exploitation of the heavy metal compound crystals (i.e. the rarer ones, e.g. Neodymium) is by no means exhausted.

As components become more intricate and delicate, soldering will lose its popularity. The introduction of a conductive heat resistant adhesive/resin for securing components may prove suitable. "Deresinification" (desoldering) would be carried out using a non corrosive solvent (actuated at time of use to prevent spillage the consequences of such an accident can be imagined).

Similarly the copper strips on Vero or p.c. boards could be replaced with electrically conductive plastic. (The price of copper rarely fluctuates from the steady rise.)

Laser development will advance to the high degree of household necessity, for some inappropriate capability.

T.V.s will change for the commercial market. All colour, quad or stereo (personal preference), even the collaboration of holography and T.V. for 3D viewing.

B. Theiss

MATURITY

OUR TECHNOLOGY has been developing exponentially for a century, and is now approaching maturity.

The significance of maturity in technology lies in the freedom from standardisation that it brings; it allows a huge increase in the range of goods available without an equivalent rise in cost at the end of the production line.

At first sight, such abundance might gladden the electronics constructor. The range of projects open to him would widen dramatically, and the price of short-run chips, anti-log pots and other expensive oddities would be decimated. Design and performance would be near-perfect; integration of circuitry would be combined with flexibility of application. But the home constructor enjoys his hobby because it tests his skill, and the hobby magazines reflect this fact, suggesting projects that (a) are not available in the shops (or not so cheaply), (b) involve some skill in construction and "tuning" and (c) give enjoyment through the intelligent use of the latest technological developments. A maturing technology combined with an aggressive electronics industry will force the home constructor into beyond-the-fringe gadgetry if he wants to retain any of these features.

The start of this trend is already evident. If the history of other technology-based hobbies can be trusted to repeat itself, the electronics constructor will soon be tempted to return to the comfortable past when his radio needed him. Like a vintage car enthusiast a plate photographer, or a steam fanatic, he will gladly exchange the boring best for the challenge and involvement that previous eras provided.

D. Beattie.

IDEAS IN INK

IT IS my opinion that the next ten years will bring a much wider application of plastics within the field of electronics. I envisage the development of synthetic materials with various electronic properties.

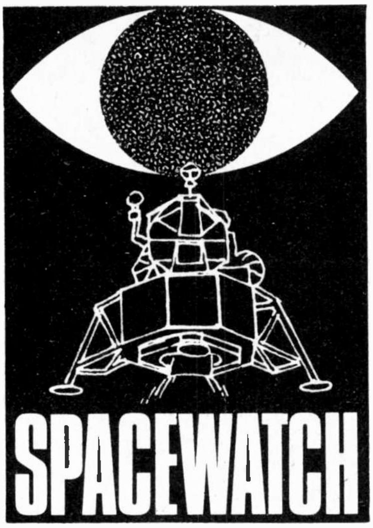
Not only will this include the simple properties of conductivity, resistivity, capacitance, etc. but it seems quite possible that a substitute for silicon and germanium could be produced.

Taking this idea a little further, it is easy to imagine the evolution of kits containing special resins and "inks" with templates and equipment for printing one's own "giant size" integrated circuits on little more than sheets of paper.

The key factor here of course is the price of the plastics involved. If they are to be particularly expensive this might more than compensate for the cheap production of i.c.s and put them out of reach of the home constructor. However, if this is not to be so then the potential of the amateur could be greatly extended.

D. Gowe

. . . a further selection of readers' predictions will appear next month



BY FRANK W. HYDE

THE NEW JUPITER

An analysis of the data provided by *Pioneer 10* reveals some startling facts. Many of the previous conjectures about the constitution and structure of the giant planet will have to be abandoned. No doubt the first findings will be confirmed by *Pioneer 11*, which will fly past the planet in the first week of December, a year from the time that *Pioneer 10* collected the initial data.

One of the puzzles of Jupiter has been the great Red Spot. For something like three hundred years there have been many observations and almost as many theories. These range from the possibility of a submerged satellite, suggested by Firsoff, to the Taylor column. This is an effect that could take place if there was a high projection of, say, a mountain and the consequence of hydrodynamic waves in the atmosphere. In fact it does appear that the red spot might be caused by an updraught of hurricane force. The red spot would be the vortex centre. The size of the spot, some 40,000km (25,000m), could be the visible evidence of this. If such is the case then the views of Professor Raymond Hide would be relevant.

The severe atmospheric effects would be expected on the new facts. From the analysis of the gravity sensing experiment, Dr J. Henderson of the Jet Propulsion Laboratory and Dr W. B. Hubbard of the University of Arizona, it appears that Jupiter is largely liquid. If there is a core at all, it would be molten and very small. The temperature would be very high and pressures would be high. It is worth remembering that the late B. M. Peek in his book "The Planet Jupiter" discusses these early models in detail.

COLOURED BELTS

The coloured belts have been a continuous study particularly by the amateur astronomers. The periods of revolution of some of the white and grey areas have resulted in thousands of sketches of great accuracy by members of the Jupiter section of the Astronomical Association.

The new thoughts on this subject are that the white and grey areas are in fact cloud tops only some 240km (150m) below the upper limit of the planet's atmosphere. The brown and orange areas would be troughs. It would appear that the clouds on Jupiter are stretched round the planet, rather than in circular groups as they are in the Earth's atmosphere. The stretching out round Jupiter is most likely due to the rapid rotation of Jupiter on its axis, some 9 hours 55 minutes. The actual speed at the equatorial belt is of the order of 35,000km (22,000m) an hour.

Another problem that has been the subject of conjecture is the excess of heat radiated by Jupiter. This level is some two and one half times that which Jupiter receives from the Sun. The new model of the planet suggests that it is cooling off and growing smaller, this would account for the high level of heat being given off. The model of the planet which now emerges is that of a body of four conditions. The first is the possible core which would have a temperature of 29,000°C. Next there is a level extending for many thousands of kilometres where the hydrogen has become metallic with a temperature in the region of 11,000°C. In this area pressures could be as high as 45,000,000 lbs/sq.in. The next region which starts at about 1,000km into the atmosphere is a transitional zone where there is liquid hydrogen.

The magnetic field has already been described in *Snacewatch* (Sept. '74) with considerable detail. One new point to be added is that as a result of the high level of the radiation belts, which are of a similar configuration to those surrounding the Earth, high energy particles have been radiated and detected on Earth.

The four large satellites, almost of planetary size, all appear to have atmospheres of their own. The densities are proportional to the distance between them and the planet. Pictures were obtained of the satellite Ganymede, these are being processed but first findings do indicate that there are highlands and lowlands similar to Mars and the Moon. The composition of the satellites do indicate the possible combination of ice and rock, in the case of Ganymede and Callisto. Io and Europa are certainly rock.

After *Pioneer 11* has made its fly-past it will be on the way to Saturn. It will pass between the main body of Saturn and the innermost ring.

LARGEST KNOWN OBJECTS

Two radio galaxies of immense size have been discovered by A. G. Willis, R. Strom and A. Wilson, using the Westerbork radio telescope.

One of these, the largest object so far known in the universe is 3C 236. The radio components of this galaxy are spread over the vast distance of 18 million light years. The second object is DA 240 and is 6.6 light years across.

The measurements were made by the synthesis telescope which comprises 12 parabolic reflectors working in a linear base line of 1·5km. This provides a beam of resolution of 1·0 arc minute, with a field of 1·5°. The frequency of operation is 49cm.

It is certain that more of these objects will be found. They are on such a vast scale and the density as low as 30 atoms per cubic centimetre, that is almost the mean density of the universe. The energy in these extensive objects must be so high that there are electrons moving at almost the speed of light.

One thing is certain and that is that if more of these objects exist, then rather drastic remodelling will need to take place. With objects like these the radio clouds will have spread relativistic plasma throughout a volume of space equal to that of large galaxies or even clusters of galaxies. Estimates of the age of these radio sources is increased by a factor of ten. Obviously some re-thinking is likely to be extensive, for the effect on cosmological theory will be profound.

MOVEMENTS OF THE CRUST OF THE EARTH

A project by NASA called Astronomical Radio Interferometric Earth Surveying (ARIES) will provide information about continental drift and improve earthquake prediction.

The technique is to receive radio emissions from extra-galactic sources at two places, and time the arrival differences. In practice this means that the antenna at Goldstone and the antenna at the Jet Propulsion Laboratory are focused on a quasar. The difference of the time of the arrival of the signals at the two places can be measured to 0·1 of a billionth of a second. These data can then be resolved in terms of distance between the two stations. This can be done at the moment with an accuracy of 10cm; later it will reach an accuracy of 2cm. Any difference in the measurements will indicate movement and strain.

It will be possible to use portable antennas for this work so that by changing the position of any two an almost three dimensional picture can be built up. Thus the movement and strain along the San Andreas fault can be detected.

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Strictly Instrumental

by K. Lenton-Smith

WITH many electronic projects, there are no half measures—they either work or fail when first tested. Where audio applications are concerned, the project could work but only after a fashion and then some very critical faculties (sic) will come into play!

The listener with anything approaching perfect pitch will find tuning discrepancies particularly objectionable. He will stomach single note melodies, perhaps, but sustained chords produce violently noticeable beats—even to those that are tone deaf: the more upper harmonics in the chord, the worse the effect.

VOLTAGE

The last article in this series dealt with tuning generally and its main purpose was to warn the constructor to take great care in choosing his generator system. That article prompted a letter from a reader experiencing tuning drift, due to mains voltage fluctuation, with a commercially made electronic accordion. The instrument concerned uses astable multivibrators as master oscillators, followed by bistable multivibrator dividers. I decided to confirm the comments about R/C oscillators in the previous article by making up the accordion's master oscillator to see how voltage changes affected it. Using a frequency meter, a one volt change in supply in either direction caused a frequency change of about 6 per cent—or a semitone in musical terms.

If such an instrument was only played solo, very few listeners would object. After all, the key of C sharp sounds better than C—provided the whole system is in tune with itself! But the problems arise when playing with other instruments and the player will find himself at odds with a well-tuned piano. Nothing will throw a small band into confusion quicker than this type of problem—or encountering a continental pitch piano!

SPACE PROBLEMS

It is essential that any electronic instrument can be accurately tuned and will stay that way. The keen amateur may be itching to get with the problem, but commercial instruments may present difficulties because of lack of space due to the use of i.c.s, and general condensation of circuitry. Reorganisation of master oscillators may have to be ruled out, therefore.

As we have seen, R/C oscillators require a precise supply voltage to stay in tune, so it might pay to look carefully at the power pack. There will probably be an array of voltages for generators, keying, pre-amplifiers, power amplifier, etc. but the most important supply is that to the generators and in particular the master oscillators. Regulation should be checked with the instrument in operation and, if this is found lacking, one of the TO3 encapsulated regulators (MVR type) might be incorporated. Both load and line regulation of these devices are better than a fraction of one per cent, if their output voltages match the circuit's requirements.

MAINS REGULATOR

If it can be proved that mains voltage fluctuation is the root cause of tuning instability, the simplest course would be to fit a mains voltage stabiliser between the a.c. supply and the instrument. If the load is fairly light, the type sold by photographic shops (for stabilising brightness and colour temperature of enlarging lamps) might be one solution.

No apologies are due for labouring the point concerning tuning: building a polyphonic keyboard instrument is a major operation. It is as well to be absolutely sure that the home constructed instrument will not require an expensive and time consuming modification after completion because the back has to be taken off every week to re-tune it.

TREMULANT

Tremulant is an amplitude modulation effect, and should not be confused with vibrato which is frequency modulation. It is fairly easy to arrange by connecting the signal across an l.d.r. and modulating this resistor by means of a lamp. The lamp could form part of the collector load of a multivibrator, or it could be a miniature neon in a relaxation oscillator circuit. Whilst the filament lamp is best suited for tremulant effect, the more precise pulsing of a neon enables it to be used for higher speed chopping—repeat effects such as mandolin and banjo.

In early instruments, tremulant was often obtained by using a motor driven variable resistor across the signal source, but these were noisy and tended to wear rapidly. Devices such as the ORP12 l.d.r. have since come on the market and are both dependable and noiseless.

VIBRATO

Good vibrato is by no means easy to obtain, especially if the oscillators are really stable. The fact is that, if you have a stable oscillator, you must expect stability! When the oscillator refuses to be modulated by an electronic vibrato, the effect is best obtained by mechanical means—such as the Leslie speaker.

The vibrato oscillator should ideally produce a sine wave, although multivibrators are often used commercially. A fair amount of drive will be required, in some cases of almost medium power proportions, to the base of the oscillator transistor. A good deal of care is required in setting up, too much signal making the oscillator fail on peaks and too little producing nothing more than a mild tremulant.

DELAY LINE

Electronic vibrato often sounds uninteresting as its effect is similar for all frequencies. The Hammond delay line system overcomes this problem as its effect is more prominent at higher frequencies. The line consists of some 18 L/C sections and, according to the vibrato depth chosen by the player, sections are switched to the stators of a multi-element variable capacitor whose rotor picks up the modulated signal. By scanning back and forth along the line, phase differences are converted to frequency differences: this contributes to chorus effect as modulation takes place per section of the line according to frequency.

PE MINISONIC

By D. SHAW

PART TWO

- Voltage Controlled Oscillators
- Voltage Controlled Filter and Envelope Shaper
- Voltage Controlled Amplifiers

THIS month we begin the circuit construction of the P.E. Minisonic series by detailing the VCO's, VCF and Envelope Shaper/VCA's.

BATTERY LIFE

The average current drawn by the P.E. Minisonic is about 62mA, so it is estimated that a pair of PP9 batteries will provide up to 50 hours of useful life. Much depends, of course, on the length of the periods during which the instrument is switched on. When usage is restriced to around two to four hours per day then maximum battery life can be expected.

On the current price of PP9's, therefore, the running costs of the P.E. Minisonic are likely to vary between 1·4p per hour and 2·33p per hour depending on usage and this seems, on the basis of comparison with other forms of entertainment, to represent pretty good value for money.

One of the drawbacks of battery operation is that the voltage falls in a manner proportional to the drain and to the charge remaining, and thus circuits which are voltage sensitive could begin to perform in an erratic and unreliable manner.

In the P.E. Minisonic this problem has been overcome by the establishment of voltage reference rails, considerably below nominal battery potential, in order to serve those circuits which are particularly voltage sensitive.

In practical terms the VCO's and VCF will operate without any change in performance down to $\pm 7{\cdot}5$ volts and, indeed, will tolerate supply voltages up to ± 12 volts also without change in performance.

The worst effect of falling battery voltage on these circuits not served by the reference rail is that the gain/attenuation ratio of the VCA's diminishes by between 6 to 8dB and the noise generator will cease to operate at about $\pm 7{\cdot}8$ volts.

The great advantage of battery operation is that the instrument becomes a perfectly safe proposition for the younger enthusiast who can dabble about to his heart's content without the attendant fear of electrocution.

COMPONENTS . . .

VOLTAGE CONTROLLED OSCILLATOR
(2 required)

Resistors

R1, R2	6·8kΩ (2 off)
R3–R6	47kΩ (4 off)
R7	22kΩ
R8	1·2kΩ
R9	1kΩ
R10	2·7kΩ
R11	1kΩ (see text)
R12	750Ω
R13	22kΩ
R14	82kΩ (see text)
R15, R16	10kΩ (2 off)

All ±5% ¼W or ⅛W carbon

Potentiometers

VR1	10kΩ skeleton horizontal preset
VR2	10kΩ linear carbon
VR3	100kΩ skeleton horizontal preset
VR4	10kΩ linear carbon

Capacitors

C1	0·1μF
C2	22μF 16V tantalum
C3	3·3pF

Semiconductors

D1	1N914
TR1	BC184
TR2	BC213
IC1, IC2	Type 741 8-pin d.i.l. (2 off)
IC3	Type 748 8-pin d.i.l.

Miscellaneous

JK1	3.5mm jack socket
SK1, SK2	2mm sockets (2 off)
0·1in	Veroboard, 115 × 34 holes (This board also carries Keyboard Control, Mixers and Ring Modulator)

LOGARITHMIC LAW

Both the VCO's and the VCF have a logarithmic—or, more accurately—an exponential relationship between the applied control voltage and the control current which, in turn, prescribes the frequency of the VCO and the pass-band of the VCF.

The so-called "log-law" has been adopted because it allows for a considerable simplification in the keyboard and pitch determining systems—an important factor in an instrument which is to be used for musical purposes and which, hopefully, is to remain in tune over relatively long periods.

In simple terms the "log-law" enables linear increments of control voltage to cause frequency changes of one octave in the case of the VCO or passband variations of one octave in the case of the VCF.

In the P.E. Minisonic the control voltage increment required is 600mV per octave but there is provision for adjusting this from about 220mV per octave to 1·2V per octave in order that the instrument may be matched to other synthesiser systems.

Since the control voltage increment is the same value for both VCO and VCF this enables the control node for both circuits to be identical save for two minor variations.

THE CONTROL NODE

The circuit of the control node is shown in Fig. 2.1, which shows the VCO but an almost identical control node is used in the VCF. IC1 is a four-input summing inverter in which two inputs are committed to providing bias and manual control voltages while the remaining two can be coupled to external programming sources.

The overall gain of the inverter is prescribed by VR3 which is used to set the so-called "law" of the system, i.e.—the relation of frequency or pass-band to voltage. VR1 provides a fixed bias to the inverter which serves to set the minimum frequency, or to position the overall frequency range in manual control, while VR2 provides the voltage swing, in manual, required to give a nominal ten octave range.

The input via R5 is coupled through the normally-closed contacts of JK1 to the keyboard controller "hold" circuit (which will be described next month).

Insertion of an open circuit jack plug will override the "hold" input or, alternatively, an external signal wired in to a jack plug may be routed into this input.

The input via R6 is wired to a 2mm socket so that an external programming signal may be employed in combination with the keyboard.

The output of IC1 drives a divider, R7-R8, which sets the bias on transistor TR1—a constant current generator. It is in TR1 that the exponential relationship between control voltage and control current is derived.

TRANSISTOR CHARACTERISTICS

Reference to the characteristic curves of almost any small signal transistor in which V_{be} is plotted against I_C will show that there is a fixed relationship between these factors which extends over a range of three or four decades.

V.C.O.

PERFORMANCE

Frequency Range	10 octaves, nominally 5Hz to 5kHz in manual control
Control Voltage Law	600mV per octave
Waveform	Sawtooth, 400mV p-p
Current Drain	5mA

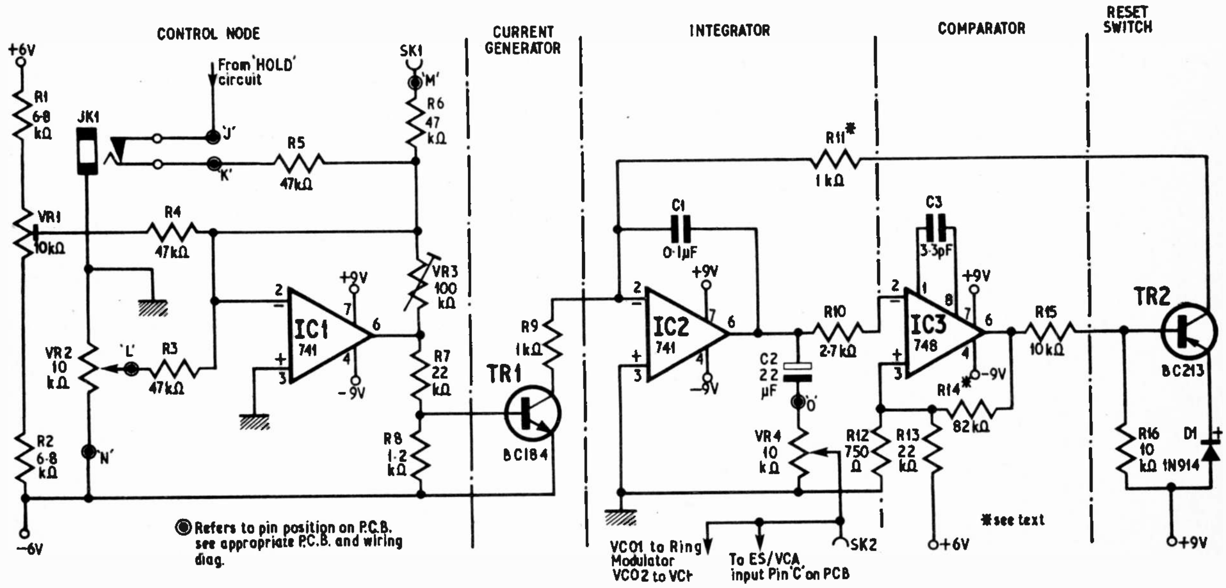
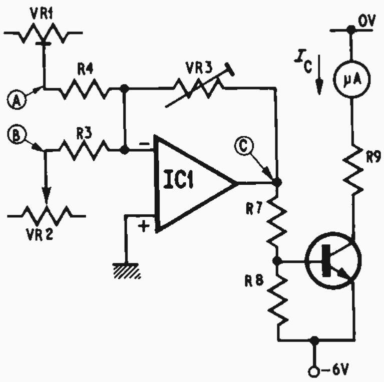


Fig. 2.1. Circuit diagram of the Voltage Controlled Oscillator. Letters in inverted commas refer to connections from the Veroboard panel to the front panel



Voltage readings with A at —1·4V and C at 0·95V

B(−V)	0	0·6	1·2	1·8	2·4	3·0	3·6	4·2	4·8	5·4	6·0
I_c(μA)	—	—	0·5	1·0	2·0	4·0	8·0	16·0	35·0	82·0	190·0

Fig. 2.2. Simplified circuit of the control node used in both the VCO and the VCF. The table shows typical current readings for different settings of VR2. Note that tolerance on R7 and R8 can cause significant departures from values shown. These may be compensated by adjustment of VR1. The important relationship is between the voltage at B and I_c

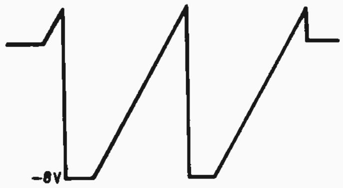


Fig. 2.3a. The integrator output with resistor R11 removed

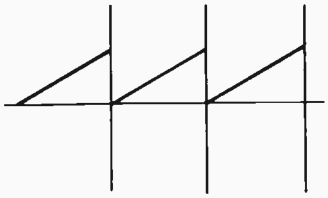


Fig. 2.3b. Output of the integrator showing, large spikes during the reset period. These are too fast to be audible

Above a minimum level of V_{be}, the collector current will double for each successive increment in V_{be} of the order of 20 to 25mV. Over the straight line portion of the curve, if it is assumed that the V_{be} increment is 24mV, then increments of 2mV will cause the collector current to increase successively in the ratio 1 : 12 $\sqrt{2}$ — which musicians will immediately recognise as being identical to the ratio in pitch between any two consecutive notes in an equal tempered scale. Indeed, this relationship serves to explain why the "log-law" circuit is so much more useful in a musical sense than its linear counterpart.

SETTING-UP PROCEDURE

The efficiency with which the vco's and vcf function relative to their respective control voltages is entirely dependent upon the accuracy with which the setting-up of the control node is accomplished.

The principal aim is to ensure that successive increments of 600mV supplied by VR2 result in successive doublings of the current through the constant current generator TR1. Fig. 2.2. illustrates a simplified control node together with a table of typical results obtained with the prototype instrument.

With the wiper of VR2 at ground potential, VR1 should be adjusted so that the wiper is at −1·4V. VR3 should now be adjusted so that the output of IC1 is at +0·95V. These adjustments will set the operating points of the control node to within close limits of the required values.

A multimeter switched to the microamp range should now be connected between R9 and the 0V rail and VR2 swung through the range of values shown in the table.

It should be noted that the current readings recorded will not necessarily correspond exactly with those quoted in the table since tolerance variations in R7 and R8 can cause significant differences.

During the first swing of VR2 it is almost certain that errors will be present and it is important, at this stage, to determine whether the current through TR1 is greater or less than the doubling required for each increment of 600mV at the wiper of VR2.

For this purpose it is best to carefully record the current readings obtained over a range of input voltages—say from 1·2V to 4·8V—in order to establish whether the error is consistent.

If the current through TR1 is greater than the doubling required for each 600mV increment then the gain of IC1 has to be reduced by adjustment of VR3. Conversely for less than the required doubling.

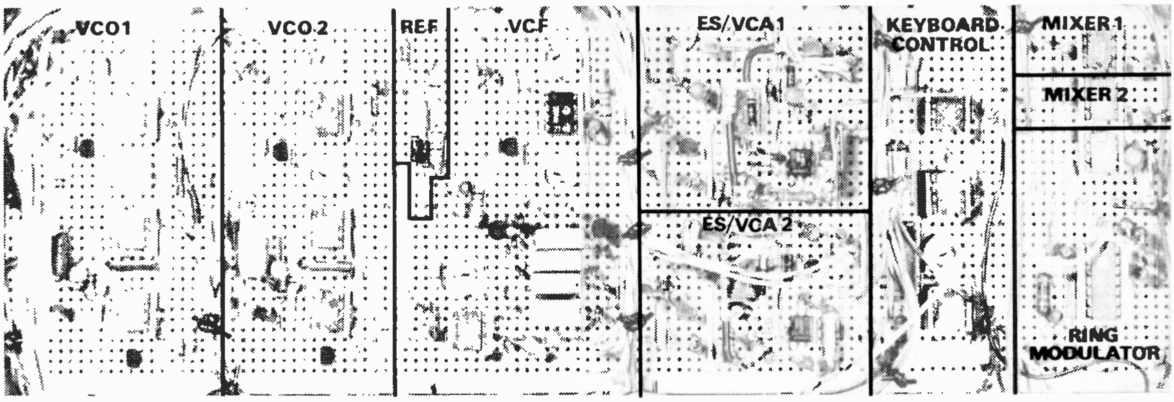
When the required relationship has been established the control nodes for the vco's may be matched by making a further adjustment to VR1 so that, for a given voltage supplied by VR2, the current through TR1 is identical in both nodes.

It should be noted that the current/voltage relationship in the control nodes need not be precisely 600mV per current doubling. Indeed the range of adjustment afforded by VR3 allows that the relationship may be set at any value lying between aproximately 220mV and 1·2V. What is important however is that the relationship adopted should be *exactly* the same for all control nodes. If it is not then the circuits will not track accurately and the overall performance of the instrument will be marred.

The design of the Keyboard Controller is such that it can accommodate any voltage/current relationship which it is possible to set up with the component values given for the control nodes.

THE VOLTAGE CONTROLLED OSCILLATOR

The complete circuit of the vco is illustrated in Fig. 2.1. Apart from the control node and current generator the vco comprises a linear integrator around IC2, a comparator around IC3 and a reset switch TR2.



Photograph of complete board on which VCO's, VCF, Voltage Reference and ES/VCA's are mounted. (Note: some minor changes have been made to this layout)

HOW IT WORKS

If we assume that the reset cycle has just completed, the output of IC2 will be zero volts, the output of IC3 will be positive due to the voltage applied by divider R12-R13, and TR2 will be hard off. C1 although nominally uncharged will, in fact, have a charge in relation to the negative rail and thus TR1 will draw on that charge at a constant rate thereby causing the output of IC2 to ramp in a positive direction.

The maximum positive level of the ramp is determined by two factors. Firstly there is a positive threshold voltage set by divider R12-R13 which is equal to:

$$\frac{750}{22750} \times 6 = 200\text{mV}$$

Secondly there is a positive feedback factor applied to IC3 by R14. This has the effect of determining a further threshold value on the basis of the currents applied differentially to IC3 through R10 and R14.

If x be a voltage at the output of IC2 then the secondary threshold value is determined by:

$$I_{R10} = \frac{x}{2700} = \frac{8}{82000} - I_{R14}$$

i.e. approximately 250mV.

The overall threshold value is thus theoretically 450mV. Although the 450mV threshold could be derived from divider R12-R13 alone the adopted method is preferable because it has the effect of speeding up the switching process.

When the output of IC2 reaches the threshold value the output of IC3 will try to go negative. However, the biasing on TR2 is such that when the output of IC3 has moved about 200mV, TR2 turns on and sends a relatively large pulse of current into C1 in order to restore the original state.

At this point the output of IC2 moves rapidly in a negative direction and when it falls to below 200mV, i.e. below the minimum threshold value on IC3, then IC3 will switch to positive saturation again before the output of IC2 actually reaches its minimum level. At this point the cycle repeats.

The overall effect is to provide a very rapid reset which results, in relation to the integrating rates employed, in a sawtooth waveform of almost perfect shape.

The reset time occupies a period of approximately 8μs. On most oscilloscopes the reset pulse will be invisible at low frequencies and its presence will generally only be detectable at frequencies of the order of 5kHz and greater.

RESET TIME

Resistor R11 sets a limit on the reset current supplied by TR2 and thus has an effect on the reset time. With R11 significantly greater than 1kΩ it will be found that the reset will terminate at a point about +100mV or so above zero volts, at which point integration will re-commence.

With R11 removed altogether the output of IC2 will go hard negative at each reset resulting in an output waveform as shown in Fig. 2.3a and a very slow rate of oscillation.

The ideal situation is when the value of R11 is such that the reset, as measured at the output of IC2, terminates on the zero volt rail. The output waveform of the integrator is shown in Fig. 2.3b.

Resistor tolerances being what they are there could, in a worse case, be as much as 20 per cent variation in the integrator output waveform peak-to-peak value between oscillators. This means that, with matched control nodes and for a given control voltage, the vco with the greater amplitude waveform will run at a proportionately lower frequency.

Fortunately this error is constant over the whole frequency range and may thus be compensated for by adjustment of the bias control VR1. It is more elegant however to make the adjustment on the vco itself so that the greater level in output waveform will not introduce any impairment of performance in relation to the sound treatment circuits.

Resistor R14, in view of its value and position on the circuit board is the most convenient resistor to adjust. Any adjustment should be directly proportional to the error variation in output waveform level, i.e. if the output waveform is 10 per cent high in relation to the other vco then the value of R14 should be increased by 10 per cent—to 91kΩ say—and vice versa.

From Fig. 2.3b it will be seen that the integrator output waveform exhibits a substantial positive and negative going spike at the reset point. This is due to the differentiation of the reset pulse by C1.

Although rather unsightly, the spike is too fast to have any effect on the audio output.

V.C.F.

PERFORMANCE

Passband	3Hz to 15kHz (—6dB)
Dynamic Range	—54dB (referred to peak output signal)
Resonance Range	5kHz to 25kHz
Current Drain	4mA (min), 8mA (max)

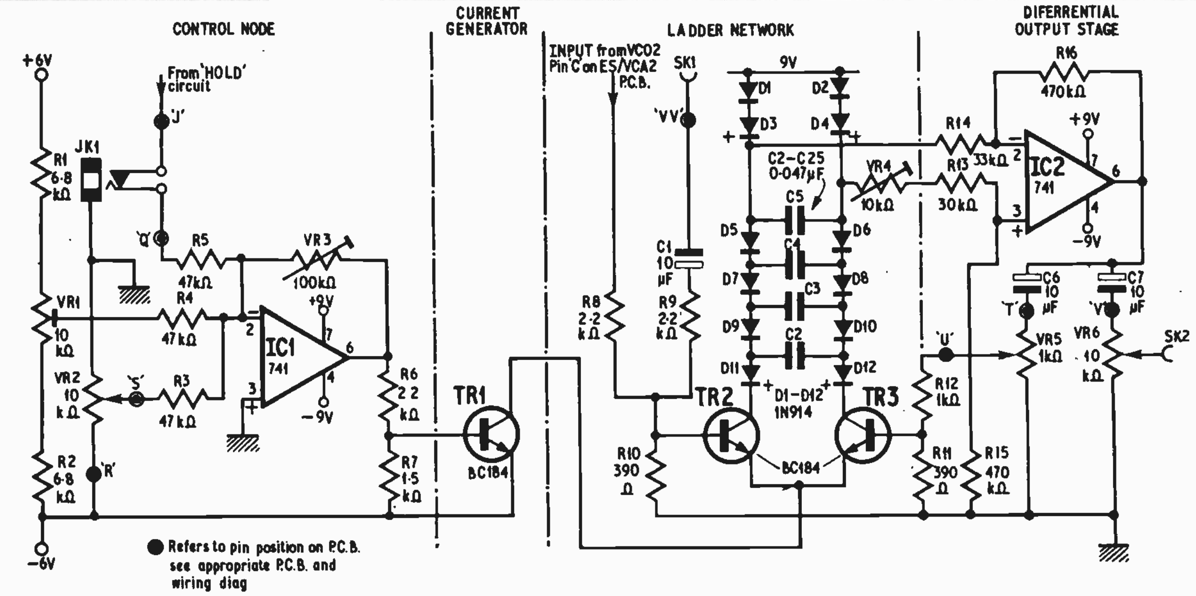


Fig. 2.4. Complete circuit diagram of the Voltage Controlled Low-pass Filter

VOLTAGE CONTROLLED LOW-PASS FILTER

The complete circuit of the filter is shown in Fig. 2.4 and comprises, in addition to the control node and current generator, a ladder network and a differential output stage. The ladder network, in which the filtering action takes place, is based on the design by Dr R. A. Moog.

The diode may be considered to be an impedance which varies inversely as the current through it, i.e. at low currents the impedance is high and vice versa. The a.c. signal is superimposed on to the diode current flow as shown in Fig. 2.5 which represents the lower half of the ladder network.

The ladder terminates in transistors TR2 and TR3 which are effectively biased on by referring their bases to the 0V rail. Thus any current drawn through the network by means of the constant current generator passes, without restriction, through these transistors.

If an a.c. signal is now applied to the base of TR2 there will be a proportional variation in the current through the transistor and thus also a voltage variation at each diode junction in the ladder.

This applies over virtually any current drawn by the constant current generator so that, for a given level of a.c. signal, the smaller the current through the network, the smaller will be the proportional variation induced by the signal. Thus the concept of variable impedance is, in fact, due to the combined effect of diode, transistor and current generator.

FILTER PERFORMANCE

The range extends over several decades and, in the circuit given, the −6dB passband at maximum is from 3Hz to 15kHz.

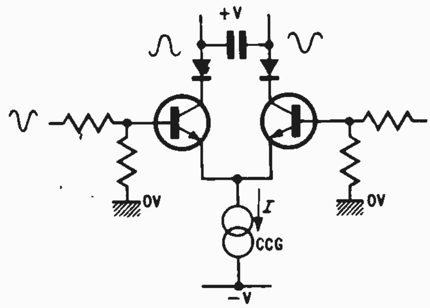


Fig. 2.5. Simplified circuit diagram of the lower section of the VCF showing how the a.c. signal is superimposed on the ladder current

Four filter stages are cascaded in the ladder network and since each stage has a theoretical roll-off of 6dB per octave the maximum roll-off of the filter should be 24dB per octave. Efficiency in this respect can only be achieved, however, if every precaution is taken to prevent loading the network both at the point of entry of the a.c. signal and also at the point of extraction.

In the interests of simplicity and economy the buffer stages have not been included in the circuit but, even so, the roll-off possible is around 12 to 15dB per octave and, for the majority of purposes, this will be found to be quite sufficient.

FEEDBACK

The output from the filter network is amplified differentially by IC2, with VR4 being employed to cancel out any d.c. imbalance due to variations in

COMPONENTS . . .

VOLTAGE CONTROLLED FILTER

Resistors

R1, R2	6·8kΩ (2 off)
R3–R5	47kΩ (3 off)
R6	22kΩ
R7	1·5kΩ
R8, R9	2·2kΩ (2 off)
R10, R11	390Ω (2 off)
R12	1kΩ
R13	30kΩ
R14	33kΩ
R15, R16	470kΩ (2 off)

All ±5% $\frac{1}{4}$W or $\frac{1}{8}$W carbon

Potentiometers

VR1	10kΩ skeleton horizontal preset
VR2	10kΩ linear carbon
VR3	100kΩ skeleton horizontal preset
VR4	10kΩ skeleton horizontal preset
VR5	1kΩ linear carbon
VR6	10kΩ linear carbon

Capacitors

C1	10μF 6·3V tantalum
C2–C5	0·047μF (4 off)
C6, C7	10μF 6·3V tantalum (2 off)

Semiconductors

D1–D12	1N914 (12 off)
TR1–TR3	BC184 (3 off)
IC1, IC2	Type 741 8-pin d.i.l. (2 off)

Miscellaneous

JK1	3·5mm jack socket
SK1, SK2	2mm socket (2 off)

diode characteristics. The output signal from IC2 is capacitatively coupled into two potentiometers. VR6 is simply the output level control while VR5 is the feedback or *Q* control.

With the *Q* control at zero the base of TR3 is referred closely to the 0V rail and thus TR2 and TR3 behave essentially as a differential pair. The output of IC2 is therefore nominally in phase with the input signal at the base of TR2.

As VR5 is advanced from zero a proportion of the output signal appears at the base of TR3 thereby tending to induce a signal in the collector circuit which is 180 out of phase with the signal which is already there due to the effect of the signal on TR2. The result is that the output signal will become significantly attenuated except at the frequency whose period is equal to the adjusted time-constant of the network.

At this critical frequency the output of the filter will peak up, the bandwidth of the signal depending on the degree of feedback applied.

Further application of feedback will cause the filter to oscillate. The frequency of oscillation is proportional to the current through the ladder network and the oscillation, which is of sine form, will be superimposed on the filter output signal. The P.E. Minisonic filter oscillates over the range 5kHz to 25kHz.

The filter may be operated in a number of modes each of which finds a place in the tone colour spectrum of the synthesiser. An outline of the various possibilities will be given in a later part of the series.

SETTING-UP THE VCF

The setting up of the control node for the VCF should follow exactly the same procedure as the VCO with the exception that, having established the correct voltage/current relationship, VR1 is adjusted so that the maximum current through TR1 with an applied voltage of −6V at VR2 should be of the order of 3mA instead of the 190μA quoted in the table shown in Fig. 2.2.

In order to achieve this result the value of R7 in the VCF is 1·5kΩ instead of the 1·2kΩ specified for R8 in the VCO control nodes. Increasing the value of R7 requires that the gain setting of IC1 be reduced by adjustment of VR3 and, in relation to an initial setting at VR1 of −1·4V, the output of IC1 should be approximately +0·84V at the commencement of the setting-up procedure.

The setting-up of the filter proper is essentially concerned only with providing the optimum balance between extreme d.c. conditions arising in the ladder due to current variations. With a high resistance voltmeter directly monitoring the output of IC2, VR5 at zero, and with the audio inputs uncommitted, the frequency control (VR2) should be moved from one extreme to the other.

The meter readings at extreme settings of VR2 should be noted and VR4 adjusted to reduce the voltage swing at the output of IC2 to a minimum. It may require several iterative adjustments to get the best possible balance.

This adjustment is not too critical since the output of IC2 is capacitatively coupled although, if the filter is being programmed by a fairly rapid envelope, any significant change in d.c. level at the output of IC2 can be differentiated by the coupling capacitor and induce an unpleasant click on to the audio signal.

THE ENVELOPE SHAPER AND VOLTAGE CONTROLLED AMPLIFIER

Two distinct but very closely related circuits are covered by this section. The first is the envelope shaper which is of considerable importance in the scheme of the synthesiser since, by variation of just two controls, a whole range of differing characteristics can be imparted to an otherwise uninteresting sound.

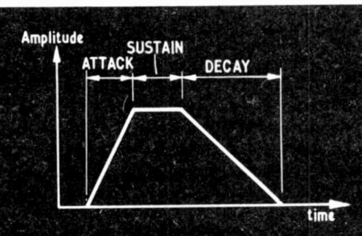


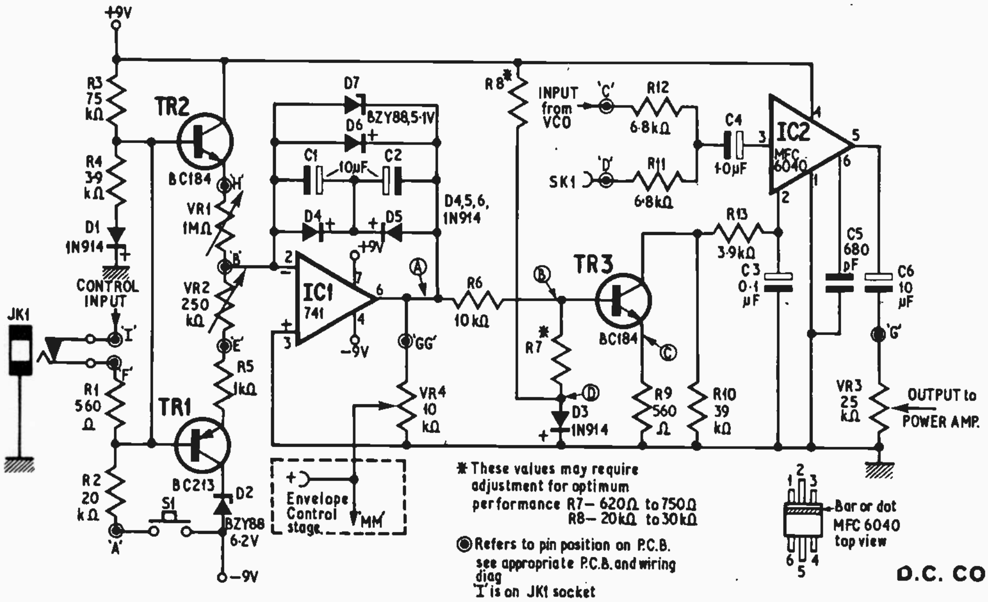
Fig. 2.6a. Typical Envelope Shaper output waveform showing the three variable parameters: attack, sustain and decay

Fig. 2.6b. A selection of envelope formats

E.S./V.C.A.

PERFORMANCE

Attack	Variable 30ms to 4s
Decay	Variable 100ms to 16s
Attenuation Range	48 to 54dB (referred to peak output)
Nominal Input	400mV p-p
Nominal Output	1·25V p-p
Operating Voltage Range	±9V to ±7·5V



D.C. CONDITIONS (volts)

	A	B	C	D
TR3 off	−0·5	0·6	0·01	0·65
TR3 on	4·5	0·8	0·24	0·65

Fig. 2.7. Complete circuit diagram of the Envelope Shaper/Voltage Controlled Amplifier. Note that potentiometer VR4 is fitted only to ES/VCA 1 to provide positive and negative going control envelopes (see block diagram Fig. 1.1)

Essentially the envelope shaper generates a control voltage which, if plotted graphically, will be found to conform with the basic waveform illustrated in Fig. 2.6a. If this waveform is applied to the control input of a VCA the amplitude of the audio signal will vary proportionately, i.e. with the envelope at zero the output of the VCA will be at its minimum volume (in the P.E. Minisonic about 54dB below the peak output signal level).

The first excursion of the envelope shaper output voltage is known as the "attack" and is variable, in the P.E. Minisonic, between about 30 milliseconds and four seconds.

The flat topped portion shown in the illustration is known as the "sustain" and represents the period of time that the VCA output is maintained at maximum volume while, finally, the return to zero volts is known as the "decay" and is variable between about 100 milliseconds and 16 seconds. The period of sustain is determined entirely by the length of time that the envelope shaper trigger signal is present and no separate control is provided. Some idea of the kind of envelope formats possible with this arrangement is given by Fig. 2.6.

CIRCUIT DESCRIPTION

The complete circuit of the ES/VCA is shown in Fig. 2.7. IC1 is a linear integrator whose output voltage is bounded, in a negative direction, by D6 and in a positive direction by D7. Thus the output voltage excursions of the envelope shaper range between −0·5V and +4·5V.

In the quiescent condition R3, R4 and D1 set the bias on TR1 and TR2 such that TR1 is off and TR2 is on. Current reaching the inverting input via TR2/VR1 charges C1/C2 and thus, with the aid of D6, holds the output of IC1 at −0·5V.

When a negative trigger signal is applied TR2 turns off and TR1 turns on. The charge on the integrating capacitors C1/C2 thus leaks away via VR2/TR1 and the integrator output ramps in a positive direction until it reaches the bounded value set by D7.

Triggering signals may be applied in one of three ways:

(i) Through the manual push button S1.
(ii) From an h.f. detector (to be described next month) operated from the stylus or external keyboard.
(ii) From an external source via JK1, thereby overriding the connection to the h.f. detector.

The integrator output is linked through a divider network R6-R7 to the base of TR3 which, with the output of IC1 at −0·5V, is held at the point of conduction by means of a current supplied from the positive rail by means of R8. The table in Fig. 2.7 gives the "on" and "off" d.c. conditions which have proved to be ideal in practice.

COMPONENTS . . .

ENVELOPE SHAPER/V.C.A. (2 required)

Resistors

R1	560Ω
R2	20kΩ
R3	75kΩ
R4	3·9kΩ
R5	1kΩ
R6	10kΩ
R7	620Ω to 750Ω } see text
R8	20kΩ to 36kΩ } see text
R9	560Ω
R10	39kΩ
R11, R12	6·8kΩ (2 off)
R13	3·9kΩ

All ±5% ¼W or ⅛W carbon

Potentiometers

VR1	1MΩ linear carbon
VR2	250kΩ linear carbon
VR3	25kΩ log carbon
VR4	10kΩ log sub. min. carbon (ES/VCA1 only)

Capacitors

C1, C2, C6	10μF 16V tantalum (3 off)
C3	0·1μF 35V tantalum
C4	1·0μF 35V tantalum
C5	680pF

Semiconductors

D1	1N914
D2	BZ88C6V2 6·2V 400mV Zener
D3–D6	IN914 (4 off)
D7	BZY88C5V1 5·1V Zener
TR1	BC213
TR1, TR3	BC184 (2 off)
IC1	Type 741 8-pin d.i.l.
IC2	Motorola MFC6040

Miscellaneous

JK1	3·5mm jack socket	SK1	2mm socket
S1	Miniature pushbutton		

SETTING-UP THE ENVELOPE SHAPER

Setting-up is restricted to the establishment of the bias conditions on TR3 as shown in the table of Fig. 2.7. With the output of IC1 at −0·5V, R8 should be adjusted so that a slight positive potential is apparent at the emitter of TR3. This indicates that the transistor is just beginning to conduct.

The actual d.c. level is fairly critical since too much conduction will restrict the gain/attenuation range of the VCA whilst too little will result in a propagation delay between the occurrence of the envelope shaper trigger pulse and the appearance of the audio signal at the output of the VCA.

After setting the bias the envelope shaper should be triggered manually and the button held down in order to check that the bias on the base of TR3 rises from +0·600V to +0·800V with the envelope at maximum level.

It is a good thing, at this time, to run a check on the VCA output with an input signal of 0·4V peak-to-peak. With correct biasing on TR3 the VCA output should be around 1·25V peak-to-peak.

It may be necessary to adjust the value of R7 in order to achieve the VCA output signal specified and, if this is the case, it is well to recheck the biasing with the envelope in the off state and re-adjust R8 as necessary to establish the ideal minimum bias point.

No setting up is required on the VCA as such except as explained above in relating input/output signal levels with the VCA on.

ELECTRONIC ATTENUATOR

The VCA, or to give it the proper title, electronic attenuator, is a purpose designed i.c. by Motorola.

The specification of the device is to provide an attenuation of 77dB and a gain of 13dB, relative to the input signal which should not exceed 500mV r.m.s., when the current sink from the control input (pin 2) is varied from minimum to maximum respectively.

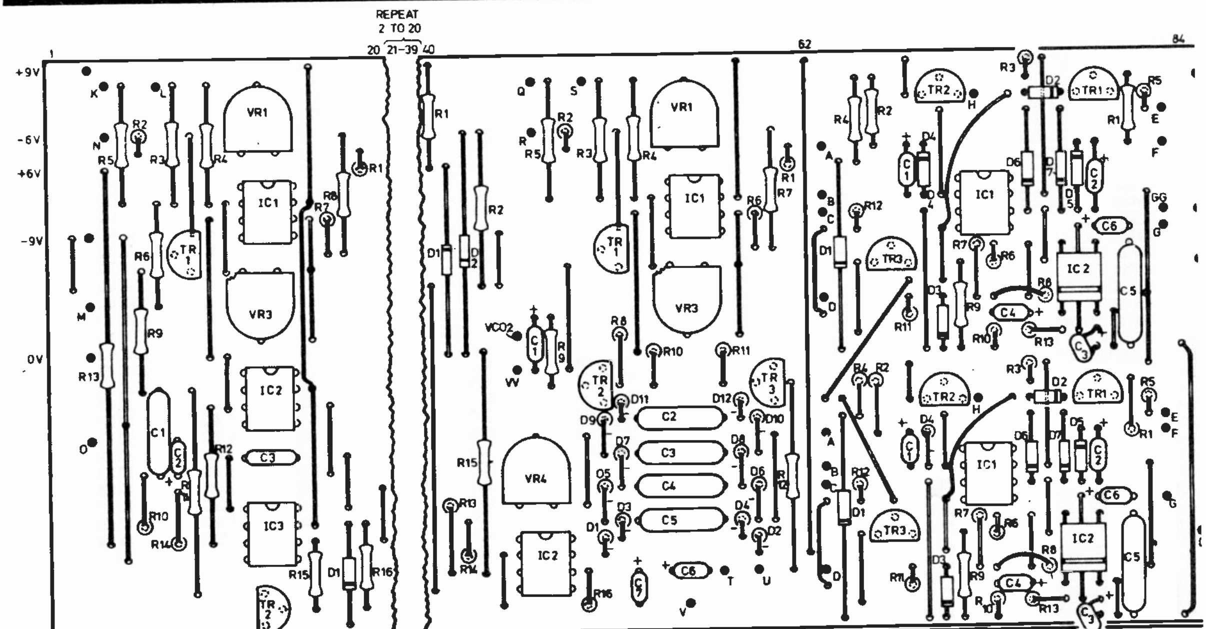
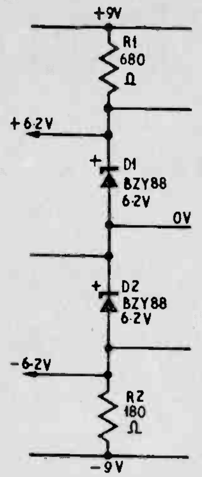


Fig. 2.8. Layout of the components on the Veroboard. Note that two identical VCO's are required side by side on the panel, only one is shown. Both Envelope Shapers are shown in full. Letters next to Veropins are for wiring to the front panel and correspond with those on the circuit diagrams



VOLTAGE REFERENCE

Resistors
R1 680Ω } ±5% ½W carbon
R2 180Ω }

Diodes
D1, D2 BZY88C6V2 6·2V Zener (2 off)

Fig. 2.9. Circuit of the voltage reference section giving ±6V

In the P.E. Minisonic the relatively low operating voltages result in a reduction of the overall attenuation/gain range to about 54dB which is sufficient for most practical purposes.

The current sink from pin 2 of IC2 is, in the off condition, restricted by the series combination of R10 and R13. As TR3 turns on it progressively short circuits R10 with the result that the current sink increases proportionately to a maximum which is limited by R13. It should be mentioned, of course, that the linear envelope of IC1 is converted into a negative exponential characteristic by TR3.

Although this is not ideal for an audio signal envelope, experience has shown that it is extremely difficult to differentiate subjectively between a negative exponential envelope and a positive exponential, or square law, envelope which is considered to give the best effect.

CONSTRUCTION

All the prototype circuits have been built in a number of alternative layouts and there appears to be no particular layout which gives rise to problems. The recommended Veroboard layout is shown in Fig. 2.8.

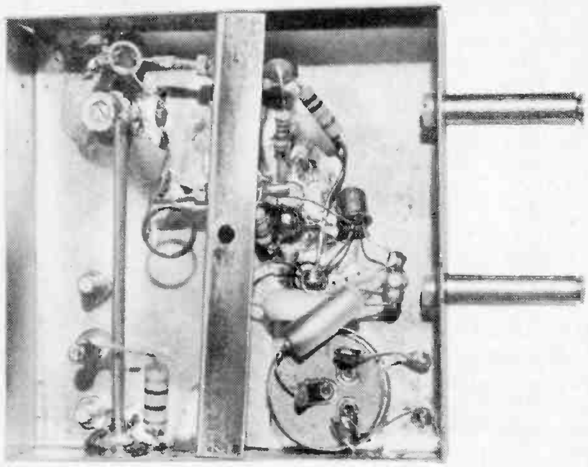
Also mounted on this section of Veroboard is the voltage reference section the circuit of which is shown in Fig. 2.9 (see photograph). This gives the stabilised ±6V rail for use in the VCO's and VCF.

It is recommended that all circuits in the P.E. Minisonic be bench tested and adjusted before any attempt to link the circuit boards with the front panel.

Next month: More of the P.E. Minisonic electronics plus details for wiring and setting-up.

P.E. CCTV CAMERA

continued from page 1059



Interior view of Crofton unit

camera u.h.f. signal might be beating with a normal transmitted signal giving patterning on the screen. Loss of sync is usually due to overloading of the signal and if the tuner has too much gain R10 can be increased until satisfactory results are obtained.

ALTERNATIVE MODULATOR

From what has gone before it can be seen that this form of modulator with a separate tuner might deter some constructors particularly if their involvement has never extended to u.h.f. It is for this reason that a commercial kit, the Crofton modulator, is recommended as an alternative, its obvious attractions being simplicity and small completed size.

The circuit for this is shown in Fig. 4.5 for which we are indebted to Crofton Electronics.

The kit comes complete with detailed building instructions. Numbered packs of piece parts with contents detailed means that instructions can be ticked off in the manual as construction proceeds until the unit is completed.

A step-by-step testing procedure is also included.

SCAN COIL CHANGES

Since the publication of the camera series a run on the specified EMI scan/focus coil assembly and a surprise discontinuation from the contracted manufacturer has meant finding a new coil assembly.

The author has found that the Japanese KV-13 assembly was not only a suitable substitute but provided an improvement in picture quality. Features include an automatic vidicon target connection and vidicon lens focusing by the turn of a small screw.

Both the coils and fitting data can be obtained from EMI, 243 Blythe Road, Hayes, Middlesex. The price is £14 plus VAT.

The only electrical modifications to be made is in the focus coil current supply. For this R50 and C31 in Fig. 2.10 are not required. The supply line input is +15V and should be taken from the Regulator circuit of Fig. 2.8.

Note that in the Components List for Part 1, R39 is 2·7kΩ, R8 —4·7kΩ and R42 —390Ω. These values are correctly shown in the circuits. ★

NEXT MONTH...

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ORION

HI-FI STEREO AMPLIFIER

From the same stable as the now-famous P.E. Gemini, comes the P.E. Orion. A medium power stereo amplifier contained in a compact cabinet offering a high performance for a modest outlay. The 20 + 20 watt output will satisfy almost all domestic requirements.

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★ Distortion less than 0·1%

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★ Will drive electrostatic loudspeakers

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Flexible decorative effect for the home, discotheque or shop. Can be shaped to almost any desired form.

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Automatic moisture control for greenhouse plants.

Controls a mist watering system so that your plants get just the right amount of water.

PRACTICAL

ELECTRONICS

JANUARY 1975 ISSUE ON SALE DECEMBER 13, 1974

I.C. PULSE GENERATOR

BY M.E. THEAKER

During the course of work with logic circuits it has been found useful to have a source of suitable digital waveforms to hand. However, the popular sine/square-wave generator is not ideal for this task as its signals are not compatible with the two most commonly used logic families, TTL (transistor-transistor logic) and DTL (diode-transistor logic). Whilst complex signal generators, which provide suitable signals, are available at great expense, using one of these for most amateur purposes is rather like using a sledgehammer to crack a nut.

For this reason a simple and compact source of various digital waveforms was developed. It will provide a mechanically switchable output at either of the two logic levels corresponding to 0 and 1, a continuous train of square-wave pulses variable in frequency from 10MHz down to a pulse every few seconds, a monostable multivibrator for providing single pulses of any given duration from seconds to microseconds, a Schmitt trigger circuit and, lastly, a lamp indicator circuit to show whether the logic state of a circuit is high or low (1 or 0).

LOGIC LEVELS

Some basic rules are common not only to 74 series but also to most other TTL and DTL logic families.

First, the signal level should never exceed 5·5V or be less than −0·6V. It should occupy one of two states, "0" which is typically 0·2V (maximum 0·4V), and "1" which is typically 3·0V (minimum 2·4V).

The next important requirement is that the time taken to go from the low state (0) to the high state (1), which is known as the rise time, or the reverse which is known as the fall time, should not exceed one microsecond ($1\mu s$).

The reason for this is that both TTL and DTL are saturated logic circuits which operate in one of two stable states corresponding to 1 and 0. As they switch from one state to the other they pass through an unstable linear zone where the circuit can act as an amplifier or an oscillator.

If the signal input to a logic circuit has an unduly long rise or fall time, oscillation of the circuit will occur and is highly undesirable. If the rise and fall times are less than $1\mu s$ for gates (150ns for flip-flops), then spurious oscillation will not occur.

THE CIRCUITS

The first requirement for testing logic circuits is to be able to provide a steady output corresponding to logic state 1 or 0 and to be able to switch between these two states at will. It might be thought that a simple switch connected to either 0·2V or 3V as shown in Fig. 1a would suffice, but this circuit would not give a single transition from one state to the other, instead it gives rise to a number of pulses due to contact bounce as at Fig. 1b.

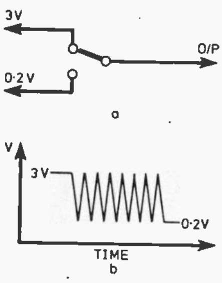


Fig. 1. Illustrating the effect of contact "bounce" when using a normal switch

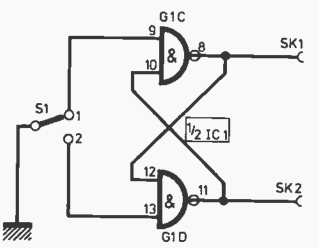


Fig. 2. Eliminating switch bounce using half an SN7400N

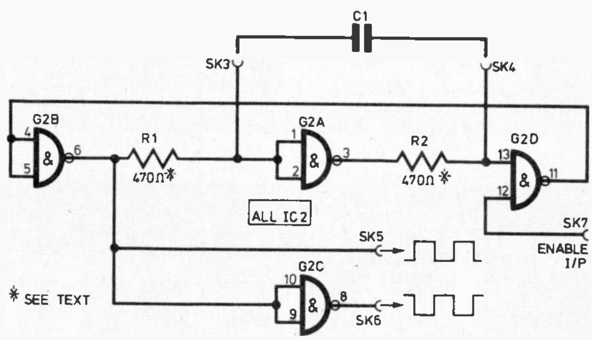


Fig. 3. The frequency of operation of this free-running multivibrator is selected using various values for C1

SWITCHED LOGIC LEVELS

In order to overcome contact bounce problems the switch can be used in conjunction with a flip-flop, which is made up from two 2-input NAND gates as shown in Fig. 2.

With the switch shorting S1.1 to ground one input to gate G1C is low (0 state). As S1.2 is not grounded it is high (1 state). Thus the output at SK2, gate G1D is low. Since both inputs to gate G1C are low its output at SK1 is high.

When the switch is moved to short S1.2 to ground, G1D output goes high. Since S1.1 is no longer connected to ground, it is now high and G1C output goes low. The outputs at SK1 and SK2 are now reversed and the transition is free from contact bounce. Returning the switch to position S1.1 restores the circuit to its original condition once again without contact bounce.

FREE-RUNNING MULTIVIBRATOR

Besides being able to switch at will from one logic level to the other, it is also useful to have a continuous source of pulses variable in speed from very slow to very fast. A suitable circuit is shown in Fig. 3 and consists of four 2-input NAND gates G2A, G2B, G2C and G2D. R1 and R2 affect the symmetry of the waveform and are nominally 470Ω. When they are equal in value the output waveform is nominally square, i.e. the waveform has a 1:1 mark/space ratio. The repetition rate or frequency of the signal is determined by capacitor C1.

The 2-input NAND gates G2A, G2B and G2C, are connected with their two inputs tied together as inverters.

To explain the operation of the circuit, consider the moment when the output of gate G2B goes from 0 to 1. Gate G2A inverts this signal and its output goes from 1 to 0.

The charge on C1 cannot change instantaneously and so the input to gate G2D also goes to 1 and the output goes to 0.

Now capacitor C1 begins to charge through R2 since G2A input is high whilst its output is at 0. As the capacitor charges so the voltage at pin 13 falls until it is sufficiently low to force the output of gate G2D into the high state, which in turn forces the output of gate G2B to go low, thereby commencing the second half of the cycle.

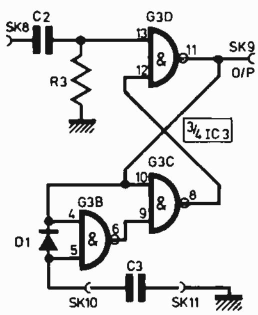


Fig. 4. A three-gate monostable provides a source of single pulses with adjustable duration

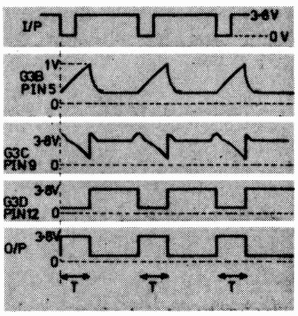


Fig. 5. The waveforms appearing at points in the circuit of Fig. 4

The input to gate G2A now being low forces its output high. Once again the charge on the capacitor cannot change instantaneously and so pin 13 is also low. Capacitor C1 now charges through R2 until the voltage at pin 13 is sufficiently high for gate G2D to change state and its output to go low, causing the output of gate G2B to go high, completing the cycle and starting another.

The process continues indefinitely as long as input to G2D at pin 12 is high. As soon as this input is taken low by an external circuit or is connected to earth, it stops the cycle. So pin 12 can be used to switch the oscillator on and off or, in other words, to "gate" or enable the oscillator. Gate G2C is used merely as an inverter and provides a complementary output from socket SK6.

Values of capacitance C1 for various frequencies are given in Table 1.

MONOSTABLE MULTIVIBRATOR

The third requirement is for a source of single pulses of adjustable duration and such a circuit is shown in Fig. 4. This forms a three-gate one-shot (or monostable) multivibrator circuit.

Varying C3 alters the output pulse duration and approximate values of capacitance for various pulse durations are given in Table 2.

A negative-going edge at the input produces a positive pulse at the output. The various waveforms of the circuit are shown in Fig. 5.

TABLE 1

C1	Period	Frequency
None	60 ns	16·7 MHz
47 pF	120 ,,	8·33 ,,
100 ,,	170 ,,	5·88 ,,
220 ,,	280 ,,	3·57 ,,
470 ,,	515 ,,	1·94 ,,
1 nF	1 μs	1·0 ,,
2·2 ,,	2·1 ,,	476 kHz
4·7 ,,	4·3 ,,	233 ,,
10 ,,	8·1 ,,	123 ,,
22 ,,	19 ,,	53 ,,
47 ,,	37 ,,	27 ,,
100 ,,	70 ,,	14 ,,
220 ,,	190 ,,	5·3 ,,
470 ,,	430 ,,	2·3 ,,
1 μF	909 ,,	1·1 ,,
100 ,,	91 ms	11 Hz

TABLE 2

C3	Pulse width
None	180 ns
47 pF	230 ,,
100 ,,	300 ,,
220 ,,	430 ,,
470	900 ,,
1 nF	1·5 μs
2·2 ,,	3·0 ,,
4·7 ,,	5·8 ,,
10 ,,	12 ,,
22 ,,	25 ,,
47 ,,	50 ,,
100 ,,	110 ,,
220 ,,	260 ,,
470 ,,	680 ,,
1 μF	1·3 ms
10 ,,	2·3 ms

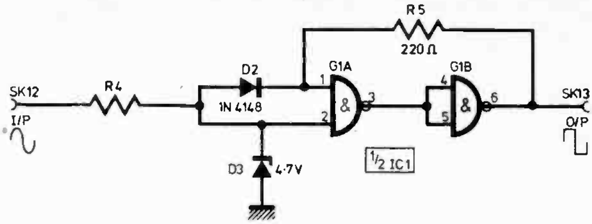


Fig. 6. A simple Schmitt trigger circuit using half of a SN7400N

SCHMITT TRIGGER

As mentioned earlier, TTL circuits require a pulse waveform with a fast rise time. If this requirement is not met, positive feedback between the output and input of the circuits will give rise to high frequency oscillation.

In order to be able to feed signals with slow rise times such as sinusoidal waveforms into TTL circuits a Schmitt trigger is incorporated as shown in Fig. 6. Positive feedback is applied via R5 in order that the output switches swiftly from one state to the other when the threshold is reached. The Zener diode D3 protects the circuit from overvoltage and the resistor R4 protects D3 from exceeding its maximum power dissipation. With R4 equal to 330Ω, inputs of up to 20V r.m.s. can be accommodated and the circuit will trigger on 2·8V r.m.s. With R4 equal to 100Ω, the maximum input is 6V r.m.s. and the minimum input 2V r.m.s.

LAMP INDICATOR

In order to check whether a circuit under test is at high or low level a lamp indicator circuit is included. The circuit is shown in Fig. 7 and consists of a transistor, TR1, a lamp LP1 and a base resistor R6 to limit the input current to the transistor.

COMPONENTS . . .

Resistors
R1 470Ω
R2 470Ω
R3 22kΩ
R4 330Ω
R5 220Ω
R6 470Ω or 1kΩ (see text)
R7 180Ω
All ½W, 5%

Capacitors
C1 68pF Polystyrene (see Table 1)
C2 150pF ,,
C3 68pF polystyrene (internal)
(internal see Table 2)

Semiconductors
IC1 SN7400N or equivalent
IC2 ,, ,,
IC3 ,, ,,
D1 1N4148
D2 1N4148
D3 4·7V, 400mW Zener
TR1 BFY51 or similar

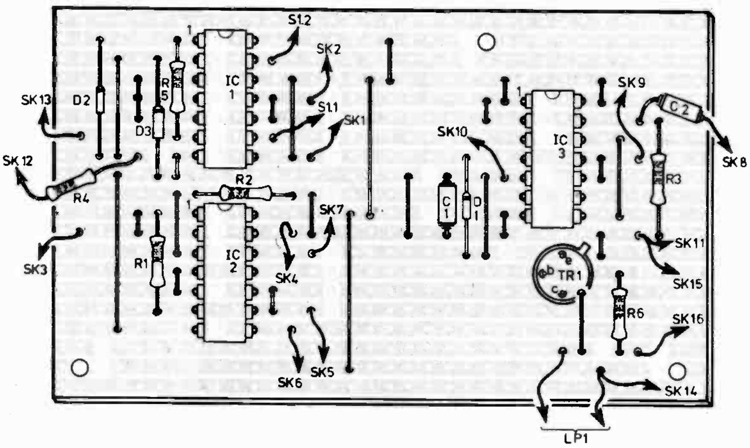


Fig. 9. Veroboard and component layout for the pulse generator

Miscellaneous
LP1 Miniature 6V, 0·36W Lilliput lamp and holder (Or l.e.d.)
S1 Miniature toggle switch, SPCO
SK1 to 16 16 single-pole miniature 1mm sockets, colour to suit
Single-pole miniature 1mm plugs in colour and quantity to suit for leads and supply lines
Veroboard, 0·1in pitch, 3·4in × 2·0in. Veropins.
Case (Prototype used 2 × 2oz tobacco tins), wire, solder etc.

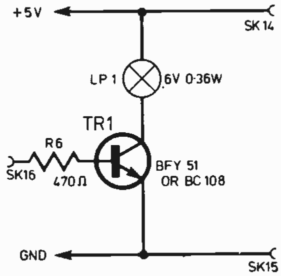
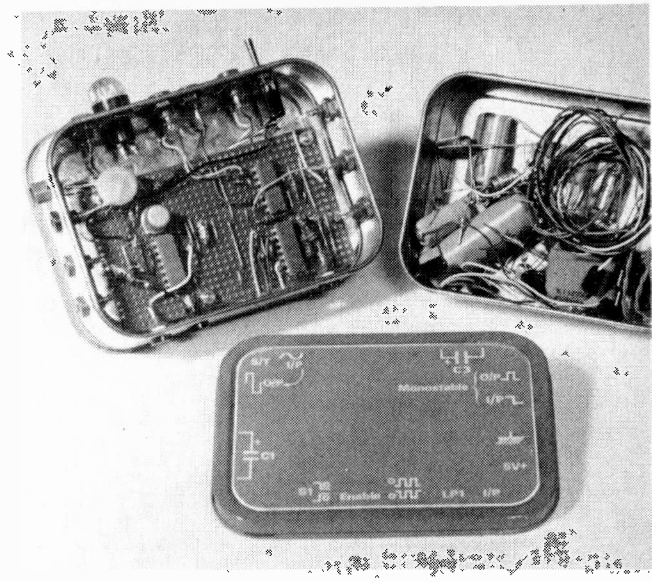


Fig. 7. Lamp indicator using a filament lamp. Note that the power supply is fed to sockets 14 (+5V) and 15 (0V) from an external battery or p.s.u.



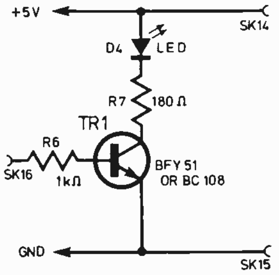


Fig. 8. Indicator using an l.e.d.

When logic 0 is applied at SK16 the transistor is cut off and no current passes through the lamp, but when logic 1 is applied the transistor is switched on and current passes through the lamp which lights.

A further version of the lamp circuit using an l.e.d. is shown in Fig. 8.

CONSTRUCTION

The circuits are all constructed on one piece of 0·1in pitch Veroboard, 3·4in by 2·0in. Whilst the layout is not critical leads should be kept as short as possible and the suggested layout of Fig. 9 works well.

The easiest way of constructing such a board is first to cut it to size, then drill the three 6B.A. clearance holes required for mounting the board in the case. Next the pins should be inserted and then the cuts in the copper strips should be made. Following this, the wire links should be inserted and soldered in place, followed by the discrete components and finally the transistor and three integrated circuits.

CASE

The case for the prototype pulse generator was made from a standard two-ounce tobacco tin. Three 6B.A. screws approximately half an inch long should be screwed through the bottom and Araldited in place to accept the Verobard. The top of a further tin can be rubbed down to remove the paint from the top rim and then Araldited underneath the bottom of the case and allowed 24 hours to set.

Bonding a lid underneath the case prevents the heads of the 6B.A. screws (which are now hidden) from scratching other equipment or furniture and means the generator may be stacked on to a second tin containing the leads and spare timing capacitors.

When the Araldite has set, the case should be painted and the sockets labelled as shown in the photograph. "Letraset" was used for the prototype and then varnished, which provides a very durable finish.

The capacitors used for adjusting the frequency of the astable multivibrator and the pulse width of the monostable multivibrator should have Veroboard (or similar) pins soldered to their leads for connection into the sockets provided on the case. A number of leads should be made up, some with a plug on one end for connection to external circuits, and some with plugs on both ends for interconnecting the sockets of the generator. These leads should preferably not exceed 1ft length for reliable operation.

The 1mm sockets used here are probably the only ones small enough to use in a tobacco tin. However, if a larger unit is used different output arrangements could be adopted. If component switching and other refinements are added care will be required over length of leads and interaction between signals. ★

NEW DEVICES ...APPLICATIONS

PHASE LOCKED LOOP FOR HIGH PERFORMANCE F.M. RECEIVERS

THE SIGNETICS International Corporation have recently introduced a new type of phase locked loop integrated circuit known as the NE563. This device employs new techniques to provide an extremely good performance in high quality f.m. receivers.

PERFORMANCE

The NE563 can provide an audio output signal having a total harmonic distortion of less than 0·5 per cent when fed with a 10·7MHz input signal having a 75kHz deviation at a 1kHz modulation frequency. This distortion level is lower than that of any other f.m. demodulator circuit known to the writer.

However, the NE563 not only excels in its low distortion, the a.m. rejection is 70db, far greater than that of most other circuits which seldom exceed 50db. The signal-to-noise ratio of 70db also illustrates the performance of this new device.

Although it provides such good performance figures, the NE563 is also convenient to use, since it functions as a complete i.f. strip without any coils whatsoever. It also contains a built-in limiter circuit which itself has a gain of up to 60db.

POWER SUPPLY

The NE563 operates from power supply voltages in the range 10V to 15V, this being less than that required by the earlier NE560, 561 and 562 series. The supply current is about 35mA. The NE563 is more sensitive than these earlier devices, having an input sensitivity of typically 5μV (maximum 10μV) for a 30db signal-to-noise ratio.

A further added bonus provided by the 563 is the high audio output level of 500mV r.m.s. (which may be compared with the typical value of 60mV obtainable from the NE560 series of devices). The maximum load which can be applied to the audio output is 2kΩ.

The NE563 also incorporates facilities for inter-station muting and for the operation of a signal strength meter.

The 563 device is encapsulated in a 16 pin dual-in-line case with the connections shown in Fig. 1.

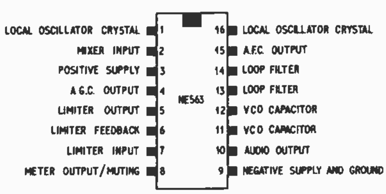


Fig. 1. The connections of the NE563 device

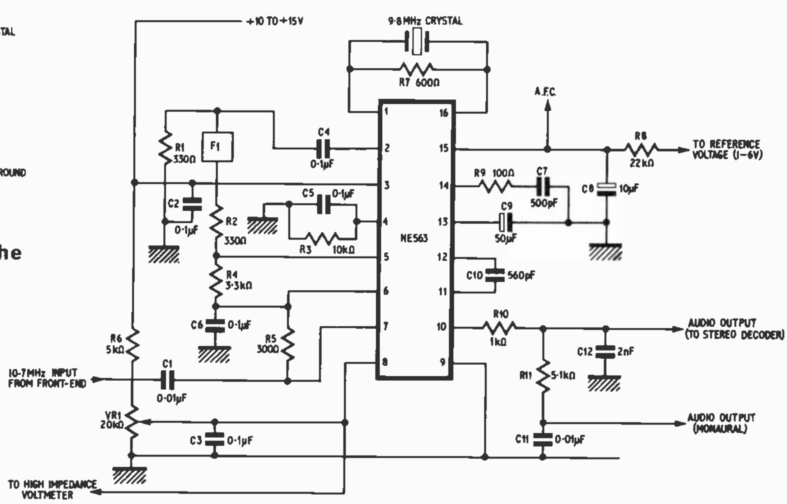


Fig. 2. Recommended circuit for the NE563. (R11 has been reduced from the value of 7·5kΩ suitable for the 75μs pre-emphasis used in the U.S.A.)

CIRCUIT OPERATION

The basic circuit recommended by the manufacturers of the 563 is shown in Fig. 2. The excellent performance is, of course, related to the techniques employed in this circuit.

A 10·7MHz signal from the front-end unit is capacitively coupled into the limiter input at pin 7 of the device. The limited output signal from pin 5 is passed through the 10·7MHz miniature ceramic filter marked F1 into the mixer input at pin 2.

The two resistors R1 and R2 on each side of the filter F1 are required for matching the filter impedance to that of the circuit. If they are omitted, the band-pass characteristics of the filter will be impaired.

The 10·7MHz signal entering the device at pin 2 is mixed with a 9·8MHz local oscillator signal generated by the crystal controlled oscillator connected in the circuit of pins 1 and 16. A difference frequency of 0·9MHz is thereby generated.

Table 1: Showing the typical readings of a high resistance voltmeter connected to pin 8 at various input signal levels

Input	Meter Reading (V)
1μV	0·3
10μV	0·35
50μV	0·6
100μV	0·85
500μV	1·4
1mV	1·6
5mV	2·3
10mV	2·75
50mV	3·6
100mV	4·0

The centre frequency of the voltage controlled oscillator of the phase locked loop is determined by the value of the capacitor C10 connected between pins 11 and 12 of the device; this capacitor is selected to provide a free-running or centre frequency of about 0·9MHz. The loop therefore becomes locked to the frequency of the difference signal.

The error signal voltage which keeps the loop in lock is the required audio output. The audio signal is filtered by R10 and C12 (time constant 2μs) to reduce the amplitude of any radio frequencies present, whilst leaving the high frequency components of the stereo signal virtually unaffected.

The audio signal is also filtered by R11 and C11 which provide the required de-emphasis of 50μs for monaural signals.

The 563 provides an automatic frequency control output signal from pin 15 which may be fed to the front end unit. A voltage is provided by pin 8 which can be fed to a high resistance voltmeter to provide an indication of the signal level at pin 7. Typical values of the meter reading for various input voltages are shown in the table.

CONCLUSION

The use of this new device should lead to both an improvement in the performance of high quality f.m. receivers and also a simplification in their circuitry. Although a 9·8MHz crystal is required for use with the NE563, the circuit is extremely simple and requires no coils or alignment. It seems to be equally suitable for use by the manufacturer of high quality commercial receivers and by the amateur constructor.

NEWS BRIEFS

Approval of Ceefax and Oracle experiments

THE Home Secretary has approved the introduction for a two-year experimental period, of the broadcasting of live information on television by means of the techniques known as CEEFAX (BBC) and ORACLE (IBA).

The purpose of the experiment, whereby those in possession of the necessary receivers will be able to receive printed information over a wide range of topics on their television screen, is to enable an assessment to be made of the demand for the service, to determine what form it should take and to estimate the scope for the manufacture of the equipment. It is assumed that the Annan Committee on the Future of Broadcasting will consider the techniques involved against its review of broadcasting policy as a whole.

Oracle demonstration

JUST prior to the Home Secretary's approval a "live" demonstration of the "Oracle" system was staged at Crawley Court near Winchester, headquarters of IBA's engineering division. There direct feeds from ITN, the Meteorological Office and the A.A. provided information which could be immediately up-dated. The display material was coloured with upper and lower case letters, included graphics and whole words could be flashed to rivet the attention of the viewer to an important item.

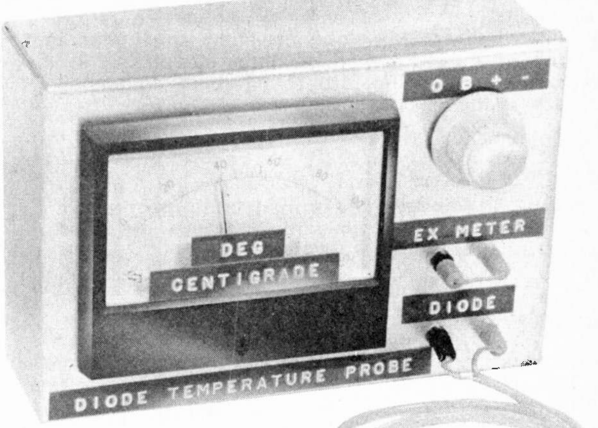
"Oracle," an acronym for Optional Reception of Announcements by Coded Line Electronics, can provide such presented information at the touch of a button.

This "broadcasting of the written word" is obtained by inserting a digital signal during part of the field blanking interval of a 625 line waveform. Since the details of the signal coding differed for the experimental BBC and IBA systems it has been necessary to draw up a common data broadcast standard which has now been ratified.

Up to 100 different pages of data, each page comprising up to 150 words or diagram could be transmitted continuously. Viewers having the necessary decoder (which will be integral to future generation receivers) will have immediate access to any of the pages being transmitted on the channel tuned. This can be displayed on a neutral background or superimposed on the television picture.

Whilst a regular transmission of live broadcasts by the BBC was started on September 23rd, the IBA experimental service is not expected to commence till next year.

−68°C to +175°C THERMOMETER / CONTROLLER



By J. N. JONES

THE relationship between the forward voltage drop of a diode and the temperature of the surroundings often causes problems in electronic circuitry. The present project makes use of this drawback to measure temperature.

The circuits described are simple, easily constructed and linear. The diode used is the very common 1N914 (equiv: 1S914) which can be obtained for as little as 3p and, since it is physically small, can be used to sense the temperature of small as well as large objects. Also, the size leads to a fast response rate.

Silicon diodes have one limitation, the range extends only from −65°C up to +175°C but this is wide enough for most applications and the instrument can be calibrated anywhere in this range.

APPLICATIONS

The article describes four basic circuits, a simple indicator in detail and an indicator/controller with set-point display, a blind (non-indicating) controller and a switched range version of the first indicator. The first mentioned is taken to the prototype stage in detail whilst the others are described in basis only.

Obviously there are many applications including normal workshop testing as when a transistor is running hot. The indicator can show if it is too hot or still within its range. The blind controller can be used to maintain an item of equipment at a given pre-set temperature using a heating element.

CIRCUIT

A basic indicator circuit is shown in Fig. 1. Here a stable reference voltage for the diode probe and operational amplifier inputs is provided by an integrated circuit IC1 which is in fact a 723 device which also carries an amplifier used elsewhere in the circuit (IC3).

The diode probe is connected in the feedback loop of IC2, connected to the inverting input. By careful adjustment of the potentiometer VR1, the bias provided to the non-inverting input of IC2 is held to about 600mV below the V_{ref} (Pin 6) provided by IC1. (Actually the diode D1 forward voltage drop at 0°C or whatever temperature zero meter current represents.)

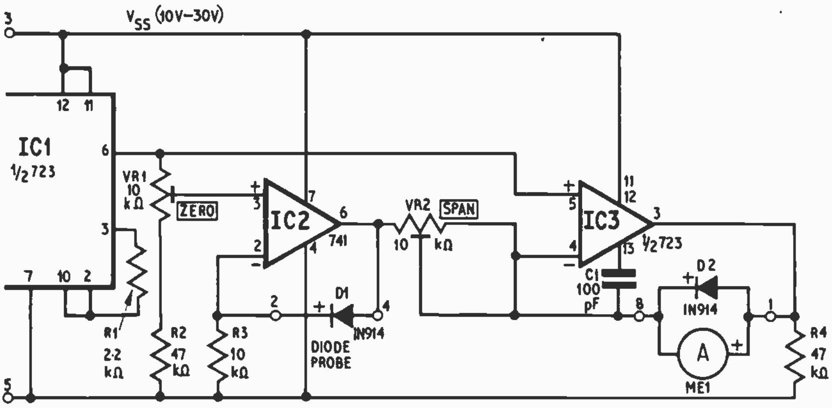


Fig. 1. Circuit diagram of the heart of the indicating diode thermometer showing the use of integrated circuits to provide sophisticated circuit functions in a very simple manner

IC2 works in the inverting mode feeding current through D1 to R3 so that the inverting input is held at the same potential as the non-inverting. The output is thus one diode drop greater than the bias voltage provided by VR1.

The sensitivity of a silicon diode is about -2mV/degree C, thus the p.d. is in fact about 600mV at 0°C and 400mV at 100°C. IC2 output thus changes from V_{ref} at 0°C (or zero meter current temperature) to approximately $V_{ref}-200$mV at 100°C.

Amplifier IC3 also operates in the inverting mode, passing current through the indicator ME1 to maintain the two input pins at the same potential. As the input impedance of IC3 is high all the meter current passes through VR2. Thus one end of VR2 is held at V_{ref} by IC3 whilst the other varies from V_{ref} to V_{ref} -200mV (at 100°C).

Thus VR2 value determines the current per unit temperature flowing in ME1. A 100μA indicator, to correspond to 0°C to 100°C requires VR2 of about 2kΩ and thus a 10kΩ potentiometer is suitable.

VOLTAGE REGULATOR

A circuit of this type, to retain accuracy, needs to be supplied with reasonably constant voltage at the probe and other operational amplifier inputs. Hence the use of the 723 regulator chip. These can be obtained for about 57p and contain the required 7V reference source and an amplifier which is useful.

In the circuit, R1 provides short circuit protection for the amplifier section and C1 is necessary for frequency compensation.

The 741 amplifier chip was selected for IC2 and either the 8 or 14-pin d.i.l. packages may be used in the Veroboard layout of Fig. 2. This device has its own internal frequency compensation.

R4 is required if negative (below 0°C) temperatures are to be investigated and for setting to zero since IC3 can only drive the meter in one direction.

METER PROTECTION

Since removal of the diode probe with the instrument switched on will cause heavy meter current, apart from any other reasons, meter protection is a good idea. Hence diode D2 which protects the meter against large overloads but does not affect normal readings.

In addition, the 723 amplifier, IC3, has programmable short circuit protection which can be selected to lie close to the sum of meter f.s.d. current and R4 current. Programming is by selection of R1 from the following equation:

$$I \simeq \frac{0{\cdot}65\text{V}}{\text{R1}}$$

As R4 is selected to sink enough current to give reverse f.s.d. on the meter then I must equal (current through R4 plus the current through the meter) × 1·5. The factor 1·5 is to ensure that normal IC3 currents do not enter the range where

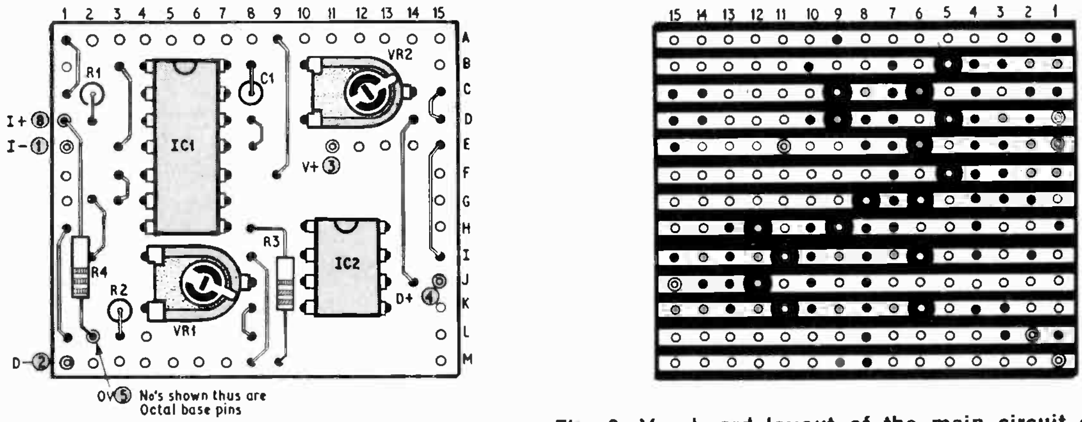


Fig. 2. Veroboard layout of the main circuit components of Fig. 1

COMPONENTS . . .

Resistors

R1	2·2k Ω	R7	1k Ω
R2	47k Ω	R8	3·9k Ω
R3	10k Ω	R9	68k Ω
R4	47k Ω	R10 to R18	100 Ω
R5	180k Ω	R19	18k Ω
R6	47k Ω		

All 2% except R10 to R18 which are 1%.

Potentiometers

VR1 10k Ω VR3 5k Ω VR5 50k Ω
VR2 10k Ω VR4 5k Ω

For best results use Cermets or miniature multi-turn pots

Capacitors

C1 100pF

Integrated Circuits

IC1 & 3 One 723 Regulator i.c.
IC2 741 Operational Amplifier
IC4 741 Operational Amplifier

Diodes

D1 1N914 D2 1N914

Transistors

TR1 BFY51

Switches

S1 3-pole, 4-way slide or rotary
S2 2-pole changeover
S3 1-pole, 10-way

Miscellaneous

ME1 100μA meter or to suit.
Veroboard; Octal relay plug and socket if required; case, batteries, wire, etc.

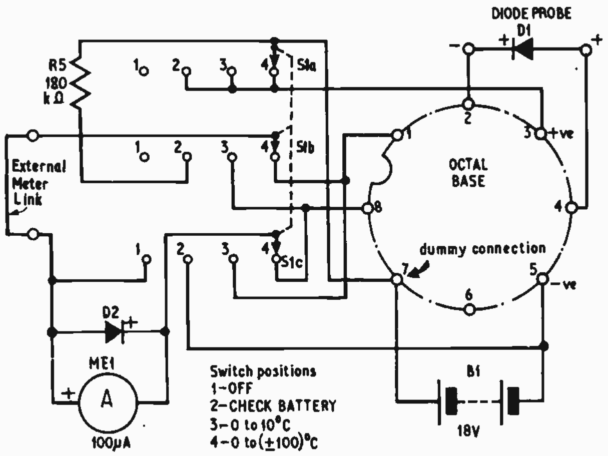


Fig. 3. The assembled circuit of the indicating instrument developed from the basis of Fig. 1

short circuit protection begins as scale non-linearity could result.

PROTOTYPE CONSTRUCTION

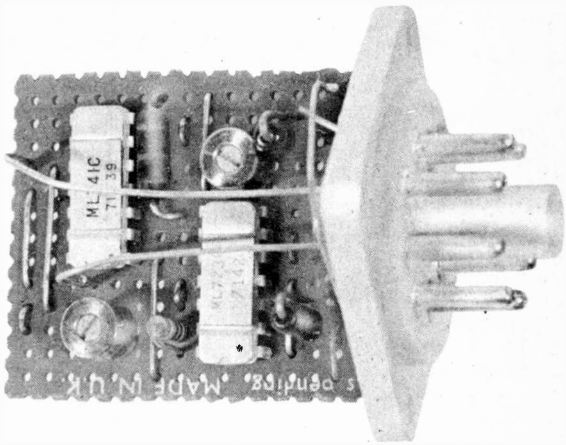
For convenience and neatness the original was made up in an octal-based relay case and the pin numbers used are shown in both Fig. 1 and Fig. 3. These are not firm and can be modified. Pin 7 for example was used to retain the battery lead for convenience but is not connected to the Veroboard.

SWITCHING

The 3-pole, 4-way switch S1 of Fig. 3 provides on/off, battery check, 0 to ±100°C (in fact only to −60°C). In the off position the meter is shorted out for added protection.

In the battery check position the 180kΩ resistor R5 converts ME1 to an approximately 18V voltmeter. This is effected with the load connected so a proper test is indeed performed.

In fact the instrument can function with battery voltage as low as 10V with very little loss in accuracy.



An assembled circuit board mounted on its octal plug carrier and with the cover removed

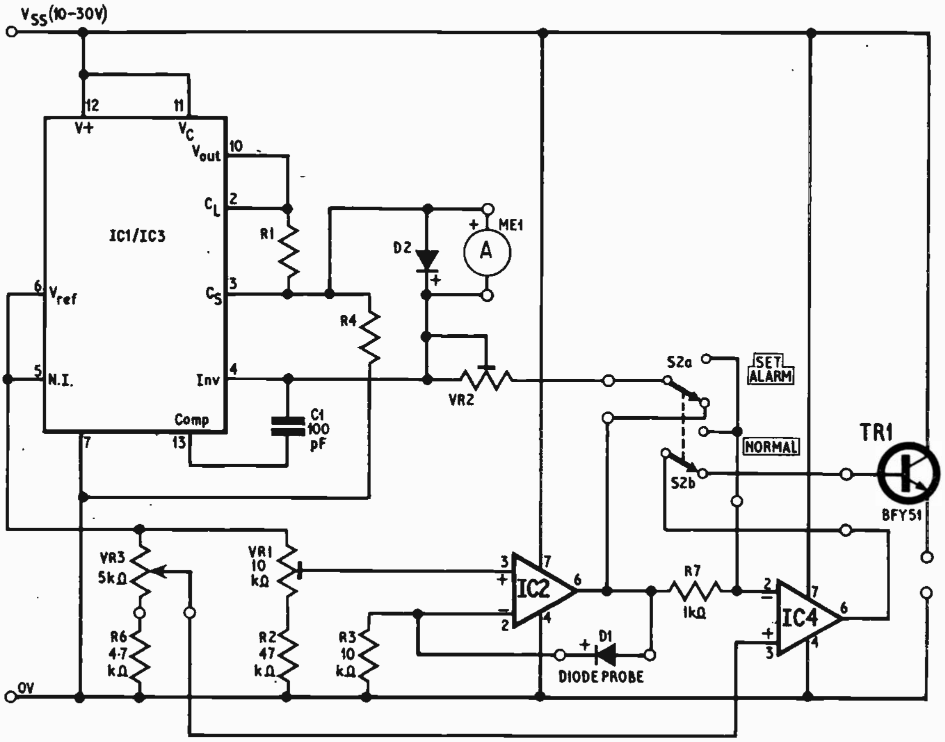


Fig. 4. A variation of the diode thermometer designed to give both control and indication functions

METER

Provision is made for an external meter if this is required. It should of course match the existing meter (100μA). Normally the link is left in place.

If it is required to substitute a 1mA movement for the 100μA suggested in Fig. 1 then R1 becomes 220Ω, VR2 becomes 1kΩ, and R4 becomes 4·7Ω. Other meter values between these two limits can be accommodated if desired by interpolation.

CALIBRATION

Instrument calibration is in fact fairly simple. After assembly and circuit checking the instrument is now ready. Due to characteristic variations from diode to diode, calibration is needed each time a diode is changed.

In addition, the diodes themselves need some form of protection. Thus it is best to coat them with material such as cellulose varnish, synthetic resin, silicone rubber or the like to both prevent ingress of damaging fluids and, of course, to avoid faulty readings due to conductive fluids altering the diode characteristics.

Of course the coating will to some extent reduce the speed of reaction of a diode but this can be accepted happily in many applications.

The easiest way to calibrate is to use boiling water for the 100°C standard and melting ice for the other 0°C level. Thus a simmering pan of water and a thermos flask containing a water/ice mix are convenient.

With the instrument switched on, place the probe first in the ice/water mix and adjust VR1 to set the meter zero value. Now place the probe in the simmering water and adjust VR2 to set the end-of-scale 100°C correctly to the f.s.d. mark on the meter if it is a 0 to 100 scale.

An interesting point is that whilst Fahrenheit is now out of fashion it is just as easy to calibrate a scale to Fahrenheit if one wants.

It will probably be necessary to repeat the procedure to check calibration. Of course, the scale can be compressed or expanded as required.

INDICATOR/CONTROLLER

By using an extra amplifier IC4 as in Fig. 4, in the comparator mode, the signal at IC2 output can be compared to any preset value and a resulting switching action used to provide control or alarm functions. With the switch S2 in the "Normal" position the circuit of Fig. 4 provides both visual indication of temperature and a switching output function. IC4 comparator controls TR1 which in turn controls the required external circuits.

With S2 in the "Set Alarm" position IC4 is connected as a voltage follower, buffering the set-point potential of VR3 and presenting it to IC3 and the meter. Thus the meter indicates the setpoint value.

BLIND CONTROLLER

The circuit of Fig. 5 can be used to drive lamp or relay circuits in order to effect a blind (non-indicating) control function.

SWITCHED RANGE INSTRUMENT

The circuit of Fig. 1 can be modified as in Fig. 6 to provide a scale expansion function in which the indicator gives a 0 to 10 degree indication and the

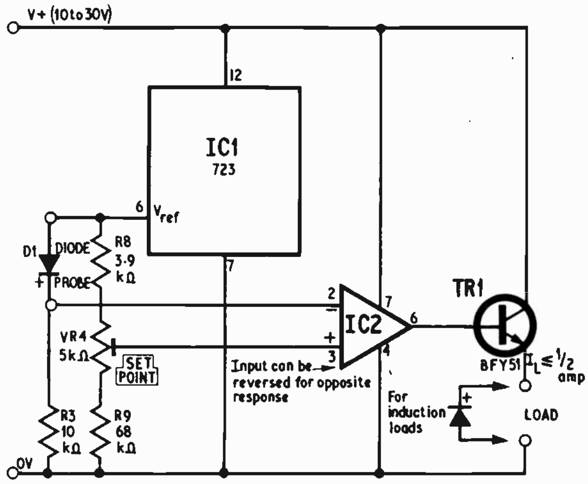


Fig. 5. A "blind" controller based on the diode thermometer. The output is "on" when the sensed temperature is below the set point

switch S3 selects the lower point of the indicated scale. Thus as shown the 10°C scale can start at 0°C, 10°C, 20°C and so on up to 90°C as selected by the switch.

This gives a scale expansion of one order of magnitude which can be useful in many applications.

When calibrating this version of the instrument VR1 is adjusted as before with S3 in the 0°C position, VR2 is adjusted to give a 10°C range indication, and then VR5 is adjusted with S3 at 90°C position and the probe in boiling water to give f.s.d. The VR2 adjustment will probably require the use of a normal thermometer. ★

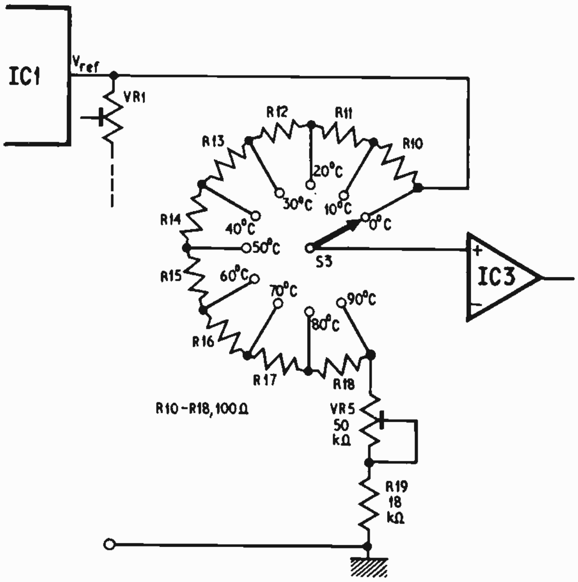


Fig. 6. A modification of Fig. 1 which gives an expanded scale covering 10°C but switchable to start at any of a number of selected temperatures

BOOK REVIEWS

PIEZOELECTRIC CERAMICS

By J. van Randeraat and R. E. Setterington
Published by Mullard Ltd.
211 pages. Price £4 clothbound

THIS latest addition to the Mullard technical library offers, in one volume, a comprehensive textbook on the subject of piezoelectric ceramics from basic theory through mechanics and associated mathematics to the practical application of a wide range of devices manufactured by the publishers.

This volume is up to the usual high Mullard standards with plenty of back-up information provided in the form of recognised symbols used in the art, tables of information on the various shapes and forms of device available and details of behaviour under temperature variation.

Apart from the in-depth technical information, space is given to discussion of the main application areas for this recently developed material, such as in gas ignition, in flexture elements (those which move on application of electric current) and in resonant devices as in filters and ultrasound equipment.

A variety of circuits are worked through, even as far as production of p.c.b., and suggestions are put forward for such items as a depth sounder, control transmitter/receiver installations and intruder alarms.

Following the usual Mullard tradition this book will be of use anywhere this type of device is considered from the educational establishment to the industrial workshop and is undoubted value in current terms.

Available from technical bookshops or directly from the distributor, Technical Press Ltd., Freeland, Oxford, OX7 2AP.

R.D.R.

SL600 SERIES APPLICATIONS MANUAL

By James M. Bryant
92 pages, 6in × 8¼in

THIS is the second edition of collected applications information specific to the Plessey Semiconductors SL600 series i.c.s.

Completely updated, the contents break down to three sections with appendices. Section 1 covers circuit data; section 2—system design and section 3 on relevant technical data.

In section 1 chip circuitry is explained and the area of applications detailed. The remainder of the manual looks at complete communications systems including the devices with an end section on product characteristics with operating notes.

Copies of the manual are available from Plessey Components Ltd., Plessey Semiconductors, Cheney Manor, Swindon, Wiltshire SN2 2QW. Price 50p.

G.G.

RADIOISOTOPE EXPERIMENTS IN PHYSICS, CHEMISTRY AND BIOLOGY

By J. B. Dance
Published by Hutchinson Educational
246 pages, 8½in × 5½in (softback). Price £1·75

THE study of nuclear radiation is receiving increasing attention in schools and colleges. It offers opportunities to demonstrate the fundamental nature of matter with quite simple equipment, such as the well-known Geiger counter.

This book describes in full detail more than 70 experiments that can be performed using either naturally occurring radioisotopes or artificially produced isotopes. The topics covered include those of interest to students of physics, chemistry, statistics, and biology, up to G.C.E. Advanced Level.

The collection of experiments (well catalogued for immediated reference in the Contents) makes up rather more than half of this book. It is preceded by five sections dealing with theoretical and practical matters, which collectively form an excellent introduction to the subject.

Appendices give valuable information and data; in particular, the regulations and codes of practice governing the use of radioisotopes in educational establishments and addresses of suppliers of equipment and radioactive sources.

This book is an expanded and updated version of the author's *Radioisotope Experiments for Schools and Colleges* which was first published by Pergamon Press in 1967.

F.E.B.

RECEIVING PAL COLOUR TELEVISION

By A. C. Priestley
Published by Argus Books Ltd.
261 pages. Price £5

TO readers of our companion magazine Television, the author's name is no doubt familiar. With a background of many years in TV design and the creator of correspondence courses in colour TV one would assume these were the ingredients for producing a successful book on the subject.

With a publishing date that coincides nicely with the start of a new term of evening and day classes it will obviously attract engineers, technicians and students who already have a working knowledge of the principles of monochrome television and wish to extend their knowledge to embrace PAL colour systems.

Since the mathematical explanations are marginal, the enthusiastic amateur might get better results from his set with judicious reading.

Chapter one deals with the origins of the PAL system, basic light theory and a short review of monochrome fundamentals.

Subsequent chapters include analyses of the transmitted colour signal, display tubes, decoding, colour display adjustment and servicing which includes test gear requirements, interpretation of results along with rudimentary troubleshooting procedures.

The reading is made so much easier by the abundance of sideheads which break up each chapter. They also prove a useful reference, being included in the contents page.

There are many line drawings and a number of colour plates. Final appendices cover vectors, phasors and colour bar signal waveforms.

G.G.

INDUSTRY NOTEBOOK

By Nexus

CALCULATOR NEWS

Sinclair Radionics, Britain's largest calculator manufacturer with an output of 50,000 units per month, of which 70 per cent are exported, is on the brink of its biggest deal ever. This is a completely new calculator which will be marketed by the Gillette Company of Boston, U.S.A. First reports suggest that the calculator is unlike any of the five Sinclair models currently available and is being designed to an original Gillette specification. Details are hush-hush at the time of writing, but I understand a test marketing by Gillette in the United States is imminent. If the market responds satisfactorily, big production contracts will follow. And it is hinted that "big" is measured in millions of units.

Advance Electronics is offering a version of the Model 162P fully programmable calculator in kit form at £99 plus VAT. The assembled 162P is listed at almost £200 which suggests that assembly and testing is a tedious and time-consuming affair. But Advance say that the kit can be assembled "in a matter of minutes without requiring any special tools". This is another example, it seems to me, of the erratic pricing structure in the calculator business. Even in these days of wage inflation, £70 or so for "a matter of minutes" in assembly seems somewhat excessive.

Mullard's new MOS i.c.s for calculators enable any would-be calculator manufacturer to get into business. Announcing the new range, Mullard say all you need is a keyboard, a display and a few interface components. There are four i.c. kits for desk models of all complexities, including memory circuits and print-out drives, and a couple of single-chip i.c.s for the simpler pocket calculators. But before leaving the car in the drive and setting up an assembly plant in the garage, remember that it's easier to make things than market them. I have been told that in the early days it cost one manufacturer £15 in press advertising for each calculator he sold.

BARGAINS

With share prices at an all-time low it's a wonder more companies haven't been snapped up by bargain hunters than have been. Who would have imagined a few years ago that one of the real high flyers, Advance Electronics, would change hands for a mere £4·25 million? But so it was after weeks of rumour. Advance, who was once well fancied as a possible buyer of Marconi Instruments, now finds itself a wholly-owned subsidiary of Gould Inc., of Chicago.

As long ago as November 1971 Gould was known to be shopping for European companies with over £25 million to invest and is now operating in nine European countries. It's hard to believe that this go-ahead concern runs its European operations not from some lush office suite in one of the great financial centres but from the Epping home of Gould Europe's director Richard A. Holmes.

Advance Electronics is a good buy. Chairman Sir Edward Howard reported record pre-tax profits of £709,793 for 1973 and full order books for 1974. And the Advance product range in no way conflicts with Gould's own range.

Whether George Kent will be a bargain for GEC remains to be seen. Kent was about to conclude a deal with the Swiss company Brown Boveri in which the latter would have acquired a majority shareholding. With remarkable suddenness, and apparently with Government support, GEC put in a counter-bid which would give GEC 50 per cent ownership, the other shares being owned 41 per cent by the Government and nine per cent by Rank. The new alignment was not firm at the time of writing but few observers doubted that the deal would go through. The odd thing about the offer, apart from its speed and timing, was that it is entirely contrary to GEC's normal policy of total control. But these are strange times.

SEMICONDUCTOR PRICE WAR

Following dire warnings from Fairchild, reported in last month's *Industry Notebook*, there is evidence that a new round of price-cutting has started. The European SGS-ATES concern has reacted to reports of U.S. underpricing by slashing their own prices by up to 50 per cent on some consumer i.c.s and by up to 40 per cent on some professional devices.

We all know that demand for consumer i.c.s has slackened but I feel it is perhaps going too far to talk of a "semiconductor mountain". But it is true that stocks have been building up and first reports suggest that the SGS-ATES price cuts apply only to the U.K. market—at least for the time being. Whatever the decline in the demand, a spiral down in prices on a world scale can hardly do anyone any good. As it is, today's prices for i.c.s average out at less than 50 per cent of what they were four years ago in spite of inflation.

AEROSPACE FLIES HIGH

Britain's aerospace industry stood up well in comparison with foreign exhibits at last September's Farnborough Air Show. In round figures the output of the industry is £800 million including £500 million of exports with a labour force of under 200,000 people. And the electronics sector looked really good with plenty of advanced technology products ranging in size from Plessey's new 3-D radar down to a tiny hand-held laser rangefinder shown by Barr & Stroud which, in size and appearance, is like a pair of binoculars and yet has a range of three miles with L.E.D. digital read-out, and all operating from internal batteries.

Industry leaders were clearly pleased with the performance of their companies but with the threat of nationalisation over their heads I can only sum up the general atmosphere as one of nervous optimism.

The most honoured guests were those from the oil-rich nations whose multi-million pound orders were gratefully received. It's a straight swap of technology against the purchase price of oil.

BRIGHT BOYS

Keep an eye on Membrain, already big in automatic test equipment and growing at a phenomenal pace. It's manned by a youthful team of enthusiasts headed by C. A. (Tony) Davies, now aged 30, who started the company in July 1970. Average age of Membrain staff is 33 years and 42 per cent of the 140 staff are under 30.

Starting from zero they have built a business which is now turning over £1·5 million a year. It is still on the cards that Membrain will acquire the ATE interests of Honeywell, though both sides are currently dismissing the rumour. Not bad going for a bunch of youngsters who, apart from building a fine business, won the Queen's Award for Technological Innovation earlier this year.

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

NEON OSCILLATOR

THIS circuit is simple for the beginner to both build and understand and, using readily available components it can be assembled very cheaply. The frequency range is quite wide, from one pulse per second or less up to the higher audio frequencies.

In the circuit of Fig. 1 the capacitor C1 charges via R1 and R2 and the primary of T1, an old valve output transformer of 20 or 30 to 1 turns ratio. When the voltage across C1 reaches the striking voltage of the neon, the latter discharges, producing a flash at the neon and an output pulse from the secondary of T1.

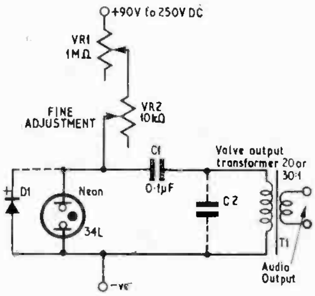


Fig. 1

After the circuit is constructed R1 should be adjusted from its highest value until oscillation starts and then R2 is adjusted to set the rate of charge of C1 and thus the frequency of oscillation. In this way one can use R1 as a coarse adjustment and R2 as a fine adjustment increasing the resistance to reduce the frequency.

With C1 at 0·1μF oscillations vary from a slow flash to about 50Hz. Smaller values of C1 produce higher frequencies. Capacitor C2 is really optional and is used to alter the tone of the audio output. The output can be fed to a small loudspeaker or an amplifier as desired.

Applications are numerous. The circuit can form a useful voltage indicator or can perhaps be the basis of a synthesiser. Powering is either from the mains using a suitable rectifier and smoothing or using a battery of the valve receiver type (90V). With the former it is possible to obtain a descending audio note on switching off and a continued illumination of the neon for some time after that because of smoothing capacitor charge holding. This could perhaps have timing applications.

The diode D1 can be used to replace the neon if only an audio output is required. This should be a low reverse breakdown device so that C1 discharges through it when the breakdown voltage is reached.

M. J. Maynard
Wednesbury.

ZENER DIODE CHARACTERISTICS

AN OSCILLOSCOPE is a fairly usual adjunct to the workshop these days and most oscilloscopes are fitted with a sawtooth output from the ramp generator. This can be used to great advantage to measure the characteristics of Zener diodes.

All that is required in addition to the oscilloscope is a potential divider network which is connected up as shown in Fig. 1. The sawtooth potential is divided down so that it can be applied to the device under test, the same points being connected to the Y-amplifier input.

With no device connected, or one which is open circuit, the oscilloscope will display the plain ramp waveform, an evenly increasing voltage. With a short-circuit device connected the display will be a simple horizontal line as there will be no input to the Y amplifier.

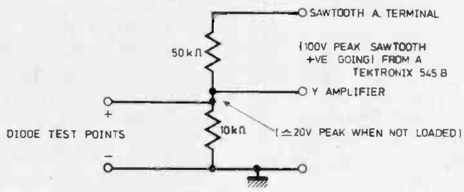


Fig. 1

A good device will cause the display to assume the normal ramp shape until the voltage across the diode reaches the Zener voltage value when the trace will become horizontal. Thus the Zener voltage can be read from the scope graticule and Y amplifier setting.

A device with an intermittent fault will show a display which oscillates between the two possible other displays, depending on the fault failing to short or open circuit.

The characteristics of any diode can be investigated using this method and for other voltages the potential divider is suitably modified using Ohms Law to give a voltage level which exceeds the Zener voltage of the device under test. Of course, the sawtooth output must not be overloaded or the diode parameters exceeded.

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C	1	4·7–10M	3·2	2·5	1·92 nett
MO	1/2	10–1M	4	3·3	2·3 nett
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22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
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	—
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INTEGRATED TRIFFID

READERS may be interested in this integrated version of the Triffid receiver published in Practical Electronics. As shown in Fig. 1 the circuit works only on medium waves but if long wave coverage is required the modifications can be found in Practical Electronics, February 1973.

The present circuit was built on a small printed circuit board and mounted in a case measuring 2 × 3 × $\frac{7}{8}$in using a 250pF trimmer fitted with a long spindle for tuning.

For size reduction reasons it is probably best to use a combined potentiometer and switch for the 10kΩ potentiometer.

C. M. Rose
Alsager, Stoke-on-Trent

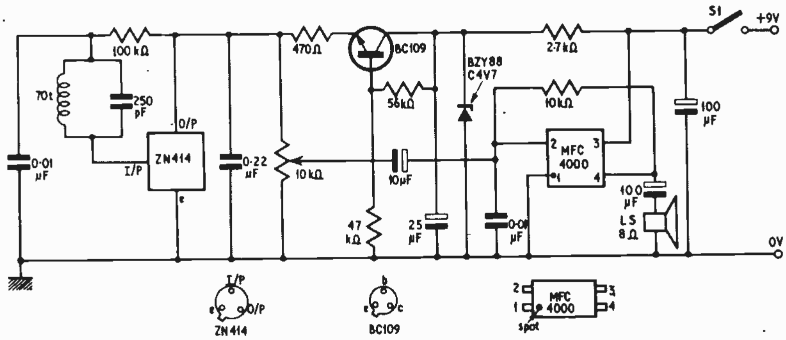


Fig. 1.

OPTICAL COMMUNICATION

THIS system was originally developed for transmitting digital information on a light beam in a security system. In view of the nature of the information a fairly flat response was required and as may be well known, incandescent lamps have a very unlinear response because of their thermal inertia.

Thus one way of overcoming the trouble is to amplify the lamp signal using an amplifier with considerable treble boost. Hopefully in such a case the amplifier characteristics would be a reverse of the lamp characteristics to obtain fairly level response, but this is difficult to obtain in practice.

One way round the problem is proposed here in which an amplifier is still used to feed the lamp but at the same time the output from the lamp is observed by a photocell which is positioned in the feedback circuit of the amplifier. In this way light output is directly linked to amplification with a corresponding smoothing of the response curve.

In the circuit of Fig. 1 an operational amplifier is used to provide the lamp drive via transistor TR1. Output from the lamp is sensed by the ORP70 light dependent resistor which in practice is mounted next to the light bulb. This signal is applied to the amplifier as negative feedback via R4.

In the present instance the amplifier gain is set at 100 by R4 and R5 as higher gain makes the loop unstable but probably it is best to use the highest gain commensurate with the lamp in use.

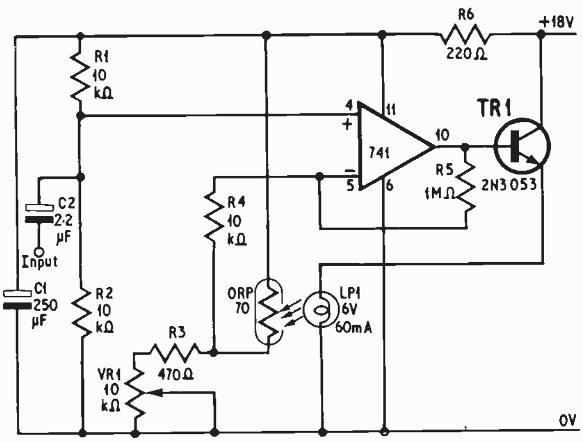


Fig. 1

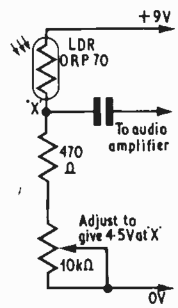


Fig. 2

VR1 sets the quiescent current/brightness of the bulb and is adjusted to give 7V across the bulb in the no-signal condition. Remember to set VR1 to maximum value before switching on the circuit.

The prototype was used over a distance of 10ft but no doubt greater distances could be accommodated with some care as to use of reflectors at transmitter and receiver. In the model these were simple bicycle lamp reflectors and no real care was taken over alignment.

Both speech and music were transmitted over the model circuit with good results but better treble boost above 1kHz would improve matters in noisy environments.

Input to the system was about 100mV to give a reasonable signal and a simple receiver is shown in Fig. 2.

R. Warren-Smith
Redhill.

555 RAMP GENERATOR

Engineers are often on the look-out for a better linear voltage sweep generator for their deflection, ramp, and function generator circuit designs. The recently introduced MC1555 timer can be used to make a simple linear voltage sweep circuit.

In the usual MC1555 timing circuit, it senses the exponentially rising voltage across the capacitor in an RC network. Essentially, from a discharged state, the capacitor begins receiving charge until the voltage across it rises to $2/3V_{CC}$ at which time it is discharged in preparation for the next charging (trigger) pulse.

By replacing the resistor in the RC network with a constant current source, the voltage across the timing capacitor is caused to increase linearly.

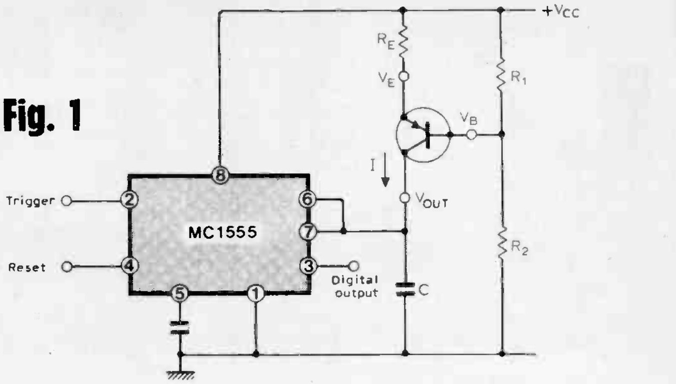
The charging time can be determined as follows:—

$$t = \frac{2/3\ V_{CC}\ .\ C}{I}$$

$$\text{where : } I = \frac{V_{CC} - V_E}{R_E} = \frac{V_{CC} - V_B - V_{BE}}{R_E}$$

(t in seconds, V in volts and C in farads)

Fig. 1



By setting $V_{CC} - V_B$ so that V_{BE} is negligible :

$$I = \frac{V_{CC} - V_B}{R_E}$$

Since V_B is directly proportional to V_{CC}

$$I = \frac{V_{CC} - K\ .\ V_{CC}}{R_E} = \frac{V_{CC} - V_B}{R_E}$$

$$\text{where : } K = \frac{V_B}{V_{CC}}$$

$$\text{or : } t = \frac{2/3\ V_{CC}\ .\ C}{\dfrac{V_{CC}(1-K)}{R_E}} = \frac{2/3\ C\ .\ R_E}{1-K}$$

From this equation, it can be seen that the time period is essentially independent of the supply voltage if the voltage across the emitter resistor of the current source is much larger than the V_{BE} of the transistor.

Since the capacitor voltage must reach at least $2/3V_{CC}$, the current source may be operated on a higher voltage supply than the timer although this is not necessary if the supply voltage is well regulated. The constant current source should be kept larger than $1\mu A$ so that it is always large compared to the current needed for the comparators.

Motorola Semiconductors Ltd.
Geneva

BOOK REVIEWS

NEW DIRECTIONS IN PARAPSYCHOLOGY

Edited by J. Beloff, B.A., Ph.D.
Published by Elek Science
174 pages, 8¾in × 5½in. Price £3·00

Psychical research with its considerable involvement in spiritualism was treated with scepticism by the scientific world following its inception towards the end of the 19th century despite the fact that two of its most important and earliest supporters were those eminent men of science, Sir Oliver Lodge and Sir William Crookes. In later times investigations into the supernatural or paranormal have taken on a more respectable guise and the field of investigation has been extended to cover all phenomena that cannot be explained by the accepted laws of physics.

The number of workers in parapsychology—which is the present day term that has more or less replaced psychical research—is large and includes distinguished academics working in universities and other learned establishments in various countries. It may be "a struggling science" as the Editor of this book describes it, but there can be no doubt of the sincerity and devotion of its apostles.

In *New Directions In Parapsychology* seven specialists who are all actively engaged in research in one or another aspect of ESP or PK have contributed accounts of their experiments and results obtained. Only one of these contributions has direct relevance to electronics, but since most paranormal experiments are based upon statistical data, electronic equipment plays a major role. In the chapter Instrumentation In The Parapsychology Laboratory, Helmut Schmidt describes the use of automated equipment, data recording equipment, random number generators, PK test machines, and provides circuit and technical details of a remote number generator designed by the author for ESP and PK experiments. This chapter makes clear the heavy dependence of parapsychology upon modern electronic techniques.

Through this association many people involved in electronics will already have become aware of parapsychology and some begun to apply their circuit expertise to the devising of circuits for ESP and PK investigations, if not actually undertaking an active part themselves in such investigations. Such individuals and others wishing to learn more about this unusual science will find this book a useful acquisition. The Glossary of Technical Terms and Abbreviations is in itself a good guide for the uninitiated around this strange science.

The Editor John Beloff, who is Senior Lecturer in Psychology at the University of Edinburgh, contributes a reasoned introduction to Parapsychology, arguing that sufficient evidence exists now for a general acceptance of this new "borderland" science, whilst at the same time also acknowledging some embarrassment from the activities of earlier "spiritist" workers and from the current wave of bandwagon jumpers (many associated with fanciful and unscientific occult and religious bodies) who offer a threat to the credibility of Parapsychology as a reputable science.

Arthur Koestler contributes a postscript and appears to support a "chance" basis for paranormal phenomena; this is in contradiction to the "orthodox" philosophy which considers that the prime aim of all PSI experiments is to achieve repeatability and thus establish a clearly defined *cause* as the basis for all extra-sensory experiences. A most fascinating and pregnant argument to round off this instructive and authoritative book.

F.F.B.

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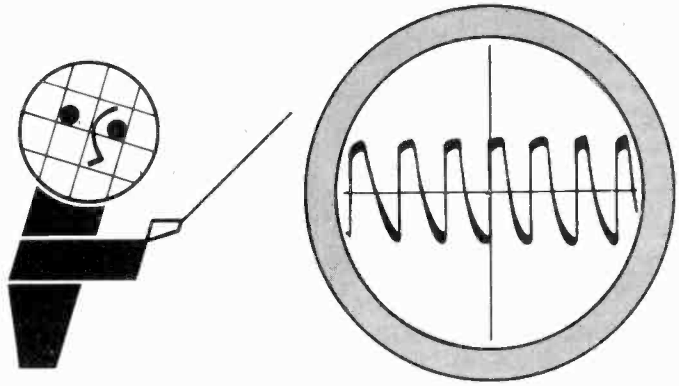

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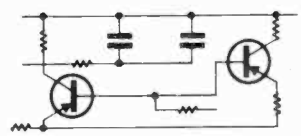

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PATENTS REVIEW...

AUDIBLY DETECTING SPEED CHANGES

BP 1 352 030

In BP 1 352 030 Customflex Inc. of Ohio, USA, describes a simple gadget for use with a transistor radio to provide an audible indication of speed change, for instance of a boat through water.

As the inventors point out, the ear has difficulty in detecting the difference between 500 clicks per second and 505 clicks per second, but has no trouble in detecting the same difference between 10 clicks and 15 clicks.

With this premise in mind, the inventors suggest an arrangement consisting of a small brass rod, pivoted at one end. A water resistant thread passes from the end of the rod through a coiled compression spring to a ferrite core. All these elements are contained in a hollow, plastic cylinder, which is wrapped with an insulated reaction coil.

This arrangement is mounted on the underside of a boat. As the boat moves through the water, the rod is repeatedly moved in an arc to pull the thread and with it the ferrite core, down against the spring. This movement of the ferrite core changes the induction of the reaction coil.

The coil is connected to an ordinary portable transistor radio by two leads and a miniature jack plug which is inserted in the jack socket provided on most radios for ear-plug use.

According to the inventors this produces a change in the oscillator and thus the sound produced by the radio which is indicative of the rate of the boat movement.

Also described is a circuit for a transistor converter which combines the functions of oscillator and mixer. A capacitor and a variable induction coil is incorporated in a series tuned circuit which imposes an electrical load on the converter to produce controlled "motor boating" clicks. Varying the radio set tuning capacitor by turning the tuning dial will adjust the basic rate of digital clicks heard on the radio.

Few further details of the transistor converter are given because the inventors regard the circuit as sufficiently well known already.

KEYBOARD INSTRUMENT

BP 1 354 407

Electronic musical instruments having 12 keys to the octave are well known. These instruments can produce only semitones and in BP 1 354 407, a Japanese inventor suggests that under certain circumstances it may be desirable for exotic musical effects to produce quarter tones as well.

The circuit achieves this in a very simple manner. A keyboard of the conventional semitone type operates twelve switches of an array, and a d.c. power source circuit which produces d.c. voltages to control a v.c.o.

In conventional manner, individual operation of the keys of the chromatic octave produces individual semitones from the loudspeaker. But, when adjacent keys are simultaneously depressed, the v.c.o. is supplied with a voltage which is substantially one half of the sum of the voltages representative of the keys pressed. The frequency produced is substantially a quarter tone between the two keys simultaneously pressed.

ELECTRONIC AID TO CURE STAMMERING

In BP 1 352 682, George Donovan and Charles Hansel of Swansea claim electronic circuitry for use in speech therapy with particular relevance to the suppression, treatment and study of stammering. The object is to produce speech-masking signals in the lower part of the audio frequency band of various duration and type. For instance, it has been found that a continuous masking sound is effective in most cases to suppress a stammer but, for therapy, bursts of masking sound are required.

As shown in Fig. 1, a Schmitt trigger Q1 is connected as a free running multivibrator with fixed and adjustable resistors R1, VR1 and a 10μF capacitor C1 to generate a masking signal of which the frequency, 180Hz, is controlled by adjustment of VR1. The output of trigger Q1 is coupled to the first input of NAND gate G1, of which the output is coupled to an earphone.

A second Schmitt trigger Q2 is connected with 2 000μF capacitor C2 as a free running multivibrator and generates a lower frequency, for example 60 or 90Hz, adjustable by R3, VR2. The output of Q2 is coupled to trigger a monostable multivibrator, with parallel capacitances C3, C4, selectively switchable by switch S1. The switch S1 also controls connection of the output of the monostable to the second input of the gate G1.

When the supply switch S2 is closed and with switch S1 in position A, the masking input of the gate G1 is not inhibited and a substantially continuous masking noise is delivered through gate G1 to the earphone. Switching S1 to positions B and C will cause the continuous output of trigger Q1 to be inhibited and an accurately shaped output of adjustable width delivered by the monostable to gate G1. Adjustment of VR3 controls the pulse width, for instance, to give a short burst of speech masking sound producing a metronomic beat in the earphone or a pulse with a mark-to-space ratio of 1 or more, equivalent to long bursts of speech-masking sound. The socket SK1 is provided for coupling auxiliary apparatus to the output of G1.

BP 1 352 682

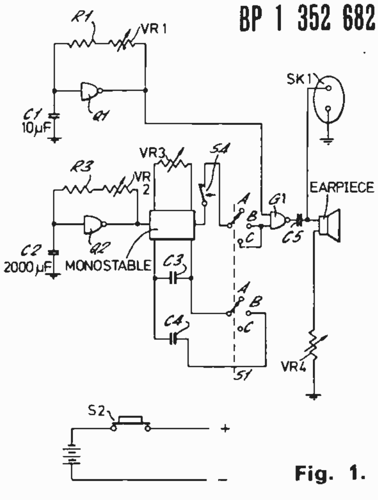


Fig. 1.

Readout—
A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Visual monitor

Sir,—A musician myself, I frequently end up advising other musicians on p.a. equipment, not infrequently building units to their requirements. Although most users seem rather unconcerned with it, a point that always worries me is that of the keen performer who turns his volume controls full on automatically (yes! they are still around—you don't have to look for them, just listen!) Distortion and ruined speakers may be prestige symbols to some, but work out expensive.

Whilst it is possible to straddle Vu meters on pre-amplifier outputs it is usually fairly messy to do, and is still only a rough guide (honest) to how rough you are being.

Recently, however, after building a power amplifier that delivered about 100W with an input of 1V, I thought of a very simple way of having a visual indication of overload on the input. I simply put an l.e.d. across it; I used a TIL 209 straight across the input. This device needs just over 1V across it before it will light up and goes on up to about 3V quite happily. Its current consumption is exceedingly low and at worst it puts about 20kΩ across the input. The effect on the input is acoustically unnoticeable.

I've given it a good try out and it does its job very well. Those unavoidable peaks give a pleasing little red flash and on real overload (don't watch the speaker) it works like a traffic light.

It doesn't matter which way round it is connected, of course, since the signal will be a.c. and scanning the market should provide a device of suitable voltage to suit most high power amplifiers.

I know the idea sounds too simple but who cares? It works!

Peter Quinn,
Portsmouth

Russian roulette

Sir,—In his novel "The Gambler", the Russian author Fyodor Dostoyevsky writes the following:

"However, I deduced from the scene one conclusion which seemed to me reliable—namely, that in the flow of fortuitous chances there is, if not a system, at all events a sort of order. This is, of course, a very strange thing. For instance, after a dozen middle figures there would always occur a dozen or so outer ones. Suppose the ball stopped twice at a dozen outer figures; it would then pass to a dozen of the first ones, and then, again, to a dozen of the middle ciphers, and fall upon them three or four times, and then revert to a dozen outers; whence, after another couple of rounds, the ball would again pass to the first figures, strike upon them once, and then return thrice to the middle series—continuing thus for an hour and a half, or two hours. One, three, two; one, three, two. It was all very curious. Again, for the whole of a day or a morning the red would alternate with the black, but almost without any order, and from moment to moment, so that scarcely two consecutive rounds would end upon either the one or the other. Yet, next day, or, perhaps, the next evening, the red alone would turn up, and attain a run of over two score, and continue so for quite a length of time—say, for a whole day".

Alexei Ivanovitch's observations concerning the phenomena of roulette seem to tally very well with Mr. Baily's experiences with the "Random Timer". Perhaps the tense atmosphere which must be in evidence in places where roulette is played is a factor which should be taken into account.

A. J. Fisher,
Hereford

Discord

Sir—I would like to take to task your correspondent Mr Malcolm Pointon regarding his article "Electromuse" in the September issue of P.E. He is altogether making too big a deal about synthesisers and electronic music generally.

What is this new phase we are entering in 1974? Evidently Mr Pointon overlooks the fantastic new phase of electronic music (in its own right) in the early 50's when no-one knew where it was leading—except Stockhausen; or the pioneers of voltage control whose work was consolidated by R. A. Moog in the mid-sixties. No, Mr Pointon, the only new phase entered into in 1974 was my acquisition of a synthesiser and an incredible education in electronics thanks to Messrs. G. D. Shaw and P.E. Music, I'm afraid, is always wallowing in primeval mud waiting for the particles to settle (at least it has been ever since someone discovered the great polyphonic era was not the musical ultimate).

What seven modes were used in early music? As far as I know only six were used. The seventh (Locrian) has never been used except as a joke—no doubt because of its peculiar interval relationships, there being no perfect fifth from the "keynote".

Regarding the emancipated second half of the twentieth century, I cannot see how this suddenly makes the aural universe boundless and open to anyone. It always has been for someone having the will to pursue it. Wagner, Stravinsky *et al.* chose dynamics from the inaudible to the painful; Aloir Haba played "between the cracks"; Liszt and Paganini are known for playing music unperformable by a human being . . . In any event, how much of our human-being music can be played by machine? I'd be delighted to hear from anyone who has patched Stravinsky's "Rite of Spring" or Ravel's "Daphnis and Chloe" on a synthesiser.

Lastly, how are we "widening our horizons beyond the natural?" With electronics? If Mr Pointon is suggesting that acoustic instruments are natural, a quote from "Studio Sound", May 1972, page 33, would be in place:

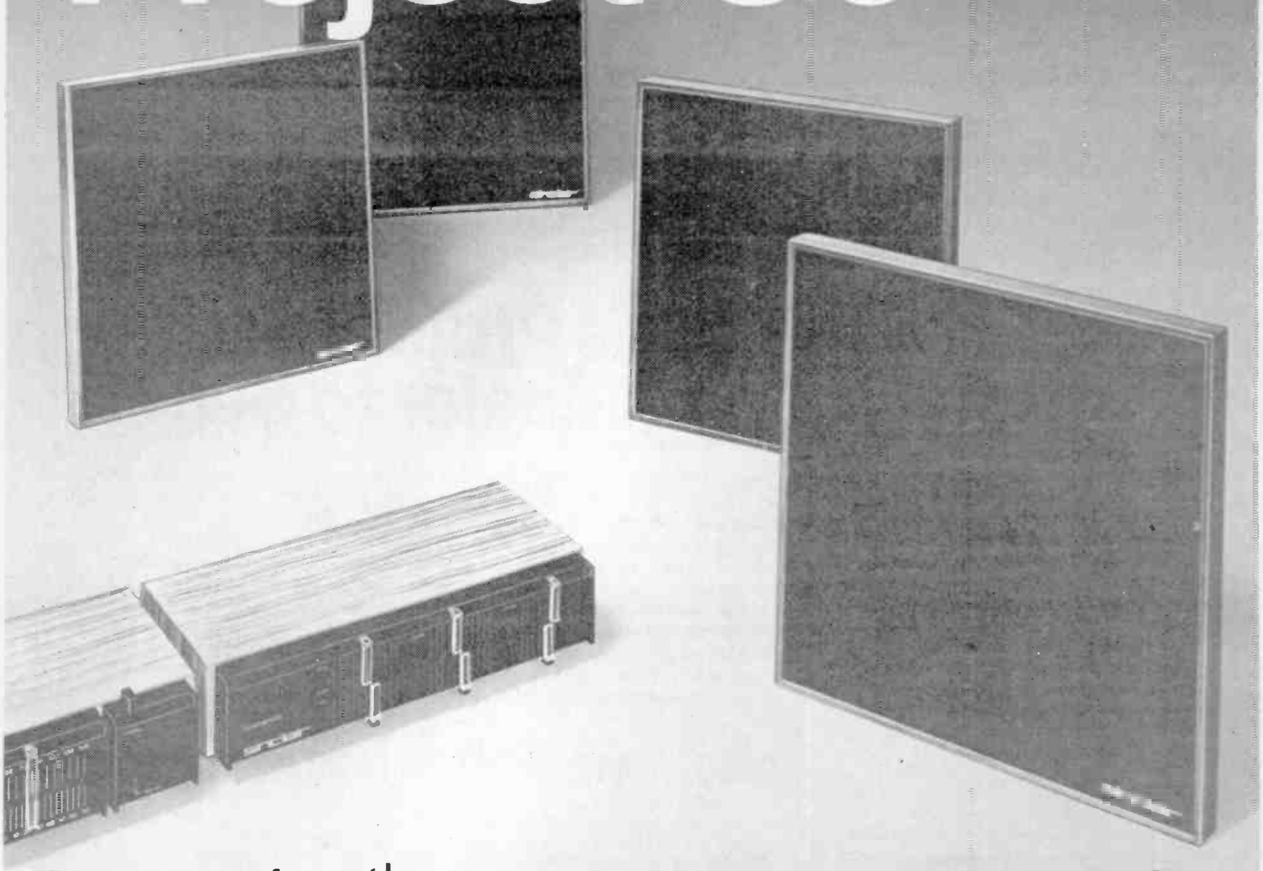
"The synthesiser is no more artificial than a saxophone. The one produces sound from vibrating electronics, the other from a vibrating reed, the harpsichord from vibrating strings . . . etc."

Coming to terms, the synthesiser is nothing more than a labour-saving device. Most of the gadgets contained therein have been around for a long time in one form or another. Dr Moog spotted the commercial value of putting them all in the same box, and Mr G. D. Shaw repackaged this to the less wealthy, like myself, who could not afford Dr Moog's prices.

Tragically, many synthesisers will fall to a fate best summarised by a further quote from the above journal: "But, for the love of music, avoid the trap which faces composers of electronic pop: using a £7,500 synthesiser to imitate unconsciously but all too successfully a cheap divider organ. It has been done and it degrades the most promising invention since the development of the chromatic keyboard."

Ivor Stuart-Colwill,
London, S.W.16.

Quadraphonic Project 80



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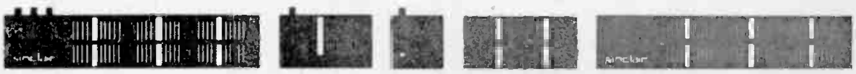

Stereo 80 pre-amp/control unit | Project 80 F.M. tuner | Project 80 stereo decoder | Project 80 active filter unit | Project 80SQ quadrophonic decoder

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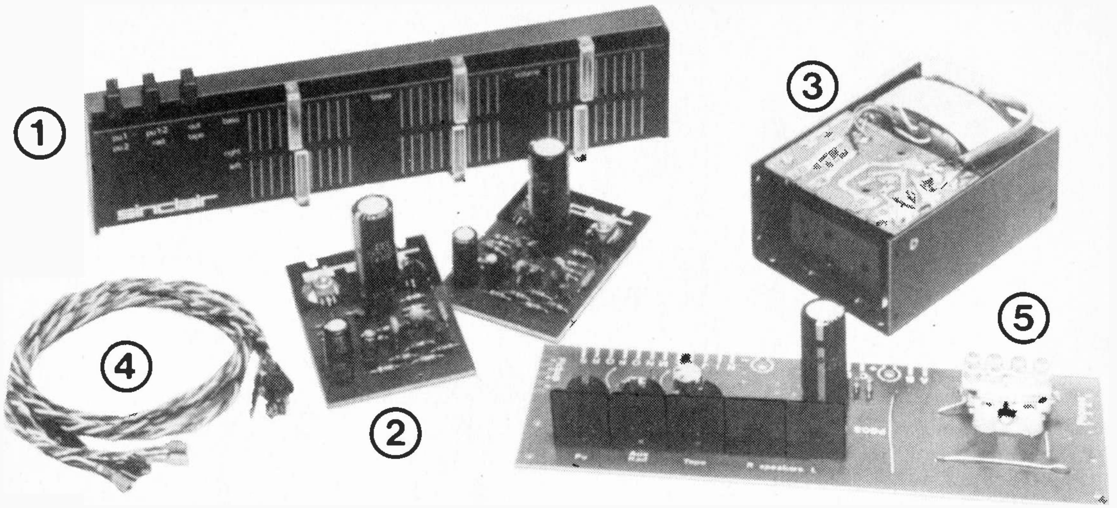

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6. Mains switch block and instructions manual (not illustrated).

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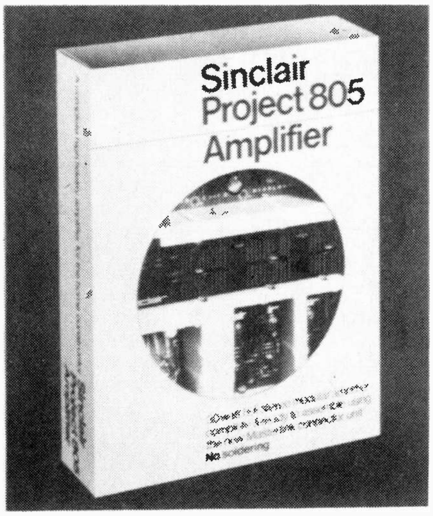

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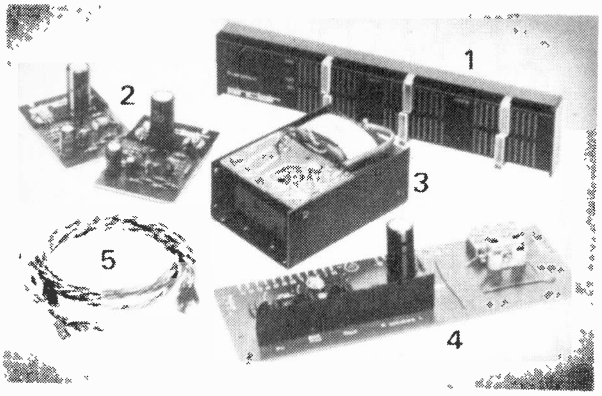

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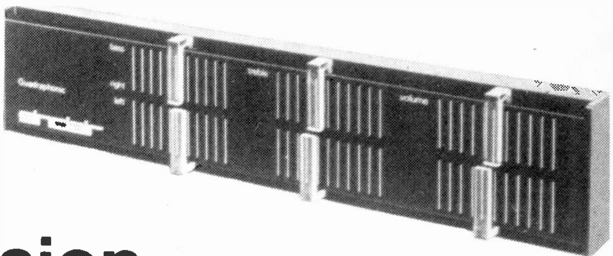
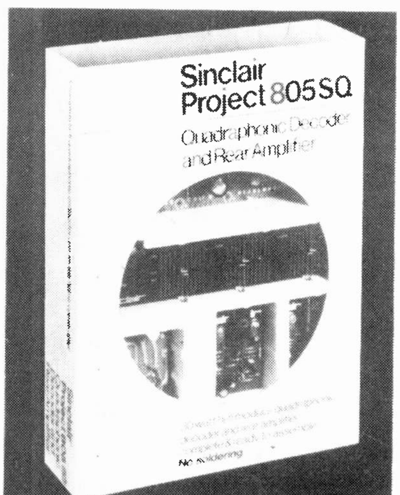


1. Project 80SQ decoder with controls.
2. Two Z.40 power amplifiers.
3. PZ.5 power pack
4. Project 80Q Masterlink unit.
5. Wire loom, with clip-on tags – NO SOLDERING!
6. (Not illustrated) Instructions manual, nuts bolts, washers, etc.

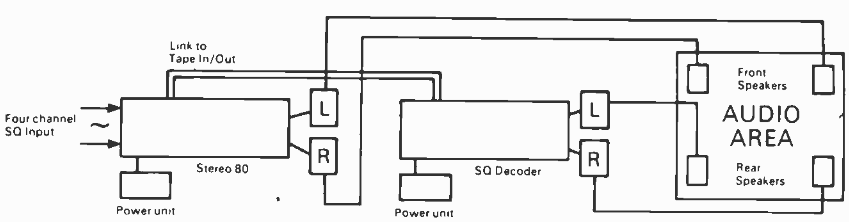
Add a fourth dimension to your stereo sound

It's so simple to convert to quadraphonics when you already have Project 80, or are about to start with Project 805. Project 805SQ is a complete add-on system at the heart of which is the Project 80SQ decoder. It uses the CBS.SQ matrix principle, by now the widest used method of containing four sound channels within the groove of the record. Project 805SQ includes two power amplifiers, power supply unit, connecting wire loom, 805Q Masterlink, switch block and instructions manual. The 80SQ decoder (also obtainable separately) has independent tone and volume slider controls on the two rear channels for matching true four channel sound to domestic environment. Project 805SQ is money saving too since you do not have to scrap existing Project 80 equipment to enjoy the newest and most exciting form of home listening in the entire history of sound, and your Project 80 quadraphonic assembly is compatible with stereo and mono records.

- Frequency response ± 3db 15 Hz-25kHz
- Rated output 100mV
- S/N ratio 58dB
- Distortion 0·1%
- Power requirements 22-35 volts
- Phase shift network 90° ±10° 100 Hz-10kHz
- Adaptable to discrete (CD4) use



Project 805SQ



The output from any good stereo cartridge feeds into Stereo 80 and passes via the tape outlet to the 80SQ decoder. Here the signal is separated into its constituent 4 channels, those for the front being accepted by the Stereo 80, those for the rear going from the decoder to the two additional power amplifiers and speakers.

£44.95

+£3.60 VAT (R.R.P.)

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 within 2 years, we will service it without charge. For damage arising from mis-use a nominal charge will be made.

Project 80 quadraphonic modules may be purchased separately if required. The Project 80SQ decoder may be used with any other amplifier having tape and monitoring facilities. Z40 or Z60 power amps can be used as required.

The Project 80 programme to date

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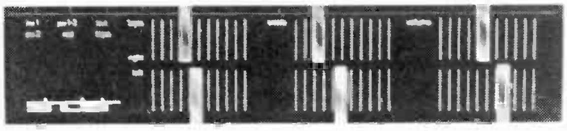
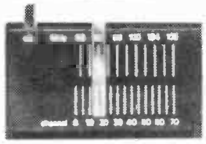
Stereo 80 pre-amp/control unit



260 x 50 x 20mm ($10\frac{1}{4}$ x 2 x $\frac{3}{4}$ ins.) separate slider controls on each channel for treble, bass and volume. INPUTS – Mag. P.U 3mV (RIAA corrected) ceramic – 300mV, Radio 100mV, Tape 30mV S/N ratio 60dB. Frequency range – 20Hz to 15KHz ± 1dB. OUTPUTS – 2·5V rms max (30V supply) and tape plus AB monitoring. PRESS BUTTONS for P.U., Radio and Tape. Operating power – 20 to 35V. Black case with white indications

£13.95 + £1.12 VAT (R.R.P.)

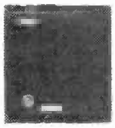
Project 80 F.M. tuner



Size 85 x 50 x 20mm ($3\frac{1}{2}$ x 2 x $\frac{3}{4}$ ins.). Tunes 87·5 to 108MHz. DETECTOR – I.C balanced coincidence (I.C equivalent to 26 transistors) Distortion – 0·2% at 1KHz for 30% modulation. SENSITIVITY – 5 microvolts for 30dB quieting. Output – 300mV for 30% modulation. Aerial imp. – 75 Ω or 240-300 Ω. Dual Varicap tuning. 4 pole ceramic filter. Switchable A.F.C. Operating power 23-30 volts.

£13.95 + £1.12 VAT (R.R.P.)

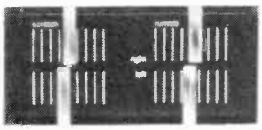
Project 80 stereo decoder



Size 47 x 50 x 20mm. For adding to Project 80 FM tuner. With one I.C equal to 19 transistors, and LED indicator which glows on tuning in stereo signal.

£8.95 + 72p VAT (R.R.P.)

Project 80 active filter unit (A.F.U.)



Size 108 x 50 x 20mm. Useful where there is need to eliminate unwanted high frequencies (scratch, whistle, etc) or low (rumble). Voltage gain – minus 0·2dB. Frequency response (filter at zero) 36Hz to 22KHz. H.F cut (scratch) variable from 22KHz to 5·5KHz 12dB/octave slope. L.F cut (rumble) – 28dB at 28Hz, slope 9dB/octave.

£7.45 + 60p VAT (R.R.P.)

Project 80 power amplifiers

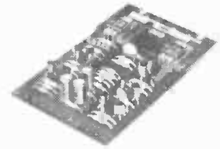
Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced

Z.40

Size – 55 x 80 x 20mm
9 transistors
Input sensitivity – 100mV
Output – 12 watts RMS continuous into 8 Ω (35v)
Frequency response – 10Hz – 100KHz ± 1dB
S/N ratio – 64dB
Distortion – 0·1% at 10 watts into 8 Ω at 1KHz
Power requirements – 12 to 35 volts

£5.95 + 48p VAT (R.R.P.)

Z.60



Size – 55 x 98 x 20mm
12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS continuous into 8 Ω (50V).
Distortion – 0.02% at 10W/8 Ω/1KHz
Frequency response – 10Hz to more than 200KHz ± 3dB
S/N ratio – better than 70dB
Built-in protection against transient overload and short circuiting
Load impedance – 4 Ω min; max. safe on open circuit

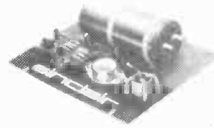
£7.45 + 60p VAT (R.R.P.)

Power-supply units

PZ.5 Unstabilized. 30 volts. Suitable for Z.40 assemblies, etc. **£5.95** + 48p VAT (R.R.P.)

PZ.6 Stabilized. Output voltage adjustable between 20 and 50 volts approx. Protecting fuse. **£8.95** + 72p VAT (R.R.P.)

PZ.8 Stabilized. Output adjustable from 20 to 60V. approx. Re-entrant current limiting makes damage from overload or even shorting, impossible. Without mains transformer.

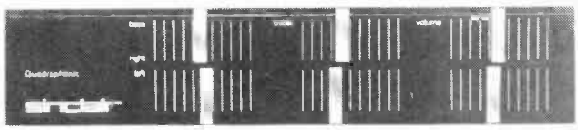


£8.45 + 68p VAT (R.R.P.)

Project 805 (previous pages) £39.95 + £3.20 VAT (R.R.P.)

Project 805SQ quadraphonic add-on kit £44.95 + £3.60 VAT (R.R.P.)

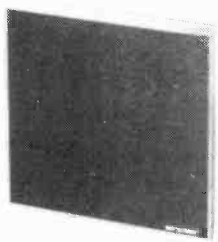
Project 80SQ quadraphonic decoder



Size 260 x 50 x 20mm, matching Stereo 80 in style. Connects with tape socket on stereo 80 or similar facility on any stereo amplifier. Frequency response 15Hz to 25KHz ± 3dB. Distortion 0·1%. S/N ratio 58dB. Rated Output – 100mV. Separate bass and treble slider controls on each channel, also volume. Phase shift network 90° ± 10° 100Hz to 10KHz. Operating power – 22-35V.

£18.95 + £1.52 VAT (R.R.P.)

Sinclair Q.16 loudspeaker



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£8.95 + 72p VAT (R.R.P.)

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telephone: 01-883 3705

RESISTORS

The standard ranges of Resistors stocked are either E12 or E24 and the values are all in multiples of ten times the decade shown below. The E12 items are only those in bold type. The E24 items are both those in bold and light type.

10	**18**	**33**	**56**
11	20	36	62
12	**22**	**39**	**68**
13	24	43	75
15	**27**	**47**	**82**
16	30	51	91

CARBON FILM /½ watt ± 5% tol. 2p ea.
E12 Series 10 to 330K

CARBON FILM ½ watt ± 5% tol. 1½p ea.
E24 Series 10 to 10M

'CERMET' THICK FILM ½ watt ± 2% tol. 8p ea.
E12 series 56 to 150K

METAL OXIDE FILM ½ watt ± 2% tol. 4½p ea.
E12 series 10 to 1M

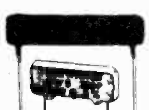
CARBON COMPOSITION ½ watt 4½p ea.
2.2 ; 2.7 ; 3.3 ; 3.9 ; 4.7 ; ±0.5 tol.
5.6 ; 6.8 ; 8.2 ±10% tol.

CARBON COMPOSITION 1 watt 5½p ea.
2.2 ; 2.7 ; 3.3 ; 3.9 ; 4.7 ; ±0.5 tol.
5.6 ; 6.8 ; 8.2 ±10% tol.

CARBON FILM 1 watt ± 5% tol. 3½p ea.
E12 series 10 to 10M

CARBON FILM 2 watt ± 5% tol. 6½p ea.
E12 series 10 to 10M

WIREWOUND 2½ watt ± 5% tol 0.22 to 0.47 15½p
E12 series ± 10% tol 1 to 270Ω 13p



WIRE WOUND 5 WATT 13p ea.

½	**25**	**250**	**1.5K**
1	30	270	1.8K
1.8	39	**300**	**2K**
2.2	**50**	330	2.2K
2.7	60	350	**2.5K**
3.3	**68**	400	2.7K
3.9	75	470	3K
4.7	82	**500**	3.3K
5	**100**	560	**3.5K**
5.6	125	600	3.9K
6.8	133	**680**	4.7K
8.2	**150**	**750**	**5K**
10	180	820	5.6K
15	**200**	1K	**6.8K**
21	220	1.2K	8.2K

WIRE WOUND 10 watt 14p ea.
All the values shown in bold in the 5 watt range

WIRE WOUND 10 watt ± 5% tol. 20p ea.
10K ; 15K ; 20K ; 25K

WIRE WOUND 15 watt 13½p ea.
All the values from 10 upward shown in bold in the 5 watt range.

POTENTIOMETERS

5K	250K	Log or Lin Less Switch (and 1K Lin)	14p
10K	500K	Log or Lin with Switch	26p
25K	1 Meg	Dual Less Switch	46p
50K	2 Meg	1 Meg Log only	57p
100K		10K Log + 10K Antilog Less Switch	46p

Sliders

10K, 25K, 50K, 100K — Single 33p; DUAL 55p

Presets

Vertical or Horizontal

.1 Watt 5½p — .25 Watt 7p

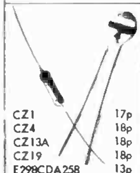
100	1K	10K	100K	1Meg
250	2.5	25K	250K	2.5 Meg
500	5K	50K	500K	5Meg

Cermets

40p

100	2.5K	25K	250K
500	5K	50K	500K
1K	10K	100K	1Meg

VDR's & Thermistors



CZ1	17p
CZ4	18p
CZ13A	18p
CZ19	18p
E298CDA258	13p
E298EDA258	13p
E298EDA260	13p
E298EDA262	13p
E298EDA265	13p
E298EDP268	13p
E298ZZ05	13p
E298ZZ06	13p
E299DDP336	14p
E299DDP338	14p
E299DDP342	14p
E299DDP348	14p
GL16	£1.21
GL23	£1.21
R53	£1.49
R54	£1.61
VA1005	16p
VA1026	16p
VA1033	16p
VA1034	16p
VA1039	16p
VA1040	16p
VA1053	16p
VA1055S	16p
VA1056S	16p
VA1066S	17p
VA1067S	19p
VA1077	19p
VA1098	21p
VA1104	31p
VA1107	29p

CAPACITORS

Ceramic Plate

Mullard C333 Series 63 Volts Wkg.

all at 5½p each

1.8pF ± 0.2pF	12pF ± 2%	68pF ± 2%
2.2pF	15pF	82pF
3.3pF	18pF	100pF
3.9pF	22pF	120pF
4.7pF	27pF	150pF
5.6pF	33pF	180pF
6.8pF	39pF	220pF
8.2pF	47pF	270pF
10 pF	56pF	330pF

Mullard 630 series 40 volts ± 10% tol
* 629 series 100 volts
all at 5½p each

390 pf	1000 pf	3300 pf
470 pf	1200 pf	3900 pf
560 pf	1500 pf	4700 pf
680 pf	1800 pf	* 10 nf
820 pf	2200 pf	* 22 nf
	2700 pf	

Erie Monolithic Ceramic 30 Volts Wkg.

27 nf 11p; 47 nf 13p; 100 nf 17p

Low Voltage Disc Ceramics
all at 5½p each

0.01 uF	18v	0.1 uF	30v
0.022 uF	18v	0.22 uF	6v
0.047 uF	18v	0.47 uF	3v

Mylar Film 100 Volts Wkg.

1000 pf	2½p	0.05 uF	3½p
2000 pf	2½p	0.068uF	5p
5000 pf	2½p	0.1 uF	5p
0.01 uF	3½p	0.2 uF	6½p
0.02 uF	3½p	0.47 uF	7p
0.04 uF	3½p		

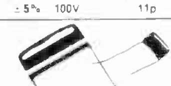
Polystyrene

MULLARD C295 Series 63 volts

Tolerance ± 1%	Polystyrene	
6.800pF (6.8nF)	C295 AH/D6K8	11p
8.200pF (8.2nF)	C295 AH D8K2	11p
13 000pF (13nF)	C295 AH D13K	15p
18.000pF (18nF)	C295 AH/D18K	15p
20nF (0.02µF)	C295 AH/D20K	15p
30nF (0.03µF)	C295 AH/D30K	18p
39nF (0.039µF)	C295 AH D39K	18p
51nF (0.051µF)	C295 AH D51K	25p

Polystyrene 160 volts Wkg
Tolerance ± pF up to 33pF ± 5% 47pF up
10 pf to 10,000 pf (0.01 uF) in multiples of:
10 ; 15 ; 22 ; 33 ; 47 ; 68.
all 5p each

Nimarks 0.22µF ± 5% 1000 11p
Wima MKS 0.22µF ± 5% 100V 11p



Mullard C280 Series. 250 Volts Wkg.
Metallised Polyester Film

0.01 uF	3½p	0.22 uF	5½p
0.015 uF	3½p	0.33 uF	7p
0.022 uF	3½p	0.47 uF	9p
0.033 uF	3½p	0.68 uF	12p
0.047 uF	3½p	1.0 uF	14½p
0.068 uF	4 p	1.5 uF	22p
0.1 uF	4½p	2.2 uF	26½p
0.15 uF	4½p		

Mullard C281 series 400 volts Wkg
Metallised Polycarbonate Film 10%

0.01 uF	5p	0.1 uF	8p
0.015 uF	5p	0.15 uF	9p
0.022 uF	5p	0.22 uF	11p
0.033 uF	6p	0.33 uF	15½p
0.047 uF	6½p	0.47 uF	16½p
0.068 uF	6½p		

CAPACITORS

Silvered Mica 350V.

Tol. ± 0.5pf 11p each

2.2 pf	18pf	30pf
3.3 pf	20pf	33pf
5 pf	22pf	39pf
10 pf	25pf	47pf

Tol. ± 1% 11p each

50pf		150pf
56pf	82pf	180pf
68pf	100pf	200pf
75pf	120pf	220pf

12p each

250pf	330pf	560pf
270pf	390pf	680pf
300pf	470pf	820pf
	500pf	

17p each

1000 pf	1500pf	220pf
	1800pf	

26p each

2700pf	3600pf	5000pf
	4700pf	

33p each

6800pf	8200pf	10000pf

Mixed Dielectric 600 Volts Wkg.

0.01 uF	8p	0.1 uF	9 p
0.022 uF	8p	0.22 uF	17½p
0.033 uF	8p	0.47 uF	26½p
0.047 uF	8p	1 uF	36½p
0.068 uF	9p		

Mixed Dielectric 1000 Volts Wkg.

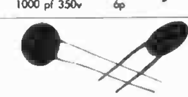
1000 pf	6½p	0.022uF	11p
2200 pf	6½p	0.047uF	13p
3300 pf	7p	0.1 uF	13p
4700 pf	7p	0.22 uF	24½p
0.01 uF	10p	0.47	33p

Solid Tantalum Beads
all at 16½p

0.1 uF	35v	10 uF	6.3v
0.22 uF	35v	10 uF	16v
0.47 uF	35v	10 uF	25v
1.0 uF	35v	22 uF	16v
2.2 uF	35v	47 uF	6.3v
4.7 uF	35v	100 uF	3v

Feed-through Ceramics

1000 pf 350v 6p

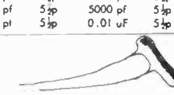


Disc Ceramics 750 Volt Wkg.
all at 5½p each

470 pf; 1000 pf; 5000 pf; 0.01 uF

Tubular HI-K Ceramics 750 Volts Wkg.

1000 pf	5½p	3000 pf	5½p
1500 pf	5½p	5000 pf	5½p
2000 pf	5½p	0.01 uF	5½p



Pulse Ceramics all at 10p each

12 kv.D.C. Wkg		8kv D.C.
10pf	120pf	200pf
22pf	140pf	220pf
68pf	150pf	250pf
82pf	180pf	270pf
100pf	200pf	300pf

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2N491	3·58
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2N493	4·20
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2N697	0·16
2N698	0·40
2N699	0·45
2N706	0·14
2N706A	0·16
2N708	0·17
2N709	0·42
2N711	0·50
2N718	0·23
2N718A	0·28
2N720	0·50
2N721	0·55
2N914	0·22
2N916	0·28
2N918	0·32
2N929	0·30
2N1302	0·19
2N1303	0·19
2N1304	0·24
2N1305	0·24
2N1306	0·31
2N1307	0·22
2N1308	0·40
2N1309	0·36
2N1671	1·44
2N1671A	1·54
2N1671B	1·72
2N1671C	4·32
2N1711	0·45
2N1907	5·50
2N2102	0·50
2N2147	0·78
2N2148	0·94
2N2160	0·90
2N2192	0·40
2N2192A	0·40
2N2193	0·58
2N2193A	0·61
2N2194	0·73
2N2194A	0·30
2N2218A	0·22
2N2219	0·24
2N2219A	0·26
2N2220	0·25
2N2221	0·18
2N2221A	0·21
2N2222	0·20
2N222A	0·25
2N2368	0·25
2N2369	0·37
2N2369	0·41
2N2646	0·55
2N2647	1·12
2N2904	0·22
2N2904A	0·24
2N2905	0·24
2N2905A	0·26
2N2906	0·19
2N2906A	0·21

Type	Price
2N2907	0·22
2N2907A	0·24
2N2924	0·14
2N2925	0·17
2N2926	
Green	0·12
Yellow	0·11
Orange	0·11
2N3053	0·25
2N3054	0·60
2N3055	0·75
2N3390	0·26
2N3391	0·23
2N3391A	0·29
2N3392	0·13
2N3393	0·13
2N3394	0·13
2N3402	0·18
2N3403	0·19
2N3440	0·59
2N3441	0·97
2N3442	1·25
2N3414	0·20
2N3415	0·21
2N3416	0·34
2N3417	0·24
2N3638	0·15
2N3638A	0·15
2N3639	0·27
2N3641	0·17
2N3702	0·12
2N3703	0·13
2N3704	0·14
2N3705	0·12
2N3706	0·09
2N3707	0·13
2N3708	0·10
2N3709	0·11
2N3710	0·12
2N3711	0·11
2N3712	0·96
2N3713	1·20
2N3714	1·33
2N3715	1·50
2N3716	1·80
2N3771	2·20
2N3772	1·80
2N3773	2·65
2N3789	2·06
2N3790	2·40
2N3791	2·35
2N3792	2·69
2N3794	0·24
2N3819	0·37
2N3820	0·64
2N3823	0·78
2N3900	0·28
2N3901	0·32
2N3903	0·24
2N3904	0·27
2N3905	0·24
2N3906	0·27
2N4036	0·63
2N4037	0·42
2N4058	0·16
2N4059	0·09
2N4060	0·11

Type	Price
2N4061	0·11
2N4062	0·11
2N4126	0·20
2N4289	0·34
2N4919	0·84
2N4920	0·99
2N4921	0·73
2N4922	0·84
2N4923	0·83
2N5172	0·12
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5190	0·92
2N5191	0·95
2N5192	1·24
2N5195	1·46
2N5245	0·43
2N5457	0·49
2N5458	0·45
2N5459	0·49
40361	0·48
40362	0·50
40363	0·88
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·33
40498	0·50
40409	0·52
40410	0·52
40411	2·00
40414	3·55
40430	0·85
40583	0·23
40601	0·67
40602	0·46
40603	0·53
40604	0·56
40636	1·10
40669	1·00
40673	0·70
AC107	0·51
AC113	0·16
AC117	0·20
AC126	0·20
AC127	0·20
AC128	0·20
AC151V	0·25
AC152V	0·17
AC153	0·25
AC153K	0·33
AC154	0·20
AC176	0·23
AC176K	0·33
AC187K	0·23
AC188K	0·34
ACY18	0·24
ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY28	0·20
ACY30	0·58
AD142	0·59
AD143	0·60
AD149V	0·58

Type	Price
AD150	0·63
AD161	0·45
AD162	0·45
AD161 } AD162 } PR	1·05
AF109R	0·40
AF115	0·24
AF116	0·25
AF117	0·20
AF118	0·55
AF124	0·30
AF125	0·30
AF126	0·28
AF127	0·28
AF139	0·39
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·58
AF186	0·46
AF200	0·35
AF239	0·51
AF240	0·72
AF279	0·54
AF280	0·54
AL102	0·75
AL103	0·70
BC107	0·16
BC108	0·15
BC109	0·19
BC113	0·15
BC115	0·17
BC116	0·17
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·29
BC121	0·23
BC125	0·16
BC126	0·23
BC132	0·13
BC134	0·13
BC135	0·13
BC136	0·17
BC137	0·17
BC138	0·24
BC140	0·34
BC141	0·29
BC142	0·23
BC143	0·25
BC145	0·21
BC147	0·12
BC148	0·13
BC149	0·12
BC153	0·18
BC154	0·18
BC157	0·14
BC158	0·16
BC159	0·14
BC160	0·37
BC167B	0·13
BC168B	0·13
BC168C	0·11
BC169B	0·13
BC169C	0·13
BC170A	0·11

Type	Price
BC171	0·13
BC172	0·11
BC182	0·12
BY182L	0·12
BC183	0·09
BC183L	0·09
BC184	0·11
BC184L	0·11
BC186	0·25
BC187	0·27
BC207	0·12
BC208	0·11
BC212K	0·10
BC212L	0·16
BC214L	0·16
BC237	0·09
BC238	0·09
BC239	0·09
BC251	0·20
BC252	0·18
BC253	0·23
BC257	0·09
BC258	0·09
BC259	0·13
BC261	0·20
BC262	0·18
BC263	0·23
BC300	0·36
BC301	0·34
BC302	0·29
BC303	0·54
BC307	0·11
BC307A	0·10
BC308	0·12
BC308A	0·12
BC308B	0·09
BC309	0·10
BC309A	0·10
BC309B	0·10
BC237	0·21
BC238	0·19
BC337	0·19
BC338	0·19
BCY30	0·64
BCY31	0·64
BCY32	1·15
BCY33	0·45
BCY34	0·49
BCY38	0·55
BCY39	1·50
BCY40	0·87
BCY42	0·28
BCY58	0·21
BCY59	0·22
BCY70	0·17
BCY71	0·22
BCY72	0·13
BCY87	3·54
BCY88	2·42
BCY89	0·97
BD115	0·75
BD116	1·00
BD121	0·75
BD123	0·32
BD124	0·67
BD131	0·40
BD132	0·50

Type	Price
BD135	0·43
BD136	0·49
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·87
BDY20	1·05
BF115	0·25
BF116	0·23
BF117	0·43
BF119	0·58
BF121	0·25
BF123	0·27
BF125	0·25
BF152	0·20
BF153	0·21
BF154	0·20
BF158	0·23
BF159	0·27
BF160	0·23
BF161	0·42
BF163	0·32
BF166	0·32
BF167	0·21
BF173	0·24
BF177	0·29
BF178	0·35
BF179	0·43
BF180	0·35
BF181	0·34
BF182	0·40
BF183	0·40
BF184	0·30
BF185	0·30
BF194	0·12
BF195	0·12
BF196	0·13
BF197	0·15
BF198	0·18
BF199	0·18
BF200	0·40
BF225J	0·19
BF237	0·22
BF238	0·22
BF244	0·21
BF245	0·33
BF246	0·58
BF247	0·49
BF254	6·16
BF255	0·17
BF257	0·46
BF258	0·59
BF259	0·55
BFS21A	2·30
BFS28	0·92
BFS61	0·27
BFS98	0·25
BFX29	0·30
BFX30	0·27
BFX44	0·33
BFX63	2·48
BFX68	0·30
BFX84	0·24
BFX85	0·30
BFX87	0·28
BFX88	0·25
BFX89	0·45
BFY18	0·52

Type	Price
BFY19	0·62
BFY20	0·50
BFY29	0·40
BFY50	0·23
BFY51	0·23
BFY52	0·21
BFY53	0·18
BFY90	0·75
BRY39	0·23
BU104	2·00
BU105	2·25
C106A	0·46
C106B	0·55
C106D	0·65
C106E	0·43
CA3020A	1·80
CA3046	0·70
CA3048	2·11
CA3089E	1·96
CA3090Q	4·23
CD4000	0·51
CD4001	0·51
CD4002	0·51
CD4009	1·07
CD4010	1·07
CD4011	0·51
CD4015	2·66
CD4016	1·02
CD4017	2·66
CD4020	2·96
CD4023	0·51
CD4024	1·90
CD4027	1·56
CD4028	2·34
CD4029	3·79
CD4041	2·11
CD4044	2·11
CD4047	1·65
CD4049	0·90
CD4050	0·90
LM301A	0·48
LM304A	2·03
LM309K	1·88
LM702C	0·75
LM709	
TO99	0·48
8DIL	0·38
14DIL	0·40
LM723C	0·90
LM741	
TO99	0·40
8DIL	0·40
14DIL	0·38
LM747	1·00
LM748	
8DIL	0·60
14DIL	0·73
LM7805	2·00
MC1303P	1·26
MC1310	2·92
MC1458CP1	0·79
MJ480	0·90
MJ481	1·14
MJ490	0·98
MJ491	1·38
MJE340	0·45

Type	Price
MJE2955	1·12
MJE3055	0·68
MP8111	0·32
MP8112	0·40
MP8113	0·47
MPF102	0·39
MPSA05	0·25
MPSA06	0·26
MPSA55	0·26
MPSA56	0·27
NE555V	0·70
NE560	4·48
NE561	4·80
NE565A	4·48
OC23	1·35
OC28	0·76
OC35	0·60
OC42	0·50
OC45	0·32
OC71	0·20
OC72	0·25
OC81	0·25
OC83	0·24
ORP12	0·55
R53	1·20
RL54	0·15
SC35D	1·68
SC36D	1·46
SC40D	1·89
SC41D	1·32
SC45D	1·89
SC45D	1·96
SC50D	2·60
SC51D	2·39
SL414A	1·80
SL623	4·59
TAA263	1·00
TAA350	2·10
TAA621	2·03
TAA661B	1·32
TAD100	1·50
Filter	0·70
TBA271	0·64
TBA641B	2·25
TBA800	1·50
TBA810	1·50
TIL209	0·30
TIP29A	0·49
TIP30A	0·58
TIP31A	0·62
TIP32A	0·74
TIP33A	1·01
TIP34A	1·51
TIP35A	2·09
TIP36A	3·70
TIP41A	0·79
TIP42A	0·90
TIP2955	0·93
TIP3055	0·60
ZTX300	0·13
ZTX302	0·20
ZTX500	0·15
ZTX502	0·18
ZTX530	0·21

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BSTB0246 £1·05. Transformer £2·75.
Minitron £1·55.
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Resistors / Tant Beads

W	Tol	Price	Value	Price
⅛	5%	1p	0·1/35	14p
¼	5%	1½p	0·22/35	14p
½	5%	2p	0·47/35	14p
1	10%	2½p	2·2 35	14p
2	10%	6p	4·7/35	18p
2½	5%	7p	10/16V	18p
5	5%	9p	47/6·3V	20p
10	5%	10p	100/3V	20p

Veroboard

	Copper		Plain	
	0·1	0·15	0·1	0·15
2·5 × 3¾in	28p	20p	—	14p
2·5 × 5in	30p	30p	—	14p
3¾ × 3¾in	30p	30p	—	—
3¾ × 5in	34p	35p	—	24p
3¾ × 17in	£1·21	95p	76p	69p
Pins × 36	24p	24p		
× 200	89p	92p		

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Integrated Circuits—TTL Reductions!

Type	Price
SN7400	0·16
SN7401	0·16
SN7401AN	0·38
SN7402	0·16
SN7403	0·16
SN7404	0·24
SN7405	0·24
SN7406	0·45
SN7407	0·45
SN7408	0·25
SN7409	0·33
SN7410	0·16
SN7411	0·25
SN7412	0·28
SN7413	0·50
SN7416	0·45
SN7417	0·30
SN7420	0·16
SN7423	0·37
SN7425	0·37
SN7427	0·45
SN7430	0·16
SN7432	0·45
SN7437	0·35
SN7438	0·35
SN7440	0·16
SN7441	0·85
SN7442	0·85
SN7445	1·59
SN7446	2·00
SN7447	1·30
SN7448	1·50
SN7450	0·16
SN7451	0·16
SN7453	0·16
SN7454	0·16
SN7460	0·16
SN7470	0·30
SN7472	0·38
SN7473	0·44
SN7474	0·48
SN7475	0·59
SN7476	0·45
SN7480	0·75
SN7481	1·25
SN7482	0·87
SN7483	1·20
SN7484	0·95
SN7485	1·58
SN7486	0·45
SN7490	0·65
SN7491	1·10
SN7492	0·75
SN7493	0·65
SN7494	0·85
SN7495	0·80
SN7496	1·00
SN74100	2.16
SN74107	0·43
SN74118	1·00
SN74119	1·92
SN74121	0·57
SN74122	0·80
SN74123	0·72
SN74141	1·00
SN74145	1·44
SN74150	1·44
SN74151	1·10
SN74153	1·09
SN74154	1·66
SN74155	1·55
SN74157	1·09
SN74160	1·58
SN74161	1·58
SN74162	1·58
SN74164	2·01
SN74165	2·01
SN74167	4·10
SN74174	1·80
SN74175	1·29
SN74176	1·44
SN64180	1·44
SN74181	5·18
SN74190	1·95
SN74191	1·95
SN74192	2·05
SN74193	2·30
SN74196	1·58
SN74197	1·58
SN74198	3·16
SN74100	2·88

Potentiometers

Linear or Log	Single	Double
Rotary Pots	18p	45p
Rotary Switched	28p	—
Sliders	50p	80p

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C 1W 6p 0·2W 6p 0·3W 6p

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PIV	50	100	200	400	600	800	1000
1·5	15p	17p	20p	22p	25p	27p	30p
3	15p	17p	20p	22p	25p	27p	30p
10	—	35p	40p	47p	56p	—	—
35	84p	92p	1·18	2·15	2·52	3·65	4·20

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Type	Price
IN34A	10p
IN914	7p
IN916	7p
AA119	7p
AA129	15p
BA100	15p
BA102	25p
BA110	25p
BA115	7p
BA141	17p
BA142	17p
BA144	12p
BA145	17p
BA154	12p
BY100	15p
BY126	15p
BY127	17½p
BY140	£1
BY237	12½p
BYZ10	35p
BYZ11	32p
BYZ12	30p
OA9	10p
OA10	20p
OA47	7½p
OA70	7½p
OA73	10p
OA79	7p
OA81	8p
OA85	10p
OA90	7p
OA91	7p
OA95	7p
OA200	7p
OA202	10p
OA210	27p

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0·16 diameter 31p
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100	0·36	0·37	0·70	0·75
200	0·30	0·41	0·75	0·80
400	0·36	0·45	0·85	1·10
600	0·40	0·52	0·95	1·25
SCR's	100V	200V	400V	600V
½A	0·43	0·44	—	—
1A	0·45	0·50	0·60	—
1·2A	0·38	0·42	0·53	0·75
3A	0·47	0·53	0·60	0·90
4A	0·50	0·55	0·65	—

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UHS70 Transmitter	£2·74
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B81	10	Reed Switches. 1" long ⅛" dia. Highspeed P.O. type	50p
H35	100	Mixed Diodes, Germ. Gold bonded, etc. Marked and Unmarked	50p
H38	30	Short lead Transistors, NPN Silicon Planar types	50p
H39	6	Integrated circuits 4 gates BMC 962, 2 flip flops BMC 945	50p
H41	2	BD131/BD132 Complementary Plastic Transistors	50p
H65	4	40361 Type NPN Sil. transistors TO-5 can comp. to H66	50p
H66	4	40362. Type PNP Sil. transistors TO-5 can comp. to H65	50p

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B83	200	Transistors, manufacturers' rejects, AF, RF, Sil. and Germ.	50p
B84	100	Silicon Diodes DO-7 glass equiv. to OA200, OA202	50p
B86	100	Sil. Diodes sub. min. IN914 and IN916 types	50p
H20	20	BY126/7 Type Silicon Rectifiers 1 amp. plastic. Mixed volts	50p
H34	15	Power Transistors, PNP, Germ. NPN Silicon TO-3 Can	50p
H67	10	3819N Channel FET's plastic case type.	50p

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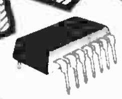

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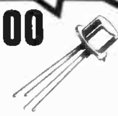

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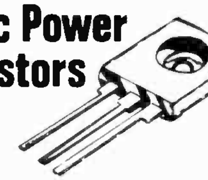

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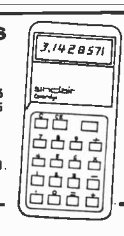

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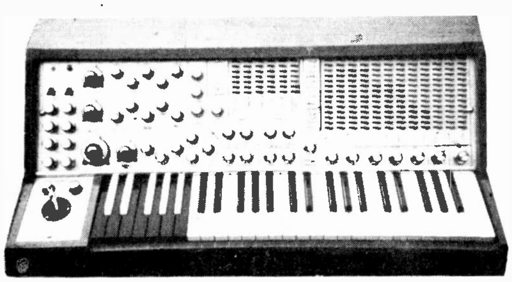

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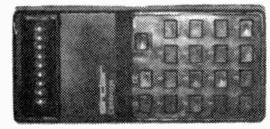

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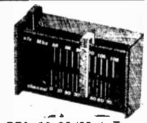

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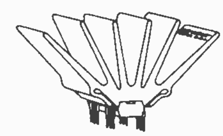

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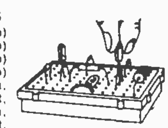

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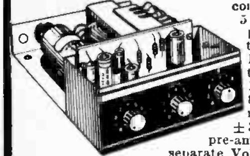

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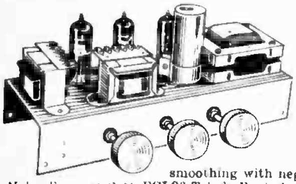

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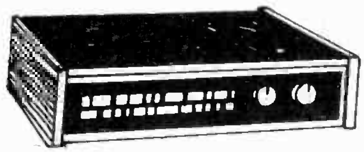

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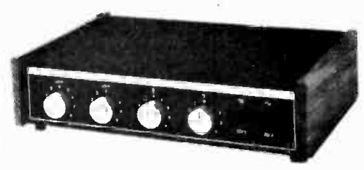

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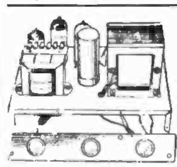

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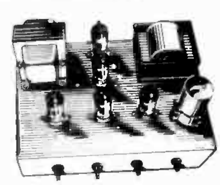

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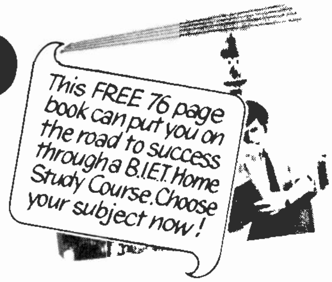

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