RADIO & ELECTRONICS CONSTRUCTOR

MAY 1980
Volume 33 No. 9

Published Monthly

First published in 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9 1SN

Telephone 01-286 6141 — *Telegrams* Databux, London

Annual Subscription: £8.50, Eire and Overseas £9.50 (U.S.A. and Canada $20.00) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers, please pay by cheque or International Money Order.

Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that queries cannot be answered over the telephone, they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production— Web Offset.

Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London W9 1SN.

The *Radio & Electronics Constructor* is printed by Swale Press Ltd.

THE JUNE ISSUE WILL BE PUBLISHED EARLY IN MAY

THREE FOR FREE FROM CSC

NEW PROJECTS

Electronics by Numbers
Projects No 4, No 5, No 6

Available from selected stockists

ELECTRONICS BY NUMBERS

RAIN ALARM

You need never be caught out by the weather again. The rain alarm will emit a warning sound whenever there's rain or moisture in the atmosphere. The current drawn from the battery is negligable so it can be left switched on for up to a year!

WOBBLY WIRE GAME

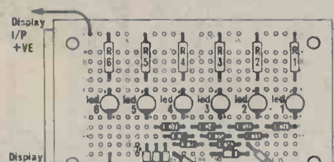
All the fun of the fair, in your own home! Test your skill at building and playing this version of the popular game, where a 'wand' has to be moved from one end of a wire to the other, without the loop at the end of the wand ever touching the wire.

HIGH QUALITY CONTINUITY TESTER

An invaluable piece of test gear for testing and fault finding circuits and wiring. Pure continuity checks can be carried out without being affected by adjoining circuitry.

Want to get started on building exciting projects but don't know how? Now using EXPERIMENTOR BREADBOARDS and following the instruction in our FREE "Electronics by Numbers" leaflets, ANYBODY can build electronic projects.

Look at the diagram, select R1, plug it in to the letter numbered holes on the EXPERIMENTOR BREADBOARD, do the same with the other components, connect to battery and ANYBODY can build a perfect working project.



YOU WILL NEED

e.g. LED Bar Graph (a previous project)
components EXP300 or EXP350
D1 to D15 — Silicon Diodes
R1 to R6 Resistors
LED 1 to LED 6 Light emitting diodes

For the full detailed instructions, including "Electronics by Numbers" circuit diagrams, simply take the coupon to your nearest CSC stockist or send direct to us and you will receive "THREE FREE PROJECTS FROM CSC".

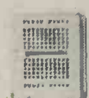
If you missed Free project No's 1, 2 and 3, please tick the appropriate box in the coupon.

EXPERIMENTOR BREADBOARDS

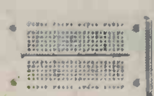
No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build a breadboard of any size.

All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP 4B.

EXP 325 £1.60 The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars.

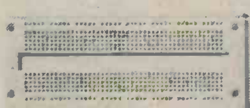


EXP 350 £3.15 Specially designed for working with up to 40 pin ICs perfect for 3 & 14 pin ICs. Has 270 contact points including two 20 point bus-bars.

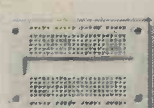


EXP 300 £5.75 The most widely bought bread-board in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 x 14 pin DIPS.

EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.



EXP 650 £3.60 Has ·6" centre spacing so is perfect for MICROPROCESSOR applications.

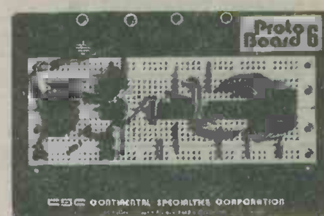


EXP 4B £2.30 Four more bus-bars in "snap-on" unit.

The above prices are exclusive of P&P and 15% VAT.

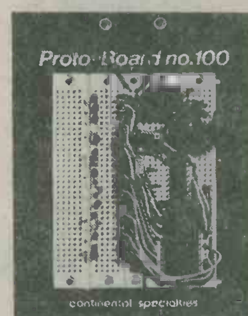
PROTO-BOARDS

The ultimate in breadboards for the minimum of cost. Two easily assembled kits.



PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

PROTO-BOARD 6 KIT £9.20



PB 100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy.

PROTO-BOARD 100 KIT £11.80

THE CSC 24 HOUR SERVICE
TELEPHONE (0799) 21682

With your Access, American Express, Barclaycard number and your order will be in the post immediately

CONTINENTAL SPECIALTIES CORPORATION

CSC

CSC (UK) LTD. EUROPE, AFRICA, MIDEAST
Dept 16 EE Shire Hill Industrial Estate Units 1 and 2
Saffron Walden, Essex CB11 3AQ
Tel: Saffron Walden **(0799) 21682**. Telex: 817477

IT'S EASY WITH C.S.C.
TO RECEIVE YOUR FREE COPY OF PROJECTS 4, 5 and 6.

Just clip the coupon

Give us your name and full postal address (in block capitals). Enclose cheque, postal order or credit card number and expiry date, indicating in the appropriate box(es) the breadboard(s) you require.

For immediate action

The C.S.C. 24 hour, 5 day a week service.
Telephone 0799 21682 and give us your Access, American Express or Barclaycard number and your order will be in the post immediatley

EXPERIMENTOR BREADBOARDS	CONTACT	IC CAPACITY 14 PIN DIP	UNIT PRICE INC P&P & 15% VAT	Qty req.
EXP 325	130	1	£ 2.70	
EXP 350	270	3	£ 4.48	
EXP 300	550	6	£ 7.76	
EXP 600			£ 8.39	
EXP 650	270	use with 0 6 pitch Dip's Strip Bus Bar	£ 5.00	
EXP 4B	Four 40 Point Bus Bars		£ 3.50	
PROTO-BOARDS				
PB6	630	6	£11.73	
PB100	760	10	£14.72	

NAME ....

ADDRESS ....

....

....

I enclose cheque/P.O. for £ ....
Debit my Barclaycard, Access, American Express card No. .... Expiry date ....

If you missed project No's 1, 2 and 3. Project 1: Two-Transistor Radio. Project 2: Fish'n'Clicks. Project 3: Led Bar Graph tick box ☐

For Free catalogue tick box ☐

C.S.C.(UK)LTD. Dept 16 EE Shire Hill Industrial Estate Units 1 and 2 Saffron Walden, Essex CB11 3AQ
Tel: Saffron Walden (0799) 21682. Telex: 817477

BI-PAK SEMICONDUCTORS

Send your orders

DEPT. RC5, PO Box 6, WARE, HERTS.

Visit our Shop at: 3 Baldock Street, Ware, Herts.

TEL: 0920 3182 TELEX: 817861

CERAMIC PAK

16160 – 24 – 3 of each value – 22pf 27pf 33pf 39pf 47pf 68pf 82pf £0.69
16161 – 24 – 3 of each value – 100pf 120pf 150pf 180pf 220pf 270pf 330pf 390pf £0.69
16162 – 24 – 3 of each value – 470pf 560pf 680pf 820pf 1000pf 1500pf 2200pf 3300pf £0.69
16163 – 24 – 3 of each value – 4700pf 6800pf 01uf 015uf 022uf 033uf 047uf £0.69

ELECTROLYTIC PAKS

A range of paks each containing 18 first quality, mixed value miniatures
16201 — 47mFD-10mFD £0.69
16202 — 10mFD-100mFD £0.69
16203 — 100mFD-680mFD £0.69

CARBON RESISTOR PAKS

16213 – 60 mixed ¼w 100 ohms – 820 ohms £0.69
16214 – 60 mixed ¼w 1K ohms – 82k ohms £0.69
16215 – 60 mixed ¼w 10K ohms – 83K ohms £0.69
16216 – 60 mixed ¼w 100K ohms – 820K ohms £0.69
16217 – 40 mixed ½w 100 ohms – 820 ohms £0.69
16218 – 40 mixed ½w 1K ohms – 82K ohms £0.69
16219 – 40 mixed ½w 10K ohms – 82K ohms £0.69
16220 – 40 mixed ½w 100K ohms – 820K ohms £0.69
16230—60 mixed ¼w 1 Meg 10 Meg ohms £0.69
16231 – 40 mixed ½w 1 Meg – 10 Meg ohms £0.69

COMPONENT PAKS

16164 – 200 Resistor mixed value approx (Count by weight) £0.69
16165 – 150 Capacitors mixed value approx (Count by weight) £0.69
16166 – 50 Precision resistors. Mixed values £0.69
16167 – 80 ⅛w resistors. Mixed values £0.69
16168 — 5 pieces assorted ferrite rods £0.69
16169 – 2 Tuning gangs. MW LW VHF £0.69
16170 – 1 Pack wire 50 metres assorted volours single strand £0.69
16171 – 10 Reed switches £0.69
16172 – 3 Micro switches £0.69
16173 – 15 Assorted pots £0.69
16174 – 5 metal jack sockets 3 x 3.5mm 2 x standard switch types £0.69
16175 – 30 Paper condensers – mixed values £0.69
16176 – 20 Electrolytics trans types £0.69
16177 – 1 Pack assorted hardware – Nuts, bolts, gromets etc £0.69
16178 – 5 Mains slide switches, assorted £0.69
16179 – 20 Assorted tag strips and panels £0.69
16180 — 15 Assorted control knobs £0.69
16181 – 3 Rotary wave change switches £0.69
16182 – 2 Relays 6-24v operating £0.69
16183 – 1 Pak copper laminate approx 200 sq inches £0.69
16184 – 15 Assorted Fuses 100mA 5 amp £0.69
16185 – 50 metres PVC sleeving assorted size and colours £0.69

METAL FOIL CAPACITOR PAK

16204 – Containing 50 metal foil capacitor like Mullard C280 series – Mixed values ranging from 01uf-2.2uf. Complete with identification sheet £1.38

SLIDER PAKS

16190 — 6 slider mixed £0.69
16191 – 6 slider 470 ohms £0.69
16192 — 6 slider 10K ohms lin £0.69
16193 – 6 slider 22K ohms lin £0.69
16194 – 6 slider 47K ohms lin £0.69
16195 – 6 slider 47K log £0.69

TRANSISTORS

AC107	£0.26
AC113	£0.23
AC115	£0.23
AC117	£0.35
AC117K	£0.39
AC121	£0.23
AC122	£0.15
AC125	£0.21
AC126	£0.21
AC127	£0.21
AC128	£0.18
AC128K	£0.30
AC132	£0.23
AC134	£0.23
AC137	£0.23
AC141	£0.24
AC141K	£0.35
AC142	£0.23
AC142K	£0.35
AC151	£0.23
AC153	£0.25
AC153K	£0.35
AC154	£0.23
AC155	£0.23
AC156	£0.23
AC157	£0.29
AC165	£0.23
AC166	£0.23
AC167	£0.23
AC168	£0.29
AC169	£0.23
AC171	£0.29
AC176	£0.21
AC176K	£0.30
AC178	£0.29
AC179	£0.29
AC180	£0.23
AC180K	£0.32
AC181	£0.23
AC181K	£0.32
AC187	£0.21
AC187K	£0.32
AC188	£0.21
AC188K	£0.32
AD140	£0.69
AD142	£0.96
AD143	£0.86
AD149	£0.69
AD161	£0.40

AD162	£0.40
AD161/162	£0.81
ADT140	£0.63
AF124	£0.35
AF125	£0.35
AF126	£0.35
AF127	£0.37
AF139	£0.40
AF178	£0.69
AF179	£0.69
AF180	£0.69
AF181	£0.67
AF186	£0.58
AF239	£0.44
AL102	£1.38
AL103	£1.36
AU104	£1.61
AU110	£1.61
AU113	£1.61
BC107	£0.09
BC107A	£0.09
BC107B	£0.10
BC107C	£0.12
BC108	£0.09
BC108A	£0.09
BC108B	£0.10
BC108C	£0.12
BC109	£0.09
BC109B	£0.10
BC109C	£0.12
BC113	£0.16
BC114	£0.18
BC125	£0.20
BC126	£0.25
BC132	£0.21
BC134	£0.21
BC135	£0.17
BC136	£0.21
BC137	£0.21
BC139	£0.37
BC140	£0.35
BC141	£0.32
BC142	£0.25
BC143	£0.25
BC145	£0.53
BC147	£0.06
BC148	£0.08
BC149	£0.08
BC150	£0.23

BC151	£0.26
BC152	£0.23
BC153	£0.29
BC154	£0.22
BC157	£0.12
BC158	£0.12
BC159	£0.12
BC160	£0.30
BC161	£0.44
BC167	£0.14
BC168	£0.14
BC169	£0.10
BC169C	£0.12
BC170	£0.10
BC171	£0.10
BC172	£0.10
BC173	£0.10
BC174	£0.17
BC175	£0.40
BC177	£0.18
BC178	£0.18
BC179	£0.18
BC180	£0.29
BC181	£0.10
BC182	£0.26
BC182L	£0.10
BC183	£0.10
BC183L	£0.10
BC184	£0.10
BC184L	£0.10
BC186	£0.25
BC187	£0.26
BC207	£0.13
BC208	£0.13
BC209	£0.14
BC212	£0.10
BC212L	£0.10
BC213	£0.10
BC251	£0.17
BC251A	£0.16
BC301	£0.32
BC302	£0.33
BC303	£0.32
BC304	£0.44
BC327	£0.18
BC328	£0.17
BC337	£0.17
BC338	£0.17
BC440	£0.35

BC441	£0.35
BC460	£0.44
BC461	£0.44
BC477	£0.23
BC478	£0.23
BC479	£0.23
BC547	£0.12
BC548	£0.12
BC549	£0.12
BC550	£0.16
BC556	£0.16
BC557	£0.15
BC558	£0.14
BC559	£0.16
BCZ10	£0.69
BCZ11	£0.69
BCZ12	£0.69
BD115	£0.58
BD116	£0.92
BD121	£0.75
BD123	£0.75
BD124	£0.81
BD131	£0.40
BD132	£0.40
BD131/132MP	£0.92
BD133	£0.46
BD135	£0.44
BD136	£0.40
BD137	£0.40
BD138	£0.41
BD139	£0.41
BD140	£0.41
BD139/140MP	£0.92
BF115	£0.26
BF152	£0.29
BF153	£0.29
BF154	£0.26
BF155	£0.40
BF156	£0.32
BF157	£0.32
BF158	£0.32
BF159	£0.32
BF160	£0.35
BF162	£0.35
BF163	£0.35
BF164	£0.55

BF165	£0.55
BF167	£0.28
BF173	£0.23
BF176	£0.44
BF177	£0.30
BF178	£0.32
BF179	£0.35
BD239A/240AMP	£1.15
BF180	£0.35
BF181	£0.35
BF182	£0.35
BF183	£0.35
BF184	£0.23
BF185	£0.23
BF186	£0.30
BF187	£0.30
BF188	£0.46
BF194	£0.12
BF195	£0.12
BF196	£0.12
BF197	£0.14
BF198	£0.16
BF199	£0.18
MJE340	£1.50
MJE2955	£1.04
MJE3055	£0.69
TIP29A	£0.46
TIP29B	£0.48
TIP29C	£0.51
TIP30A	£0.46
TIP30B	£0.48
TIP30C	£0.51
TIP31A	£0.46
TIP31B	£0.48
TIP31C	£0.51
TIP32A	£0.46
TIP32B	£0.48
TIP32C	£0.51
TIP41A	£0.51
TIP41B	£0.53
TIP41C	£0.56
TIP42A	£0.51
2N706	£0.12
2N707	£0.56
2N708	£0.16
2N1302	£0.17
2N1303	£0.21
2N1304	£0.21

2N1305	£0.21
2N1306	£0.29
2N1307	£0.29
2N1308	£0.35
2N1309	£0.35
2N1711	£0.23
2N2219	£0.23
2N2221	£0.23
2N2222	£0.23
2N2369	£0.16
2N2711	£0.25
2N2712	£0.25
2N2714	£0.25
2N2904	£0.21
2N2905	£0.21
2N2906	£0.16
2N2907	£0.23
2N2923	£0.17
2N2924	£0.17
2N2925	£0.17
2N2926G	£0.10
2N2926Y	£0.09
2N2926O	£0.09
2N2926R	£0.09
2N2926B	£0.09
2N3053	£0.18
2N3054	£0.46
2N3055	£0.46
2N3402	£0.24
2N3403	£0.24
2N3404	£0.33
2N3405	£0.38
2N3702	£0.09
2N3703	£0.09
2N3704	£0.08
2N3705	£0.08
2N3706	£0.09
2N3707	£0.09
2N3708	£0.08
2N3709	£0.08
2N3710	£0.08
2N3711	£0.08
2N3772	£1.84
2N3773	£2.53
2N3819	£0.21
2N3820	£0.40
2N3821	£0.69
2N3823	£0.69
2N3903	£0.12

74 SERIES TTL IC's

7400	£0.10
7401	£0.13
7402	£0.13
7403	£0.13
7404	£0.13
7405	£0.13
7406	£0.26
7407	£0.26
7408	£0.15
7409	£0.15
7410	£0.13
7411	£0.20
7412	£0.17
7413	£0.28
7414	£0.56
7416	£0.26
7417	£0.26
7420	£0.13
7421	£0.23

7422	£0.18
7423	£0.24
7425	£0.22
7426	£0.26
7427	£0.28
7428	£0.30
7430	£0.15
7432	£0.26
7433	£0.35
7437	£0.24
7438	£0.24
7440	£0.14
7441	£0.58
7442	£0.46
7443	£0.81
7444	£0.81
7445	£0.75
7446	£0.69
7447	£0.55

7448	£0.64
7450	£0.13
7451	£0.13
7453	£0.13
7454	£0.13
7460	£0.13
7470	£0.29
7472	£0.23
7473	£0.29
7474	£0.29
7475	£0.33
7476	£0.29
7480	£0.51
7481	£0.98
7482	£0.78
7483	£0.67
7484	£1.01
7485	£0.78
7486	£0.25

7489	£1.96
7490	£0.37
7491	£0.74
7492	£0.40
7493	£0.35
7494	£0.86
7495	£0.58
7496	£0.58
74100	£0.98
74104	£0.45
74105	£0.44
74107	£0.28
74110	£0.41
74111	£0.67
74118	£0.92
74119	£1.36
74121	£0.28
74122	£0.45

74123	£0.46
74136	£0.60
74141	£0.63
74145	£0.63
74150	£0.78
74151	£0.55
74153	£0.55
74154	£0.94
74155	£0.58
74156	£0.58
74157	£0.58
74160	£0.67
74161	£0.71
74162	£0.71
74163	£0.71
74164	£0.78
74165	£0.78
74166	£0.90
74174	£0.75

74175	£0.71
74176	£0.67
74177	£0.67
74180	£1.73
74181	£0.67
74182	£0.81
74184	£0.81
74190	£0.78
74191	£0.71
74192	£0.69
74193	£0.67
74174	£0.71
74195	£0.69
74196	£1.21
74197	£1.21
74198	£2.13
74199	£2.13

CMOS IC's

CD4000	£0.16	CD4012	£0.22	CD4021	£0.94	CD4030	£0.55	CD4045	£1.61	CD4070	£0.20
CD4001	£0.23	CD4013	£0.46	CD4022	£0.94	CD4031	£2.30	CD4046	£1.50	CD4071	£0.20
CD4002	£0.16	CD4015	£0.94	CD4023	£0.22	CD4035	£1.38	CD4047	£1.00	CD4072	£0.20
CD4006	£1.06	CD4016	£0.49	CD4024	£0.75	CD4037	£1.09	CD4049	£0.55	CD4081	£0.20
CD4007	£0.20	CD4017	£0.94	CD4025	£0.22	CD4040	£1.01	CD4050	£0.55	CD4082	£0.25
CD4008	£1.06	CD4018	£0.98	CD4026	£1.38	CD4041	£0.87	CD4054	£1.27	CD4510	£1.27
CD4009	£0.62	CD4019	£0.46	CD4027	£0.58	CD4042	£0.83	CD4055	£1.15	CD4511	£1.44
CD4010	£0.55	CD4020	£1.04	CD4028	£0.78	CD4043	£1.01	CD4056	£1.55	CD4516	£1.15
CD4011	£0.23			CD4029	£0.98	CD4044	£0.94	CD4069	£0.20	CD4518	£1.15

LINEAR IC's

CA3011	£1.12	CA3090	£4.14	LM3900	£0.67	NE567	£1.96	741P	£0.23	TBA810S	£0.86
CA3014	£1.55	CA3123	£2.19	MC1303L	£0.98	UA702C	£0.83	UA747C	£0.69	TBA810	£1.13
CA3018	£0.75	CA3130	£1.07	MC1304	£2.19	72702	£0.83	72747	£0.69	TBA820	£0.81
CA3020	£1.96	CA3140	£0.81	MC1310	£1.09	UA703	£0.29	UA748	£0.40	TBA9200	£2.88
CA3028	£0.92			MC1312	£2.19	UA709	£0.29	72748	£0.40	TCA270S	£2.30
CA3035	£1.61	LM301	£0.33	MC1350	£1.38	72709	£0.63	748P	£0.40	TBA800	£0.92
CA3036	£1.15	LM304	£1.84	MC1352	£1.61	709P	£0.29	SN76013N	£1.97		
CA3042	£.73	LM308	£1.15	MC1469	£3.39	UA710C	£0.46	SN76023N	£1.97		
CA3043	£2.13	LM309	£1.73	MC1496	£1.04	72710	£0.35	SL414A	£2.24		
CA3046	£0.81	LM320-5V	£1.73	NE536	£3.06	UA711C	£0.37	TAA550B	£0.40		
CA3052	£1.84	LM320-15V	£1.73	NE550	£1.09	72711	£0.37	TAA621A	£2.30		
CA3054	£1.27	LM320-15V	£1.73	NE555	£0.28	UA723C	£0.52	TAA621B	£2.88		
CA3075	£1.73	LM320-15V	£1.73	NE556	£0.69	72723	£0.52	TAA661	£1.73		
CA3081	£1.73	LM380	£0.98	NE565	£1.38	UA741C	£0.28	TAD100	£1.50		
CA3089	£2.30			NE566	£1.73	72741	£0.28	TBA540	£2.42		

DIODES

AA110	£0.19	BA173	£0.17	BY127	£0.18	BYZ13	£0.46	OA81	£0.12	IN34	£0.08
AA120	£0.09	BB104	£0.46	BY128	£0.18	BYZ16	£0.47	OA85	£0.12	IN34A	£0.08
AA129	£0.09	BAX13	£0.08	BY130	£0.20	BYZ17	£0.41	OA90	£0.12	IN914	£0.07
AAY30	£0.10	BAX16	£0.09	BY133	£0.24	BYZ18	£0.41	OA91	£0.12	IN916	£0.07
AAZ13	£0.17	BY100	£0.25	BY164	£0.59	BYZ19	£0.41	OA95	£0.12	IN4148	£0.07
BA100	£0.12	BY101	£0.26	BY176	£0.86	OA5	£0.59	OA182	£0.15	IS44	£0.06
BA102	£0.37	BY105	£0.25	BY206	£0.35	OA10	£0.40	OA200	£0.09	IS920	£0.07
BA148	£0.17	BY114	£0.25	BYZ10	£0.52	OA47	£0.09	OA202	£0.09		
BA154	£0.14	BY124	£0.25	BYZ11	£0.52	OA70	£0.09	SD10	£0.07		
BA155	£0.16	BY126	£0.17	BYZ12	£0.46	OA79	£0.12	SD19	£0.07		

IC PAKS

Manufacturers 'Fall Outs' which include functional and part functional units. These are classes as 'out-of-spec' from the makers very rigid specifications, but are ideal for learning about I.C's and experimental work.
16224 – 100 Gates assorted 7400 01 04 10 50 60 etc. £1.38
16226 – 30 MXI assorted types 7441 47 90 154 etc. £1.38
16227 – 30 Assorted Linear types 709 741 747 748 710 588 etc. £1.00
16228 – 8 Assorted types SL403 76013 76003 etc. £1.15
16229 – 5 I.C's 76110 Eqv. to MC13130P MA767. £1.73

MAMMOTH I.C. PAK

16223 – Approx 200 pieces assorted fall out integrated circuits including Logic 74 series Linear Audio and DTL Many coded devices but some unmarked you to identify £1.44

JUMBO PAK SEMI CONDUCTOR

16222 Transistors Germ and Silicon Rectifiers Diodes Triacs – Thyristors IC's and Zeners. ALL NEW & CODED Approx 100 pieces. Offering the amateur a fantastic bargain pack and an enormous saving. £2.50

UNTESTED SEMI-CONDUCTOR PAKS

16130 100 Germ gold bonded OA47 diodes £0.69
16131 150 Germ point contact 100mA OA70 81 diode £0.69
16132 100 Silicon diodes 200mA DA200 £0.69
16133 150 Silicon fast switch diode 25mA IN41 18 £0.69
16134 50 Silicon rectifiers top hat 250mA £0.69
16135 20 Silicon rectifiers stud type 3 amp £0.69
16136 50 400 mW zeners DO7 case £0.69
16137 30 NPN transistors BC107 8 plastic £0.69
16138 25 NPN TO39 2N697 2N1711 silicon £0.69
16138 30 PNP transistors BC177 178 plastic £0.69
16140 25 PNP TO39 2N2905 silicon £0.69
16141 30 NPN TO18 2N708 silicon switching £0.69
16142 25 NPN BFY50 51 £0.69
16143 30 NPN plastic 2N3906 silicon £0.69
16144 30 PNP plastic 2N3905 silicon £0.69
16145 30 Germ OC71 PNP £0.69
16146 15 Plastic power 2N3055 NPN TO220 case £1.38
16147 10 TO3 metal 2N3055 NPN £1.38
16149 10 1 amp SCR TO39 £1.38
16150 8 x 3 amp SCR TO66 case £1.38

TANTALUM CAPACITORS

3137	1MFD	35V	£0.13
3138	22MFD	35V	£0.13
3139	47MFD	35V	£0.13
3141	2.2MFD	35V	£0.14
3142	4.4MFD	35V	£0.21
3157	3.3MFD	25V	£0.21
3143	10MFD	35V	£0.26
3144	22MFD	16V	£0.26
3156	33MFD	35V	£0.13

SOCKETS

1611 8 Pin DIL	£0.10
1612 14 Pin DIL	£0.13
1613 16 Pin DIL	£0.14
1614 24 Pin DIL	£0.28
1615 28 Pin DIL	£0.30
1720 18 Pin DIL	£0.20
1721 20 Pin DIL	£0.22
1722 22 Pin DIL	£0.23
1723 40 Pin DIL	£0.31

G.P. SILICON DIODES

300mW 40PiV (min) sum-min. FULLY TESTED. Ideal for Organ builders. 30 for 68p, 100 for £1.85, 500 for £5.75, 1000 for £10.35.

G.P. SWITCHING TRANSISTORS

TO18 sim to 2N7068 BSY27 28 95A ALL usable devices. No open and shorts. ALSO available in PNP similar to 2N2906 BCY70. 20 for 68p, 50 for £1.15, 100 for £2.07, 500 for £9.20, 1000 for £16.10. When ordering please state NPN or PNP.

All prices include VAT: Add 35p post per order — Just quote your Access or Barclaycard number

Terms: Cash with order, cheques, POs, payable to Bi-Pak at above address

Access and Barclaycard also accepted

GIRO A/C No. 3887006

SAME DAY SERVICE

QUALITY COMPONENTS

ALL PRICES INCLUDE V.A.T. AND P. & P.

AXIAL CAPACITORS

1/25v	4p	150/25v	6p
2.2/63v	4p	160/25v	6p
3.3/50	4p	220/16v	8p
4.7/40v	4p	220/25v	8p
10/25v	4p	220/63v	9p
15/16v	5p	330/10v	9p
22/10v	5p	330/25v	9p
22/16v	5p	330/63v	12p
22/25v	5p	470/6.3v	9p
33/35v	5p	470/16v	12p
33/50v	5p	470/40v	15p
47/25v	5p	680/6.3v	12p
47/16v	5p	1000/6.3v	15p
47/50v	6p	1000/16v	20p
100/10v	5p	1500/25v	20p
100/16v	5p	2200/10v	20p
100/63v	8p	3300/16v	25p

RADIAL CAPACITORS

.47/50v	4p	220/50v	9p
1/50v	4p	220/63v	9p
2.2/25v	4p	330/10v	8p
10/40v	4p	330/25v	8p
10/50v	5p	330/50v	9p
15/16v	5p	330/63v	9p
22/25v	5p	470/6.3v	8p
22/50v	6p	470/16v	9p
33/63v	6p	470/25v	10p
47/16v	6p	1000/16v	20p
47/35v	6p	1000/25v	21p
100/35v	6p	2200/10v	23p
220/16v	8p	2200/10v	23p
220/40v	8p	3300/6.3v	24p

C280 POLYESTER CAPACITORS

.01uF	4p	.15uF	6p
.015uF	4p	.22uF	6p
.022uF	4p	.33uF	8p
.033uF	4p	.47uF	8p
.047uF	4p	.68uF	12p
.068uF	5p	.68 F 630v	10p
.1uF	5p	1.0uF	15p

AXIAL POLYESTER

.001uF	400v	3p
.0015uF	400v	3p
.0022uF	160v	3p
.0022uF	400v	3p
.0027uF	400v	3p
.0068uF	400v	3p
.01uF	160v	4p
.022uF	160v	4p
.033uF	400v	4p
.039uF	400v	4p
.047uF	160v	4p
.1uF	160v	5p
.1uF	400v	5p
.15uF	160v	6p
.18uF	160v	6p
.22uF	160v	6p
.22uF	400v	6p
.47uF	400v	8p
1uF	160v	15p

CERAMIC DISC

.047 24v 9mm dia 3p
.1uF 30v 13mm dia 5p

CAN CAPACITORS

1250/50v	50p	10,000/10v	60p
2500/35v	70p	15,000/10v	60p

TANTALUM BEAD

.22/35v	8p	10/16v	11p
.33/35v	8p	15/16v	14p
.47/35v	8p	22/6.3v	14p
2.2/35v	8p	47/16v	16p
4.7/25v	11p	100/3v	16p
6.8/35v	11p		

HIGH VOLTAGE CAPS

Polystyrene .1uF 10% 1000v 8p
Paper .1uF 10% 1000v 10p

TRANSISTORS

AC128	15p	T1P2955	65p
BF137	11p	2N3053	20p
BFX84	20p	2N3819	19p
C106D	40p	2N5062	20p
MJE2955T	80p	2N5064	20p
MJE3055T	70p		

DISPLAYS

TLR302 .3 inch Common Cathode	70p
TLR308 .6 inch Common Anode	£1.10
DL500 .5 inch Common Cathode	75p
FND507 .5 inch Common Anode	£1.20
Red L.E.D's .2 inch	8p
Green L.E.D's .2 inch	12p
Yellow L.E.D's .2 inch	12p

DIODES

IN914	3p	IN4006	6p
IN4001	4p	IN4150	3p
IN4002	4p	IN5401	10p
IN4003	5p	IN4148	2p
IN4004	5p	OA91	4p
IN4005	6p	OA200	6p

LINEAR I.C.'s

LM380	50p	TBA820	70p
LM741	19p	TCA270SQ	55p
NE555	22p	SN70613N	£1.20
CA1310Q	£1.20	SN76023N	£1.20
CA3089Q	75p	SN76033N	£1.20
TAA350	£1.00	SN76110N	75p
TBA120A	50p	SN76131N	£1.30
TBA120S	70p	SN76660N	75p
TBA800	70p	711	40p

SUB-MIN PRESETS

Horizontal:
100Ω, 220Ω, 470Ω, 1k, 1k5, 2k2, 4k7, 10k, 47k, 100k.
Vertical:
470Ω, 2k2, 4k7, 47k.
All price 5p each

SWITCHES

Push to make switches	16p
Sub-min DPDT Slide switches	14p
Standard DPDT Slide switches	12p
Standard DPDT Toggle switches	49p

Rotary switches 1p 12w, 2p 6w, 3p 4w, 4p 3w All 41p each

VARIOUS ITEMS

P.C. Board	
Approx. 2⅝" x 8½"	10p
Approx. 4½" x 9"	25p
Etch Resist Pen	85p
PP3 battery clips	6p
PP9 battery clips	14p
Din Plugs 5 pin 180°	10p
Din Sockets 5 pin 180°	
Standard metal type	10p
Green Phono Plugs	6p
Latch switches 2p 2w	10p
20mm chassis mounting fuseholders	6p

SPECIAL OFFER

(While stocks last)

100	IN4001	£3.00
100	IN4003	£3.50
100	IN4005	£4.00
100	IN4006	£4.00
100	BC107	£7.50
100	BC109	£7.50
100	BC183L	£5.50
25	High Quality CA741 8 pin (metal can)	d.i.l. £3.25
IN4148	100 off	£1.75
	1000 off	£15.00

TTL

7400	10p	7474	23p
7401	12p	7475	24p
7402	12p	7476	19p
7404	12p	7485	50p
7405	12p	7486	21p
7406	25p	7489	£1.25
7408	14p	7490	32p
7409	14p	7491	30p
7410	10p	7492	30p
7411	15p	7493	25p
7412	16p	7494	43p
7414	42p	7495	37p
7416	22p	74107	20p
7420	12p	74121	26p
7421	20p	74122	34p
7427	20p	74123	42p
7430	13p	74132	48p
7432	17p	74141	56p
7437	18p	74151	38p
7438	19p	74153	38p
7440	12p	74154	60p
7441	50p	74160	45p
7442	38p	74164	60p
7446	51p	74174	55p
7447	43p	74175	55p
7450	12p	74192	48p
7451	12p	74193	48p
7470	26p	74194	43p
7472	22p	74196	48p

CMOS

4000	15p	4026	£1.25
4001	18p	4027	48p
4002	15p	4028	78p
4006	91p	4030	48p
4007	15p	4035	93p
4008	78p	4040	80p
4009	41p	4041	80p
4010	36p	4042	76p
4011	19p	4043	76p
4012	15p	4044	78p
4013	42p	4046	£1.10
4014	73p	4049	42p
4015	70p	4050	42p
4016	40p	4052	65p
4017	76p	4053	65p
4018	78p	4066	48p
4019	43p	4068	15p
4020	80p	4069	15p
4021	80p	4070	22p
4022	85p	4071	20p
4024	64p	4072	20p
4025	15p	4078	20p

TRANSISTORS

AD161/162 MP	75p	BD116	45p
OC36	47p	BD131	30p
BC107	9p	BD183	90p
BC107B	10p	BF185	19p
BC108	9p	BF194	12p
BC108A	10p	BF195	12p
BC108C	11p	BF198	12p
BC109	9p	BF200	25p
BC109C	11p	BF240	8p
BC142	21p	BF241	7p
BC147	7p	BF244	14p
BC148	7p	BF245	14p
BC149C	8p	BF255	10p
BC149S	9p	BF336	16p
BC153	8p	BFX88	28p
BC154	8p	BFY50	15p
BC171B	10p	BFY51	20p
BC172B	10p	BSX21	10p
BC182L	9p	BU208	90p
BC183A	10p	BF256	15p
BC183L	8p	TIP29	38p
BC207B	11p	TIP30	38p
BC212L	10p	TIP31A	45p
BC213LB	10p	TIP32A	45p
BC308	10p	TIP32B	31p
BC338	10p	TIP41A	65p
BC455	7p	TIP42A	65p
BC456	9p	2N2905	20p
BC547	11p	2N2906	16p
BC548	9p	2N2907	18p
BC549	9p	2N3055	45p
BCY70	11p	2N3702	9p
BCY72	12p	2N3703	9p
BCY79	12p	2N3704	9p

HARRISON BROS. P.O. Box 55, Westcliff-on-Sea
Essex SS0 7LQ
Telephone: Southend-on-Sea (0702) 32338
TRADE ENQUIRIES WELCOME

TRANSISTORS

BF355	15p
BFT71	15p
BFQ37	15p
BFT70	15p
BCY79B	15p
BFQ35	15p
BFT41	15p
2N2192A	15p
2N3418	15p
2N914	15p
BFT30	15p
2N2586	15p
2N3714	54p
BFY52	15p
2N2217	15p
2N4026	15p
BFT31	15p
2N4000	15p
BC304	15p
BFT60	6p
BU105/04	78p
BU204	53p
BF257	20p
R2540	£1.70
SGS308	4p
ACY28	22p
ASZ21 (T2040)	4p
OC76	15p
BF451	6p
BC141	11p
BF198	5p
2N3715	£1.15
2N6028 PUJT	3p
TIS91	3p
TIS73L	3p
2N3703	3p
BF394B	3p
BC182L	3p
BC251	3p
2N3707	3p
BC213LA	3p
BDY20	86p
2N5247	40p
BSX78	8p
2N3645	3p
AC126	16p
AC127	16p
AC153	11p
AC128	5p
AC176	11p
ACY20	30p
ACY21	30p
AD161-162 (matched pair)	70p
AF116	21p
AF119	35p
AF126	27p
AF127	27p
AF139	23p
AF178	35p
AF180	35p
AF181	33p
AF239	35p
ASY60	35p
ASY63	12p
ASY73	35p
AUY10	70p
AU110	£1.51
AU113	£1.18
BC107/A/B	6p
BC108/A/B/C	6p
BC109/B/C	6p
BC125B	3p
BC147/A/B/C	5p
BC148/A/B/C	5p
BC149/A/B/C/S	5p
BC154	7p
BC157/A	5p
BC158/A/B	5p
BC159/B/C	5p
BC171B	8p
BC172	6½p
BC172C	7½p
BC173	4p
BC177A	14p
BC178A/B/C	14p
BC179B	14p
BC182/AL	5p
BC183/A/AL/L	3p
BC184L	5p
BC186	21p
BC187	8p
BC204	11p
BC212L/B	5p
BC213L/B	5p
BC214L/B	5p
BC237A	7½p
BC238	5p
BC238B/C	7½p
BC239C	7½p
BC257B	7½p
BC258B/C	7½p
BC259C	7½p
BC307	7p
BC308B/C	7½p
BC309B	7½p
BC327	8p
BC328	8p
BC337	8p
BC338	5p
BC547/A/B	5p
BC548/A/B/C	5p
BC556	5p
BC557/8	6p

BC558A	5p
BC559	5p
BCW71R	1p
BCX32	15p
BCX36	15p
BCY11	28p
BCY31	59p
BCY56	10p
BCY70	8p
BCY71	8p
BCY72	8p
BCZ11	32p
BD113	57p
BD115	35p
BRC/BD116	45p
BD375	35p
BD437	35p
BD438	28p
BD239C	29p
BD246 (55V TIP2955)	32p
BD133	28p
BD135	25p
BD136	25p
BD137	28p
BD138	28p
BD137-138 (matched pair)	60p
BD139	17p
BD142	35p
BD156	50p
BD201	86p
BD202	84p
BD203	86p
BD204	86p
BD232	52p
BD233	20p
BD234	13p
BD235	35p
BD238	28p
BDX77	97p
BF115	18p
BF167	18p
BF173	18p
BF178	23p
BF179	23p
BF180	12p
BF181	8p
BF182	18p
BF183	18p
BF184	18p
BF185	18p
BF194/A	5p
BF195/C/D	5p
BF196	5p
BF197	5p
BF200	13p
BF245	6p
BF256	4p
BF256LB/LC	3p
BF258	17p
BF262	29p
BF263	29p
BF274	8p
BF324	3½p
BF336	18p
BF494	10p
BFR34A	36p
BFR38	68p
BFR86	19p
BFS2/BFS21 pair	£3
BFS28	50p
BFW10	46p
BFW11	46p
BFW30	24p
BFW57	18p
BFW58	18p
BFX12	23p
BFX29	15p
BFX30	18p
BFX37	16p
BFX84	20p
BFX85	14p
BFX88	20p
BFX89	20p
BFY39	20p
BFY50	13p
BFY75	15p
BFY90	40p
BLY10	23p
BR101 PUJT	20p
BRY39 PUJT	29p
BRY56 PUJT	29p
BSV64	36p
BSV79	50p
BSV80	50p
BSV81	75p
BSX19	15p
BSX20	10p
BSX21	10p
BSY40	30p
BSY95A	10p
BU105	78p
BU208	90p
D1693	£2.85
GET102	48p
GET111	45p
GET120	30p
GT46B	16p
M103G	
MOS FET	30p
MA393	25p
MD7000	£2.25
ME2	13p

ME0412	14p
ME8003	20p
MJ481 (BDY23)	23p
MJE371	40p
MJE2371	80p
MM15 Russian	25p
MM1417A Russian	25p
MPF131 Dual MOS FET	15p
MPU131 Prog UNIJ	15p
MRF502 Improved BFY90	50p
M16A Russian	25p
M42A Russian	25p
NKTA49	23p
NKTA52	20p
NKT854	30p
NKT152	38p
NKT153	24p
NKT154	26p
NKT251	18p
NKT775	16p
NKTME2	13p
OC41	12p
OC42	21p
OC43	55p
OC44	12p
OC45	13p
OC71	4p
OC77	48p
OC84	30p
OC200	41p
OC201	66p
OC202	66p
OC603	50p
OC701	50p
ON222	23p
P346A	24p
P7029	30p
PXB103	25p
R1039 (2010)	54p
R2008B	£1.18
R2010B	£1.18
S3017	25p
SB240	28p
SFT357	26p
SJE5039	8p
SL102	40p
TE886	£1
TIP30	22p
TIP31	24p
TIP32C	26p
TIP48	33p
TIS43	4p
TIS61	3p
TIS90	4p
TIS92	3p
TK24	20p
V435	20p
ZT403P	30p
U14710	20p
ZT1486	£1.10
ZTX300	9p
ZTX327	18p
ZTX341	9p
2G103	33p
2G302	12p
2G309	30p
2G339A	20p
2G371	18p
2N456A	71p
2N597	16p
2N598	16p
2N601	£1.50
2N644	22p
2N706A	12p
2N708	9p
2N918	12p
2N929	16p
2N984	28p
2N987	45p
2N1091	16p
2N1132	14p
2N1302	16p
2N1303	16p
2N1395	25p
2N1484	£1.15
2N1487	90p
2N1490	£3
2N1500	30p
2N1507	18p
2N1711	13p
2N1748	28p
2N2219	14p
2N2221/A	9p
2N2222A	8p
2N2369	10p
2N2401	7½p
2N2412	27p
2N2483	28p
2N2484	10p
2N2887	£2
2N2894	11p
2N2904	9p
2N2905	15p
2N2906	9p
2N2907/A	8p
2N2926	4p
2N3020	25p
2N3053	16p
2N3054	35p

2N3055RCA	68p
2N3133	24p
2N3283	25p
2N3553	56p
2N3583	18p
2N3614	75p
2N3704	4p
2N3711	3p
2N3716	23p
2N3794	14p
2N3799	18p
2N3823	25p
2N3906	8p
2N4037	30p
2N4062	4p
2N4285	17p
2N4891	30p
2N4918	15p
2N5298	44p
2N5484	37p
2N6385 PWR DARL	54p
2N6124	24p
2SA12	42p
2SA50	36p
2SA80	36p
2SA83	38p
2SA141	38p
2SA142	38p
2SA234	50p
2SA235	50p
2SA354	38p
2SA360	34p
2SA367	56p
2SA518	38p
2SA634	80p
2SB56	18p
2SB75	25p
2SB77	25p
2SB134	25p
2SB135	25p
2SB136	25p
2SB156	60p
2SB175	20p
2SB176	20p
2SB187	25p
2SB405	18p
2SB457	25p
2SD28	80p
2SD315D	80p
40235	50p
40250	36p
40310	23p
TOR67	1p
TOR04	1p
TOR45A/B	1p
TOR47	1p
TOR37	1p
TOR50	1p
2N(SX)3704	7½p
BC382L	7½p
BF244C	7½p
2N1716	15p
BC384B	7½p
BF224	7½p
BC612L	4p
BF615	27p
BF617	27p
BFQ85	15p
BFW31	15p
TIS92GY	15p
2N5147	15p
BC140	15p
2N4031	15p
BFT39	15p
BC302	15p
BFT61	15p

RESISTOR PACKS

10 for 4p
5K6 ¼wT
3K9 1wT
22M 2wT
1M5 1wT

100K ¼wT
1K8 ¼wT

100 for 40p
68Ω 1wT
12K ¼wT 2%
560Ω ¼wT 2%
2K ¼wT

MOTOROLA EX-EQUIPMENT (unused) 2N3055
28p

MARKED FULL SPEC DIGITAL I.C's
25 for £1
Branded-new

HUGHES MICRO ELECTRONICS 400MW ZENER DIODES 200 IN CLEAR PLASTIC HINGED LID COMPONENT BOX
£3.65
3.6V, 3.9V, 4.3V or 4.7V

ELECTROLYTICS — Hundreds more in catalogue
Value/Voltage

Tant Bead .22, .47/35v **6p.** .1, 1/35v, 47/6.3v **8p.** .22/20v, 3.3/16v, 4.7/35v, 10/25v, .22/16v **9p.** 4.7/16v, 10/3v **10p.** 3.3/35v **12p.**

Wire End
63v 2.2, 3½p. 4.7, 4p. 10, 33, 5p. 2.5 3p. 1.5, 22 47 **6p.** 68, 100, 220 **8p.** 150 **7½p.** 330 **8p.** 470 **12½p.** 1000 **29p.** 25v 6, 6.4, 10, 12, 16, 22, 25, 30, 33, 40, 47, 50, 64 **4p.** 100, 150, 160, 330 **6p.** 220 **7p.** 250, 300, 470 **8p.** 1000 **11½p.** 22/16. 3.3/50, 10/50 **4p.** 100/10, 47/16. **5p.** 100/16 100/35, 220/16 **6p.** 470/6.3, 10/350 470/16 **8p.** 1000/16 **10p.** 1500/6.3 **7½p.** 2200/10 **20p.** 4700/10 **9p.** 15/160 **7p.** CANS 250/300, **45p.** 300/450 **90p.** 100/275 **14p.** 2000/100 **82p.** 1000/100 **70p.** 8+8/450 **9p.** 10,000/16 **36p.** 2000/50 **35p.** 2000 + 2000/50 **40p.** Full range in catalogue.

CAPACITORS: up to 500v: **Ceramic** up to 4700pF **2p**, to .047 **2½p**, to .1 **5p**, to .47 **8p. Silvermica** up to 5000pF **5p**, to .01 **21p. Poly, etc** up to 820pF **3p**, to 0.1 **2p**, to .27 **5p** to .47 **5½p**, .5 **9p**, .68 **11p**, 047/630V **11p.**
.1, .22/900v **15p.** .3/600v **4p.** .97/160v **7½p.** 1mFd up to 250v **10p.** 2.2mFd up to 100v **14p.** 4/16v **25p.** 4.7/63 **10p.** 6.8/63, 25/50 **19p.** 8/20v **40p.** CAN 1/350 **12p.** 8/660 vac **£2.** 3/660 vac **£1.75.** 5/150 **70p.**
Pulse Tube: 8-12kV, 10, 47, 56, 82, 100, 120, 300pF **2p each.** Hundreds of others in Catalogue

TV MAINS DROPPERS
5 assorted multiple units for **45p**

16 Watt Power Amp. Module
35v 1A power required, giving 16 watt RMS into 8 **£3.65**
RS neg. volt regulator 103, 306-099 (equiv. MPC900) 10A, 100 watt 4-30 volt. Adjustable short circuit protection. Sacrifice at **75p**

RESISTORS
⅛-¼-½ watt **1p**
1 watt **1½p**
1 or 2% **1½p**
Up to 15W w/wound **10p**, 10 same value **75p**

Skeleton Presets
Slider, horizontal or vertical standard **7p** or submin **5p.**

RELAYS
RS/Alma reed relay, 1K12v or 3k Ω 18-30v d.c. coil, normally open **36p**
12v d.p.c.o. heavy duty octal **£1**
600 Ω 4 p/co min sealed **75p.** Base **10p.**
D.I.L. 3.7-12V S.P. **£1.00**

THERMISTORS and V.D.R's
CZ1/2/6/11/14, KR22, KT150, VA1005/6/8/1010/1033/4/7/8/9 1040/1053/5 /1066/7/1074/6/7 / 1082/6/1091/6/7/8 / 1100/3/8/8602. Rod with spot blue/fawn/green. E299DDP120 / 218 / 224 / 338 / 340 / 350 / 352 · YF020 · E220ZZ/02 · KR100C · KR150 · E23 glass bead · YG150-S534 bead · KB13 · E299 DHP230 · R53 Glass bead
All 7p each

POTS
Wirewound **38p.** Log or Lin rotary **22p**, or slide **30p.** With switch **40p**, Dual **45p** Dual switch **55p** 1.5m Edgetype 10 for **40p.**

COMPUTER & AUDIO BOARDS/ASSEMBLIES
VARYING CONTENTS INCLUDE ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES, INTEGRATED CIRCUITS, ETC.
3lb for **£2.30** 7lb for **£4.30**

1k horizontal preset with knob 10 for **40p**

3" Tape Spools **5p**
1" Terry Clips ... **5p**
12 Volt Solenoid **40p**

ENM Ltd. cased 7-digit counter 2¼ x 1½ x 1½" approx. 12V d.c. (48 a.c.) or mains **£1.10**

Auto charger for 12v Nicads, ex-new equipment **£3.95**

SAPHIRE STYLII. 10 different; dual and single point, current and hard to get types. My mix **£1**

INDICATORS
Bulgin D676 red, takes M.E.S. bulb **38p**
12 volt, or Mains neon, red pushfit **23p**
R.S. Scale Print, pressure transfer sheet **12p**

PAY A VISIT — THOUSANDS MORE ITEMS BELOW WHOLESALE PRICE. CALLERS PAY LESS ON MANY ITEMS AS PRICES INCLUDE POSTAGE. PRICES INCLUDE VAT AND ADDITIONAL DISCOUNT IN LIEU OF GUARANTEE. GOODS SENT AT CUSTOMERS' RISKS UNLESS SUFFICIENT ADDED FOR REGISTRATION OR COMPENSATION FEE POST.

TRADE COMPONENTS

ESTABLISHED 23 YEARS

BRIAN J. REED

161 ST. JOHNS HILL, BATTERSEA, LONDON SW11 1TQ
Open 11 a.m. till 7 p.m. Tuesday to Saturday. VAT receipts on request.
Terms: Payment with order. Telephone: 01-223 5016

Due to lack of space, items (i.e. pots, caps, etc) can only be collectively priced. Catalogue often shows much lower individual value price.
ALL ENQUIRIES, ETC. MUST BE ACCOMPANIED BY A STAMPED ADDRESSED ENVELOPE

BOXES – Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **67p**; Clear perspex with sliding lid, 46 x 39 x 24mm **11p**. **ABS**, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **69p**; 80 x 150 x 50mm black **£1.09**; 110 x 190 x 60mm black **£1.62**.
DIECAST ALI superior heavy gauge with sealing gasket, approx. 6¼" x 2¾" x 1¾" **£1.60**; 3¾ x 2¾" x 1⅜" **£1.10**.
VARIABLE CAMM PROGRAMMER 10, 12 or 15 pole 2 way, 50VAC motor – series with 1mfd, or 3k 10W or 15W pygmy bulb for mains operation. Ex equipment **£3.10**.

CATALOGUE

5300 ITEMS AT PRICES YOU WOULD NOT BELIEVE BEFORE INFLATION. YOUR MONEY MUST GO TWICE AS FAR
75p PLUS 30p POST

VAT & POST PAID

(2nd Class or Parcel)
MINIMUM ORDER £3 (excluding catalogue) OTHERWISE ADD 50% FOR SMALL ORDER HANDLING COSTS (UNDER £1.00 TOTAL ALSO INCLUDE 12p S.A.E.)

ZENERS

400MW Zener	5p
1¼ Watt Zener	11p
2½ Watt Zener	13p
5 Watt Zener	15p
10 Watt Zener	20p

OPTO ELECTRONICS

Photo Diodes: BPX40, BPX42, BPY10, CQY77, CQY17, BPY68, BPY69, BPY77 **36p**.
Wires and neons **4p**.
Photo transistors: BPX29, BPX43, BP103, 2N5777 Darlington, **36p**. OCP71 **40p**.
LEO's (Mullard Selmans) Red 2" 8p. .125" 9p; Green 2" 11p; .125" 12½p; Micro Yellow LD481 7½p.
PHOTO SILICON CONTROLLED SWITCH BPX66 PNPN 10 amp **36p**

3" red 7 segment L.E.D. 14 D.I.L. 0.9 · D.P. display 1.9v 19m/a segment, common anode **55p**
HP .43 in yellow **£1.50**
RS 0.6in green **£1.77**
Minitron 0.3in 3015F filament **£1.25**
Infra red transmit diodes CQY11B or LD27 High power 1.6-2v or 3-3.5v Pulse **53p**
LD242 **36p**

H15B Photon coupled isolator I.R. diode & NPN Photo-Darlington amp **£1.05**
Data Sheet **10p**
CNY17/1 opto coupler **70p**
Cold cathode tubes I.T.T. G517A or 5870L **60p**

UK – Postal Orders for same day service. Cheques require 8 days from a Monday banking to ensure clearance. Export – banker's draft (sterling) same day service. Foreign currency money orders etc. can lose value and take 4-6 weeks to clear. VAT content becomes documentation charge.

MORE DIGITAL I.C.s

SNI5846	37p
SNI5851	50p
SNI5858N	55p
SNI5862	6p
SNI5844P	4p
XK343	4p
XK344	4p
XK345	4p
XK346	4p
XK1446	4p
930DC/933DC	4p
936DC/937DC	4p
946DC/949DC	4p
961DC/962DC	4p
963DC	4p
9093DC	4p
9112DC	4p
930399-256	4p
930399-500	4p
930399-480	4p
930399-512	4p
953-42300	4p

DIODES

AA113	9p	OA7	25p
AA119	7p	OA10	25p
AAZ15	15p	OA47	7p
B1	11p	OA70	10p
BA116	30p	OA75	11p
BA128	2½p	OA79	11p
BA145	2½p	OA81	3½p
BA148	12p	OA95	8p
BA182 Varicap	6p	OA200	2½p
BAX14	2½p	OA202	2½p
BAY36P	2½p	IGP7	11p
BB104 Varicap	18p	IGP10	11p
BB103 Varicap	6p	IN914	1½p
BB109 Varicap	24p	IN916	2½p
BB110B Varicap	24p	IN662	2½p
BB113 Triple Varicap	43p	IN935B	7½p
BB139	£1	IN936B	7½p
BY206	7½p	IN937B	7½p
BY207	23p	IN941B	7½p
BY402	2½p	IN942B	7½p
BY403	2½p	IN943B	7½p
Centercell	3p	IN3064	2½p
CG651	9p	IN4009	2½p
CR HG/3	10p	IN4150	2½p
CSD117YLZ	40p	IN4151	2½p
CV7095	2½p	IN4148	1p
CV7098	2½p	IN4446	2½p
DC2845 Microwave	20p	IN4449	2½p
DOG53	11p	IN 3716 Tunnel Diode	30p
FSY28A	40p	IN5456	15p
HG1012	10p	5082 2900 RF Schotky Barrier	20p
HS2091	11p		
MPN3401	30p		
OA5	25p		

RECTIFIERS

Type	Volt	Amp	Price
BY103	1500	1	3p
BY127	1250	1	4p
BY212	EHT		6p
BY235	600	1½	7½p
BY236	900	1½	7½p
BY238	1200	1½	9p
BY264	300	3	9p
BY265	600	3	11½p
BY266	900	3	16p
BY274	300	5	14½p
BY275	600	5	17½p
BY299	800	2	4p
BY1202	2kV	10mA	6p
BY277	1200	5	27p
BYX20-200	200	25	72p
BYX22-200	300	1½	25p
BYX38-300R	300	2½	48p
BYX38-600	600	2½	52p
BYX38-900	900	2½	60p
BYX38-1200	1200	2½	65p
BYX42-300	300	10	36p
BYX42-900	900	10	92p
BYX42-1200	1200	10	£1.07
BYX46-300R	300	15	£1.19
BYX46-400R	400	15	£1.75
BYX46-500R	500	15	£2.00
BYX46-600	600	15	£2.30
BYX48-300R	300	6	47p
BYX48-600	600	6	60p
BYX48-900	900	6	70p
BYX48-1200R	1200	6	92p
BYX49-300R	300	3	35p
BYX49-600	600	3	42p
BYX49-900	900	3	47p
BYX49-1200	1200	3	60p
BYX52-300	300	40	£2.05
BYX52-1200	1200	40	£2.90
BYXC72-150R	150	10	42p
BYX72-300R	300	10	52p
BYX72-500R	500	10	65p
BYX94	1250	1	5p
LT102	30	2	15p
M1	68	1	5p
MR856	600	3	24p
OA210	400	5	33p
REC53A	1250	1½	16p
RAS3 10AF Avalanche	1250	1¼	48p
S10BR30	1000	30	£2.00
SKE4G	200	6	30p
SR100	100	1½	9p
SR400	400	1½	10p
IN4002	100	1	3½p
IN4004	400	1	4½p
IN4005	600	1	8p
IN4006	800	1	6p
IN4007	1250	1	6p
IS138	800	½	2½p
IS921	100	1½	8p
IN5059	200	1½	10p
IN5402	200	3	11p
E250C50	250	½	14p
25G100	100	60	£4.35

DIGITAL/COMPUTER

7400	10p
74L500	13p
74500	18p
7401	7½p
74H01	26p
7402	11p
7404	11p
54/7406	15p
74L508	15p
7410	10p
74L10	25p
74410	26p
7414	39p
7417	18p
7420	11p
74520	50p
74522	18p
7425	18p
7426	16p
5430	12p
7430	11p
74L30	11½p
7432	13p
54/7437	13p
7438	14p
7442	26p
74L542	40p
7445	42p
7450	11p
74450	26p
7451	7½p
7454	11p
74L54	11½p
54/7472	20p
74L72	25p
5473	12p
7473	17p
74H73	28p
7474	13p
74L74	25p
7475	24p
54/7476	19p
7480	22p
7482	35p
7483	45p
74L583	47p
54/7486	18½p
54/7490	25p
7493	25p
54/74L95	25p
74L598	£1.25
74107	20p
74L5107	26p
745112	38p
74118	75p
74121	12p
74122	18p
54/74123	35p
74132	44p
74141	42p
74L5145	93p
74150	12p
74151	32p
74154	35p
74155	12p
74157	12p
74S160	£1.00
74165	58p
74167	23p
74173	44p
74180	12p
74176/8280	30p
74192	33p
74L5192	60p
74193	38p
74196	36p
74L5196	90p
74197	50p
74L5221	80p
74293	80p
74298	£1.00
74490	£1.30
82590	90p
825129	£5
93510	£1.00
9311	£1.20
9370	25p
CD4002	13p
CD4011	14p
CD4012	13p
CD4013	23p
CD4019/MC14519	25p
CD4028/MC14028	42p
CD4050	25p
CD4066	27p
CD4069	13p
AY38500	£2.00
AY58300	36p (10 for £3.00)
D3624	£1.00
MM2102	73p
IM5623	£1.00
MMB008	£3.50
MM5233	£1.00
DM8214	£1.00
3351-20C 40 x 9 BIT FIFO 2MHZ	£1.07

LINEAR I.C.s

555	20p
7020L	25p
709/72709	18½p
710	28p
724	20p
741	16p
7805 (TO.3)	64p
BRC M300	£1.40
BRC/MC1310P	35½p
BRC/MC1330	85p
BTT822	£1.73
(T)CA270AE	£1.00
(T)CA270CW/AW	35½p
CA3001	86p
CA3028A	75p
CA3044	£1.20
CA3046	40p
CA3054	69p
CA3065	36p
CA3083	65p
CA3132EM	£2.22
CA3146E	90p
CA3183	80p
FPQ/MPQ3725	45p
LM300	86p
LM309 (Ex equip.)	60p
LM340T6	36p
LM1303N	65p
LM/MC1458N	19p
LM3900	36p
LM1306P	40p
MC1307P	35½p
MC1312P	40p
MC1314P	35½p
MC1315P	35½p
MC1350P	35½p
MC1357P	35½p
MC3302L	75p
MC4044P	£1.00
MC4344P	£3.50
MIC7C	28p
ML237B	£1.00
MT300	8p
MT305	8p
SA1010	34½p
SAA661	36p
SAA1025	£4.00
SL403A	38p
SN75107	£1.15
SN75110	46p
SN76001	36p
SN76003	36p
SN76003N	£1.10
SN76013	36p
SN76013ND	£1.18
SN76023	36p
SN76110P	35½p
SN76115N	35½p
SN76131	58p
SN76226	58p
SN76227	59p
SN76228N	£1.80
SN76396 (TOA396)	35½p
SN76549N	35½p
SN76650N	50p
SN76660N	35½p
SN76666N	35½p
TAA263	75p
TAA300	£1.00
TAA320	35p
TAA550	23p
TAA700	£2.30
TAD100	£1.22
TBA1205/CQ/SB/8	25p
TBA240	£3.90
TBA395Q	£1.50
TBA550	£1.61
TBA800	52p
TBA810	70p
TBA920	£1.15
TCA270Q/SA/AE/OS	£1.00
TCA270SQ	55p
TCA440	£1.25
TCA4401	£1.25
TCEP100	£1.00
TDA2610	71p
TL720	28p
TYA0171	4p
XR215	£2.00
ZN414	79p

C500 calculator	37p
AJ371-002	4p
FCJ101	50p
FCH201	18p
FZH151	18p
FZH191	18p
FZH201	18p
MC833P	4p
MC837P	4p
MC846P	4p
MC862P	4p
MC863P	4p
MM5387N	£3.00
MC830P	4p
SN150093	50p
SN158097	4p
SN158099	50p
SN15836	28p
SN15846	50p

BRIDGE RECTIFIERS

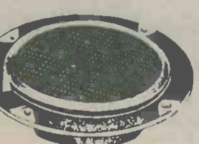
Amp	Volt		
½	1,600	BYX10	34p
1	140	OSH01-200	25p
5	100	Ex Equip	73p
0.6	110	EC433	20p
5	400	Texas	85p
2½	100	I.R.	40p
3½	100	B40C 3200	58p
½	60V	B30 C350	23p

2½	350V	9F2	70p
2½	500V	9E4	85p
Miniature	Meter	Type	34p
1	400V	WO4	28p
1	400V	MDA104	29p
1	200V	WO2 Ex Equip	15p
1	50V	WO05	19p
1	800V	WO8	27p
1½	75V	IBIBY234	11½p
1½	150V	IBIBY235	16p

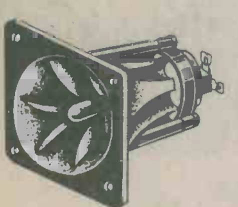
MOTORS
1.5-6VDC Model Motors **22p.** Sub. Min. 'Big Inch' 115VAC 3 rpm Motors **32p.** 12VDC 5 Pole Model Motors **37p.** 8 track 12V Replacement Motors **55p.** Cassette Motors 5-8VDC ex. equip. **70p.** Geared Mains Motors (240V) 2.5 rpm **75p.** 115VAC 4 rpm Geared Motors **95p.**

SEMICONDUCTORS
LM340 **80p.** BY103 **10p.** 2N5062 100V 800mA SCR **18p.** BX504 Opto Isolator **25p.** CA3130 **95p.** TBA800 **50p.** 741 **22p.** 741S **35p.** 723 **35p.** NE555 **24p.** 2N3773 **£1.70.** AD161/2 **70p.** ZN414 **75p.** BD238 **28p.** BD438 **28p.** IN4005 **10 for 35p.** TIL305 alpha numeric displays **£2.50.** TIL209 Red Leds **8p each.** 0.5" 7 segment Led display. Comm. Cathode, green, full spec. **85p each.**

PROJECT BOXES
Sturdy ABS black plastic boxes with brass inserts and lid. 75 x 56 x 35mm **65p.** 95 x 71 x 35mm **75p.** 115 x 95 x 37mm **85p.**

MOTOROLA PIEZO CERAMIC TWEETERS


2.5" Direct Radiating Tweeter, maximum rating 25 volts R.M.S. 100 watts across 8 ohms. Freq. range 3.8kHz-28kHz, **£4.95.**



3.5" Super Horn (flush mounting), maximum rating 25 volts R.M.S. 100 watts across 8 ohms. Freq. range 3.8-2.8kHz. **£5.25.**

MORSE KEYS
Beginners practice key **£1.05.** All metal fully adjustable type. **£2.60.**

MINIATURE LEVEL METERS
1 Centre Zero 17 x 17mm **75p.** 2 (scaled 0-10) 28 x 25mm **75p.** 3 Grundig 40 x 27mm **£1.25.**

JVC NIVICO STEREO CASSETTE MECHANISM. Music centre type. Rev. counter, remote operation **£13.50** and £1.00 p&p.

JUMPER TEST LEAD SETS
10 pairs of leads with various coloured croc clips each end (20 clips) **90p per set.**

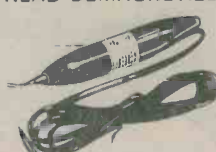
TRANSFORMERS
All 240VAC Primary (postage per transformer is shown after price). MINIATURE RANGE: 6-0-6V 100mA, 9-0-9V 75mA and 12-0-12V 50mA **all 79p each (15p).** 0-6, 0-6V, 280mA **£1.20 (20p).** 6V 500mA **£1.20 (15p).** 12V 2 amp **£2.75 (45p).** 15-0-15V 3 amp Transformer at **£2.85 (54p).** 30-0-30V 1 amp **£2.85 (54p).** 20-0-20V 2 amp **£3.65 (54p).** 0-12-15-20-24-30V 2 amp **£4.75 (54p).** 20V 2.5 amp **£2.45 (54p).**

TRIAC/XENON PULSE TRANSFORMERS
1:1 (gpo style) **30p.** 1:1 plus 1 sub. min. pcb mounting type **60p each.**

MICROPHONES
Min. tie pin. Omni, uses deaf aid battery (supplied), **£4.95.** ECM105 low cost condenser, Omni, 600 ohms, on/off switch, standard jack plug, **£2.95.** EM507 Condenser, uni, 600 ohms, 30-18kHz., highly polished metal body **£7.92.** DYNAMIC stick microphone dual imp., 600 ohms or 20K, 70-kHz., attractive black metal body **£7.75.** EM506 dual impedance condenser microphone 600 ohms or 50K, heavy chromed copper body, **£12.95.** CASSETTE replacement microphone with 2.5/3.5 plugs **£1.35.** INSERT Crystal replacement 35X10mm **40p.** GRUNDIG electric inserts with FET preamp, 3-6VDC operation **£1.00.**

LIGHT DIMMER
240VAC 800 watts max. wall mounting, has built in photo cell for automatic switch on when dark **£4.50**

RIBBON CABLE
8 way single strand miniature **22p per metre.**

SPECIAL OFFER TAPE HEAD DEMAGNETIZER


240VAC with curved probe suitable for reel to reel or cassette machines, **£1.95.**

STEREO FM/GRAM TUNER AMPLIFIER CHASSIS, VHF and AM. Bass, treble and volume controls, Gram. 8-track inputs, headphone output jack, 3 watts per channel with power supply. **£14.95** and **£1.20 p&p** (CCT supplied).

MULTIMETER BARGAINS


Pocket Multimeter, 1,000 opv sensitivity. Ranges IKV AC/DC Volts, 150ma DC current, resistance 0-2.5K, 0-100K, **£4.50.**

20,000 opv., 1,000 volts AC/DC, DC current to 500ma, 5 ranges, resistance 4 ranges to 6 meg. Mirror scale, carrying handle, **£9.75.**

MURATA MA401
40kHz Transducers. Rec./Sender **£3.50 pair.**

TELEPHONE PICK UP COIL
Sucker type with lead and 3.5mm plug **62p.**

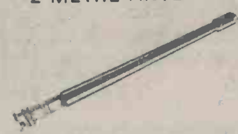
RELAYS
Plastic Encap. Reed Relay, 0.1 matrix. 1kΩ coil, 9-12VDC normally open, **35p.** Miniature encapsulated reed relay 0.1 matrix mounting, single pole make, operates on 12VDC **50p each.** Continental series, sealed plastic case relays, 24VDC 3pole change over 5 amp contacts, new **65p.** Min. sealed relay, P.C. mounting, 6-9vdc operation changeover 3 amp contacts, new **85p.** Metal Cased Reed Relay, 50 x 45 x 17mm, has 4 heavy duty make reed inserts, operates on 12VDC **35p each.** Magnets ½" long ⅛" thick with fixing hole, 10 for **40p.**

Dalo 33PC Etch Resist printed circuit maker pen, with spare tip, **79p.**

TERMS:
Cash with Order (Official Orders welcomed from colleges etc). 30p postage please unless otherwise shown. VAT inclusive.

S.a.e. for illustrated lists.

AEROSOL SERVICE AIDS, SERVISOL
Switch Cleaner 226gm **60p.** Freezer 226gm **70p.** Silicone Grease 226gm **70p.** Foam Cleanser 370gm **60p.** Plastic Seal 145gm **60p.** Excel Polish 240gm **47p.** Aero Klene 170gm **55p.** Aero Duster 200gm **70p.**

2 METRE ANTENNA


Rubber duck type PL259 termination, **£3.50.**

CRIMPING TOOL
Combination type for crimping red blue and yellow terminations also incorporates a wire stripper (6 gauges) and wire cutter, with insulated handles only **£2.30.**

POWER SUPPLIES
SWITCHED TYPE, plugs into 13 amp socket, has 3-4.5-6-7.5 and 9 volt DC out at either 100 or 400mA, switchable **£3.45.** HC244R STABILISED SUPPLY, 3-6-7.5-9 volts DC out at 400mA max., with on/off switch, polarity reversing switch and voltage selector switch, fully regulated to supply exact voltage from no load to max. current **£4.95.**

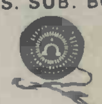
AMPHENOL CONNECTORS
(PL259) PLUGS **47p.** Chassis sockets **42p.** Elbows PL259/SO239 **90p.** Double in line male connector (2XPL259) **65p.** Plug reducers **13p.** PL259 Dummy load, 52 ohms 1 watt with indicator bulb **95p.**

BUZZERS
MINIATURE SOLID STATE BUZZERS, 33 x 17 x 15mm white plastic case, output at three feet 70db (approx), low consumption only 15mA, voltage operating 4-15VDC, **75p each.** LOUD 12VDC BUZZER, Cream plastic case, 50mm diam. x 30mm high **63p.** GPO OPEN TYPE BUZZER, adjustable works 6-12VDC **27p.** 12VDC siren, all metal rotary type, high pitched wail, **£6.25.**

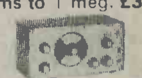
TOOLS
SOLDER SUCKER, plunger type, high suction, teflon nozzle, **£4.99** (spare nozzles **69p each**).
Good Quality snub nosed pliers, insulated handles, 5" **£1.45.**
Antex Model C 15 watt soldering irons, 240VAC **£3.95**
Antex Model CX 17 watt soldering irons, 240VAC **£3.95.**
Antex Model X25 25 watt soldering irons, 240VAC **£3.95.**
Antex ST3 iron stands, suits all above models **£1.65.**
Antex heat shunts **12p each.**
Servisol Solder Mop **50p each.**
Neon Tester Screwdrivers 8" long **59p each.**
Miyarna IC test clips 16 pin **£1.95.**

SWITCHES
Sub. miniature toggles: SPST (8 x 5 x 7mm) **42p.** DPDT (8 x 7 x 7mm) **55p.** DPDT centre off 12 x 11 x 9mm **77p.** PUSH SWITCHES, 16 x 6mm, red top, push to make **14p each**, push to break version (black top) **16p each.**

G.P.O. Telephone handsets **£1.95.** Electrolytic Caps, can type, 2,200mfd and 2,200mfd 50VDC **35p each.**

RES. SUB. BOX


Resistance Substitution Box. Swivelling disc provides close tolerance resistors of 36 values from 5 ohms to 1 meg. **£3.95.**



Signal Generator. Ranges 250Hz-100MHz in 6 Bands, 100MHz-300MHz (harmonics) internal modulator at 100Hz. R.F. output Max. 0.1vRMS. All transistorised unit with calibrating device. 220-240VAC operation, **£48.95.**

TAPE HEADS
Mono cassette **£1.75.** Stereo cassette **£3.90.** Standard 8 track stereo **£1.95.** BSR MN1330 ½ track 50p. BSR SRP90 ¼ track **£1.95.** TD10 tape head assembly — 2 heads both ¼ track R/P with built in erase, mounted on bracket **£1.20.**

PROGRESSIVE RADIO
31 CHEAPSIDE, LIVERPOOL 2.

ALL ORDERS DESPATCHED BY RETURN POST

MIDLAND TRADING CO.

GENTS MEMORY CALENDAR ALARM CHRONOGRAPH

Latest technology. Constant display of hours, minutes, sec's, weekday and snooze alarm indication. A further two optional display modes are available, one being the calendar and month, which can be increased or decreased to give the appropriate month of the year. A 1/100th sec. chronograph with split and lap mode facilities with a 12 hour capacity. A 24 hour alarm with a 10 minute snooze function is also standard to this watch. A further feature is the back light and fully adjustable stainless steel strap.

£19.95

GENTS MULTI-MELODY CHIME ALARM CHRONOGRAPH

Latest technology. Constant display of hours, minutes, sec's, weekday, date and month, with mode and chime indication display. A musical alarm is built in and can be set to anytime within 24 hours, once activated playing the tune "Oh Suzzana". Two further alarm systems are built in (i) 24 hour alarm, (ii) countdown alarm, the watch can be set to chime on every full hour. A 1/100th sec, chronograph with split and lap mode facility is standard, the watch function may also be switched off. An excellent feature is the mineral glass face. This watch also has a battery hatch, backlight and infinite adjustable stainless steel strap.

£19.95

GENTS CHRONOGRAPH

Probably the best looking chrono on the market. Constant display of hours, minutes, sec's, with am/pm indication, also month, date and weekday indication. 1/100th and 1/10th with split and lap mode facilities, backlight and close woven fully adjustable stainless steel strap.

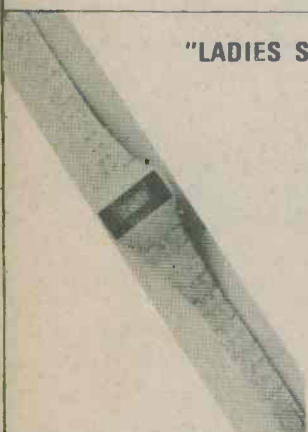
SPECIAL £8.95

GENTS FRONT BUTTON ALARM

Latest style! Constant display of hours, minutes, sec's, am/pm, weekday and alarm indication. A further two optional display modes are available. The watch comprises of 7 digits, 12 functions and is programmed to the year 2009. The alarm can be set to anytime within 24 hours and operates for 30 seconds. A backlight and a closely woven adjustable stainless steel strap highlight this extremely sleek looking watch — only 8mm thick.

£13.25

"LADIES SUGAR COATED"



Another superb ladies watch with that extremely popular sugar frosted finish, (gold or silver finish). Links can easily be removed from the strap, and the clasp has a spring mechanism built in to give a comfortable fitting. Constant display of hours and minutes, with month, date and seconds mode. Auto calendar and backlight.

£10.50

LADIES COCKTAIL

"Elegance and Style", for the lady with a discerning taste, in gold or silver finish with matching adjustable bracelet. Constant display of hours and minutes with month date and seconds. Auto calendar and backlight.

VERY SPECIAL PRICE
£10.50

"ZETRON" WHERE RELIABILITY STYLE AND ELEGANCE REALLY COUNT "ZETRON"

BEFORE BUYING A DIGITAL WATCH, CONSIDER THE FOLLOWING WE OFFER:

(i) 48 hour, display guarantee;
(ii) Full instructions and 12 month guarantee;
(iii) 10 day money back guarantee if not completely satisfied;
(iv) Felt presentation case with each watch.

Phone or write for full comprehensive catalogue on the complete range of watches we carry. Huge discounts available for bulk buyers. Trade lists on application. P&p per item 75p. Cheques or P.O.'s should be made payable to Midland Trading Co; and sent to Dept.(R.E.C.), 58 Windmill Ave, Kettering, Northants NN16 8PA. — Tel: KETTERING 522024.

SUGGESTED CIRCUIT

LOW CURRENT PILOT LIGHT

By G. A. French

With battery prices at their present high level it can be extremely annoying to find that one has inadvertently left an item of battery operated equipment switched on over a long period during which it was not used. A pilot light can be fitted to battery equipment to act as a reminder that it is switched on, but the object of the light will be defeated if it consumes a disproportionately high current. A sensitive light-emitting diode passing a current of about 2mA is representative of the lowest current which can be drawn by a continually illuminated pilot light, yet even this small figure tends to be excessive with modern low-current circuitry.

FLASHING LIGHT

A solution to the problem consists of having the pilot light turn on shortly at regular intervals. The consequently flashing light is still adequate to provide an indication that the equipment is switched on, and it draws current from the battery supply only during the brief periods when it is lit. The average battery current is thus much lower than is the current drawn by a light which is continually turned on. It then becomes necessary to devise a circuit which turns on the light at intervals without itself drawing an excessive current.

Two integrated circuits which lend themselves particularly well to an application of this nature are the ICM7555 (the "CMOS 555") and the CD4020. The latter is a 14-stage binary counter-divider which offers outputs divided by 2, by 2 to the power of 4, by 2 to the power of 5, and so on up to 2 to the power of 14, or 16,384.

A suitable flashing pilot light circuit is shown in Fig. 1. Here, the ICM7555 is connected as a standard asatable multivibrator producing a rectangular waveform output whose cycle length is 0.02 second. This output is applied to the input, at pin 10, of the CD4020. This i.c. is advanced one count on the negative-going edge of each pulse from the ICM7555. The Q8 output (i.e. the output after division by 2 to the power of 8, or 256) at pin 13 is fed to a pulse-forming circuit consisting of C2, R3, D1 and the light-emitting diode LEDI. The length of the cycle at the Q8 output is 0.02 multiplied by 256, or approximately 5 seconds.

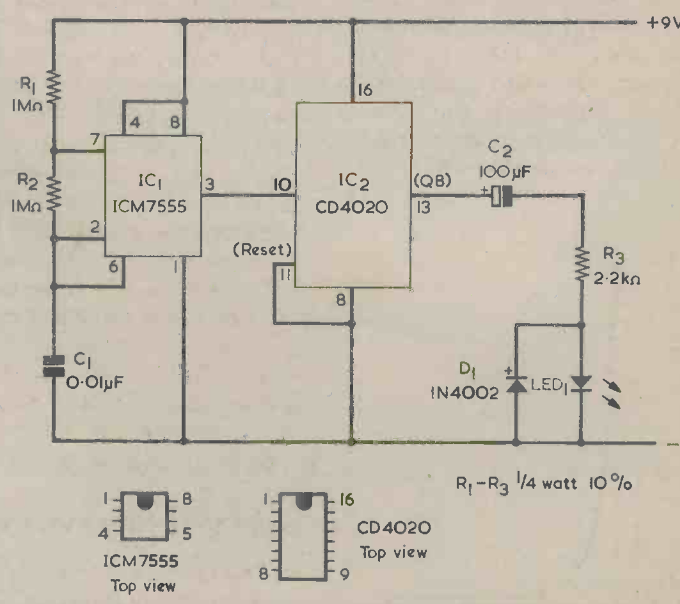


Fig. 1. The circuit of the low current pilot light. This is connected across the supply rails of the equipment in which it is fitted. The l.e.d. flashes on at 5 second intervals and average current consumption is about 190μA

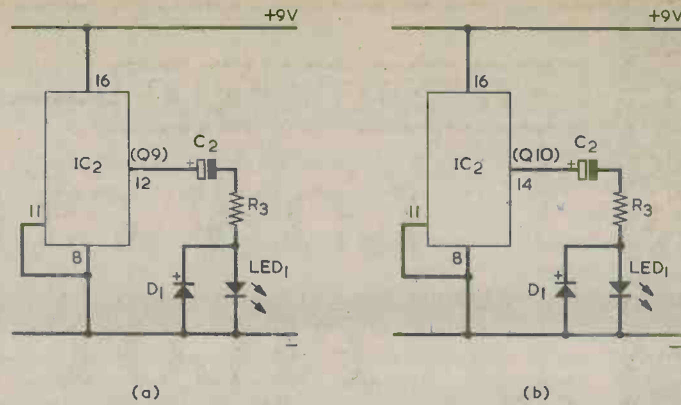


Fig. 3(a). Connecting C2 to the Q9 output of the CD4020 produces a flash every 10 seconds and a consequent reduction in average current consumption

(b). The Q10 output gives a flash every 20 seconds, with an even lower average current drain

The pulse-forming circuit functions in the following manner. The Q8 output from the CD4020 is a square wave and during the latter part of the half-cycle when it is low capacitor C2 is largely discharged. When the Q8 output goes high so also does the positive terminal of C2, whereupon the l.e.d. lights up. It produces a short but very noticeable flash, with the current flowing through it decreasing as C2 charges until, after about 2 seconds, it extinguishes. C2 is now charged to a voltage approximately equal to the supply voltage less about 2 volts forward voltage dropped in the l.e.d.

When the Q8 output from the CD4020 starts to go low the negative terminal of C2 is taken to about 0.6 volt negative of the negative supply rail, after which diode D1 commences to conduct. The capacitor then discharges through R3 and the Q8 output stage of the CD4020. When the Q8 output goes high again, the discharged C2 allows the l.e.d. to give another flash.

The current drawn from the supply rails has the waveform shown in Fig. 2. At the instant when the Q8 output goes high there is a peak of about 3mA in the l.e.d., this falling rapidly to a level at which the l.e.d. just passes forward current. The low current end of the curve is protracted because, near the onset of extinction, the l.e.d. continues to pass a very small current. If the waveform of Fig. 2 is considered as occurring once every 5 seconds, it will be evident that the average current consumed from the supply over the total cycle period will be very low. In practice it is of the order of 120μA. No current is drawn from the supply when the Q8 output goes low and capacitor C2 discharges.

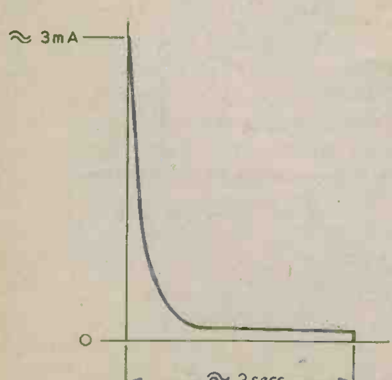


Fig. 2. Current waveform given when the l.e.d. flashes on

To the average current consumed by the flashing l.e.d. has to be added the current drawn by the ICM7555 and its timing components. With a 9 volt supply this is approximately 70μA, making a total average current consumption of about 190μA. The current consumed by the CD4020 is negligibly small and can be ignored. The 190μA figure is applicable to a 9 volt supply. With a 12 volt supply, R3 should be increased to 3kΩ and there will be a small rise in total average current. R3 should be 1.2kΩ with a 6 volt supply, and the average current will decrease slightly.

The visible effect of the l.e.d. is enhanced if this is one of the more sensitive, or "extra bright," types which are currently available.

ALTERNATE PERIODS

The l.e.d. can be made to flash at 10 second intervals if C2 is connected to the Q9 output of the CD4020, as in Fig. 3(a). It will flash at 20 second intervals if connection is made to the Q10 output, as shown in Fig. 3(b). The average current consumed by the l.e.d. is halved with the 10 second period, and is further halved with the 20 second period, giving total average currents of around 130μA and 100μA respectively. A time between flashes of 20 seconds represents what is probably the longest period suitable for a pilot light application.

In passing, it may be mentioned that the CD4020 can also be driven by the CMOS oscillator circuit shown in Fig. 4, instead of by an ICM7555. The two NAND gates shown are part of a CD4011 and the oscillator frequency is roughly equal to that provided by the ICM7555 in Fig. 1. However, the CMOS oscillator circuit will draw some 200μA from the supply rails at 9 volts, and is in consequence less at-

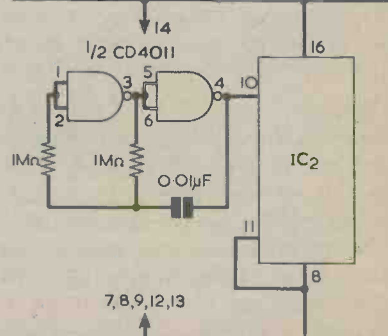


Fig. 4. A CMOS oscillator which may be employed instead of the ICM7555

tractive for this function than the ICM7555.

Finally, it should be pointed out that the l.e.d. flashing circuit can be driven directly by the ICM7555, as illustrated in Fig. 5. In this instance the ICM7555 runs at a frequency whose cycle length is 5 seconds, 10 seconds or whatever is required. The cycle length, in seconds, is equal to 0.7 (RA + 2 RB)C, where R is in megohms and C is in microfarads. However, fairly large values of C will be required. If C is, in consequence, made electrolytic it is in general preferable to avoid timing resistors as high as 1MΩ. When RA is 1MΩ, as it is in Fig. 1, the

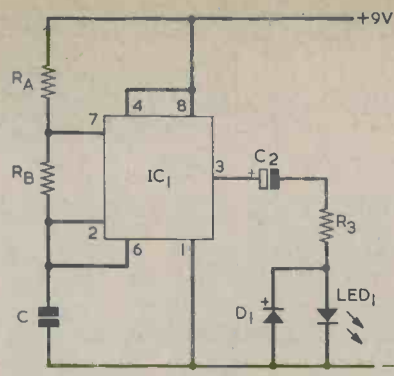


Fig. 5. The flashing circuit may be driven directly by the ICM7555. This requires relatively high values in C and can necessitate lower values of timing ciruit resistance

current drawn from a 9 volt supply by the timing components is of the order of a few microamps only. Reducing RA to, say, 200kΩ would increase the timing component current by around 5 times, whereupon that current becomes comparable with the current drawn by the ICM7555 itself. Interposing a CD4020 between the ICM7555 and the l.e.d. flashing circuit introduces only one extra i.c., and this draws a negligibly low current, requires no discrete components and has the advantage of allowing high value resistors and a low value capacitor in the ICM7555 timing circuit. ■

240 VOLT A.C. MAINS-A warning

By Recorder

Many of the home-constructor projects we build these days are intended for operation from a 9-volt battery, and it is with almost a shock that one recalls some of the mains operated units we made up some twenty years or more ago. Since these employed valves they nearly all had to be mains operated, and quite a few of them had no mains isolating transformer. I well recall one very popular home-built television receiver design which had, by modern standards, a massive chassis measuring about 18 inches square. This was, quite simply, connected to one side of the mains supply. Even its aerial input circuit wasn't isolated. If you were an aerial rigger standing on a wet roof and someone had plugged the TV into the mains so that its chassis was live, you had every chance of ending up with rigor mortis.

There are still many TV sets knocking around these days which have their chassis connected to one side of the mains. These are commercially produced sets, of course, and they are fully insulated by being housed in a proper cabinet. Also, their aerial input circuits are properly isolated by series capacitors. But you still have to be very careful with them if you attempt any repairs with the cabinet back removed.

One would think that, considering the slap-happy approach which existed in the past, it was a wonder that people didn't get electrocuted. The answer to that is that they *did* get electrocuted.

One case which hit the headlines was given when a small child was killed by touching the metal speaker grille of a console TV set at the same time as a metal fender in front of a fire. Due to the use of an excessively long, or incorrectly positioned, woodscrew holding the speaker in place inside the TV cabinet, the metal grille was connected to the TV chassis. Because the set had been plugged into the mains "wrong way round", the grille was live. The metal fire fender presented a sufficiently good connection to earth to complete the deadly circuit.

Another case concerned a young man who took a radio with a live mains chassis into the bathroom. The wave-change knob had come off and, ***whilst he was in the bath***, he leaned over to turn the metal spindle of the wave-change switch by means of a pair of pliers. Another case which occurred at a place where I was working concerned someone who was using an electric drill whilst lying on a corrugated iron roof. The drill cable went through a window to the mains plug, which had the old round contacts. Due to a shortage of plugs the bared wire ends of the drill cable were wedged into the socket with matchsticks. The earth wire became dislodged, the drill developed an internal short, and that was that.

The most hair-raising example I have heard which, fortunately, did not end in tragedy concerned the middle-aged lady with sore feet. She liked to do her ironing whilst standing in a tin bath full of warm water. The horrendous bits are first, that the bath was standing on a stone floor and second, that the iron was plugged into the 2-way lamp socket above the ironing board. Only a few thousandths of an inch of mica between the element and the metal frame of the iron was preventing the lady from sudden death. Luckily, someone was able to point out to her the error of her ways.

There ***are*** fewer deaths due to electrocution these days, but only because the requirements of the law are much more stringent. There are still many risks, nevertheless. The killing circuit is that which you complete between the live side of the mains and earth. A stone or cement floor can be considered, so far as shock hazard is concerned, as being the same as a metal area connected to earth. Just make certain you never complete that circuit, and ***always*** ensure that all mains operated equipment is connected to earth in the manner directed by the manufacturer.

If, as a home-constructor, you use a small 20 watt soldering iron, even this should be reliably earthed. An unearthed iron could not only cause the untimely demise of a CMOS device, it could also do the same to you yourself. ■

RECENT PUBLICATIONS

SINGLE IC PROJECTS. By R. A. Penfold. 127 pages, 180 x 105mm. (7 x $4\frac{1}{4}$in.) Published by Bernard Babani (Publishing) Ltd. Price £1.50.

R. A. Penfold is no stranger to the readers of this magazine, and many of his constructional articles have appeared and will continue to appear on these pages. In the book under review he concentrates on practical working circuits incorporating a single integrated circuit.

There are twenty complete projects in this book, each employing a different integrated circuit. Presentation is the same with each project. First, the i.c. to be used is introduced with a description of its functioning and principal ratings, the project circuit in which the i.c. is to be used is next discussed and, finally, constructional details are given for its assembly on a piece of stripboard, or Veroboard. Where necessary, further comments concerning operation and use are provided.

The projects are grouped into five categories with four projects in each. The first four categories deal with low level audio circuits, audio power amplifiers, timer devices and operational amplifiers. The fifth category encompasses miscellaneous applications, and includes a voltage regulator and a ZN414 receiver.

The book not only presents interesting circuits but also, by its treament, gives a good working description of each of the i.c.'s which is dealt with.

MICROPROCESSORS FOR HOBBYISTS. By Ray Coles. 92 pages, 230 x 150mm. (9 x 6in.) Published by Butterworth & Co. (Publishers) Ltd. Price £2.95.

This book has been adapted from a series of articles in ***Practical Electronics*** and, as its title suggests, is largely concerned with the practical use of microprocessors for hobby applications. It offers a general view of microprocessor systems, and will be of help to the electronics enthusiast who understandably finds himself confused with the new terminology associated with microprocessors and their peripheral chips, as well as with their functioning. However, readers with little electronic knowledge will also find the book of value, since it offers an interesting and easy to read description of home computer techniques.

The book commences with an introductory chapter which emphasises, amongst other things, that the MPU chip is a general purpose computing device rather than the single end orientated chip found in the electronic calculator. The book then carries on to the MPU chip in detail, the instruction set and programming techniques, memories, input/output devices, home computers and software. The book concludes with a 7-page glossary and an index, and is well illustrated with clearly presented diagrams and photographs.

AUDIO EQUIPMENT TESTS. By Gordon J. King, T. Eng. (C.E.I.), R. Tech. Eng., F.S.C.T.E., F.I.S.T.C., F.I.P.R.E., M.A.E.S., F.S.E.R.T., M.R.T.S. 165 pages, 230 x 155mm. (9 x 6in.) Published by Newnes-Butterworth. Price £6.50.

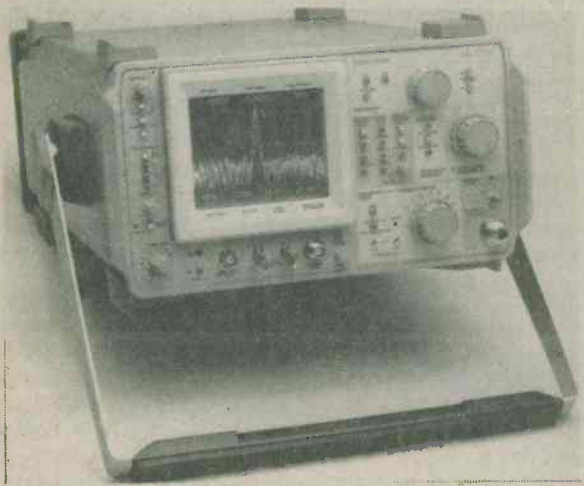
The search towards ultimate perfection in sound reproduction continues unabated and, whereas some ten years ago older engineers might have considered that little further progress in high fidelity was even necessary, the feeling nowadays is that much work has yet to be done if sound amplification and reproduction is to achieve its zenith. Subjective tests, "auditioning", are now embarked upon by audio laboratories with as great a zeal as were the objective testing methods which had previously been considered as offering all that was needed to evaluate the performance of amplifiers and transducers.

This book assembles the essential details of over a hundred laboratory equipment tests relating to domestic audio equipment. This is information which, in itself, should engross the hi-fi engineer and the amateur hi-fi buff. The tests are for performance in f.m. tuners, amplifiers, tape machines, recording tapes, record decks and loudspeakers. The next and final chapter is headed "Auditioning Tests — Is There Instrument Correlation?" and discusses stingent testing methods of amplifiers and equipment by listening panels, the members of which are themselves selected by careful checking for suitability. A similar and complementary discussion of subjective "palatability" appears at the end of the chapter dealing with amplifier tests.

"Audio Equipment Tests" offers fascinating material for the dedicated and technically minded high fidelity enthusiast.

NEWS . . . AND

NEW 60GHz PORTABLE SPECTRUM ANALYSER



New high-performance portable spectrum analyser from Tektronix, the 492, covers a range of 50kHz to 60GHz. The instrument's features include a microprocessor digital control system for easy operation, phase-lock stabilisation allowing resolution down to 100Hz, and a dynamic range of 80dB. A GP1B interface option is also available.

A new high-performance portable spectrum analyser from Tektronix, P.O. Box 69, Harpenden, Herts., the Model 492, covers a frequency range from 50kHz to 60GHz and features an internal microprocessor-based digital control system which makes the instrument simple to use. The Model 492 uses phase-lock stabilisation and has a resolution of 100Hz, permitting precise signal analysis, while the instrument's dynamic range of 80dB enables very small signal responses to be examined.

The use of digitally refreshed storage and internal digital signal processing enables relevant parameters to be displayed directly in alphanumeric form on the cathode-ray tube; these include major control settings such as reference level, frequency, vertical display, frequency span, frequency range, resolution, bandwidth and r.f. attenuation.

The Model 492 is a truly portable instrument, measuring 175 x 327 x 500 mm and weighing 18kg, and the rugged case offers environmental protection to the MIL-T-28800B standard.

As a stand-alone instrument, the Model 492 can measure signals in the frequency range 50hKz to 20GHz, and with suitable external mixers the upper limit is extended to 60GHz. Provision has also been made to extend this still further to 220GHz using mixers and down-conversion techniques.

BBC BUYS NEW SOUND CONTROL DESKS

Recently, George Cook, centre in our photo, the BBC's Assistant Director of Engineering, signed a contract worth over £300,000 with Neve Electronics Laboratories of Royston, Herts, for seven new control desks for BBC Radio.

The new Mark IV General Purpose studio control desks will be going into News and Current Affairs studios in Broadcasting House, London, where they will replace equipment that is more than twenty years old. George Cook says, 'It takes a lot of attentive engineering effort to keep hard worked equipment going for so many years. We hope to replace some of our oldest equipment but some will have to remain in service longer than we would like'.

The Mark IV desks have been developed by BBC Studio Capital Project engineers to be used mainly for News and Current Affairs, but they provide full stereo facilities and are sufficiently well equipped and flexible enough to be used on other types of production when necessary. The BBC engineers adapt the basic General Purpose design to fill the needs of each specialist application. The seven new desks will have 24 mono channels and 10 of these will be available to sources originating outside the studio. This is a necessary facility for news where correspondents in the field must be able to provide live contributions into a programme.

This contract is another example of the liaison and co-operation between the BBC and British Industry. When the new desks have been installed the new General Purpose design will have replaced the ageing equipment in 34 BBC studios from Aberdeen to Bristol, under various contracts to the same specification placed with Neve, Calrec Audio Limited and Audix Limited, all British manufacturers.

Left to right: Brian Binding (BBC Studio Captal Project Department), Derek Tilsley (Neve), George Cook (BBC), Les Lewis (Sales Director Neve), Jeff Jowers (Head of Radio Studio Unit BBC Studio Capital Projects Department).

. . . COMMENT

DIGITAL MULTI-TRACK RECORDING AT THE ROUNDHOUSE

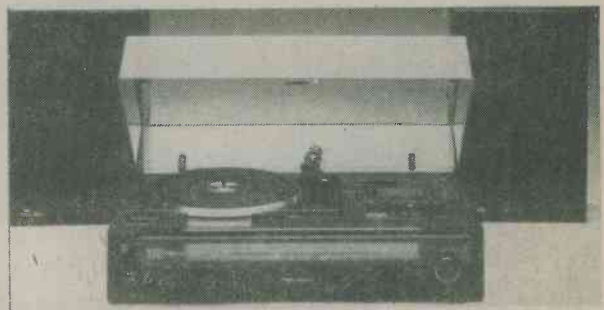
The first Digital Multi-Track Mastering System to be installed in Europe is now operational at London's Roundhouse Recording Studios.

The 3M Mincom Digital Mastering System is the biggest breakthrough in recording techniques since the Analogue System was pioneered forty years ago. With the system every digital copy is an exact duplicate of the digital master, eliminating all tape noise, distortion and wow and flutter, no matter how many digital generations are involved.

Six major USA studios, including the Record Plant, Warner Brothers and A&M currently offer 3M digital mastering facilities with artistes such as Frank Sinatra, Herb Albert and Randy Newman using the system. It is anticipated that within five years all major studios will record digitally.

The Roundhouse Recording Studio is renowned for being the first in the field with important innovations. Since opening in 1974 as a major 24 track studio the Roundhouse has pioneered the now common use of Harrison Mixing Consoles and was the first UK studio to install their computer mixdown facilities. The main control room and mixing suite are now comprehensively furnished with the finest equipment available, and now with the 3M Digital Mastering System comprising 32 track and 4 track recorders and digital editor the studio can offer full 32 track digital recording facilities.

BOOTS HI-FI COLLECTION



Boots 7000-B Music Center Radio, Record Deck, and Cassette Deck with a Dolby system

At the top 26 special Boots branches you can now choose from a carefully co-ordinated range of Hi-Fi separates which make up five complete stereo systems. You can select either a complete system or individual separates (record decks, cassette decks, amplifiers) to make up your own Hi-Fi system. If the decision is a hard one, there will be specially trained staff to help and advise you. Boots also offer the option of high performance miniature speakers (approximately 6" x 8") as part of the co-ordinated range.

Alternatively, if you prefer a music centre (combined radio, cassette recorder and record deck in one unit) you will find 12 superb models at larger Boots Audio Departments. All are supplied complete with speakers and there's a choice of top-mounted or front-mounted controls to suit low or high shelf positioning.

Change of Addresses

Home Radio now have a separate address for callers — 269A Haydons Road, Wimbledon, London SW19 8TY.

It is about 2 minutes walk from Haydons Road Station which runs between London Bridge and Wimbledon and also stops at Tooting Junction. There is also a 200 Bus from Mitcham and a 189 Bus from Tooting. Temporarily their phone number will be 01-648 3077.

Their new mail order address is P.O. Box 92, 215 London Road, Mitcham, Surrey.

Ambit International have also recently changed their address. The new address for both callers and mail order is 200 North Service Road, Brentwood, Essex.

"3 Band Short Wave Superhet"

There is still considerable interest in this project, which appeared in the issues for September to December 1978 inclusive. The 4kHz mechanical i.f. filter type MFH41-T used in the design is not now available, and a suitable substitute is the 5kHz filter type MFH51-T, stocked by Ambit International. Constructors should make sure that they have this alternative filter before obtaining the remaining components.

For new readers who would like to build this first class design we can supply the four issues involved for only £2.00 inclusive of postage and packing.

"He's about six feet tall, broad shoulders, black curly hair . . ."

DUAL POLARITY VOLTMETER

By

M. V. Hastings

• DIRECT ANALOGUE READOUT FOR EITHER POLARITY, WITH POLARITY INDICATION.

Digital voltmeters usually have two important advantages when compared with analogue voltmeters. The first of these is that they almost invariably have very high input impedances and draw little current from the circuits being tested. With analogue voltmeters a significant current has to be drawn as this current is required to deflect the moving-coil meter which is the voltmeter indicator. A full-scale deflection current of 50µA is typical of the more sensitive instruments, as this is about the highest sensitivity which can be combined with reasonable ruggedness and low cost. In parts of many modern electronic circuits, current flow is only in the order of a few microamps, and attempts to obtain voltage readings in such circuits with analogue voltmeters can often result in false indications due to the considerably higher current drawn by the voltmeter itself.

The other advantage of digital instruments is that, in most cases, there is no need to connect the test leads to the circuit with proper polarity as the voltmeters respond to inputs of either polarity. The display normally has some form of polarity indication to show the polarity of the voltage to which the test leads are connected. This fact can result in a considerable saving of time when checking through complicated circuits and it frequently allows only one test prod to be moved, whereas with an analogue voltmeter it is often necessary to move both.

This article describes a design which allows a simple analogue meter to have both the advantages conferred by the digital voltmeter. There are three ranges, these being 0-1 volt, 0-10 volt and 0-100 volt, and the input impedance on all these is a little over 11MΩ. The meter gives forward voltage indications for inputs of either polarity. When the input polarity is opposite to the nominally "correct" polarity an l.e.d. lights up.

BUFFER AMPLIFIER

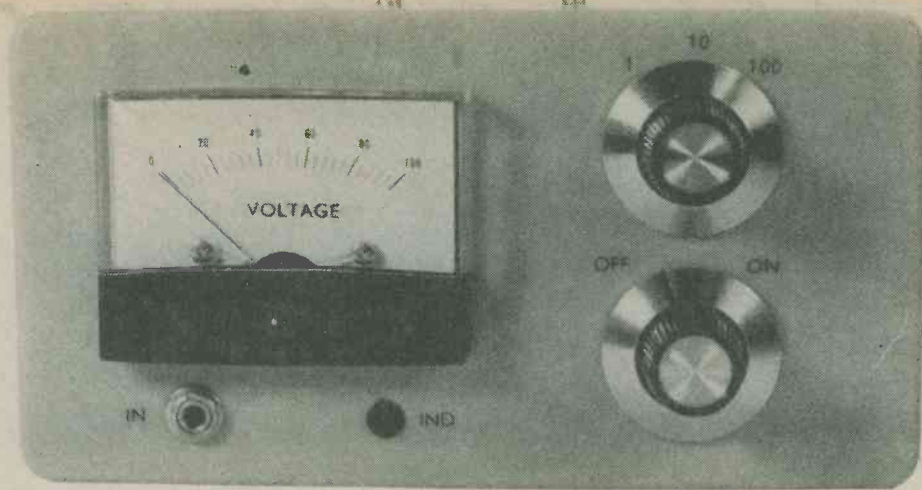
The full circuit of the voltmeter is given in Fig.1. Here the input voltage is applied to SK1, which connects to the 3-step attenuator consisting of R1, R2, R3 and S1. S1 may be adjusted for full-scale deflection readings of 1 volt, 10 volts and 100 volts. The total resistance across SK1 is 11.11MΩ.

The arm of S1 connects to the non-inverting input of the bifet op-amp IC1. This is an LF351 and its input resistance is typically 1TΩ (1 million megohms!) so that it has no shunting effect on the resistance values in the attenuator. The output of IC1 drives the analogue meter movement, M1.

In order to make the meter give forward voltage readings for output voltages of either polarity from IC1 it must be connected in a rectifier circuit. However, a simple passive rectifier incorporating germanium or silicon diodes would result in hopelessly inaccurate results, as the former type of diode has a forward voltage drop of 0.1 to 0.2 volt, and the latter has a forward voltage drop of 0.6 volt.

ACTIVE RECTIFIER

The conventional solution to this problem, and the one used here, is to connect the meter in an active rectifier circuit. This is given when the rectifying network is in the negative feedback path of an amplifier, as occurs in Fig.1. In this circuit the i.c. output passes through the network consisting of D2 to D5, the 0-100µA meter, and through the track section of R6 above the slider before being passed back to the inverting input. Provided that R6 slider is not at the lowermost end of its track there is then virtually 100% negative feedback from the amplifier output back to its inverting input. The amplifier has dual positive and negative supply rails, allowing inputs and outputs of either polarity with respect to the central earth rail.



Housed in a plastic case, this versatile voltage measuring instrument presents a neat and smart appearance

● INPUT RESISTANCE GREATER THAN 10M OHM.

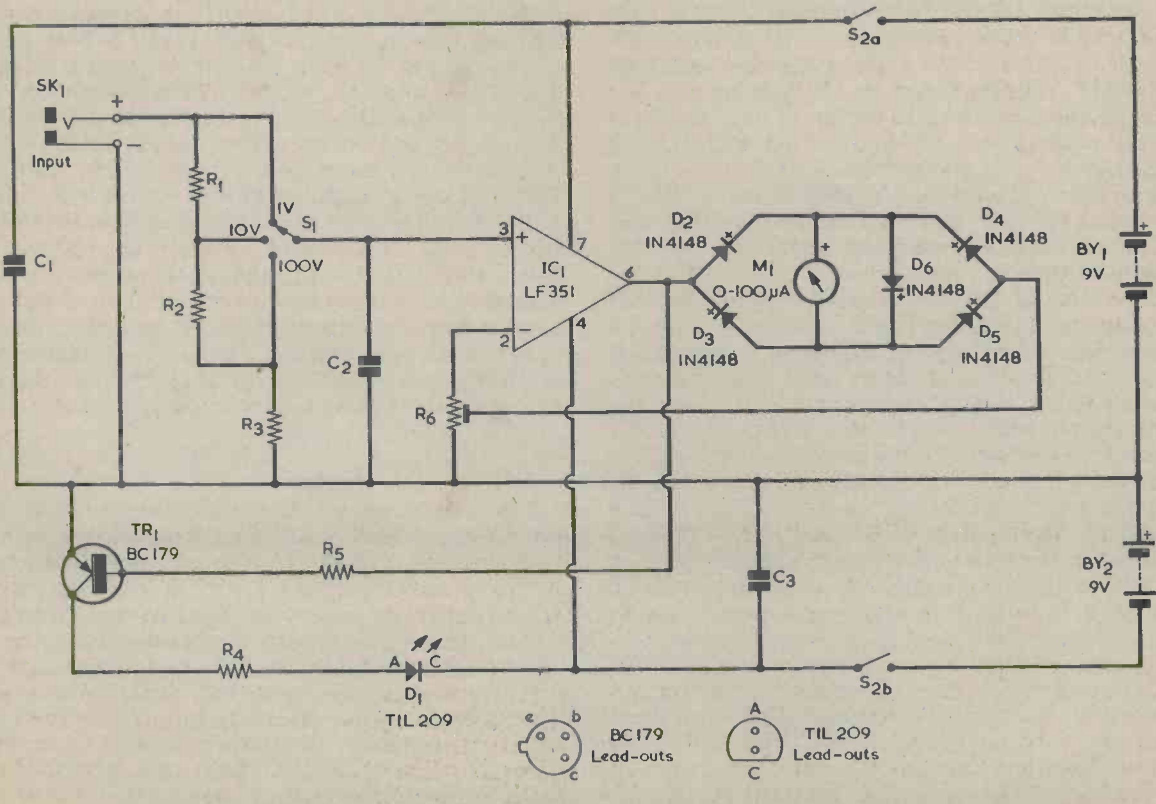
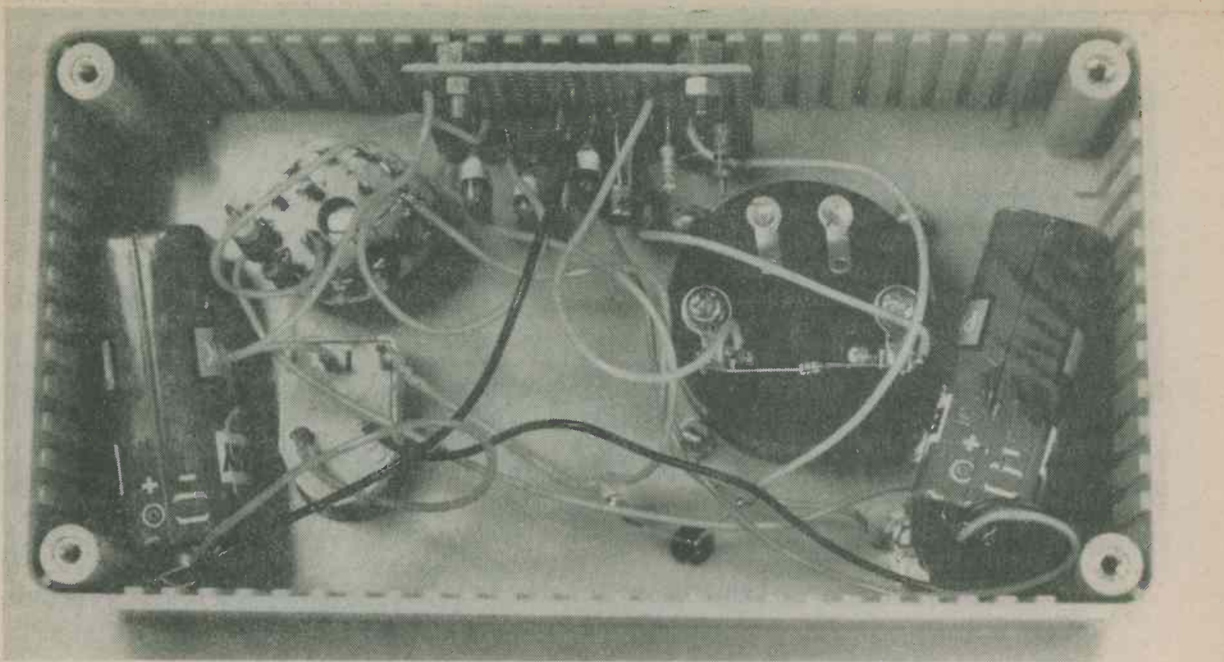


Fig.1. The circuit of the dual polarity voltmeter. The meter gives a forward indication for inputs of either polarity. If the input has a polarity opposite to that indicated at SK1, the l.e.d. D1 lights up



The small Veroboard module makes construction and assembly a relatively simple process

If the non-inverting input of the amplifier goes positive of the earth rail by 1 volt the amplifier output changes to take the inverting input positive by 1 volt also. In practice the output will go positive by about 2.2 volts, allowing about 1.2 volts to be dropped in the forward biased diodes D2 and D5, and in the meter internal resistance, before the requisite 1 volt positive appears at the slider of R6. Thus, the very high gain of the amplifier takes up the forward voltage drops in the diodes and the voltage dropped across the meter. Should the non-inverting input go negative of the earth rail by 1 volt, the output will go negative by about 2.2 volts, and this time the conducting diodes across which the forward voltage drops will appear are D3 and D4. Current flows through the meter in the same direction as before.

The amount of resistance between R6 slider and the upper end of its track has no effect on circuit operation because it is negligible when compared with the extremely high input impedance at the amplifier inverting input. On the other hand, the amount of resistance between R6 slider and the lower end of its track is of considerable importance because it governs the amount of current which flows through the meter when the amplifier output goes positive or negative. If this resistance is 10k Ω the meter will give an f.s.d. reading (of 100μA) when the voltage at the amplifier non-inverting input is 1 volt. In practice, it is preferable to have the resistance variable about 10k Ω, however, so that a precise adjustment can be made which takes in the meter resistance and any slight inaccuracy in the meter itself. This permits a higher accuracy than would be given by simply using a close tolerance 10k Ω resistor here.

As already stated, a voltage with respect to the earth rail of 1 volt, positive or negative, at the non-inverting input results in an f.s.d. indication in the meter. Smaller voltages result in proportionately smaller deflections.

POLARITY INDICATION

Polarity indication is provided by TR1, R5, R4 and the light-emitting diode, D1. Nominally "correct" input polarity is given when the input voltage at SK1 conforms with the plus and minus signs shown in Fig.1. With a "correct" input voltage, the i.c. output goes positive and simply reverse biases the base-emitter junction of TR1. D1 does not, therefore, light up. Connecting an input voltage of opposite polarity results in the output of TC1 going negative by some 1.2 to 2.2 volts, depending upon the magnitude of the voltage. Even the lowest of these output voltages is sufficient to allow a forward bias to be applied to the base of TR1 via R5, causing TR1 to turn on and light up the l.e.d. The l.e.d. becomes lit, therefore, when the input voltage has "incorrect" polarity. The meter still gives a true reading of that voltage, nevertheless.

A measure of overload protection is provided by D6, which prevents the voltage across the meter rising above 0.6 volt. This is still well in excess of the voltage which appears across the meter at f.s.d. and, whilst the diode guards against very high overloads which can occur due to accidents or possible carelessness, it should not be relied upon for continual protection. The instrument should be employed with the same care in this respect as an ordinary multimeter.

The unit responds to a.c. signals due to the inclusion of the rectifier circuitry, and this can result in stray pick-up causing a deflection of the meter. The problem is overcome by including C2 across the input, so that the input impedance is not very high at audio frequencies and above, whereupon stray pick-up is greatly reduced. C2 has no significant effect at d.c., of course.

C1 and C3 are supply decoupling capacitors, and S2(a)(b) is then on-off switch. Power is obtained from two PP3 batteries which should have a good useful life as the current consumption of the unit is

COMPONENTS

Resistors
R1 10M Ω (see text)
R2 1M Ω (see text)
R3 110k Ω (see text)
R4 1k Ω ¼ watt 5%
R5 27k Ω ¼ watt 5%
R6 22k Ω pre-set potentiometer, 0.1 watt horizontal

Capacitors
C1 0.1μF type C280
C2 0.1μF type C280
C3 0.1μF type C280

Semiconductors
IC1 LF351
TR1 BC179
D1 TIL209, with panel mounting bush
D2-D6 IN4148

Switches
S1 4-pole 3-way rotary
S2 d.p.s.t. rotary

Socket
SK1 3.5mm. jack socket

Meter
M1 0-100uA moving-coil meter

Batteries
BY1 9-volt battery type PP3
BY2 9-volt battery type PP3

Miscellaneous
Plastic case (see text)
2 control knobs
2 battery connectors
Veroboard panel, 0.1in. matrix
3.5mm. jack plug
Test leads and prods
Nuts, bolts, wire, etc.

only about 2mA. This rises to about 8mA from BY2 when the l.e.d. is turned on.

It was found, with the prototype, that no offset null adjustment was required and that, using the circuit as shown, there was no perceptible residual deflection of the meter with zero input voltage. Even under worst conditions, any offset would almost certainly result in less than 1% deflection of the meter needle. and this would hardly be noticeable in a normal panel-mounting meter.

COMPONENTS

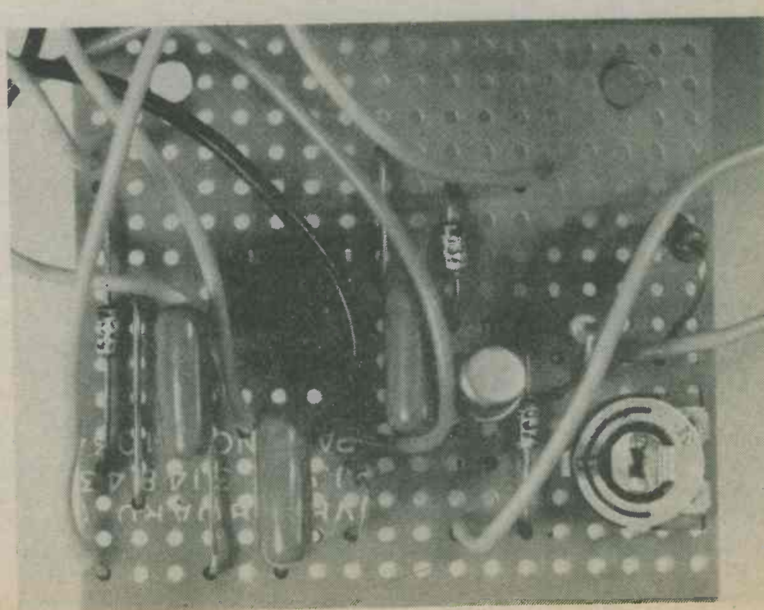
The meter employed by the author was a 0-100μA movement having front face dimensions of 60 by 45mm. The legend on the scale was changed to read "Voltage", but such a modification should not be attempted by constructors unless they feel fully competent to undertake it. It is possible to completely wreck a meter movement due to inexpert handling, or the ingress of dirt when its cover is removed. Other 0-100μA meters can, of course, be employed.

The attenuator resistors, R1, R2 and R3 should be close tolerance types. This is an easy matter to arrange with R2 and R3, which are readily available in 1% or 2% but is more difficult with the 10M Ω resistor, R1. At the risk of introducing a low level of inaccuracy, a 5% resistor can be employed here. Close tolerance resistors with wattage ratings of ¼ watt, ½ watt or 1 watt are all suitable.

Switch S1 is a 4-pole 3-way rotary switch with only one pole used.

The prototype was assembled in a plastic case measuring about 150 by 80 by 50mm. Any other plastic case of around the same size which is capable of taking all the parts, including the batteries, may be employed instead.

Close-up view of the Veroboard panel and its components



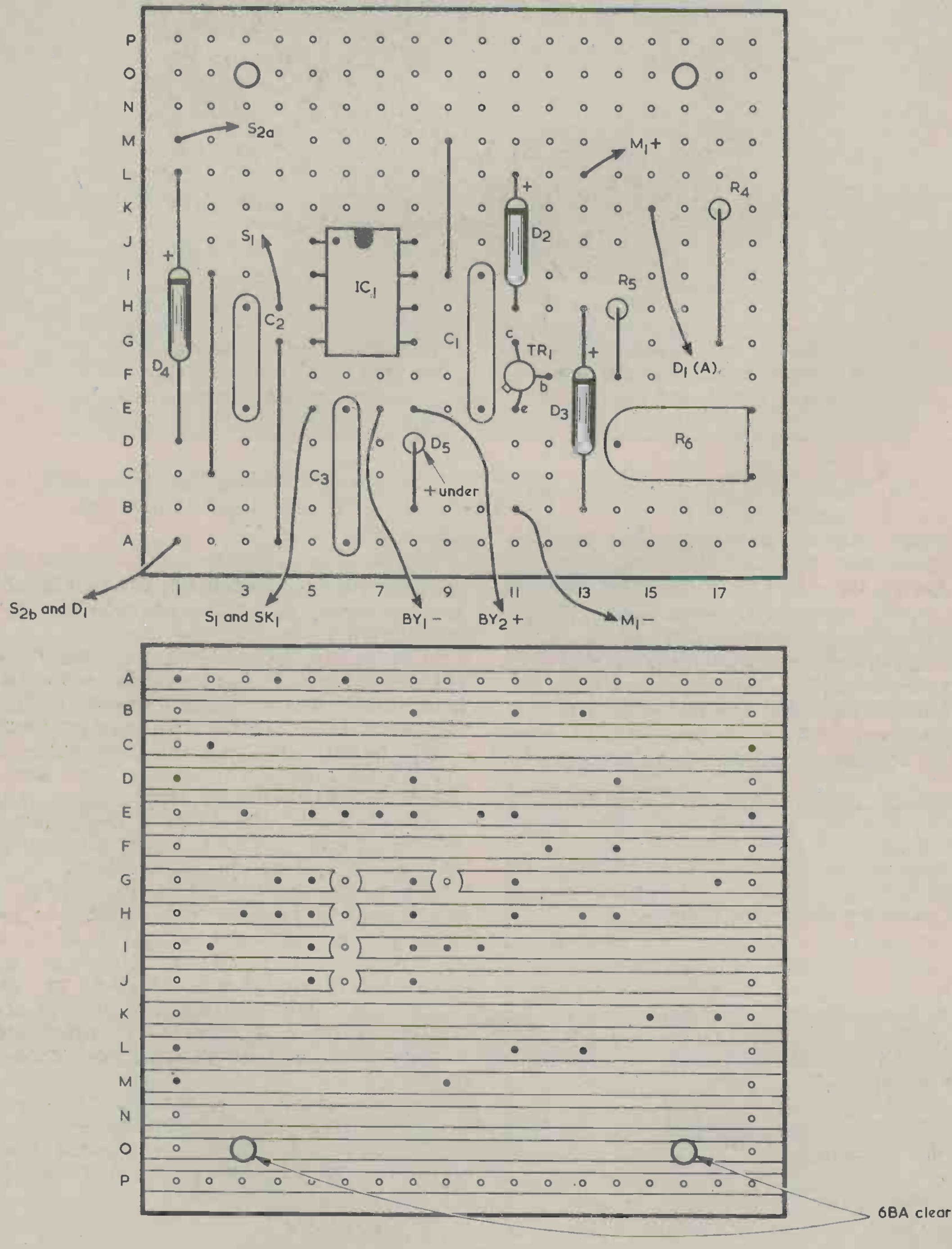
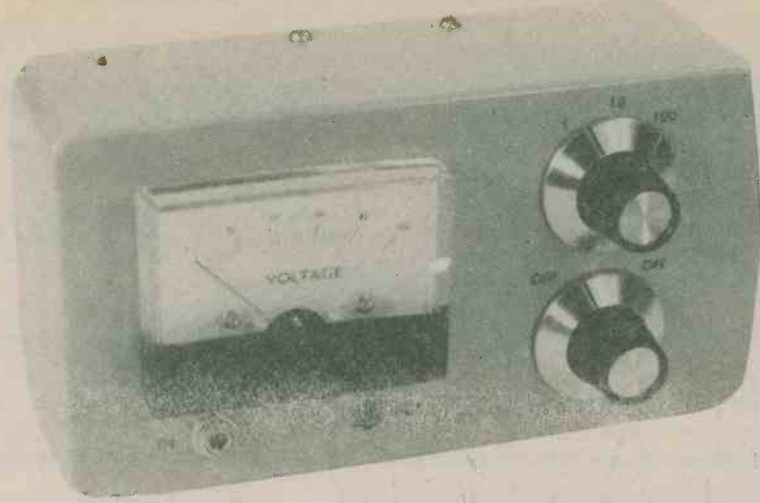


Fig.2. Component layout and wiring on the Veroboard panel



Below the meter on the front panel are the input jack socket and the polarity indicating l.e.d. To its right are the range switch, above, and the on-off switch

CONSTRUCTION

The front panel layout of the prototype can be seen in the photographs. Below the meter are SK1 on the left and the polarity indicating l.e.d. on the right. To the right of the front panel are switch S1, above, and switch S2 below. If a meter such as that employed in the prototype is used, it requires a main hole of 38mm. diameter. After this hole has been cut out the positions of the four small mounting holes can be marked out with the aid of the meter itself.

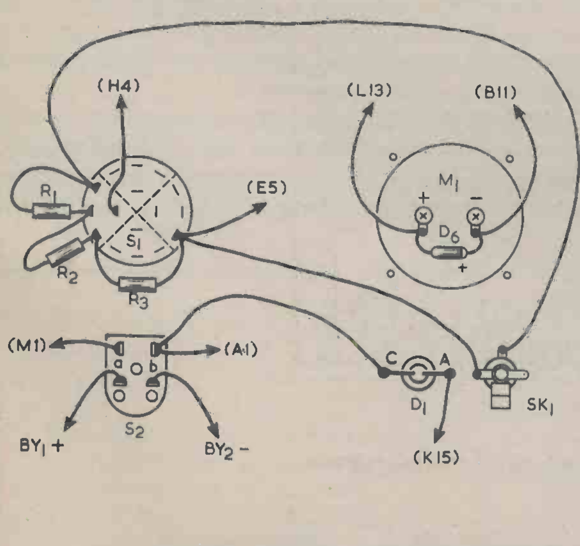


Fig.3. Wiring external to the Veroboard panel. The letter and number references in brackets indicate Veroboard connection points

Most of the components are assembled on a Veroboard panel of 0.1in. matrix having 16 copper strips by 18 holes. This is shown in Fig.2. The board is first cut out from a larger piece, after which the two mounting holes are drilled and the five breaks made in the strips. The components and wires are then soldered in place. The completed panel is mounted under the top panel of the case, or at any other convenient place, using 6BA bolts and nuts with spacing washers.

The wiring between the board and the external components is shown in Fig.3. As can be seen, R1, R2 and R3 are mounted on the tags of S1. A tag on an unused pole of this switch is used as an anchor tag for R3. Diode D6 is mounted on the terminals of the meter. Before wiring to S1 and S2 check tag positioning with a continuity tester, as some switches may have different tag positioning to that shown.

Before connecting any batteries, ensure that the slider of R6 is set fully anti-clockwise as seen in the upper view of Fig.2. Positive and negative test leads are connected to a 3.5mm. jack plug which fits into SK1.

CALIBRATION

A calibrating voltage is necessary for the setting up of R6. This can be conveniently provided by a 9 volt battery across which a standard multimeter is connected to indicate its actual (as opposed to its nominal) voltage. The unit is connected to this with the 10 volt range selected, and switched on. The slider of R6 is them slowly advanced clockwise until the meter gives the same reading as the multimeter. R6 slider must not be taken too far clockwise as relatively heavy currents can then flow through the meter and the potentiometer track. ■

DATABUS series No. 10

really explains microprocessors

By Ian Sinclair

Signed Binary Arithmetic

How the microprocessor deals with positive and negative numbers.

We've left this topic as late in the series as possible, because it causes more headaches for the apprentice microprocessor programmer than anything else, particularly when hexadecimal notation is used. You might think that one of the benefits of a microprocessor was that you didn't have to do any more arithmetic — how wrong can you possibly be?

8-BIT BYTES

As we've seen, all the data which flows into and out of the microprocessor consists of 8-bit bytes, and all arithmetic operations are carried out one byte at a time. One byte lets us represent numbers up to 11111111, 255 in decimal notation. That's not a large number, but there's no reason why we should not use another byte to represent another part of a larger number. Using two bytes lets us play with numbers up to 65,535 and if that's not enough we can use three bytes or more. We can also use the scheme adopted for pocket calculators (which are 4-bit machines, incidentally) of using a few "significant figures" and a power of ten, so that the number 235000000000000000 is represented as 2.35×10^{17}, which does not take up anything like as much space in the registers.

The fact that we carry out arithmetic one byte at a time makes little difference, but we have to make sure that a carry out of a lower order byte is added in to the higher order byte of a sum (Fig. 1). Note,

```
          1001011011100110   16-bit number
Add:      0011101110010111     "   "   "
Result    1101001001111101     "   "   "

this could be done in two bytes, using a carry:

Higher byte                 Lower byte
10010110  <--------         11100110
00111011          \         10010111
--------   (carry 1)        --------
11010010                    01111101
```

Fig. 1. By using the carry bit, a 16-bit addition can be carried out as two 8-bit additions, provided that the lower byte is added first

Rules of Binary Arithmetic

Addition

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0 and carry 1
1 + 1 + 1 = 1 and carry 1

Substraction Take 2's complement and add.

Multiplication

11001100	(multiplicand)
00011110	(multiplier)
110011000	(shifted)
1100110000	(shifted)
11001100000	(shifted)
110011000000	(shifted)
1011111101000	

When bit of multiplier is 0, shift one place left.
When bit of multiplier is 1, write multiplicand so there is a line of multiplicand written for each 1 in the multiplier, and as many places along as each 1 in the multiplier.

by the way, if you haven't had much experience of binary arithmetic before, that the rules are simple — they are summarised in the Table.

Addition, whether it's on a single byte or on several, is straightforward when positive numbers are used. How do we cope with subtraction? The answer is that addition circuits can also be used for subtraction. Because of the way in which binary numbers are formed, we can carry out subtractions by creating what is called the 2's complement of the number which is to be subtracted, then add this 2's complement to the first number. An example makes this clearer. Take the simple subtraction: 14 — 6 = 8. In binary, this could be expressed as 00001110 — 00000110 = 00001000, but we don't have subtracting circuits which will do this. The 1's complement of the figure 00000110 (decimal 6) is found by inverting each bit — that means writing 1 for each 0 and 0 for each 1 in the number. Note that this can work only if both numbers have the same number of bits — which is why each number in the example has been written as an 8-bit byte. Complementing 00000110 gives 11111001: this is the 1's complement. The 2's complement is found by adding 1 to this, giving in our example 11111010. This is now added to 00001110, giving 1 00001000. This is a 9-bit number, so that the ninth bit is carried out of the byte. The byte which remains is 00001000, decimal 8, the result we expect. The rules for subtracting are therefore:

1. Form the 2's complement of the number to be subtracted
2. Add, and discard the carry bit out of the 8th place.

Once again, we can subtract numbers which consist of more than one byte, but we have to remember that the 2's complement is used for the lowest byte only. All of the higher order bytes use only a 1's complement. This is fairly obvious if we look at a single 16-bit number and then imagine it split into single bytes (Fig. 2.)

NEGATIVE NUMBERS

So far, so good — we can use one set of circuits for both addition and subtraction, because forming complements is electrically easy. The problem of working with negative numbers now arises. The only way of indicating any difference between negative and positive is to use one bit of the number as a "sign bit". The convention, which arises straight out of the appearance of a number which has been 2's complemented, is to use the highest order bit, 0 for positive and 1 for negative. This of course restricts the range of numbers which we can represent as one byte, because if one bit is used to indicate the sign, then only seven are left to indicate the number, but the convenience of being able to use negative numbers makes it all worthwhile.

For one byte, the largest positive number we can represent in this way is 01111111, decimal 127; the largest negative number is 10000000, -128. Why is the largest negative number not 11111111? The reason is that adding a negative number must be equivalent to subtracting a positive number, so that binary negative numbers are numbers which

```
  11001111  10100101
 -01100110  11000011
 -------------------
```

is equivalent to:

```
    Higher byte    Lower byte
    11001111       10100101
   +10011001       00111101  2's complement
 1←-01101000       11100010
 carry
            1's complement
```

Fig. 2. When a 16-bit number is subtracted, only the lower byte is 2's complemented. The higher byte is 1's complemented

01111111	+127
00000011	+3
00000010	+2
00000001	+1
00000000	0
11111111	−1
11111110	−2
11111101	−3
10000000	−128

Fig. 3. Numbers in signed binary form, using the eighth bit as a sign bit

are in 2's complement form. Fig. 3 shows the numbers just above and below zero written in this form, using the sign bit.

When we look at these 2's complement numbers we can see why the convention of using a 1 as the negative sign had to be used, because all the 2's complement numbers from -1 to -128 must have a 1 as their highest order bit — this happens when the 1's complement is formed. There is no additional difficulty involved if we want to use 2-byte numbers — we simply take the 2's complement of of the lower byte and the 1's complement of the upper byte.

Now how does the microprocessor treat negative numbers when arithmetic operations are carried out? The answer is that it doesn't! As far as the microprocessor is concerned, one byte is treated like any other, whether there is a 1 as the highest order bit or not. The only times when the difference is important is when there is an overflow or when *we* want to interpret an answer.

Taking the second case first, suppose we use the microprocessor to carry out the subtraction: 73 - 26 = 47. Writing this out in binary form and using 2's complement gives (Fig.4) 00101111 as the byte representing 47, and the 0 in the highest place indicates to us that this is positive. If the subtraction had been the other way round: 26 - 73 = -47, then the binary equivalents are as shown in Fig. 5. The result 11010001 has a 1 in the highest place, indicating that we should read this as a negative number. To find what that number is, we take the inverse of the 2's complement, by subtracting 1 and inverting, so obtaining 00101111, read as -47. If further arithmetic had been needed, the result 11010001 could have been used directly by the microprocessor in this form — the reconversion is needed only when the number has to be read out. Every addition that the CPU carries out is an ordinary binary addition, treating the sign bit as a number.

STATUS REGISTER

Now this can create problems which are solved by the use of the overflow bit in the status register (remember from last month?) Suppose, for example, that we have an addition of two positive numbers which will cause a carry into the highest bit, as shown in Fig. 6, where 76 + 101 is added to give 177. Now if this were to be read as a signed binary number, we would give it a negative sign because of the 1 in the highest place, and we would then take the inverse 2's complement as the true answer, getting -79. For an operation like this, the overflow status flag would be set to indicate that the answer had overflowed from the 7th data bit, so that the sign bit was wrong. There is no change in the way that the microprocessor treats the numbers, just a status flag to warn *us* against reading the result wrongly. The overflow flag is not necessarily set every time there is a carry into the eighth bit, because this is sometimes perfectly reasonable. For example, if we add -58 to -21, to obtain -79 in binary form (Fig. 7), there is a carry out of the 7th place into the 8th which should not cause the overflow flag to be set, because the answer this time should be taken as negative. The clue here is that there has been a carry out of the 8th bit as well. The rules for setting the overflow bit are therefore that this bit is NOT set if the carries out of the 7th and 8th bit are identical (both 1 or both 0), but the flag is set if these carries differ, one 1 and one 0. If

Fig. 4. A binary subtraction, using 2's complement addition

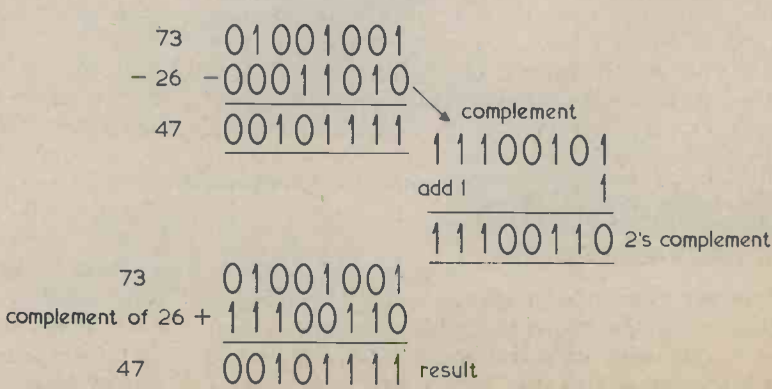


Fig. 5. A binary subtraction which results in a negative number. The value of the negative answer has to be found by inverting the 2's complement procedure

26 − 73

73 is 01001001

1's complement is 10110110

2's complement is 10110111

Now add to binary 26, which is 00011010

```
  00011010
  10110111
  --------
  11010001
```

The 1 as 8th bit indicates a negative number in 2's complement form, so we must invert the 2's complement

```
  11010001
        −1
  --------
  11010000
```

then complement: 00101111 which is 47

The answer is therefore −47

Binary	Decimal
01001100	76
01100101	101
10110001	177

Fig. 6. A straightforward addition which produces a 1 in the eighth place. This is not, however, a negative answer. The overflow bit it set to indicate that the answer is NOT negative

58 is 00111010

−58 is 11000110 (2's complement)

21 is 00010101

−21 is 11101011 (2's complement)

so that −58

```
   −21
   ---
   −79
```

is, in binary,

```
          11000110
          11101011
          --------
  carry 1 10110001
```

To convert back, subtract 1 and complement to

01001111 which is 79

Answer is therefore −79

Fig. 7. This addition of two negative numbers also produces a 1 in the eighth place, and this does indicate a negative answer. The overflow bit is NOT set

the numbers which we are working with are all positive numbers, then we can ignore the overflow bit, but if we are using signed numbers, that is numbers in which the 8th bit represents the sign, then we have to use the overflow bit to warn us if the 8th bit is correct. We can then write a program which will enable the microprocessor to make use of the overflow bit to correct the answers it gets from signed arithmetic operations.

DISPLACEMENTS

Now the relevance of all this to programming is not just in the operations of addition and subtraction — you still need to know about signed numbers even if you never use the "binary-add" instructions on a microprocessor. The importance is that so many steps, memory storage or recall, jumps and other operations require a displacement to be calculated (see Part 5). If the displacement is to a later part of the memory, a higher address number, then a seven-bit number with a zero in the eighth place will be used. If the displacement is to an earlier part of the program, to a lower address number, the displacement byte will have a 1 in the eighth place, followed by seven bits. A single step back is written as 11111111, 25 steps back as 11100111, and so on, so that we have to be rather well experienced with signed binary numbers to write these displacements into the program. Note that the microprocessor reads these numbers in the signed form.

Finally, there is the problem of error. The more

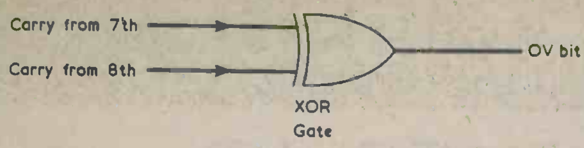


Fig. 8. The overflow bit is produced by an exclusive-OR of the carries from bits number 7 and number 8

Decimal	Binary	Hex.
0	00000000	0
1	00000001	1
2	00000010	2
3	00000011	3
4	00000100	4
5	00000101	5
6	00000110	6
7	00000111	7
8	00001000	8
9	00001001	9
10	00001010	A
11	00001011	B
12	00001100	C
13	00001101	D
14	00001110	E
15	00001111	F
16	00010000	10

Examples:

F 7
Hex F7 = 1111 0111
Binary 0110 1110 = 6E Hex

Fig. 9. Hexadecimal scale, compared with decimal and binary. Any group of four binary bits converts to a single hex character as shown

digits we have to write and copy, the greater is the chance of making a mistake. Writing decimal numbers, for example, is much less likely to cause mistakes than writing binary numbers — it's so easy to interchange a 0 and a 1 in a long string of binary digits. To avoid decimal-binary conversions, though, there's an easier method of "shrinking" binary numbers — which is to write them in octal or hexadecimal form.

The octal scale is the scale of eight, and the hexadecimal scale is the scale of sixteen; the hex scale is much more common nowadays, though octal has some advantages, so we'll stick to hex at the moment. Since the hexadecimal scale, indicated by a letter X before a number or a $_{16}$ after it, is to base sixteen, the number sixteen is written as 10 (the base of a number is always written in this way). That means we need symbols to represent the decimal numbers ten, eleven, twelve, thirteen, fourteen and fifteen. The symbols which are nearly always used are the letters A to F inclusive. This method of representing numbers may look a bit baffling at first sight, but it's very logical because a group of four binary digits can be represented by one hex digit as shown in Fig. 9. A complete byte can be represented by two hex digits, and a 2-byte address by four hex digits. Because we need only one quarter of the number of symbols to represent a byte, and because the symbols are more varied, not all 0's and 1's, the chances of error in copying hex numbers are greatly reduced as compared with binary numbers.

Nevertheless, the hex code has to be converted back to binary at some stage. For entering numbers into the microprocessor, a hex keyboard can be arranged so that each key generates its 4-bit binary equivalent — this is done by using diode gates (a hardware solution) or by using the microprocessor itself to read the keyboard (a software solution). By using electronic conversions like this the need to handle large binary numbers is almost eliminated — except for calculating displacements! We still have to convert each address back to binary, calculate the displacement, and then convert back to hex unless we have a hex calculator. An example of this desirable bit of goods is the Texas Programmer, which will perform arithmetic in Hex, Octal and Binary, giving displacements quickly and easily in whatever number base the user chooses, and saving much wear and tear on the operator.

(To be continued)

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

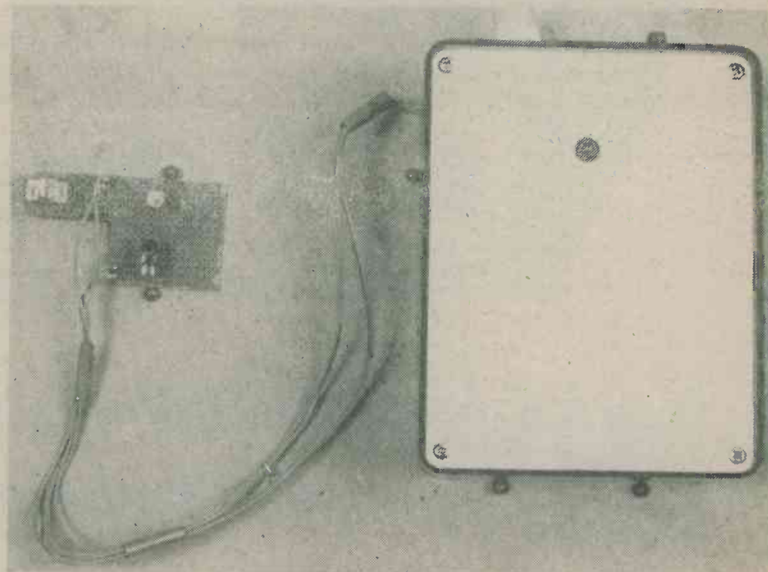
We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is 75p inclusive of postage and packing.

Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

IN OUR NEXT ISSUE

WINE TRAP WATCHER

Electronic watcher monitors wine trap bubbles and indicates the end of fermentation.



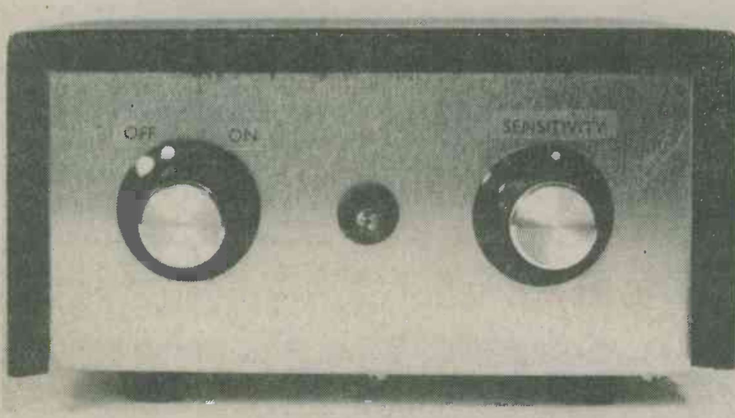
ROBUST BURGLAR ALARM

A simple intruder alarm

CALCULATORS AND PARALLEL-R

Parallel-R problems with low cost calculators are easy

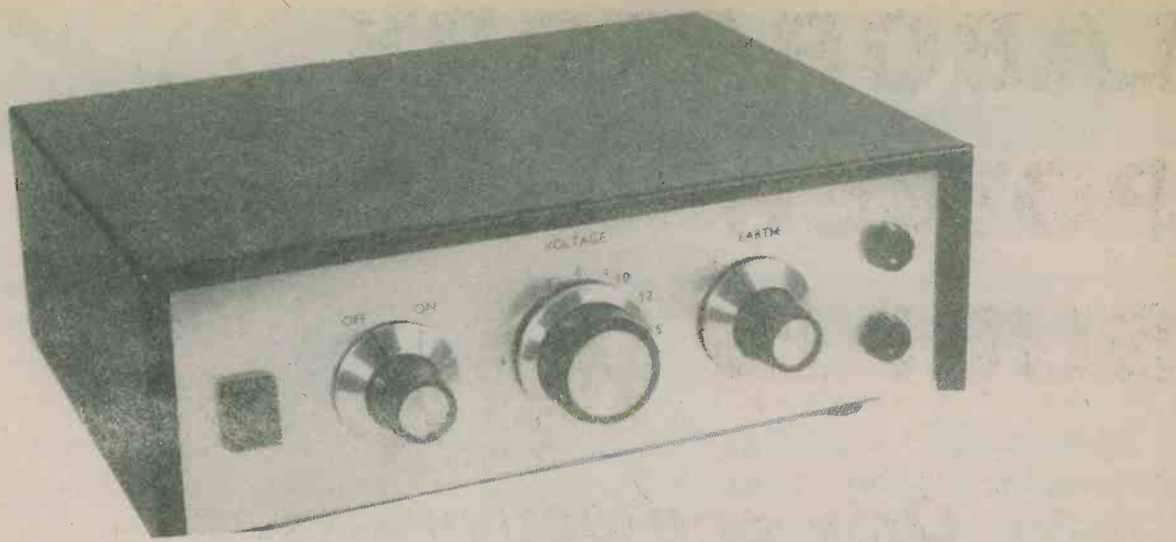
DUSK TO DAWN SWITCH



This device is a light operated switch which turns on a lamp when darkness falls.

It has two main uses, one of which is to automatically operate a porch light or a light in the hall. The other is to act as a burglar deterrent for use when the premises are left unoccupied for a few days.

PLUS MANY OTHER ARTICLES



Variable voltage output from 5 to 24 volts at 1 amp maximum

Most power supply designs appearing in the electronic press up to now which employ integrated circuit regulators have either employed the i.c. on its own in a unit offering a fixed output voltage, or have used an i.c. in conjunction with discrete active devices in supplies having variable voltage outputs. The situation is changed by the introduction of 4-terminal i.c. regulators, as these can be incorporated in variable voltage regulated supplies which require no discrete active devices whatsoever.

The power supply unit featured in this article uses a modern 4-terminal regulator i.c. and it provides a continuously variable output voltage ranging from about 5 to 24 volts at a maximum current of 1 amp continuous. The unit is therefore suitable for most normal requirements, such as powering t.t.l. and CMOS logic circuits, small 9 volt equipment and small power amplifiers. The circuit incorporates output short-circuit and overload protection in the form of foldback current limiting. The output noise level is only a few tens of microvolts at low output currents, and is no more than about 1mV at the full 1 amp output level. Output is given at a positive and a negative socket, and either of these can be switched to earth, or both may be floating with respect to earth.

4-TERMINAL REGULATORS

Fig. 1. shows the basic method of using a 4-terminal i.c. voltage regulator. As with the 3-terminal types, the unregulated input is applied to the "IN" and "COM" (common) terminals, whilst the stabilized output is taken from the "OUT" and "COM" terminals. Stability of operation is provided by the bypass capacitors, C1 and C2.

The fourth terminal, called the "CONT" (control) terminal, couples to the slider of a potentiometer connected across the output. An internal stabilised reference voltage is provided inside the i.c., and with the μA78GU1C device employed in

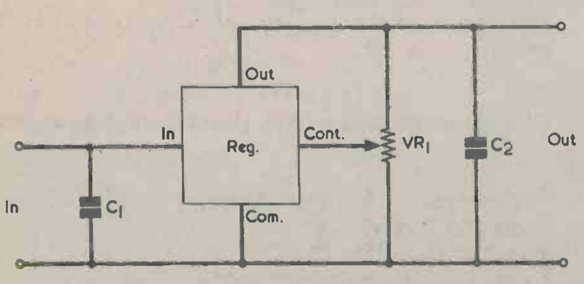


Fig. 1. The basic circuit for a 4-terminal i.c. regulator. The stabilised output voltage can be varied by adjusting the potentiometer, and no external active components are required

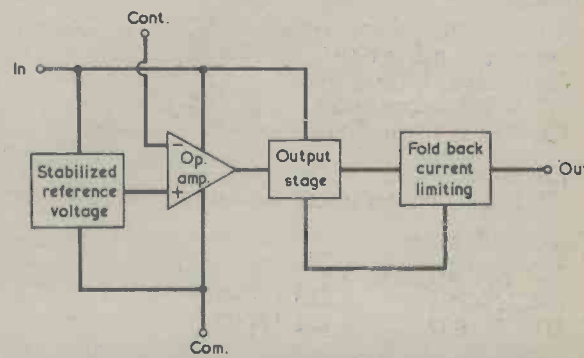


Fig. 2. The internal stages in the 4-terminal regulator depicted in block diagram form

LABORATORY POWER SUPPLY

By R. A. Penfold

Only one active device.

Foldback output overload protection

the present design this is 5 volts. (Other 4-terminal regulators may have different reference voltages). When the slider of the potentiometer in Fig. 1 is at the top end of its track, the output voltage is equal to the reference voltage, i.e. 5 volts. If the slider is taken down the track the output voltage increases, reaching 10 volts when the slider is half way down the track, 15 volts when it is two-thirds of the way, 20 volts when it is three-quarters of the way, and so on. The μA78GU1C can provide a maximum output voltage of 30 volts but, as its maximum permissable input voltage is 40 volts, such an output can only be achieved by obtaining its unregulated input from a mains transformer having a high secondary current rating. A lower current transformer capable of providing a suitable on-load input voltage would give an excessive off-load input voltage. For this reason the supply described here is designed to give a maximum regulated output of 24 volts, whereupon it is possible for the unregulated input voltage to be provided by a mains transformer with a 1 amp secondary winding.

The internal circuitry of a 4-terminal regulator is shown in the block diagram of Fig. 2. The set-up will probably be familiar to readers who have had experience with variable voltage supplies employing discrete active devices and an i.c. such as the 723C, and it is quite a conventional arrangement.

COMPONENTS

Resistors
- R1 1.2kΩ ¼ watt 5%
- VR1 5kΩ potentiometer, linear

Capacitors
- C1 4,700μF electrolytic, 40 V. Wkg. Can-type with mounting clip
- C2 0.33μF type C280
- C3 10μF electrolytic, 10 V. Wkg.
- C4 0.33μF type C280

Transformer
- T1 Mains transformer, secondary 24 V at 1A

Semiconductors
- IC1 μA78GU1C
- D1 1N4002
- D2 1N4002
- D3 1N4002
- D4 1N4002

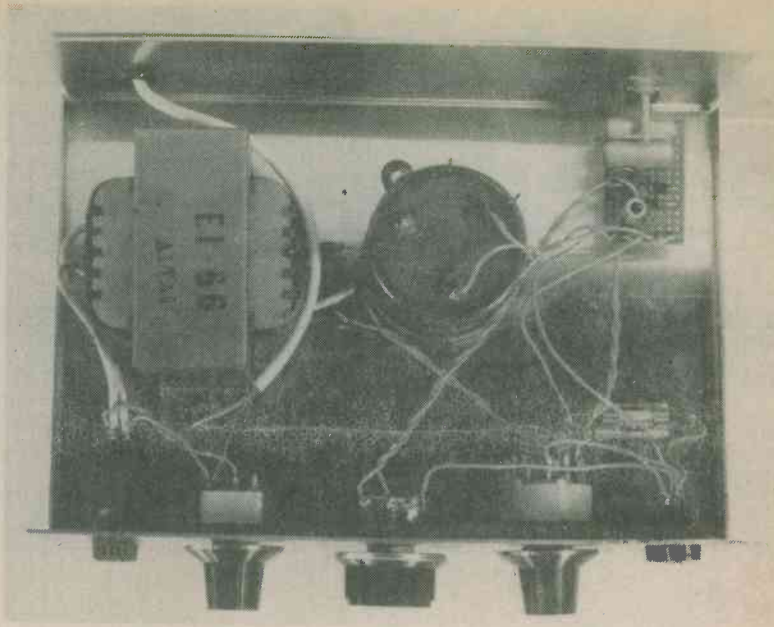
Switches
- S1 d.p.s.t. mains switch, rotary
- S2 1-pole 3-way rotary (see text)

Sockets
- SK1 insulated socket, red
- SK2 insulated socket, black

Fuse
- FS1 1A cartridge fuse, 20mm. with chassis-mounting holder

Lamp
- PL1 neon indicator with integral series resistor

Miscellaneous
- Instrument case (see text)
- 3 control knobs
- Veroboard, 0.1in. matrix
- Heatsink insulating set (for IC1)
- S.R.B.P. panel (see text)
- 3-way mains lead
- "Panel-Signs", Set No. 4
- P.V.C. grommet
- Nuts, bolts, wire, etc.



Mounted on the base of the case are the mains transformer, reservoir capacitor and the fuseholder

The circuitry is based on an operational amplifier which has its non-inverting (+) input connected to a highly stable reference voltage. The inverting (-) input connects to the "CONT" terminal. The output of the op-amp feeds a unity gain output stage which is capable of handling the high output currents involved, and which couples to the "OUT" terminal by way of the overload protection circuit.

If we now consider Fig. 2. with the "CONT" terminal coupled to a potentiometer connected up as in Fig. 1, the manner in which the regulator functions may be visualised. When the potentiometer slider is at the top end of its track, the inverting input of the op-amp is effectively connected to the "OUT" terminal, with the result that the op-amp output causes the "OUT" terminal to have the same, or very nearly the same, voltage as the reference voltage at the non-inverting input. The output voltage is then stabilized by reason of the very high voltage gain provided by the op-amp. If, for example, an attempt were made to take the output voltage negative, the inverting input would go negative of the non-inverting input and the op-amp output would swing positive to correct the attempted negative excursion.

Should the potentiometer slider be taken halfway down the track the op-amp output voltage would double, because this would then return the inverting input to the same voltage as that at the non-inverting input. The output voltage would still be stabilized by the op-amp since, say, a negative excursion at the output would once more result in a positive-going output from the op-amp to counteract the voltage change. Other settings of the potentiometer slider produce different output voltages, all stabilized in the manner just described. The output voltage increases as the potentiometer slider moves down the track until the stage is reached where the i.c. is offering the maximum stabilized voltage it can provide.

FOLDBACK CURRENT LIMITING

Some readers may be unfamiliar with the form of over-load protection provided by the μA78GU1C. This is referred to as "foldback current limiting". With ordinary output current limiting the output current which can pass cannot exceed the limiting current level. Any attempts to increase the output current merely result in a reduction of output voltage. In the extreme instance of an output short-circuit the output voltage falls to zero, and the limiting current flows through the short-circuit.

With foldback current limiting, the output current reduces, in the event of an overload, to a lower value than the rated maximum output current of the regulator device. Indeed, the output current decreases as the overload current is made more severe. This offers a number of advantages when compared with ordinary current limiting. The latter can provide protection for the power supply but not necessarily for the supplied equipment, which can suffer damage at the continued flow of a high current even if this is at a reduced voltage. The reduced overload output current given with foldback current limiting may still, in some cases, cause damage to the supplied equipment but the risk of such damage is significantly reduced. Another advantage with foldback current limiting is that when an overload occurs, the heat dissipated in the regulator circuitry is well within its working limits. With ordinary current limiting a severe overload, such as an output short-circuit, can increase the heat dissipated in the regulator device to a considerably higher level than that incurred with ordinary working. Unless extensive heatsinking is provided, regulator circuits with normal current limiting may be able to withstand high overloads for short periods but may not be able to cope with such overloads for an indefinite time. Circuits incorporating foldback current limiting can take continuous overloads without sustaining damage.

THE CIRCUIT

The full circuit of the power supply is given in Fig. 3. The live and neutral inputs of the mains supply pass via on-off switch S1(a)(b) to the neon pilot light, PL1, and the primary of mains transformer T1. The transformer provides isolation from the mains as well as producing a secondary

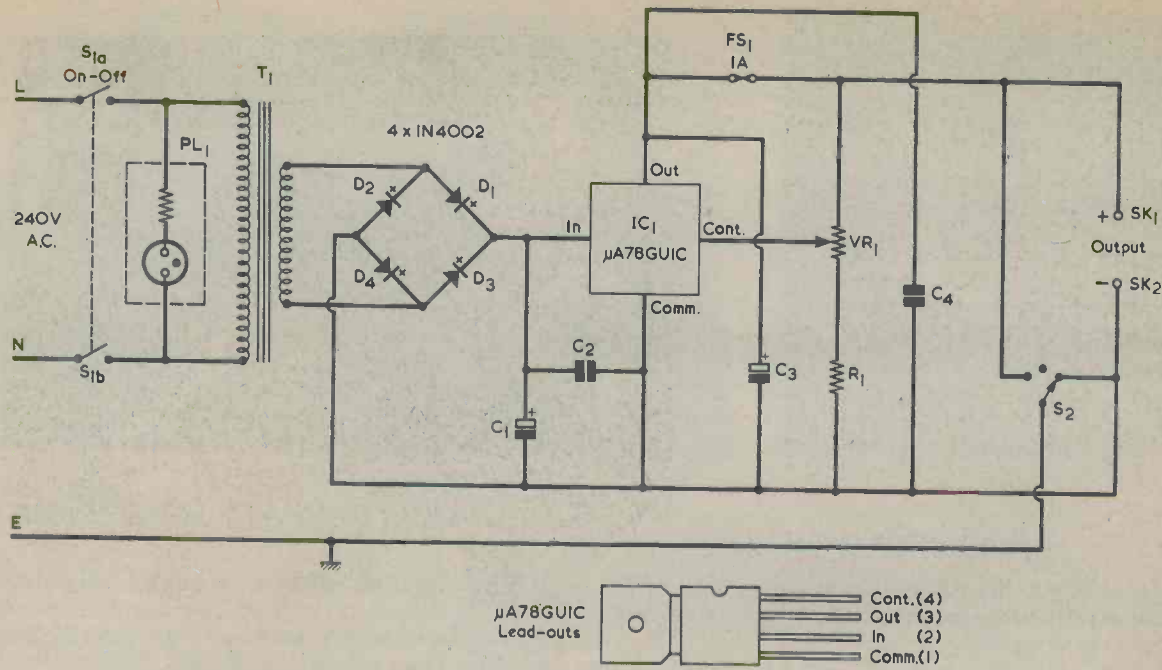


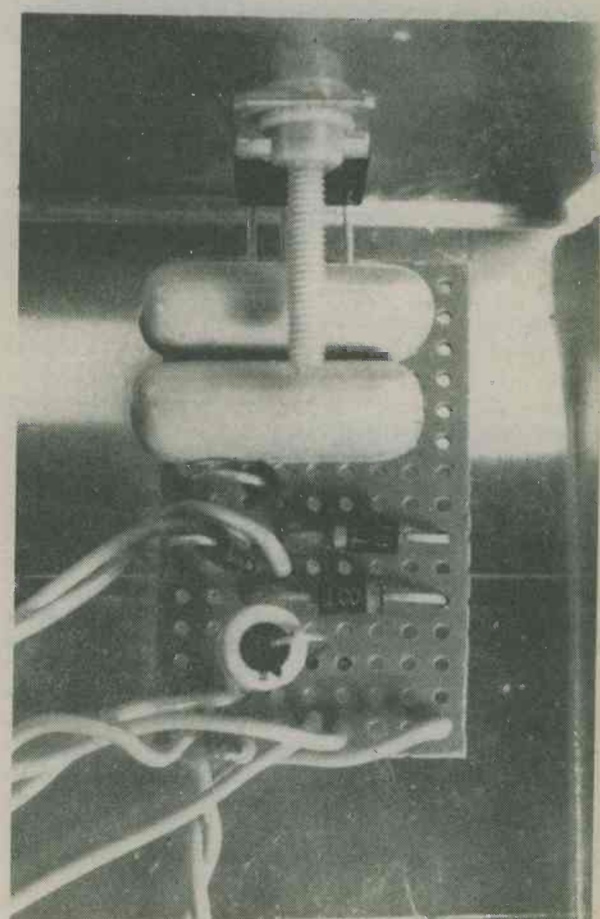
Fig. 3. The circuit of the variable voltage supply. Output voltage ranges from about 5 to 24 volts at currents up to 1 amp. The 4-terminal regulator i.c. incorporates fold-back overload protection

voltage of 24 volts at 1 amp. Full-wave rectification is provided by the bridge rectifier consisting of D1 to D4, these coupling into the high value reservoir and smoothing capacitor, C1.

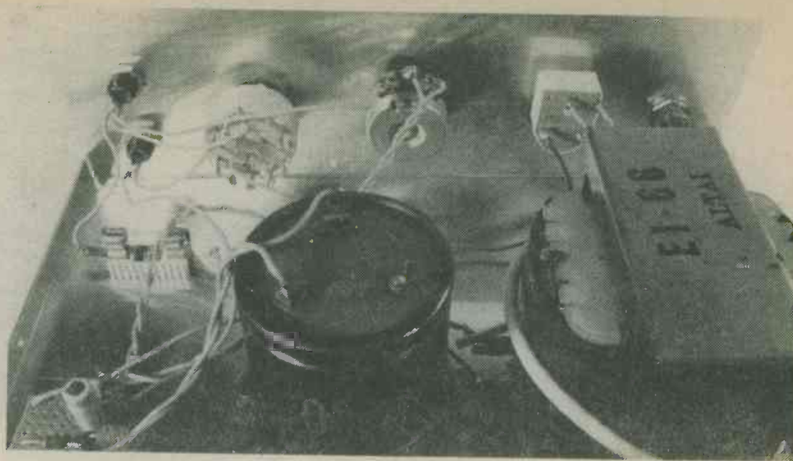
The regulator circuit is the practical development of Fig. 1, with C2 and C4 acting as the bypass capacitors. The potentiometer of Fig. 1 is now given by VR1 and R1 in series, the function of R1 being to ensure that the slider of VR1 cannot tap off too small a fraction of the output voltage. The maximum nominal output voltage at 1 amp is 24 volts, and the values of VR1 and R1 give a calculated maximum output of 26 volts. These values have been chosen because the actual values, within tolerance, of VR1 and R1 could cause the maximum output voltage to be as much as several volts below the calculated level. If it is found, in a power supply built to the design, that output voltages above 24 volts are available it should be borne in mind that a properly smoothed and regulated output up to 1 amp is only available at 24 volts or below. It is quite in order to employ output voltages above 24 volts, should it happen that these are available, but only at low output currents.

C3 provides final smoothing of the output and helps to give a really low output noise level. Nearly all of the smoothing is, of course, provided capacitively by C1 and electronically by the regulator device. It was decided to include the 1 amp fuse, FS1, despite the fact that the regulator i.c. has its own current limiting. The low-cost fuse and fuseholder assembly gives protection in the event of a fault developing or the occurence of a wiring error.

The whole circuit supplied by T1 secondary is completely isolated from the mains supply. S2 can be set to earth either the positive or the negative output. In its central position, neither of the out-



The 4-terminal regulator i.c. is bolted to the rear panel of the case, which acts as a heatsink



A view of the front panel components from the rear of the case

puts is earthed. The chassis and metal case of the supply unit is always connected to the mains earth for reasons of safety.

Dealing with components, the i.c. regulator is available from Maplin Electronic Supplies. The mains transformer may be any small transformer having a 24 volt 1 amp secondary, or two 12 volt 1 amp secondaries which can be connected in series to give a total of 24 volts. Capacitor C1 is a can-type electrolytic component which is mounted vertically, with its tags at the top, by means of a mounting clip. PL1 is a panel-mounting neon indicator, which must have its own integral series resistor and which is intended for operation from 240 volt a.c. mains. S2 is a 4-pole 3-way rotary switch with connections made to one of the poles only.

The prototype is housed in a metal instrument case type BC3 which has dimensions of about 203 by 140 by 63mm. (8 by 5½ by 2½in.). This is available from Harrison Bros., P.O. Box 55, Westcliff-on-Sea, Essex, SS0 7LQ. Since both C1 and T1 are relatively large components it is advisable to obtain these, or at least confirm their dimensions, before ordering the case. This is because excessively large components could not fit inside the case height. Generally advertised components appear, however, to have satisfactory dimensions in this respect.

CONSTRUCTION

As can be seen from the accompanying photographs there is plenty of space, laterally, inside the case for the various parts. The front panel components, from left to right, are PL1, S1, VR1, S2 and the two output sockets SK1 and SK2. SK1 is positioned vertically above SK2. Inside the case the mains transformer, C1 and the fuseholder are bolted directly to the bottom of the case, the fuseholder being situated behind the output terminals and S2. Precise positioning of these components is not important. There is a hole fitted with a p.v.c. grommet in the rear panel for the mains lead, and this lead must be secured inside the case with a suitable plastic or plastic faced clamp. Its remote end should be properly terminated in a 3-way mains plug. A chassis connection for the mains earth wire and the arm of S2 is conveniently provided by a solder tag under one of the mounting nuts for the transformer.

The can of C1, which will normally be common with its negative terminal, must be fully insulated from its mounting clip. If the can is not covered with a plastic sleeve, three or four turns of p.v.c. insulating tape should be wound around it at the point where it is secured by the clip. Confirm the tag positions of S1 and S2 with a continuity tester before wiring to these components, as some switches may have different tag positions to those shown in Fig. 4.

The remaining small components are wired up on a Veroboard panel of 0.1in. pitch having 9 copper strips by 15 holes. This must be cut down from a larger piece of board with the aid of a hacksaw, after which any rough edges are then filed to a neat finish. No mounting holes are required and there are no breaks in the copper strips. The component layout on the board is shown in Fig. 4, as also are the connections to the other components.

The lead-out wires of IC1 are bent at right angles at two points, as shown in Fig. 5, so that when the device is secured to the rear panel of the case, which provides a heatsink surface, the component board is also mounted. The metal heat tab of the μA78GU1C connects to the "COMM" terminal, and it is therefore necessary to insulate it from the metal case by means of the usual mica insulating washer and plastic bush. It is necessary to provide good thermal contact between the heat tab and the inside surface of the case, and there should be no burrs in the hole drilled in the case. A continuity tester or ohmmeter may be employed to check the insulation between the heat tab and the case after IC1 has been mounted.

The i.c. is not, however, finally mounted until all the connections to the Veroboard and remaining point-to-point wiring shown in Fig. 4 has been completed. Flexible p.v.c. insulated wire is used for these interconnections, and the wires between T1 primary, PL1 and S1 should be suitable for mains voltages. Wires in T1 secondary circuit must be capable of carrying 1 amp satisfactorily, and should be 7/0.2mm. or thicker. Many of the connecting wires available these days are not rated to carry currents of 1 amp.

Since capacitor C1 has its tags at the top, a precaution is needed to ensure that they will not be short-circuited by the metal lid of the case. A piece of thin s.r.b.p. ("Paxolin") sheet should be glued to the inside of the lid in a position which causes it to

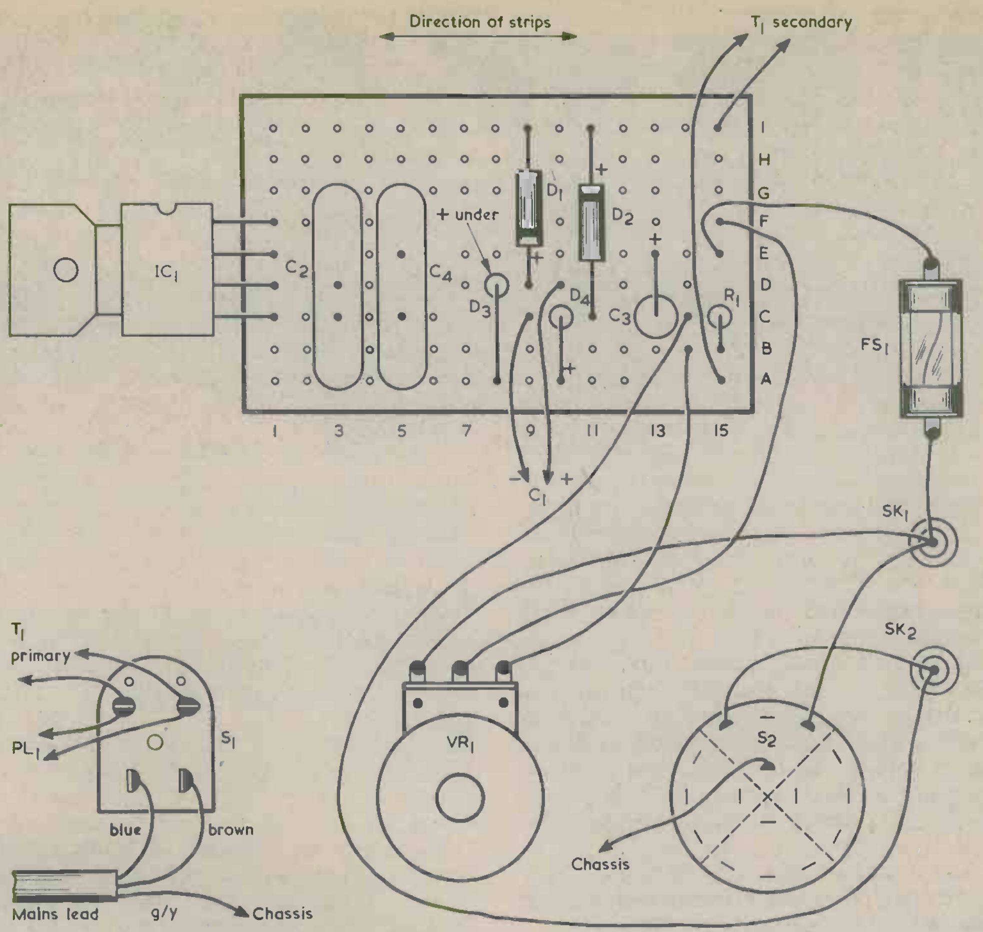


Fig. 4. Details of wiring. A small veroboard panel accommodates nearly all the components and makes wiring simple and straightforward. The two chassis connections are taken to a solder tag fitted under one of the mains transformer securing nuts

be above the capacitor tags when the lid is in place. If the mains transformer employed has tags at the top, a larger piece of s.r.b.p. sheet should be used, this being above the mains transformer tags as well as the capacitor tags when the lid is fitted.

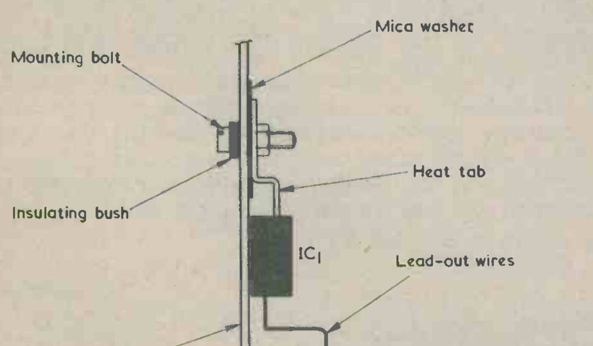


Fig. 5. The lead-out wires of IC1 are bent as shown here, and the i.c. heat tag is bolted, with insulating bush and washer to the rear panel of the case, which functions as a heatsink. The mounting also holds the veroboard component panel in place

CHECKING

Once all the wiring has been completed and carefully checked, the unit may be tried out. A voltmeter is connected across the output sockets, and VR1 is then adjusted to ascertain that the correct nominal output voltage range is given. Numbers taken from "Panel-Signs" Set No. 4 can be affixed to the front panel around the knob for VR1 to indicate the output voltages at the different settings of this control. "Panel-Signs" Set No. 4 will also provide front panel legends, these being "OFF" and "ON" for S1, "VOLTAGE" for VR1 and "EARTH" for S2. Plus and minus signs for S2 and the output sockets may also be used. "Panel Signs" are available from the publishers of this magazine.

The output short-circuit current with foldback limiting should be in the region of 300mA. The precise figure varies somewhat between one μA78GU1C and another, and it also depends upon the temperature of the device, which incorporates thermal overload protection circuitry. In use, the i.c. may run quite hot, especially when a low output voltage is selected and a high current is drawn from the unit. Nevertheless, the heatsinking provided by the metal case specified has been found to be adequate to enable the full output current of 1 amp to be continuously supplied at any output voltage. ■

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Now that the season for Far Eastern reception has ended — generally speaking it begins in late September/early October and continues through to around February with the 'peak' probably being in December — a brief review of the results achieved may be of interest to some readers of these columns.

The Chinese regional stations were well represented by Guiyang on **3260** at 1531, Kunming on **4760** around 1530 on several occasions, Changsha on **4990** during the late afternoons, Wuhan on **3940** at 2230, Quinghai on **3950** at 2151 when signing-on, Nanning on **4905** at 2030, **4915** at 2100 and on **5010** at 2202. Additionally there were the many PLA transmitters on the usual channels and the R. Peking domestic service frequencies.

Mongolia was heard on many occasions, Ulan Bator tending to be well received when opening at 2200 on **4830.**

Indonesia was well represented this season with RRI Sorong on **4875** at 2225, RRI Banda Aceh on **3905** at 1530 and on **4954** at 1543, RRI Padang on **4003** at 1520, RRI Palembang on **4956** at 1546, RRI Jakarta on **4774** at 1553, RRI Bukittingi on **3232** at 1525 and RRI Palu on **3960** at 1522.

North Korea made appearances on **3015** at 2132, on **3559** at 1538, both transmitters being based at Pyongyang. A late arrival in the season was Pyongyang on **4770** at 2200.

Malaysia was logged via the Kuala Lumpur transmitter on **4845** at 1509, Kuching in Sarawak on **4950** at 1548, Penang on **4985** at 1554, and Singapore on **5010** at 1537.

Then there was Nepal on **3425** at 1527, Lhasa in Tibet on **4750** at 1523, Bangkok on **4830.5** at 1440, Ceylon on **4870** at 1550, Rangoon in Burma on **5040** at 1600 and, of course, the many Indian stations on various channels.

Last, but not least, there were Hanoi on **4944** at 1543, Hohhot in Inner Mongolia on **6840** at 2217 and the best of them all — Luang Prabang, Laos, on **6997** at 2232.

AROUND THE DIAL

In which are included some of the loggings made over the past few weeks. However, some frequencies and times are subject to change, although many of them, particularly those on the 60 and 90 metre bands, remain constant.

● ITALY

Rome on **11855** at 2040, YL (young lady) announcer introducing records of Italian songs in the English programme for the Near East, scheduled on this channel from 2025 to 2100 GMT.

● SWEDEN

Stockholm on **11955** at 2102, OM (old man = male announcer) and YL with the English programme intended for Africa, Europe and the Middle East, scheduled on this frequency from 2100 to 2130 on Saturdays and Sundays only.

● AUSTRIA

Vienna on **9585** at 1912, Tyrolean-type music in the German programme for Europe, West and South Africa, scheduled from 1900 to 2030.

Vienna on **21655** at 1300, interval signal, OM with station identification followed by the German programme directed to Europe, South East Asia and Australasia, scheduled from 1300 to 1400.

● CANADA

Montreal on **15325** at 1554, OM with the English programme — all about Canadian Indians — to Europe and the U.S.S.R., scheduled from 1545 to 1600. Also logged in parallel on **15315.**

● SAUDI ARABIA

Riyad on **21605** at 1850, a drama in Arabic in the Domestic Service, scheduled on this channel from 1700 to 2000. Also logged in parallel on **15060** at 2010, the schedule here being from 1500 to 2300. Best reception on the former channel.

● VATICAN CITY

Vatican on **11700** at 1945, the Rosary to all Europe and Africa, scheduled here from 1945 to 2005.

● CUBA

Havana on **17705** at 2035, OM with identification in Spanish in the programme using that language to the Mediterranean Area, scheduled from 1840 to 2040.

● CHILE

Santiago on **17715** at 2000, YL with "Voice of Chile" identification and other announcements at the end of the English programme directed to Europe, scheduled from 1930 to 2000.

● EAST GERMANY

Radio Berlin International on **7185** at 1935, OM and YL alternate with announcements in the English programme for European consumption, scheduled from 1915 to 2000.

● HUNGARY

Budapest on **7200** at 1930, OM with a newscast in the German programme for Austria, scheduled from 1930 to 2000.

● GREECE

Athens on **7205** at 1925, OM with a newscast in English for Europe, scheduled from 1920 to 1930 on this channel and also logged in parallel on **7125**, the latter providing the best reception here in the U.K.

● BULGARIA
Sofia on **7670** at 1915 (yes, the frequency is correct although 'out of band'), OM and YL alternate with the Bulgarian programme for Europe, scheduled from 1900 to 1930. The English programme to the U.K. is from 1930 to 2000 on **9700** and **11720**.

● ALBANIA
Tirana on **7065** at 1910, OM with news in the Arabic programme for the Near East, scheduled from 1900 to 1930. An English programme for Europe is radiated from 1830 to 1900 on this channel.

● CZECHOSLAVAKIA
Prague on **7345** at 1905, YL with a newscast in the English programme for Europe, scheduled from 1900 to 1930.

● BRAZIL
Radio Nacional Brazil, Brasilia, on **11780** at 2020, OM with a football commentary in Portuguese. The schedule of this one is from 1900 to 2400 and the power is 250kW — relatively easy to log.

Radio Globo, Rio de Janeiro, on **11805** at 2025, OM with an excited sports commentary. The schedule is from 0800 to 0330 (variable closing time) and the power is just 10kW.

● SOUTH AFRICA
RSA (Radio South Africa) Johannesburg on **17780** at 1845, OM with the French programme to Central Africa and Europe, scheduled from 1800 to 1850. An English programme to West Africa and Europe may be heard on this channel from 2100 to 2150.

SABC Meyerton on **4880** at 1813, OM with a programme of popular classical music in the Home Service programme in Afrikaaans, scheduled here from 0348 (Saturdays 0427, Sundays 0457) to 0620 and from 1555 to 2115 (Saturdays 2200). The power is 100kW.

● IRAN
Tehran on **9022** at 1921, OM with the French programme followed by station identification at 1930 and the English programme for Europe. This was logged by our young reader (15½ years). A. Duprés of Rhiwbina, Cardiff, on his FRG-7 receiver with a 30ft long wire aerial attached. Thanks for your continued interest OM.

● POLAND
Warsaw on **6095** at 2030, OM with identification followed by a newscast in the English programme for Europe, scheduled from 2030 to 2100.

● BENIN
Cotonou on **4870** at 2144, local orchestra with rythmic African-style music — very colourful! This is the Home Service in French and vernaculars, the scheule being from 0500 to 0800 weekdays (to 1100 on Saturdays) and from 1300 to 2300 on weekdays (Sundays from 0600 through to 2300). The power is 30kW.

● MOZAMBIQUE
Maputo on **4925** at 1909, guitar music, YL with songs in venacular. This is the 'B' Programme in Portuguese and vernaculars scheduled from 0255 to 0600 and from 1600 to 2210. The power is 20kW and the frequency can vary to **4926**.

● TANZANIA
Dar-es-Salaam on **5050** at 2000, OM with identification in English followed by a newscast in Swahili. Sign-off with the National Anthem after YL with identification in both English and Swahili at 2015. This is the Commercial Service in Swahili, scheduled from 1300 to 2015, the National Service schedule being from 0300 to 0500. The power is 10kW.

● CONGO
Pointe Noire on a measured **4843** at 1919, OM with a talk in French — presumably a relay of Brazzaville. The schedule is from 0400 to 1200 and from 1500 to 2100, these times however being subject to some variations. The power is 4kW.

● ANGOLA
Luanda on **4820** at 1925, OM with a sporting commentary in Portuguese, the schedule being from 1500 to 2400 and the power 10kW.

● GUINEA
Conakry on **4910** at 2212, OM's with a discussion in vernacular. The schedule of this one is from 1230 through 0800 and the power is 18kW. If you would like to log Conakry, do so after 2200 when Lusakia, Zambia, on **4911** (50kW) is off the air. The schedule of the latter station is from 0345 (Sunday 0440) to 0530 and from 1400 to 2105 (Saturdays 2200).

● VENEZUELA
Radio Valera, Valera, on **4840** at 0348, OM with a pop love song in Spanish. This station is scheduled from 0900 through to 0400 but closing time can vary up to 0600. The power is 1kW.

Radio Barquisimeto on **4990** at 0331, OM in Spanish with news of local events. The schedule is from 1000 to 0400 and the power is 15kW.

Radio Reloj Continente, Caracas, on **5030** at 0328, OM with pop song in Spanish, OM with announcements. The schedule is from 0900 through to 0500 (Sundays from 1000 to 0400) and the power is 10kW.

"I think you're right, it could be Radio Moscow!"

THE "DIODYNE" RECEIVER

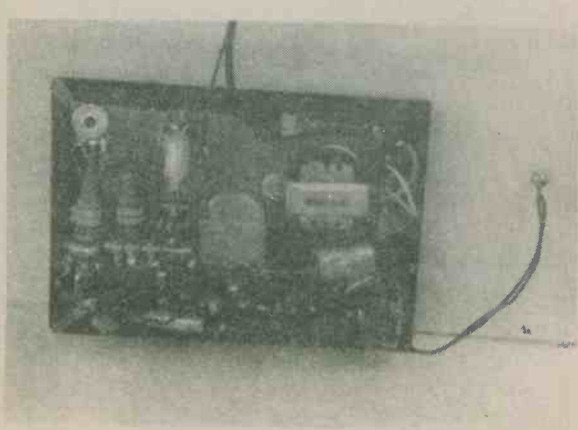
By Sir Douglas Hall, Bt., K.C.M.G.

An ingenious medium and long wave t.r.f. design incorporating automatic gain control

The "Diodyne" receiver is of the static rather than the portable type. It acquires its power from the mains supply, and needs a separate 3 Ω speaker and an external aerial. In many areas a few yards of wire across the ceiling will be adequate, although in a badly screened house a very short outside aerial may be needed. It is called the "Diodyne" because, although only three active devices are used, a total of seven diodes is employed in the circuit. The active devices are one valve and two transistors.

STRAIGHT CIRCUIT

The circuit is of the simple "straight" variety without reflexing, but the receiver differs from almost all others of its type in having a strong a.g.c. effect built in. This is not intended to prevent distant stations from fading, but rather to reduce the signal strength from powerful local stations to the same level as is given with signals of medium strength. In other words it is possible, with reaction set for maximum sensitivity, to tune each range without the annoying blast which otherwise occurs as the local station is tuned through. This a.g.c. effect does not increase selectivity and the local station will still be found to have its normal spread, but at an even level without a peak of noise at the exact tuning point. The selectivity is not claimed to be especially good. Indeed it cannot be, with a single tuned circuit and an external aerial. But it is better than that of many straight receivers, and Radios 1, 2, 3 and 4, together with Radio South West and Plymouth Sound, are all received at good strength in the author's home. And the author lives in what is generally considered to be a poor reception area.



The components are assembled on the rear surface of the receiver front panel

The circuit is shown in Fig. 1. The signal is picked up by the aerial and passes via C1 to the tuned circuit formed by VC1 with L1, or L1 plus L2 on the long wave band. It is applied to the DL96 valve which, at the low supply voltage with which it operates, acts as an extremely efficient leaky grid detector. The grid resistor, R4, and the screen grid are connected to the steady voltage appearing across sener diode D3. It is, of course, the control grid bias voltage and the screen grid voltage which determines the anode current passed by the valve. In addition, D5 stabilizes the direct voltage available for V1 and TR1 at 10 volts.

Reaction is applied via L3, or L3 plus L4, and is controlled by VR2. R1 is connected across L4 to ensure that the critical reaction setting is about the same on both medium and long waves. Some experiment to find the best value for this component is permissible. The detected signal at V1 anode passes through the reaction windings and r.f. stopper R7 to the base of TR1. This is a close tolerance transistor and is wired as a common emitter amplifier with a significant level of negative feedback due to the lack of a bypass capacitor across D4. In consequence the input impedance at TR1 base offers an acceptable match to the impedanced at V1 anode. A zener diode is used instead of a resistor, as this reduces negative feedback at d.c. which could adversely affect the a.g.c. effect. The slope resistance of D4, at a zener current of 7mA, is of the order of 60 Ω. To obtain the same bias effect with a resistor would require a value of about 560 Ω, and negative feedback of direct current would be about nine or ten times as great. The collector load of TR1 is VR4, and the signal then passes to the base of TR2, with VR5 functioning as a volume control. TR2 is another close tolerance transistor arranged as a common emitter amplifier, but without a.c. negative feedback. The filament of the valve is the emitter load for TR2, and circuit constants are arranged so that the emitter current is 25mA, which is that required to heat the filament.

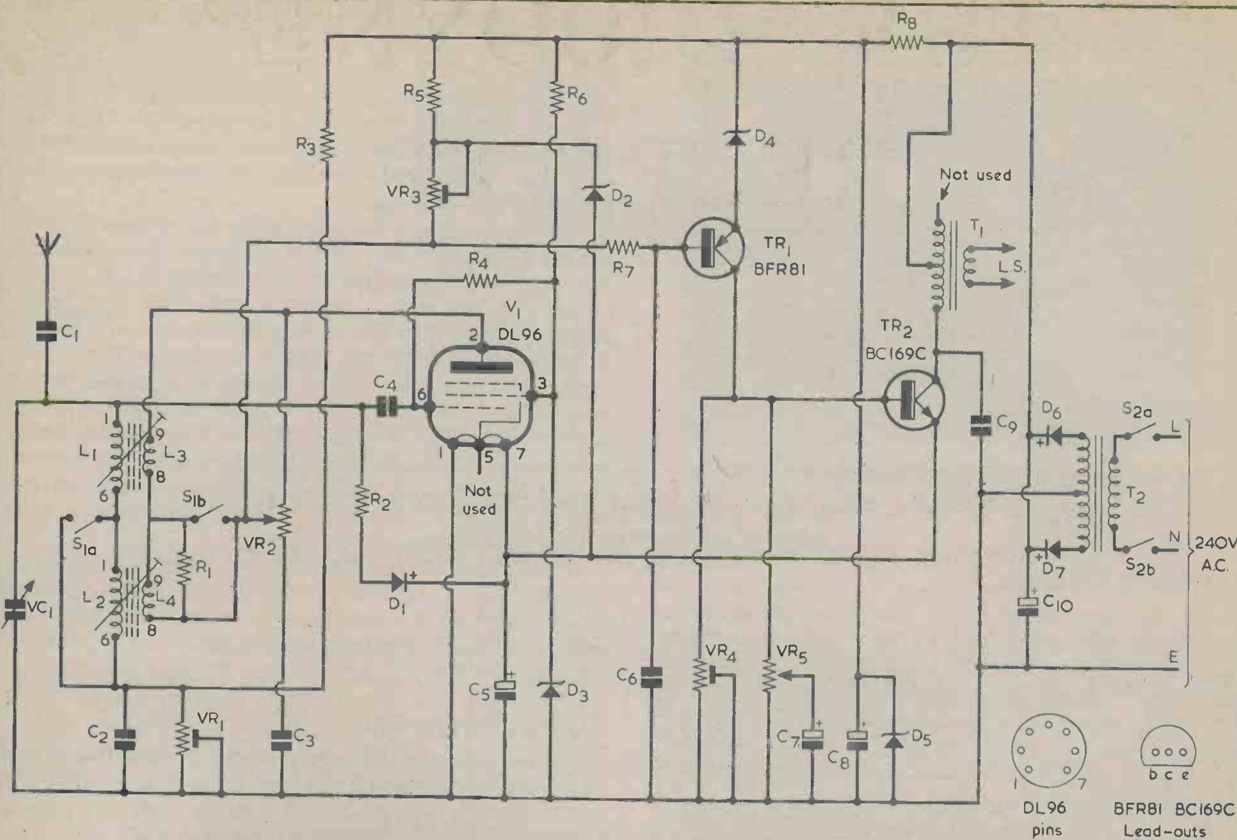


Fig.1. The circuit of the "Diodyne" medium and long wave receiver. Although this is a t.r.f. design it nevertheless incorporates an a.g.c. circuit which reduces sensitivity with powerful signals

COMPONENTS

Resistors

(All fixed values ¼ watt 10%)
R1 1kΩ (see text)
R2 680Ω
R3 10kΩ
R4 10MΩ
R5 10kΩ
R6 1kΩ
R7 22kΩ
R8 330Ω
VR1 4.7kΩ pre-set potentiometer, horizontal (see text)
VR2 10kΩ potentiometer, linear (see text)
VR3 47kΩ pre-set potentiometer, horizontal (see text)
VR4 1kΩ pre-set potentiometer, horizontal (see text)
VR5 1kΩ potentiometer, log, with switch S2 (a)(b) (see text)

Capacitors

C1 22pF silvered mica or ceramic
C2 0.1μF polyester
C3 1,000pF silvered mica or ceramic
C4 220pF silvered mica or ceramic
C5 1,000μF electrolytic, 6V. Wkg.
C6 1,000pF silvered mica or ceramic
C7 220μF electrolytic, 10V. Wkg.
C8 1,000μF electrolytic, 16V. Wkg.
C9 0.1μF polyester
C10 1,000μF electrolytic, 16V. Wkg.
VC1 365pF variable, type 01 (Jackson)

Inductors

L1, L3 Miniature dual purpose coil, Blue, valve usage, Range 1 (Denco)
L2, L4 Miniature dual purpose coil, Blue, valve usage, Range 1 (Denco)
T1 Output transformer type LT700 (Eagle)
T2 Mains transformer, secondary 12-0-12V at 100mA (see text)

Valve

V1 DL96

Semiconductors

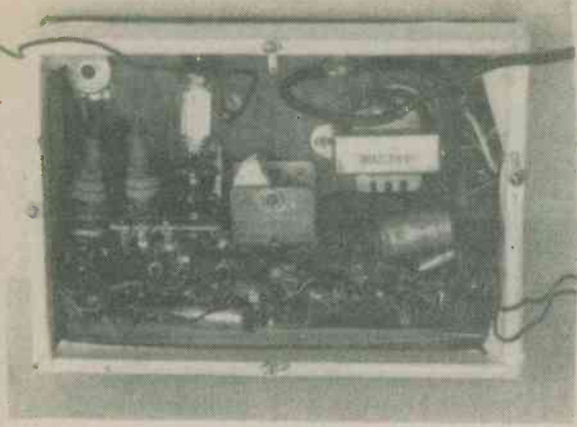
TR1 BFR81
TR2 BC169C
D1 OA90 or OA91
D2 BZY88C5V1
D3 BZY88C6V8
D4 BZY88C3V9
D5 BZY88C10V (10 volt)
D6 IN4001 or IN4002
D7 IN4001 or IN4002

Switches

S1(a)(b) 2-pole miniature slide
S2(a)(b) d.p.s.t. toggle, part of VR5

Miscellaneous

2 B9A valveholders
B7G valveholder
Tagstrips (see text)
3 control knobs
3-core mains lead
Materials for panel, case, brackets, etc.
3Ω speaker in separate enclosure



The panel with the four-sided frame fitted behind it

STARTING DEVICE

It will be observed that V1 anode current provides base bias for TR1, that TR1 collector current provides base bias for TR2, and that TR2 emitter current heats the filament of V1. A starting device is therefore needed to make these currents flow after switching on the receiver. Starting is provided by means of R5 and D2, and adjustments are made in setting up to ensure that about 0.5 volt is initiallydroppedacross the filament at switch-on. At this potential the valve will just start to pass anode current and the voltage drop across its filament will rise, slowly, because of extra current now being provided by the emitter of TR2. The process will continue until the correct voltage of 2.8 volts appears across the filament. This means that the voltage acros D2 is lowered, and it will cease to pass enough current to have any marked effect in the circuit. At the same time, V1, TR1 and TR2 are all functioning normally. When the setting-up procedure has been carried out properly, the starting process takes some two or three seconds.

The a.g.c. action may next be considered. Assume that a strong signal is received from a local station. This causes the grid of V1 to be driven more negative and its anode current, and hence the base bias current for TR1, to fall. There will be a corresponding fall in base bias current to TR2, a drop in its emitter current and a decrease in the voltage appearing across the valve filament. There will be a small drop in the efficiency of V1, both at radio and audio frequencies, but the main a.g.c. effect is provided by the clamp diode, D1. This is a normal r.f. germanium diode, and its cathode connects to the positive side of V1 filament whilst its anode couples via R2 to a voltage which is provided by R3 and VR1. VR1 is set up so that the voltage applied to the anode of D1 is, in the absence of strong signals, very slightly lower than 2.8 volts. This means that a small reverse bias is applied to the diode, so that it does not conduct and have any effect on the circuit. But, on reception of a strong signal, the falling voltage across the filament causes D1 to become forward biased. It conducts and effectively connects R2 across the receiver tuned circuit, with consequent damping of that tuned circuit and a drastic fall in receiver sensitivity.

COMPONENTS

Some points need to be made next concerning components. The DL96 valve may be obtained from mail order firms specialising in valves, such as Langrex Supplies Ltd., Climax House, Fallsbrooke Road, Streatham, London SW16 6ED. The author obtained a number of components from Electrovalue Limited, 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB, these including the BFR81 required for TR1 and the mains transformer. The potentiometers VR2 and VR5 are also available from Electrovalue as Type P20. The three skeleton pre-set potentiometers are the "standard" size rated at 0.25 or 0.3 watt, rather than the subminiature 0.1 watt type.

A 19-way tagstrip is employed in the receiver, this being cut down from an R.S. Components "Standard" 28-way strip having a length of 267mm.(10½ in.). R.S. Components do not supply directly to individual contructors, although those with access to this company will be able to obtain this strip. It may also be stocked by some component shops. An alternative approach is to use two 7-way tagstrips and one 5-way tagstrip, both with 0.375in. tag spacing, which are available from Electrovalue. These strips are mounted end to end to effectively give one 19-way strip of tags. A 4-way tagstrip is needed and this may be cut down from the R.. Components strip, or from a third Electrovalue 7-way strip.

If difficulty is experienced in obtaining the coils specified for L1, L3 and L2, L4, these may be obtained direct from the manufacturer at Denco (Clacton) Ltd., 357/9 Old Road, Clacton-on-Sea, Essex, CO15 3 RH.

CONSTRUCTION

Construction commences with the cutting out of five pieces of ¼in. plywood, as shown in Fig. 2. The four smaller pieces will be joined together later to form a frame, covered with Fablon or Contact, which makes up the case. The largest piece should have a cut-out for the wavechange slide switch and mounting holes for VR2, VR5 and VC1. It is then covered with Fablon or Contact, after which components are mounted as shown. Precise positioning is not important as long as a border ¼in. wide is left free round the edge for the frame. If the R.S. Components tagstrip is used, this is cut so that there is a mounting tag at each end, and it is mounted by small woodscrews passing through the end tags and the tag at the centre. The Electrovalue 7-way tagstrips are mounted by small woodscrews at the end tags. The 4-way tagstrip should be cut out such that there is a mounting tag at each end.

Coilholders are mounted on small metal angle

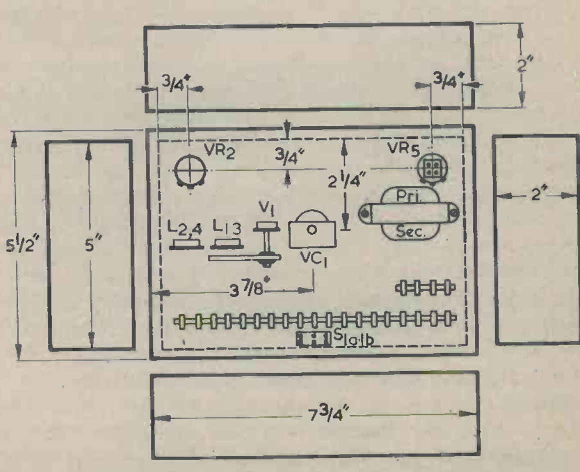


Fig.2. Rear view of the front panel and the four sides of the receiver. The positioning of the components, apart from VR2, VR5 and VC1, is not critical

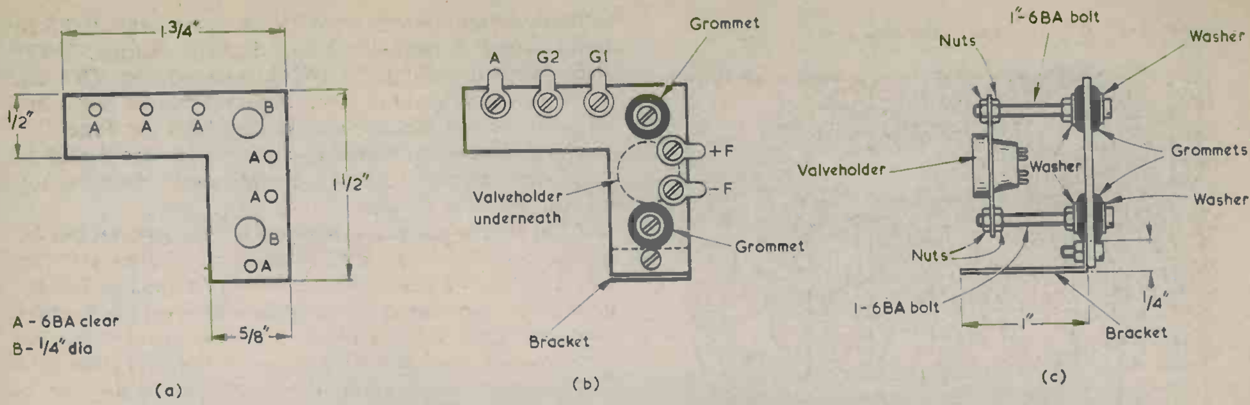


Fig.3(a) The valveholder may, if desired, be given an anti-microphonic mounting. First required is a piece of s.r.b.p. cut out and drilled as shown here
(b) Five solder tags are secured to the s.r.b.p. with short 6BA bolts and nuts
(c) Side view of the assembly, illustrating the manner in which the long 6BA screws are fitted to the grommets

brackets which are bolted to each coilholder mounting hole which is nearer pin 4. The Valveholder may be similarly mounted, but a problem can then arise due to possible microphony in the valve due to its filament vibrating with sound from the speaker. The DL96 was designed for use as an output valve but in the present application it has two stages of a.f. amplification following it, whereupon any microphonic effect becomes more evident. Individual valves vary so far as microphony is concerned and, since the speaker is separate from the receiver proper, it is quite possible that no difficulties due to acoustic feedback and howling will be encountered. Should feedback occur, it is necessary to provide a special mounting for the valveholder as shown in Fig. 3. First cut out and drill a piece of $\frac{1}{16}$in. s.r.b.p. ("Paxolin") as shown in Fig. 3(a). The two large hole centres should have the same spacing as the mounting centres of the B7G valveholder to be used. The smaller holes are positioned approximately as shown. Fit rubber grommets to the two large holes and, using short 6BA bolts and nuts, mount five solder tags and an angle bracket to the six small holes, as illustrated in Fig. 3(b). The metal bracket has the dimensions shown in Fig. 3 (c). Two 1in. 6BA screws are passed through the grommets with washers as illustrated, the securing nuts here being finger tight only. The valveholder is then mounted at the ends of the screws with nuts that are fully tightened with a spanner. Pin 7 of the valveholder should be nearer the bracket end of the assembly. Thin flexible wires connect the valveholder tags to the solder tags, and it will be found that the valve, when inserted, is capable of a small amount of movement and that there is no rigid mechanical coupling between it and the receiver panel. The positive valve filament pin is pin 7, incidentally, and the negative filament pin is pin 1. The term "G1' applies to the first grid, which is nearest the filament (i.e. pin 6).

As already mentioned, the flexible valveholder mounting of Fig. 3 may not be essential. Some constructors may prefer to provide it at the outset, whilst others may include it only if it should prove to be necessary.

Wiring up is then carried out as shown in Fig. 4, which assumes that the flexible mounting assembly for the valveholder is in use. This assembly, the coilholders and the pre-set potentiometers are all shown turned through 90 degrees for clarity. Output transformer T1 is mounted by soldering its securing lugs to the tags shown, taking care to ensure that its body does not touch the tag in-between.

Two Denco coils may have their iron dust cores adjusted so that about 5mm. of the threaded rod appears outside the coil former. Small adjustments may be made to these, if desired, to modify the ranges covered.

SETTING UP

Setting up is quite simple, but it is important that it should be correctly done. Connect a speaker but no aerial. Set VR1, VR3 and VR4 to insert zero resistance into circuit. As shown in Fig. 4, this means setting VR1 and VR3 fully clockwise, and VR4 fully anti-clockwise. Set VR2 fully anti-clockwise. Connect a meter, set to give a clear reading of 2.8 volts, across the valve filament. Convenient points of connection are at the emitter of TR2 for the positive meter lead and the right hand tag of the 4-way tagstrip for the negative lead. Switch on. Adjust VR4 until a reading of about 0.5 volt is given. Adjust VR3 slowly until the meter reading begins to increase. Continue to adjust VR3 slowly until a reading of 2.8 volts is given. Switch off, and switch on again. The meter needle should rise quickly to about 0.5 volt, pause for a second or two, and then advance to 2.8 volt. If the pause at about 0.5 volts is too short, readjust VR4 slightly so that the delay takes place. Readjust VR3 to give a final reading of 2.8 volts, if necessary. If it proves impossible to achieve a reading of 2.8 volts and there is no mistake in the wiring, it is possible that the valve is sub-standard. All top quality valves will be suitable, as well as most surplus or cheap quality valves, but a small number of the latter may have too low an emission to be suitable for this circuit. Top quality valves are available from the supplier mentioned earlier, and from other suppliers.

A large knob is required for VC1. This may be fitted with pointers and a tuning scale

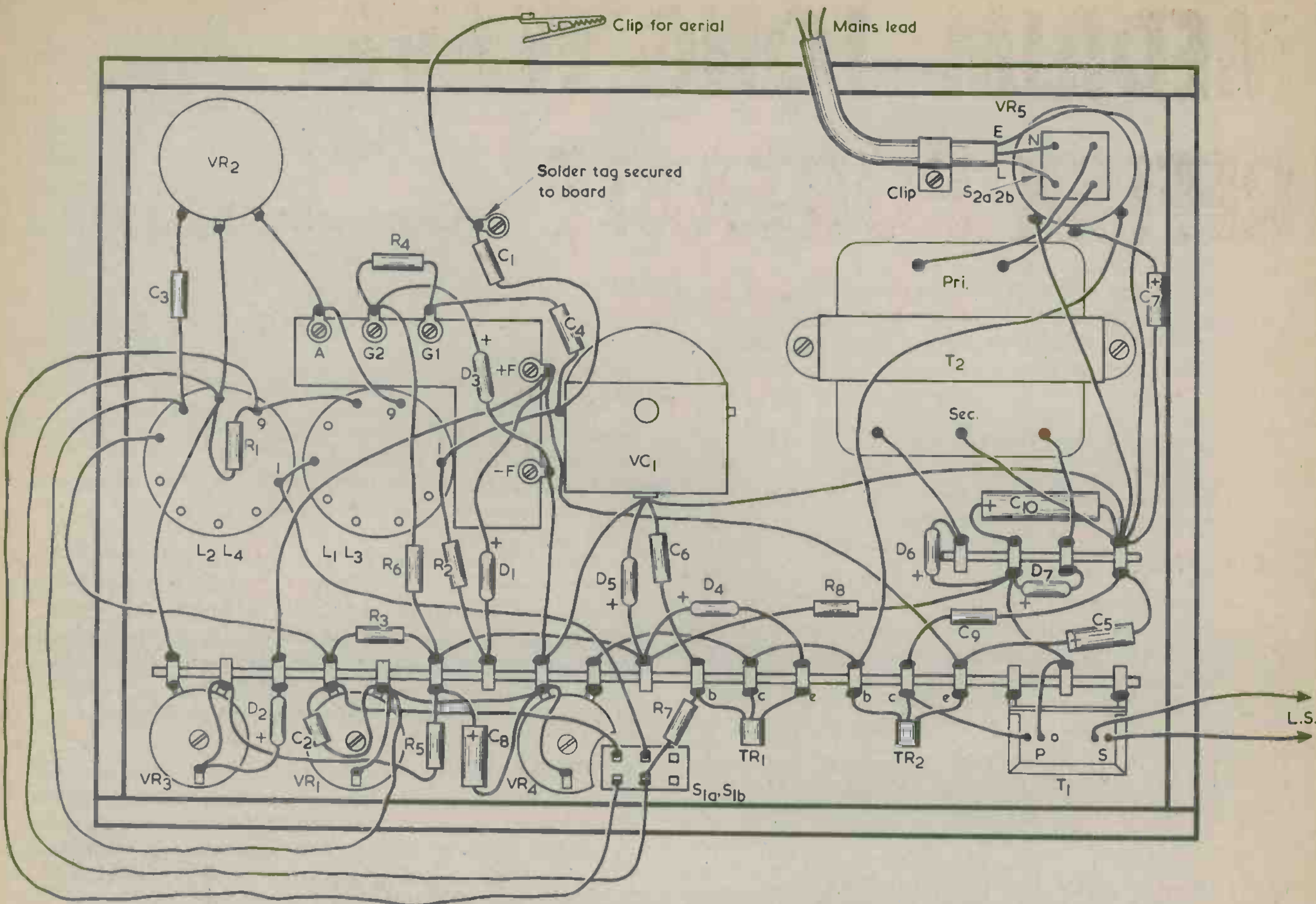


Fig.4 Wiring up the receiver. Connections should be short and direct; the wiring is shown spread out here for clarity. Pin 7 of L2, L4 is used as an anchor tag for C3. Confirm the tags of S2(a)(b) with a continuity tester before wiring up to them. Zener diode cathodes are indicated by plus signs

A.G.C. ADJUSTMENT

Next connect up an aerial and tune to a fairly weak medium wave station which is of such a strength that critical reaction can be used without distortion. With reaction at the critical setting, adjust VR1 until the reaction effect just begins to fall away, with a reduction in sensitivity just starting. This will require VR1 to be set well over half-way from its original zero resistance position.

Now tune in a strong local station. It will be found that, as VR2 is adjusted past what was previously the critical reaction setting, there is no increase in volume and, provided the station is exactly tuned, VR2 can be advanced to maximum without oscillation. If VR1 has been advanced to o far there will be a loss of sensitivity over the range and difficulty in producing a state of oscillation, whether a station is tuned in or not. Should VR1 not have been advanced far enough there will be no proper a.g.c. effect and the local station will produce blasting and overloading.

All the setting-up is now complete. No further adjustment will be necessary unless the valve or a transistor has to be replaced.

For maximum sensitivity, use reaction near the oscillation point, controlling volume by means of VR5. In these circumstances selectivity is good. Do not leave the receiver in an oscillating condition as it can then cause interference with other receivers, although the tiny power available for V1 causes the range of transmission to be very small.

After experience with the receiver has been obtained, the more experimentally minded may care to try alternative values for R1, should this be considered desirable. The function of this resistor was described earlier.

Remember, during construction and later work on the receiver, that mains voltages are present at the primary of T2 and at the tags of S2(a)(b). Always take care to ensure that there is no risk of accidental shock.

FINISHING OFF

When all is well, the panel of the receiver is screwed to the frame given by the four sides. A back is then required and this can consist of a piece of Formica measuring $7\frac{3}{4}$ in. by $5\frac{1}{2}$ in. This should be screwed to the back of the frame, and it requires small U-cuts near the edges to allow the mains lead, the speaker lead and the aerial lead to pass out.

The front of the receiver is left to the individual constructor's own preferences. A large knob for tuning is required and a suitable tuning scale and pointer may be fitted, the scale being marked up in terms of wavelength and received stations.

As a final point it may be found that short wave breakthrough may occur after dark in some areas when the tuning capacitor is at or near the minimum capacitance end of its range. This can be alleviated by putting a short wave choke between the aerial and the receiver. The choke can consist of a medium wave tuning coil, or can be made up by winding 60 turns of 30 to 34 s.w.g. enamelled wire on a 2 in. length of $\frac{3}{8}$ in. ferrite rod. ■

MEDIUM–LONG WAVE REFLEX PORTABLE

Part 2 (Conclusion)

By R. F. Haigh

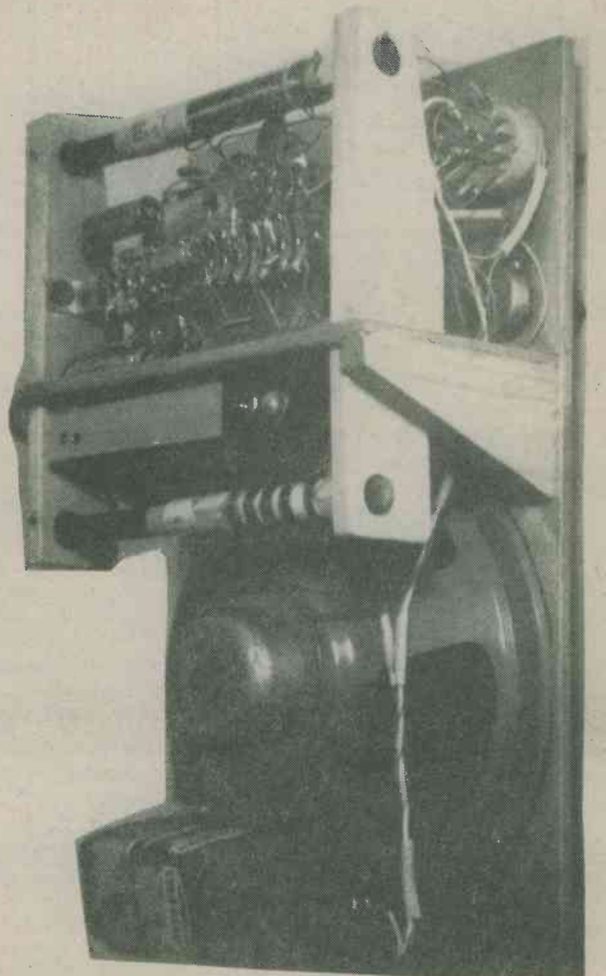
CONSTRUCTION

The front panel consists of a piece of $\frac{3}{16}$in. ply measuring 7 by 11in. Cut a hole to suit the speaker and drill holes for the tuning capacitor spindle and for the bushes of the switch, potentiometers and tuning drive spindle. These should appear in a symmetrical pattern as indicated in Fig. 2(a) and the photographs. Thicker ply can be used, but the holes for the bushes may then need to be countersunk to enable the mounting nuts to be threaded on them. When it is later mounted, the spindle of the tuning capacitor passes through the front panel, and a pointer is attached to its end. This traverses a cardboard dial which is glued to the outer face of the front panel and is protected by a piece of Perspex in a wooden frame.

Next to be cut out is a 7 by 3in. ply shelf and this requires holes for mounting the tuning capacitor. If the capacitor is secured by bolts passing into threaded holes in its base, these should not pass too far into the capacitor or they will damage the fixed or moving vanes. Suitable spacing washers will enable the variable capacitor spindle to pass through its hole in the front panel. A few holes should also be drilled to allow wiring to pass through, these being in the approximate positions shown in Fig. 2 (a).

The shelf is glued and pinned to the front panel, and small softwood brackets must be provided to impart rigidity. Softwood brackets for the ferrite rods are secured to the rear of the shelf by means of glue and screws, and the $\frac{3}{8}$in. diameter holes for the rods should be drilled before the brackets are fixed. Note that a woodscrew, inserted as in Fig. 2(b), will hold each ferrite rod in place after it has been mounted. A 14-way tagstrip is secured, by means of two small metal angle brackets, between the ferrite rod brackets, as indicated in Fig. 2(a). If the panel, shelf and bracket assembly is to be painted, this should be done now with no components mounted.

After allowing any finishes to dry, mount the front panel components, the aerial rods and the 14-way tagstrip. Next complete the tagstrip and switch wiring shown in Figs. 2 (c) and (d). The positive battery lead from S1 (d) passes through a hole in the shelf to the battery, which is positioned on the other side of the speaker. Connections to the audio amplifier section will be completed when this section is mounted. Not shown in in the wiring diagrams are C1, C2, C3, R5 and C8. In the prototype, C1 and C2 were mounted on a small tagstrip bolted to the frame of VC1. Their positioning is not critical and any other method of mounting them that does not incur long leads will be suitable. C3 is mounted on the appropriate tags of VR1. R5 is wired between the tag indicated in Fig. 2 (c) and the appropriate tag of VR2. C8 is mounted on the outside tags of VR2.



Side view, illustrating one of the support brackets for the shelf and the ferrite rod brackets

AUDIO AMPLIFIER

The audio amplifier section incorporating IC1 is assembled on a small U-shaped chassis of 24 s.w.g. aluminium having the dimensions shown in Fig. 3. Component layout is as indicated in Fig. 4, in which the flanges at the two long sides of the chassis point towards the reader. Tagstrips cut from one of the long 28-way tagstrips are positioned as shown, being spaced off from the chassis by ⅛in. spacing washers, taking care to ensure that the washers do not short-circuit to adjacent tags. The i.c. is mounted, with pins uppermost, by two bolts passing through its heat tabs, with ⅛in. metal spacing washers between the tabs and the chassis. The bolts securing the tagstrips and the i.c. should be short, so that they do not project unduly below the chassis. Alternatively, of course, the bolt heads may be below the chassis and the nuts above. Three single-ended and two double-ended solder tags are secured by the bolts to provide the chassis connections.

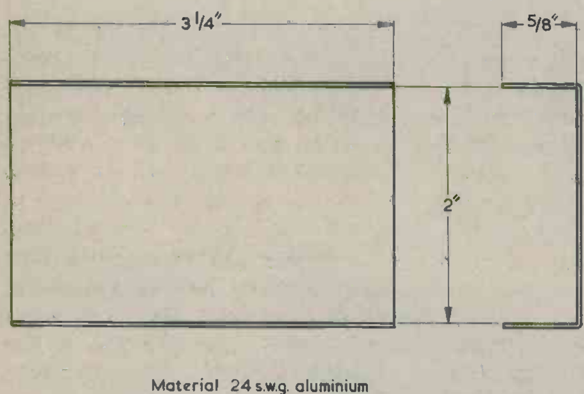
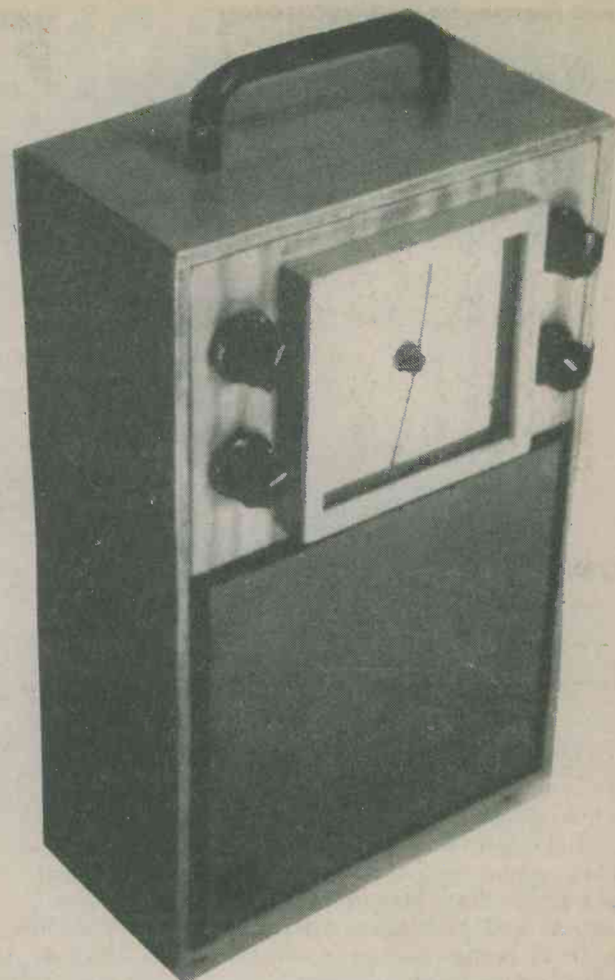


Fig. 3. The audio amplifier section is assembled on a small chassis having those dimensions



The cabinet is effectively a plywood box, having a back, two sides, a top and a bottom, into which the receiver assembly fits

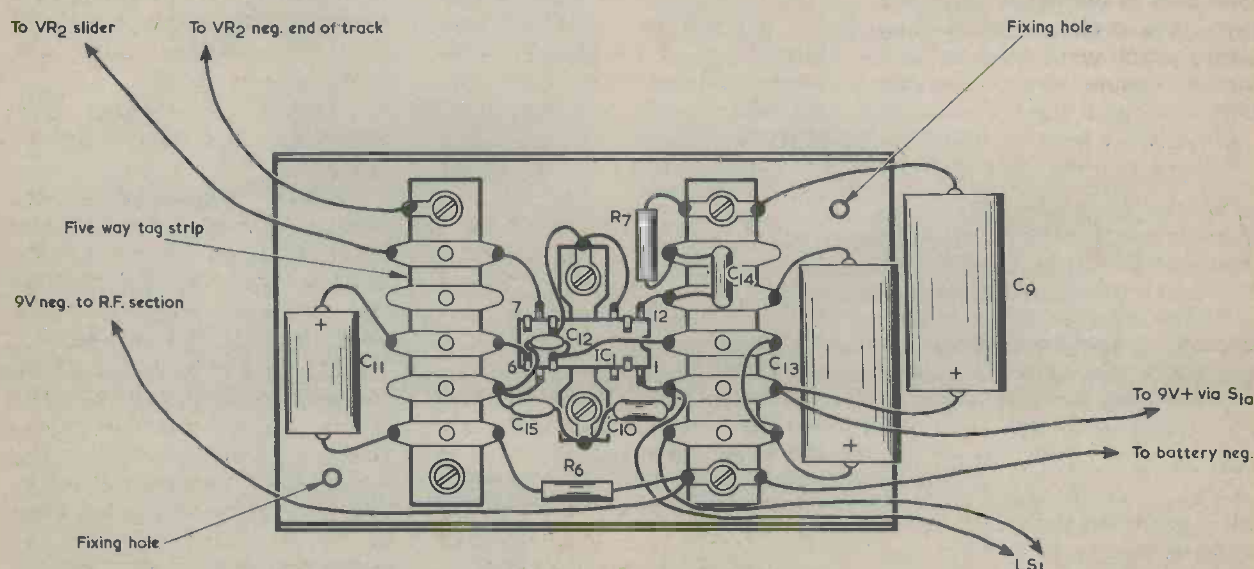


Fig. 4. Amplifier section wiring. Further details are given in the text

Continued on Page 565

FAULTS ON AN A.M. CLOCK RADIO

Alignment and timing problems

Dick placed the radio on his bench and looked at it curiously. To the right of its front panel was a horizontal tuning scale calibrated in terms of wavelength and stations for the medium and long wave bands. Above it were two edge controlled knobs with a small 2-position switch between them. He adjusted one of the knobs, to find that it moved the tuning pointer along the scale. He next turned his attention to the left hand side of the panel. And here there was a circular clock face before which were an hour hand and a minute hand, together with a second hand which circled busily in front of them.

Unconsciously, he looked down at his watch, which indicated 4.35. Precisely the same time was shown by the clock on the front panel of the radio.

To the right of the clock dial was a knob above which was the inscription "Set Alarm". Balancing it on the left was a second knob, around which were the legends "On", "Off", "Auto" and "Alarm". The knob was set of "Off". Dick put it to "On".

CLOCK RADIO

The sound of slightly distorted music became audible from the radio. Dick put his finger to the edge operated tuning control and tuned in the station correctly, thereby removing the distortion. There appeared to be a marked lack of sharpness in the tuning. He adjusted the remaining edge operated knob, which was patently a volume control. At full volume level the sound from the radio was pleasant in quality but by no means overloud.

"Hey, Smithy!"

Smithy, at his own bench, was preoccupied with the latest issue of one of the radio retail trade magazines and was poring over the tale of yet another domestic electronics manufacturer who had unloaded a whole range of products onto a discount chain, to be sold off their shelves at retail prices which were slightly less than the wholesale costs to independent dealers.

"Hey, Smithy!" repeated Dick.

Smithy dragged himself, from the unpalatable world of commerce, into the more exalted scene of straightforward servicing.

"Hallo!"

"What sort of fault," called out Dick, "would you expect in a set which tells you the correct time?"

Not unwillingly, Smithy put his magazine to one side and walked over to his assistant.

"Ah," he remarked, looking down at the set on Dick's bench, "you've got one of those little clock radios."

He picked up the set and adjusted the tuning control. As the pointer moved across the scale he was able to tune in two more stations. He next set the 2-position switch to its alternative position and adjusted the tuning until he received the Radio 4 signal on 1,500 metres. The signal was audible at a low level over a wide part of the scale. Smithy centred the tuning for the station and glanced at the tuning pointer. It indicated 1,700 metres.

"Oh dear," he remarked. "It looks as though someone has been having a fiddle around. Unless there is a definite fault, this radio shows all the signs of having been meddled with by someone who didn't know quite what he was up to."

"Then," remarked Dick assuredly, "it may well be the doings of Zilly."

"Zilly?" repeated Smithy absent-mindedly. "I wouldn't know about that. The flat tuning is the sort of thing you get when the i.f. transformers are out of alignment. When the i.f. transformers in an a.m. superhet are properly set up you get a nice sharp peaky response curve which gives reasonably selective tuning. But if they are only a little out of alignment the response curve is broad without any noticeable sharp peak. Also, of course, the sensitivity of the set goes down. You can usually get a good idea of the i.f. response in an a.m. superhet by simply tuning across the medium wave

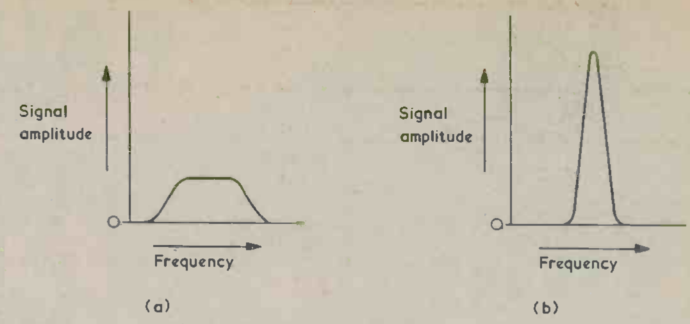


Fig. 1(a). An a.m. receiver with a misaligned i.f. amplifier has reduced sensitivity and a broad tuning response. In many cases the response curve may be highly asymmetric
(b). A properly aligned i.f. amplifier has a symmetric response curve with a sharply defined peak. If the receiver has double-tuned i.f. transformers or 'staggered' alignment, the response curve may have a relatively flat top which is several kilohertz wide

band and seeing how individual stations tune in." (Fig. 1.)

"Couldn't a fault in the i.f. amplifier cause the same effect?"

"It could," agreed Smithy, "and I'm not saying that such a fault isn't present. But there's another fact. Radio 4 is coming up at 1,700 metres on the scale instead of its proper 1,500 metres, and this also points to something wrong with the set's alignment. If we're unlucky, we may find that the alignment of the aerial and oscillator circuits has been fouled up in addition to the i.f. stages."

"It sounds," said Dick resignedly, "as though I'd better get the signal genny out."

"It does indeed," concurred Smithy. "I'm still not saying with absolute certainty that there isn't a snag somewhere which is causing the trouble. But everything indicates bad alignment and so the first thing we've got to do is to check that alignment. I'll see if we've got a service sheet for this set. While I'm doing that you could get the back off and do the routine job of checking battery voltage on load."

Smithy soon found the service manual for the receiver, and returned to find his assistant scowling fiercely at the receiver.

"This isn't half a funny set," Dick remarked. "To start off with, it's got two 1.5 volt cells in series and another 1.5 volt cell on its own. I've checked their voltages and they're all okay, but it seems a pretty queer supply arrangement to me."

Smithy laid out the receiver circuit diagram on Dick's bench. (Fig. 2.)

"This will make it all clear," he said soothingly. "The separate 1.5 volt cell powers the clock and the two 1.5 volt cells in series power the radio."

"But," protested Dick, "that means that the supply for the radio is only 3 volts."

"Quite a lot of small a.m. sets these days are powered by 3 volts," stated Smithy. "This is more than adequate for transistor amplifying circuits. The audio amplifier uses an old-fashioned driver transformer and output transformer circuit instead of a totem pole output stage, and this will work quite happily at 3 volts. It's surprising how that a.f. transformer circuit still keeps cropping up in quite recent sets. Still, it does have the advantage of allowing a low supply voltage."

I.F. ALIGNMENT

"Fair enough," said Dick. "What are you going to do first? Check the i.f. alignment?"

"I will."

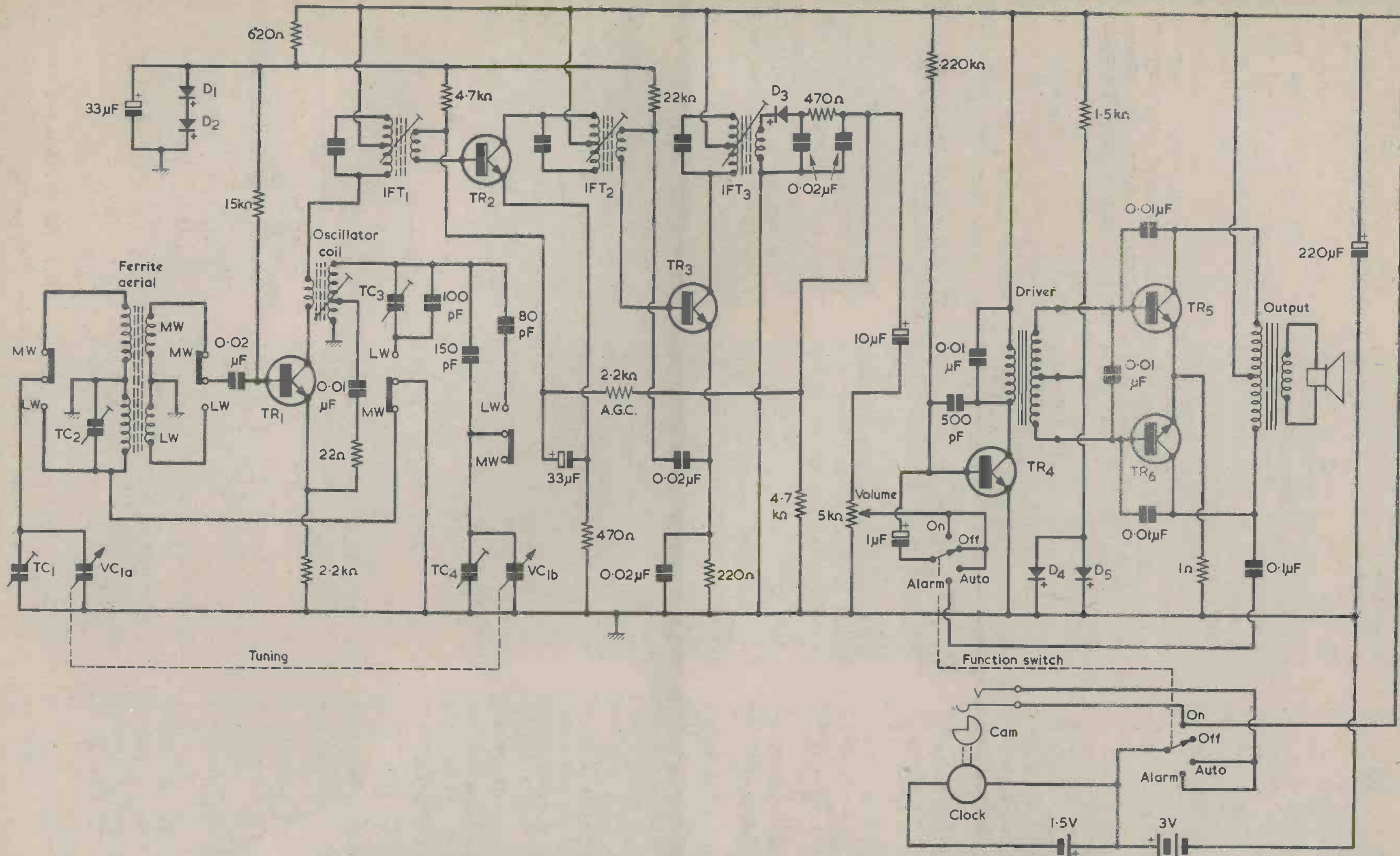


Fig. 2. Circuit of the clock radio. The two contacts shown above the clock motor close at the pre-set time. Apart from the germanium detector, D3, all semiconductors are silicon. The 4-pole wave-change switch is shown in the medium wave position. The stabilized voltage across D1 and D2 maintains base bias current for TR1, TR2 and TR3 as battery voltage falls. This circuit is based on that of the Bush BA5453 clock radio

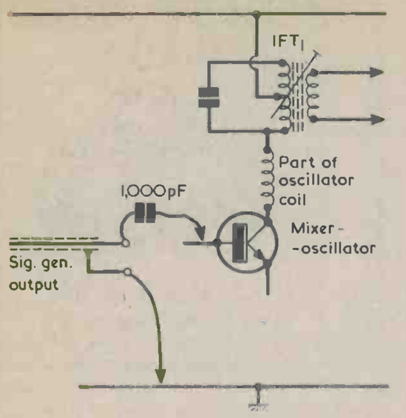


Fig. 3. It is common practice, when aligning an i.f. amplifier, to apply the signal generator output via a series capacitor to the base of the mixer-oscillator transistor, as in the typical example shown here

Smithy studied the service manual.

"It's always a lot easier to line up a set when you've got the manual in front of you," he continued, "even if only because the manual tells you what the proper i.f. is. With this set the i.f. transformers should all be peaked at 470kHz. The manual suggests that the 470kHz signal should be injected via a coupling loop when the set is tuned to the low frequency end of the medium wave band. Since the ferrite rod aerial will then be tuned to about 550kHz, the i.f. signal at 470kHz has a good chance of breaking through to the mixer-oscillator base and then getting to the first i.f. transformer. With some sets you apply the i.f. signal direct to that base via a capacitor of around 1,000pF or so." (Fig. 3.)

"Coupling loop?" repeated Dick blankly. "Have we got a coupling loop?"

"I've got one on my bench," said Smithy, walking across the Workshop. "You need a coupling loop if you want to line up the ferrite aerial circuits of an a.m. set with a signal generator. The aerial tuned circuit usually has very low capacitance at the high frequency end of the medium wave band and the tuning could be affected if you tried to connect the signal genny to it directly in any way. So you couple to it inductively by means of the loop."

"What sort of loop should be used?"

"For ordinary servicing work," said Smithy, "any coil with a diameter of about 3in. and about 20 turns of wire will do, and it's simply connected directly to the signal generator output. It's quite a rough and ready scheme. In fact, you could wind the wire round your hand like a roll of string, and just tape it up to make it self-supporting." (Fig. 4).

After a little searching Smithy located the coupling loop on his bench. Armed with this humble item of test equipment, he returned to Dick's bench and connected it to his assistants venerable and scarred signal generator. He set the receiver to 550 metres on the medium wave band, switched it on and turned its volume control to full. Dick's signal generator was an old valve model and Smithy had to wait some moments for it to warm up after switching it on. He positioned the coupling loop in line with the receiver ferrite aerial rod and swung the generator output over a range from 600kHz down to 400kHz. The 1kHz modulation from the generator was reproduced loudly by the receiver speaker and Smithy attenuated the generator output until only peak responses could be heard. He found that there was a broad peak at around 570kHz on the signal generator scale, and another peak, significantly weaker but similarly broad, at about 450kHz.

"This looks," said Smithy cheerfully, "as though the i.f. transformers are way off tune. The peak at 570kHz will be a signal input frequency, as selected by the receiver oscillator. The lower peak, at 450kHz, will almost certainly be the one which the i.f. transformers have now become tuned to. Somebody must definitely have had a go at those transformers."

"I tell you," said Dick. "Blame Zilly."

But Smithy had no ears for Dick's comments.

"I'll set the signal generator to the proper intermediate frequency of 470kHz," he announced, "and then I'll bring up the i.f. transformers to that frequency."

He tuned the generator to 470kHz and reduced its attenuation until the 1kHz tone just became audible. The i.f. transformer cores had screwdriver slot adjustment and he took an insulated screwdriver from his top overall pocket. Carefully, he unscrewed the core of the first i.f. transformer. At once, the sound of the 1KHz tone increased in volume. All the three transformer cores had to

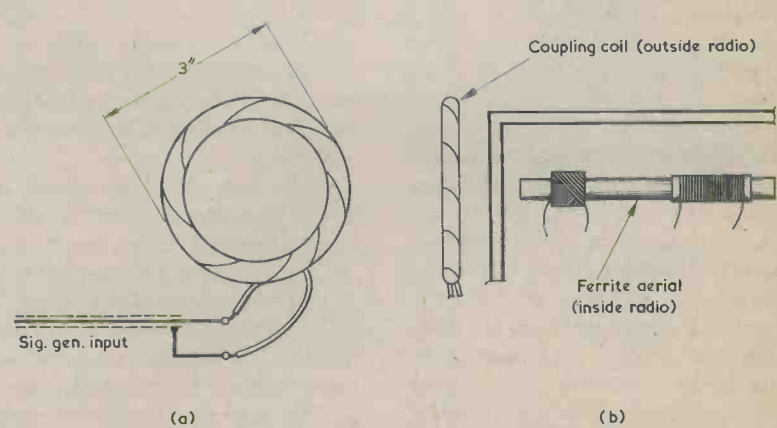


Fig. 4(a). A coupling loop for a.m. signal injection can consist of about 20 turns of thin p.v.c. covered wire covered with p.v.c. tape to make it self-supporting (b). The loop is positioned broadside on and in line with the receiver ferrite aerial

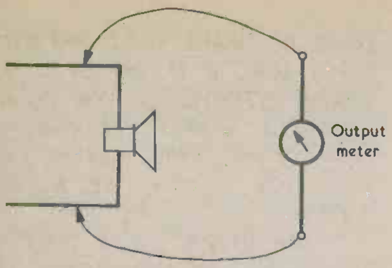


Fig. 5. For high alignment accuracy an output meter should be connected across the receiver speaker. In practice this may be a multimeter switched to a low a.c. volts range

be unscrewed to some extent to resonate at 470kHz and he continually attenuated the signal generator output as he proceeded with the adjustments, keeping the modulating tone at a just audible level.

"Officially," he remarked, "these adjustments should be carried out with an output meter connected across the speaker, but in practice with these simple sets it's usually in order just to work with the sound level from the speaker. The secret is to keep the volume control set to maximum and to attenuate the signal generator output so that its modulation is just audible. This procedure will also ensure that adjustments are not masked by a.g.c. action in the receiver." (Fig. 5.)

OSCILLATOR TRIMMING

"Let's hear what the set sounds like now," suggested Dick.

"All right."

Smithy took the coupling loop away from the receiver, reduced its volume and tuned across the medium wave band. The performance of the radio was vastly improved. Where, previously, there had been only three weak signals the band was now bristling with stations. All tuned sharply, and Smithy looked closely at the scale as he tuned in the local Radio 1, 2 and 3 stations. He switched to long waves and tuned in the Radio 4 signal.

"Radio 4 is coming in spot-on at 1,500 metres," he remarked with satisfaction. "Also, all the medium wave signals seem to be at their proper places on the scale. So, with a bit of good fortune, it could be that our mysterious meddler has only messed around with the i.f. transformer cores and has left the aerial and oscillator adjustments alone. Since the signals are apparently coming in at their proper places on the dial, the oscillator trimming, at any rate, should be all right."

"Why," asked Dick, "did the Radio 4 signal come in at 1,700 metres before you re-aligned the i.f. amplifier?"

"Think about it," replied Smithy. "The i.f. transformers were roughly set up to 450kHz instead of their correct frequency of 470kHz. Now the 1,500 metre Radio 4 signal has a frequency of 200kHz and so, to get it through the i.f. amplifier, the receiver oscillator had to run at 200 plus 450, or 650kHz. This oscillator frequency, with a correctly aligned i.f. amplifier, corresponds to a signal frequency of 650 minus 470, or 180kHz. In consequence, assuming that the oscillator alignment is correct, the tuning scale pointer will then indicate the wavelength corresponding to 180kHz. Which is, rough check, around 1,700 metres."

"How do you arrive at that wavelength figure?"

"Blimey," snorted Smithy, "I hardly need to tell you that, do I?"

"Should I know how?"

"Of course you should. To convert kilohertz to metres, you divide 300,000 by the number of kilohertz."

"Oh yes, of course you do! Still, it seems surprising that a fairly small shift in intermediate frequency produced such a large change in wavelength."

"Not on long waves," stated Smithy. "If we say that the long wave band is from 1,000 to 2,000 metres, this corresponds to a frequency range from 300 to 150kHz only. The signal frequencies are very low on long waves."

"Shall we," asked Dick,

"check the aerial and oscillator alignment with the signal generator next?"

"We'd better do that," concurred Smithy, "just to be on the safe side."

He glanced at the service manual.

"Simplifying things a bit," he remarked, "on medium waves the oscillator coil core is adjusted at the low frequency end of the band and TC4 is adjusted at the high frequency end. Then the position of the medium wave aerial coil on the ferrite rod is adjusted at the low frequency end of the band and TC1 at the high frequency end. On long waves TC3 in the oscillator circuit is adjusted at the high frequency end, as also is TC2 in the aerial circuit. At the low frequency end the position of the long wave coil is adjusted on the ferrite rod. Oscillator adjustments are for correct tuning scale indications and aerial circuit adjustments are for maximum signal strength at the frequencies selected by the oscillator."

Smithy settled down in front of the receiver and proceeded to check the oscillator and aerial alignment, as detailed in the service manual.

"The r.f. alignment hasn't been altered," he announced. "It's pretty well just as it was when the set left the factory. Now, why on earth should someone want to screw in only the i.f. transformer cores?"

"Perhaps an old-fashioned clock repairer was goaded to it by Zilly," said Dick darkly. "He found nothing wrong with the clock in this radio and so he just screwed up the i.f. cores!"

Smithy gazed at his assistant with a bemused expression.

"What in heaven's name are you raving on about?" he asked. "And who the dickens is this Zilly?"

"He's the person who gets everywhere and who's changing all our lives," replied Dick. "Whenever anything goes wrong everybody blames Zilly. On TV, on the radio and in the papers, Zilly gets the blame for everything."

"Zilly?"

"Zilly Connship!"

A.F. OSCILLATOR

"You must be crazy," said Smithy flatly. "Well, let's get back to reality. Now we've got this set fixed you'd better button it up and get on with the next job."

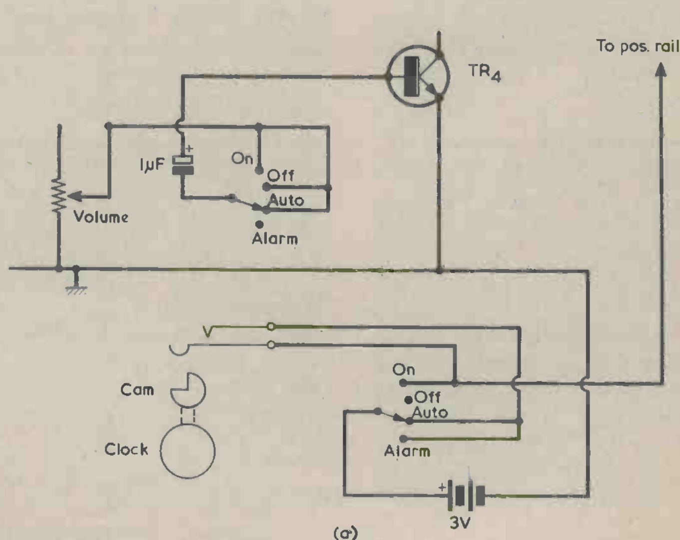
"Shouldn't we check that the clock part is working?"

"I'd forgotten about the clock," admitted Smithy. "It's conceivable that there's a fault here as well. Indeed, your maniacal suggestion just now may have something in it after all. Maybe some ham-handed character tried to rectify a clock fault and merely succeeded in messing up the i.f. alignment. I've encountered stranger things. Well, it will be easy enough to see if the alarm circuit is working. All we've got to do is select 'Auto' or 'Alarm', advance the clock hands to the alarm setting and see what happens. We'll try 'Auto' first."

Smithy took the function switch on the left of the clock face through the "Off" position and set it to "Auto". The radio was silent. Smithy noted that the "Alarm" pointer on the clock face was set to 8 o'clock, and he manually advanced the minute and hour hands. As they reached 8 o'clock the set commenced to play. (Fig. 6(a).)

"That's all right, then," he pronounced. "On 'Auto' the idea is that the set turns on at the pre-selected time. I'll try 'Alarm' next."

He manually advanced the



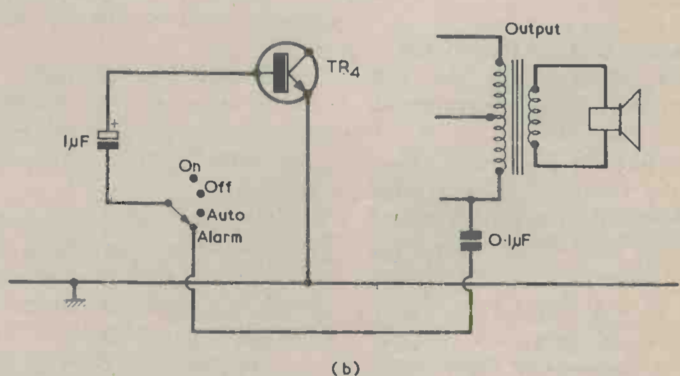


Fig. 6(a). When the radio is set to "Auto" the clock cam-operated contacts have to close to enable the positive battery supply to connect to the positive rail. The base of the a.f. driver transistor, TR4, couples to the volume control slider
(b). Supply switching is the same on "Alarm" but, now, the base of TR4 couples via a 0.1μF capacitor to one side of the output transformer primary

clock hands until the radio fell silent and then switched to "Alarm". He next took the clock up to 8 o'clock again. There was a quiet click from the speaker but no other sound.

"Well, there's definitely a snag here," Smithy stated.

"What should have happened?"

"We should have heard an a.f. tone. On 'Alarm', part of the function switch contacts disconnect the base of the first a.f. transistor from the slider of the volume control and connect it instead to a 0.1μ F capacitor which couples to one side of the audio output transformer primary. This gives positive feedback and changes the whole a.f. amplifier section into one big a.f. oscillator with a frequency which is mainly determined by its distributed inductances and capacitances." (Fig.6(b).)

"Well, the audio amplifier is working all right," put in Dick. "So the fault can only be in the feedback path. Perhaps that 0.1μF capacitor has gone open." open."

"That's doubtful," growled Smithy. "It's more likely to be a poor contact in the function switch. However, we'll try the capacitor first because it's easier to get at."

INTERMITTENT

And luck, that fickle figure of fate and fortune, was on the side of Dick and Smithy that afternoon. After Dick had located the 0.1μF feedback capacitor on the printed board he gave it an experimental prod, to be at once rewarded with a momentary loud a.f. tone from the speaker of the radio. The pair did not spend an undue period of time in checking whether the fault was due to the capacitor connections to the board (which looked perfectly adequate) or to the capacitor itself. They simply removed the existing capacitor, soldered in a new one and listened with gratification to the continuous a.f. tone that this produced. To make quite certain that there were still no intermittent connections they moved the new capacitor about and gently flexed the board, but there was no break in the tone from the speaker.

Whistling cheerfully, Dick carried the now serviceable clock radio over to the "Repaired" rack while Smithy returned to his trade journal. As he scanned the news items in this his mind dwelt momentarily on the powerful and omnipresent character which Dick had referred to. What was the name again? Zilly Connship? Ah yes, that was it — Zilly Connship!

Smithy shrugged his shoulders. Never heard of him. ■

Medium Long Wave Portable — continued from Page 558

Connections are made directly to the pins of the i.c. by means of reasonably fine tinned copper wire, being soldered with an instrument type iron. The component layout of Fig. 4 should be closely adhered to, and the leads to C10 and C15 must be as short as possible.

The completed amplifier is mounted to the underside of the shelf as shown in Fig. 2 (a), using short woodscrews with spacing washers as required. Interconnections to the r.f. section tagstrip may then be completed. It was not found necessary to use screened leads to the volume control, but amplifier input and output leads must be kept as far apart from each other as possible.

USING THE SET

Carefully check the whole of the wiring, particularly the connections to the integrated circuit, transistors, diode and aerial coil windings. Set the volume control at half travel, connect up a 9 volt battery, switch to medium waves and advance the reaction control until a hiss is heard in the speaker. Tune in a station and then adjust the reaction control for maximum sensitivity. The reaction control is smooth and free from backlash, but it needs to be adjusted with care when receiving weak signals. It should not be used as a volume control, and best results will be obtained if it is set for maximum sensitivity, even when the receiver is tuned to local stations. The reaction control should not be advanced too far, however, or severe distortion will result. The directional properties of the ferrite rod aerials can be of help in dealing with interference, and the set should be rotated for best reception.

The receiver is capable of delivering a good output and the bass response is extended. No-signal current consumption is less than 10mA rising to 20mA at reasonable volume levels and up to 90mA with the loud reproduction of music. A PP6 or larger battery is recommended, but no battery can be expected to give a long life if the set is constantly driven at high volume levels. The set is tolerant of falling battery voltages and will work with worn batteries capable of maintaining only 6 volts on load. However, any attempt to obtain high volume under these conditions will result in "motor-boating", as the battery will be incapable of supplying the amount of current needed by the amplifier.

Manufacturers' circuits for the TBA810AS normally show a high value capacitor between its pin 7 and the negative rail. This capacitor is for hum attenuation and is not needed when a battery supply is employed. Indeed, it was found that the capacitor was not required even when the receiver was operated from a 9 volt mains supply.

MODIFICATIONS

A phone jack can be wired across the speaker connections, and results with hi-fi earphones are particularly pleasing. The tuner section can be used as an excellent earphone receiver with high impedance magnetic headphones connected in place of R2. ■

GENERAL PURPOSE 8 WATT AMPLIFIER

Part 1

By A. P. Roberts

★ 2 i.c's only ★ Choice of Inputs

★ Full bass and treble tone controls

This useful and versatile amplifier will give an output power of up to 8 watts r.m.s. into an 8Ω speaker, and is capable of producing excellent quality. It has a high level input that needs about 500mV into 1 MΩ for maximum output, and this input is suitable for use with crystal or ceramic pickups, cassette decks, tuners, etc. A low level input having a sensitivity of approximately 25mV into 47kΩ is also provided, and this is suitable for use with a guitar pick-up or similar signal source. The unit is therefore suitable for most normal applications.

Although the circuit is quite simple, the use of modern semiconductor devices enables a very acceptable performance to be attained. The circuit is based on a TDA2030 i.c. audio power amplifier, this being a recently introduced device having an impressive specification. In appearance the device resembles a plastic cased power transistor, but it has five lead-outs rather than three, these being the positive and negative supply leads, two leads for non-inverting and inverting inputs and a lead for output. In fact, the i.c. can be looked upon as an operational amplifier having a Class B power output stage. Advantage of this fact has been taken in the present design by incorporating the tone control network in the power amplifying section of the complete amplifier, thereby providing a simplification in the circuitry.

Another advantage of the TDA2030 is that its heat tab is common with the negative supply pin. This enables it to be bolted directly to its heatsink without any necessity for insulating washers and the like.

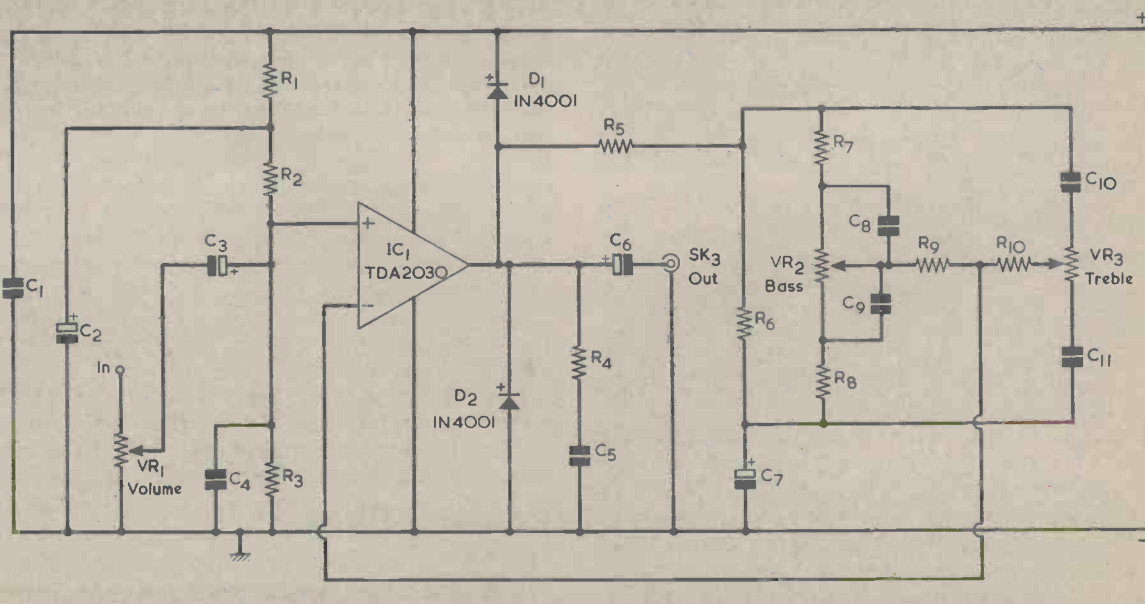


Fig. 1. The circuit of the power amplifier section of the general purpose amplifier. Since IC1 has both inverting and non-inverting inputs it becomes possible to incorporate the tone control network in this section, with a consequent simplification of amplifier circuitry

Front panel layout for the amplifier. On the left is the on-off switch with the neon pilot light to its immediate right. Next in order are the volume control and the treble tone control, with the bass tone control at extreme right

A pre-amplifier is needed to boost the input sensitivity and impedance to satisfactory levels, and a further simplification in design is achieved by employing a bifet operational amplifier here. A bifet op-amp incorporates Jfet and bipolar transistors on the same chip, resulting in a superior performance for noise, distortion and input impedance when compared with the standard 741 i.c. or similar bipolar types.

POWER AMPLIFIER

The circuit of the power amplifier section is given in Fig. 1. The TDA3020 is used in the non-inverting mode, with the input signal from volume control VR1 being passed to it via C3. The non-inverting input is biased at approximately half supply voltage by R2 and R3, with R1 and C2 decoupling this potential divider from the positive rail and filtering out any mains hum or noise which could otherwise be fed into this input. C4 assists in maintaining stability by shunting the input at r.f. and thereby reducing any stray high frequency feedback. D1 and D2 are protective diodes, whilst R4 and C5 form a Zobel network. C6 provides d.c. blocking at the output.

At d.c. there is virtually 100% negative feedback via R5 and the tone control components. The voltage gain at d.c. is therefore almost exactly unity, with the result that the quiescent output voltage is the same as that at the non-inverting input, i.e. half the supply voltage. This is, of course, exactly what is required as the highest possible peak-to-peak output voltage swing can then be provided before the onset of clipping.

The gain at audio frequencies is considerably higher than unity due to the a.f. bypass provided by R6 and C7. The level of feedback at different audio frequencies is also modified by the settings of the two tone controls, VR2 and VR3. The tone controls provide bass and treble lift and cut, using a standard circuit configuration. VR2 is the bass control. There is maximum bass boost in the feedback loop when its slider is at the upper end of its track as shown in Fig. 1, and maximum bass cut when the slider is at the lower end of the track. Since this boost and cut are in the feedback loop, they cause an opposite effect in the overall amplifying circuit, resulting in maximum bass cut with VR2 slider at the upper end of its track, and maximum bass lift at the lower end of the track. The treble tone control, VR3, operates in a similar manner inside the feedback loop, and maximum treble cut in the overall amplifying circuit is given when VR3 slider is at the upper end of its track and maximum treble boost when it is at the lower end.

POWER SUPPLY

Ideally, the amplifier would be powered by a stabilized supply giving about 28 volts at currents up to 500mA. TDA2030 is then capable of supplying 8 watts into an 8Ω load with a maximum t.h.d. level of 0.1%. However, good results can be achieved with a simple unstabilized supply, and the one used in the present design has the circuit shown in Fig. 2. The 24 volt secondary of the mains transformer connects to a bridge rectifier, the output of which is smoothed to a reasonably ripple-free direct voltage by C18.

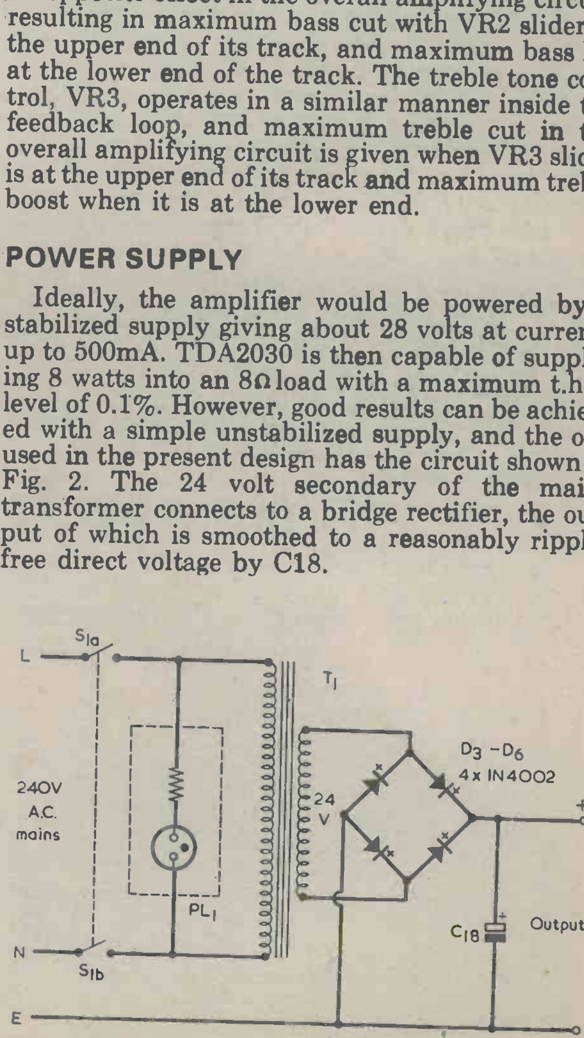


Fig. 2. The power supply section of the amplifier employs a bridge rectifier without stabilization

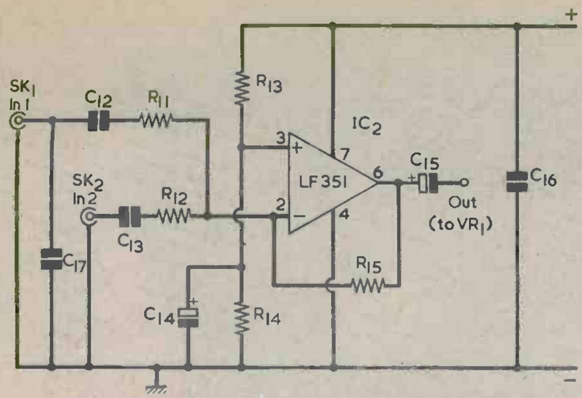


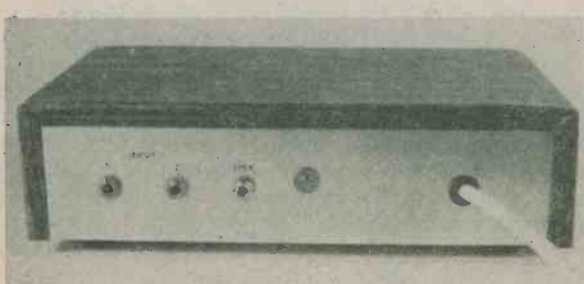
Fig. 3. The pre-amplifier boosts sensitivity at Input 1 and input impedance at Input 2

Under no-load conditions, the voltage across C18 will be about 34 volts or a fraction more. This will fall to lower than 34 volts with the power amplifier section connected since the quiescent current of the amplifier is about 40mA. (The pre-amplifier draws a further 5mA or so.) Under full load the supply voltage will drop to less than 28 volts, but the amplifier r.m.s. output power will still be 8 watts. The lower supply voltage will cause a loss of performance in the form of increased distortion at output levels above about 6 watts r.m.s.

It is not possible to use a mains transformer having a higher secondary voltage in the circuit of Fig. 2, because the quiescent supply voltage would be in excess of the TDA2030 maximum rated voltage of 36 volts. Nevertheless, the simple power supply employed will enable a good performance to be obtained, since practical speech and music input signals are not pure sine waves and are less demanding on the supply. With a speech or music signal fully driving the amplifier the supply voltage is likely to be in the region of 28 to 30 volts. Despite its extreme simplicity, the power supply employed is perfectly adequate to give acceptable results.

PRE-AMPLIFIER

Fig. 3. shows the circuit of the pre-amplifier, in which an LF351 is used in the inverting mode. The non-inverting input is biased at half supply potential by R13 and R14, with C14 removing any hum or noise which may be present on the supply lines.



Looking at the rear of the amplifier. At the left is SK1, then SK2 and SK3. To the right of SK3 is the bolt securing the heat tab of IC1 to the rear panel

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 1.5kΩ
R2 100kΩ
R3 100kΩ
R4 1Ω
R5 15kΩ
R6 10kΩ
R7 10kΩ
R8 1.5kΩ
R9 10kΩ
R10 4.7kΩ
R11 47kΩ
R12 1MΩ
R13 4.7kΩ
R14 4.7kΩ
R15 470kΩ
VR1 10kΩ potentiometer, log
VR2 100kΩ potentiometer, linear
VR3 100kΩ potentiometer, linear

Capacitors
C1 0.1μF type C280
C2 100μF electrolytic, 40V. Wkg.
C3 1μF electrolytic 63V. Wkg.
C4 560pF ceramic plate
C5 0.1μF type C280
C6 2,200μF electrolytic, 25V.Wkg.
C7 10μF electrolytic, 25V. Wkg.
C8 0.047μF type C280
C9 0.47μF type C280
C10 0.001μF polystyrene
C11 0.01μF type C280
C12 0.47μF type C280
C13 0.047μF type C280
C14 100μF electrolytic, 25V. Wkg.
C15 10μF electrolytic, 25V. Wkg.
C16 0.1μF type C280
C17 100pF ceramic plate
C18 2,200μF electrolytic, 40V. Wkg.

Transformer
T1 mains transformer, secondary 24 volts at
500mA (see text)

Semiconductors
IC1 TDA2030
IC2 LF351
D1 IN4001
D2 IN4001
D3-D6 IN4002

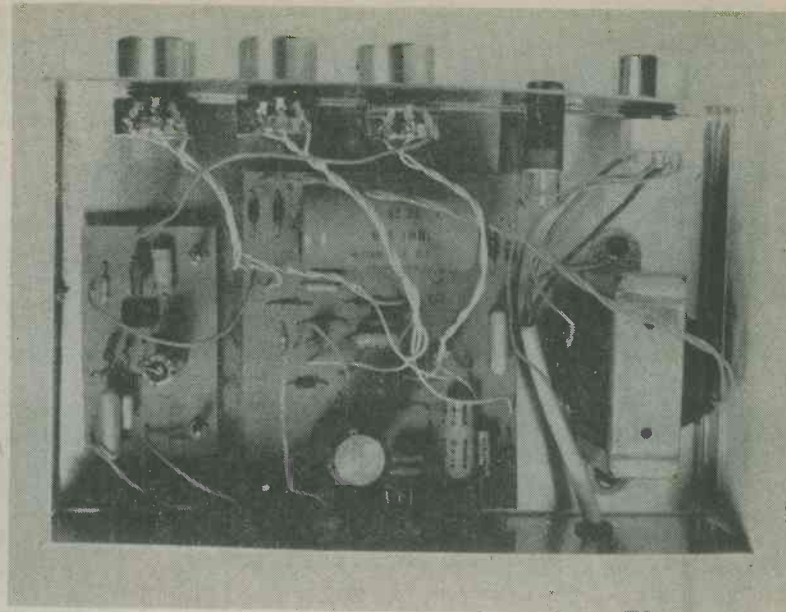
Switch
S1(a) (b) d.p.s.t., toggle, rotary

Sockets
SK1-SK3 3.5mm. jack socket

Lamp
PL1 Neon indicator with series resistor (see text)

Miscellaneous
Metal case (see text)
4 cabinet feet
4 control knobs
Printed circuit boards
3-core mains lead
Nuts, bolts, wire, etc.

Layout inside the amplifier case. The mains transformer is behind the on-off switch, whilst the power amplifier section board is mounted centrally. On the other side of the main power board is the pre-amplifier board



At d.c. the negative feedback in the circuit is virtually 100° so that, as with ICI, the quiescent output voltage is similarly at half supply potential. The pre-amplifier can therefore provide an output signal of about 10 volts r.m.s. before serious distortion occurs in this stage. Since the TDA2030 section requires only about 250mV r.m.s. for full output, there is an excellent overload margin of around 32dB.

The voltage gain from Input 1 to the output is roughly equal to R15 divided by R11. This is about 10 times (20dB) whereupon the r.m.s. input sensitivity here is approximately 25mV. The input impedance is equal to R11, or 47kΩ.

With Input 2 the voltage gain is R15 divided by R12, i.e. 0.5 times (-6dB). Input sensitivity is therefore 500mV r.m.s. with an input impedance, given by R12, of 1MΩ. This is a suitable match for most tuners, amplifiers, etc. The relatively high input impedance is also suitable for crystal and ceramic pick-ups.

C12 and C13 provide d.c. blocking at the inputs, whilst C15 carries out the same function at the output. C17 prevents possible r.f. instability when the amplifier is run at maximum volume and treble boost conditions, and reduces stray feedback to an insignificant level. C16 is merely a supply bypass capacitor positioned close to the i.c.

Returning to the TDA 2030, this has both output short-circuit and thermal overload protection circuitry. If it is overdriven or has inadequate heatsinking, it will sense any unacceptably high temperature and will shut down. The output is then cut off with current consumption reduced to a very low level. The TDA2030 remains in this state until it has cooled down again to an acceptable temperature. The amplifier is, therefore, not easily damaged through misuse.

COMPONENTS

Most of the components are generally available, but some comments are needed for the remainder. The mains transformer has a secondary rated at 24 volts 500mA, and it may be necessary to obtain a transformer with two secondaries, each rated at 12 volts 500mA. Such a transformer is listed by Home Radio (Components) Ltd., 215 London Road, Mitcham, CR4 3ND. The two secondaries are connected in series to give a total secondary voltage of 24 volts. The two integrated circuits are available from Maplin Electronic Supplies. The mains indicator, PL1, is a panel-mounting neon indicator with integral series resistor intended for 240 volt a.c. mains.

The prototype is housed in a metal instrument case type TP3 which has dimensions of 203 by 127 by 51mm. and which is also available from Maplin Electronic Supplies. This has an aluminium base, front and rear section, with a steel top section which is covered with a woodgrain patterned plastic veneer. Any other all-metal case of about the same size can be employed provided it can take the components. It is recommended that an all-metal case be employed as this provides screening, carries some of the amplifier connections and serves as a heatsink for IC1. It is advisable to obtain the mains transformer, or at least ascertain its dimensions, before ordering the case in order to ensure that the transformer is not too large for it.

The four controls and PL1 are mounted on the front panel in the manner shown in the photographs. From left to right, these are S1, PL1, VR1, VR3 and VR2. Inside the case, T1 is mounted on the extreme left hand side behind S1, with a solder tag under its front securing nut. The power amplifier section printed board will, after completion, be mounted in the centre and the pre-amplifier board to the right. A hole for the mains lead is required in the rear panel behind T1, and this must be fitted with a grommet. The three jack sockets are mounted on the rear panel with the Input 1 socket to the right (still viewing the case from the front), the Input 2 socket next and the output socket nearer the centre. Remember that IC1 heat tab also bolts to the rear panel, and that space must be left available for this.

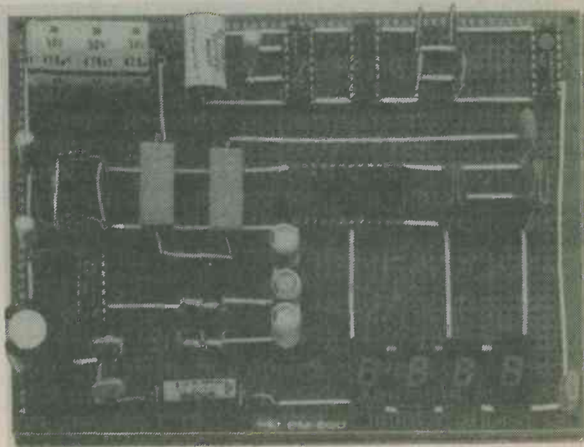
(To be continued)

New Products

PROTOTYPE BOARDS

OK Machine & Tool (UK) Ltd have introduced a new series of 'Circuit Mount' boards for electronic projects and prototypes. All boards feature solderless insertion type sockets on 0.1in centres and each row has five common points. Larger boards also feature 40-point bus lines, while a separate bus strip module is also available. Furthermore, all boards can accept standard component leads including DIPs, while interconnections are easily made using standard 22AWG (0.64mm) solid wire.

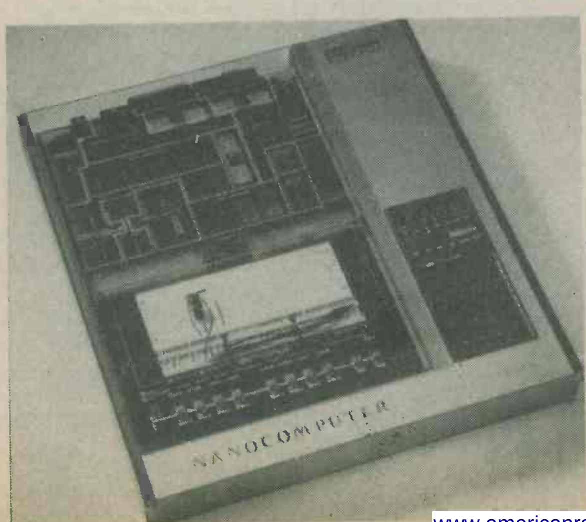
Circuit Mount prototype boards are available in a range of sizes from small modules designed to hold a single IC up to 1020 point panel-mounted boards complete with binding posts. All separate modules are interlocking and also feature screw holes for permanent mounting. Units are available from stock directly from OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA.



SELF-CONTAINED MICROCOMPUTER

The latest single-board microcomputer from Cambridge Micro Computers Ltd. is the NBZ80-S Nanocomputer, a completely self-contained unit containing its own power supply, hexadecimal keyboard, and a hardware development system consisting of a solderless breadboard of experimental elements, light-emitting diode indicators and switches, allowing the development of increasingly complex interface circuits. Price of the system is £421 (plus V.A.T.), and Cambridge Micro Computers is also offering a free one-day training course to purchasers of the NBZ80-S Nanocomputer.

The new Nanocomputer system, based on the SGS-ATES version of the Z80 microprocessor, is ideally suited to educational use, with particular attention being paid to documentation. The system is provided with an introductory volume in which the user is taken step by step from the fundamental notions of microprocessors through the more complex techniques of programming the Z80 microprocessor.



A second volume covers the techniques for interfacing external systems to a Z80 microprocessor system. The two volumes together form a complete microprocessor course. They contain a wide variety of worked examples in programming and in interfacing using the solderless breadboard, LED indicators and switches with which to build and interface external systems. So as to facilitate hardware development, all signals from both the Z80 bus and one of the input/output ports are available to the breadboard.

The basic NBZ80-S Nanocomputer is designed as a powerful educational and training system, incorporating 4kbyte of random-access memory, 2kbyte of read-only memory, an interface for a serial terminal and cassette recorder, two input/output ports, a 26-key keyboard, an 8-digit display, and a fully accessible bus.

The system is designed for maximum flexibility and expandability; within the basic Nanocomputer unit expansion facilities include 16kbyte of random-access memory, 8kbyte of read-only memory, a USART (universal synchronous/asynchronous receiver/transmitter) and a parallel printer. Expansion is also possible with additional boards up to 64kbyte of random-access and read-only memory, plus facilities for a video interface and a flexible disk store.

Other facilities available with the system include complete hardware and software support, with a 2kbyte monitor; assembler, editor, debugger and BASIC packages on one board; plus an expansion kit and associated wire-wrap boards, cables and connectors.

SMALL ADVERTISEMENTS

Rate: 12p per word. Minimum charge £2.00

Box No. 30p extra

Advertisements must be prepaid and all copy must be received by the 4th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the *bona fides* of Advertisers. Where advertisements offer any equipment of a transmitting nature, readers are reminded that a licence is normally required. (Replies to Box Numbers should be addressed to: Box No. —, *Radio and Electronics Constructor,* 57 Maida Vale, London, W9 1SN.

ANY REQUESTED SERVICE SHEET £1 (Plus large s.a.e.). Full repair data any named TV £5.50 (with circuits, layouts, £7). Large s.a.e. brings newsletter, bargains, etc. Ausrec, 76 Church Street, Larkhall, Lanarkshire, ML9 1HE.

FREE 1980 AMTRON CATALOGUE with new range of kits and equipment cabinets. Send s.a.e. Amtron UK Ltd., 7 Hughenden Road, Hastings, Sussex, TN34 3TG. Telephone: Hastings 436004.

FREE! 12" x 6" Veroboard, with first 50 orders for our compilation pack of components. Hundreds of common and exotic use devices plus pcb's, thermistors, etc. This is really an offer not to be missed. Send P.O. or cheque for £8.20 immediately to: R. E. Norman, Portbuild Limited, 57 Amberwood Rise, New Malden, Surrey. Or send s.a.e. for list.

MODULES: Mullard LP1164 AM/FM I.F. Unused and guaranteed. £1.50. P.&P. C.W.O. BA screws, hardware, components, manufacturers' clearance. S.A.E. lists. Tennex Ltd., Stock Road, Southend-on-Sea, Essex, SS2 5QF.

FOR SALE: *"Challenge of the Stars"* by Patrick Moore and David A. Hardy £2.00. *"Destroyers"* by Antony Preston £4.00. Box No. G376.

COMPONENTS, Items, Bargains. Various lists 15p or s.a.e. Sole Electronics (REC), 37 Stanley Street, Ormskirk, Lancs., L39 2DH.

OSCILLOSCOPE FOR £12. Easy build converter plugs into TV aerial socket and converts to large screen oscilloscope. Components cost approx £12. Circuit and plans £3. Kerr, 27 Coles Road, Milton, Cambridge, CB4 4BL.

FOR SALE: Cassette tapes 6 — £5.00. Classical, rock, disco, country, party time or easy listening. J Fulton, Derrynaseer, Dromore, Co. Tyrone, N. Ireland.

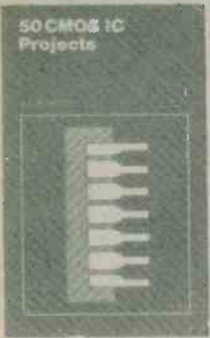
COLLECTORS' ITEMS. Nearly 50 copies of Radio Society of Great Britain's *Bulletins* covering period 1945 to 1949. In reasonable condition. Offers to: Box No. G377.

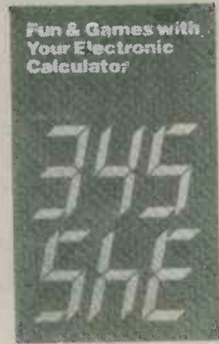
INGENIOUS GAMES to distract and tantalise — and to construct. Three original designs by me in kit form, pocket sized with a top quality finish to grace your coffee table and deceive your friends. From £4.25. Send s.a.e. for details of all three to: H. S. Houston, 12 Harlech Avenue, Leeds 11, Yorkshire.

BE PROFESSIONAL! Use our P.C.B. equivalent to old-fashioned 8/way group boards. Incorporates locations for additional components if required. Pack of three in high-quality fibre-glass — includes special services catalogue and price list — only £2.00 post paid (Mail Order only). M. J. Evans, 7 Shap Drive, Warndon Estate, Worcester, WR4 9NY.

FOR SALE: Arac 102 receiver 28-30MHz and 144-146MHz. AM-FM-CW-SSB. 12V d.c. Excellent condition. £85.00 o.n.o. G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk.

(Continued on page 573)





DIRECT READER SERVICE
RADIO & ELECTRONICS BOOKS

17. Solid State Power Supply Handbook £1.25
18. 50 Projects Using IC CA3130 £1.25
19. 50 CMOS IC Projects £1.25
20. A Practical Introduction to Digital IC's 95p
22. Beginners Guide to Building Electronic Projects £1.25
23. Essential Theory for the Electronics Hobbyist £1.25
25. 79 Electronic Novelty Circuits £1.00
26. 52 Projects Using IC741 95p
28. Two Transistor Electronic Projects 85p
29. How to Build Your Own Metal and Treasure Locators £1.00
30. Electronic Calculator Users Handbook 95p
31. Practical Repair and Renovation of Colour TVs £1.25
32. Handbook of IC Audio Preamplifier and Power Amplifier Construction £1.25
33. 50 Circuits Using Germanium, Silicon and Zener Diodes 75p
34. 50 Projects Using Relays, SCR's and TRIACS £1.25
35. Fun and Games with your Electronic Calculator 75p
36. 50 (FET) Field Effect Transistor Projects £1.25
37. 50 Simple L.E.D. Circuits 75p
38. How to Make Walkie-Talkies £1.25
39. IC 555 Projects £1.75
40. Projects in Opto-Electronics £1.25
41. Radio Circuits Using IC's £1.35
42. Mobile Discotheque Handbook £1.35
43. Electronic Projects for Beginners £1.35
44. Popular Electronic Projects £1.45
45. IC LM3900 Projects £1.35
46. Electronic Music and Creative Tape Recording £1.25
47. Practical Electronic Calculations and Formulae £2.25
48. Radio Stations Guide £1.45
49. Electronic Security Devices £1.45
50. How to Build Your Own Solid State Oscilloscope £1.50
51. 50 Circuits Using 7400 Series IC's £1.45
52. Second Book of CMOS IC Projects £1.50
53. Practical Construction of Pre-Amps, Tone Controls, Fitters & Attenuators £1.45
54. Beginners Guide to Digital Techniques 95p
55. 28 Tested Transistor Projects £1.25
56. Digital IC Equivalents and Pin Connections £2.50
57. Linear IC Equivalents and Pin Connections £2.75

POSTAGE: 20p PER BOOK. IF MORE THAN 3 BOOKS ORDERED: 10p PER BOOK

To: Data Publications Ltd., 57 Maida Vale, London W9 1SN

Please send me within 21 days ....copy/copies

Book Nos:..

....

....

I enclose Postal Order/Cheque for £.................

Name ....

Address ....

....

(Block Letters Please)

(We regret this offer is only available to readers in the U.K.)

SMALL ADVERTISEMENTS

(Continued from page 571)

FOR SALE: Wide angle 9.5mm cine equipment: camera, projector, screen, etc. Also several other 9.5mm cine cameras. S.A.E. for details. Box No. G388.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free services to members including Q.S.L. Bureau, Amateur and Broadcast Translation, Technical and Identification Dept. — both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, *Monitor*, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazines, etc., £6.00 per annum. (U.K. and British Commonwealth), overseas $12.00. Secretary ISWL, 1 Grove Road, Lydney, Glos., GL15 5JE.

FOR SALE: Sinclair MK14 mini-microprocessor with power supply. £45.00 o.n.o. Box G389.

FOR SALE: 2000 diodes £2.50. 25 mixed voltage zeners £1.00. LCD 1/100 sec. stopwatch £12.00. LCD watch £7.50. Voice control ladybird toy £15.00. 3 dimensional hologram pendants £12.50. 10" x 8" holograms £30.00. S.A.E. for details. Damaged video tape recorders and CCTV cameras £25.00 to £75.00. Nicad battery chargers £1.50. Light powered calculator, needs no batteries, £20.00. Credit card calculator. C60 tapes 25p, 10 — £2.00, 100 — £15.00. Chess challenger 10 level £150, 7 level £100. Draughts challenger 4 level £90. 2 level £75. Football table plans £5.50. Pair walkie talkies £15.00. J. Fulton, Derrynaseer, Dromore, Co. Tyrone, N. Ireland.

INTERESTED IN OSCAR? Then join AMSAT-UK. Newsletters, OSCAR NEWS Journal, prediction charts, etc. Details of membership from: Ron Broadbent, G3AAJ, 94 Herongate Road, Wanstead Park, London, E12 5EQ.

BOOKS TO CLEAR. *"Solid State Design for the Radio Amateur"*, ARRL. £3.50. *"The Radio Amateur's Handbook"* by Frederick Collins, £3.00. *"Amateur Radio Antennas"* by Harry Hooton, £1.00. *"Ham Antenna Construction Projects"* by J. A. Stanley, 75p. *"Ham RTTY"* by W2NSD, 50p. *"The New RTTY Handbook"* by Byron Kretzman, £1.00. *"RTTY from A to Z"* by Durward J. Tucker, £1.00. *"All about Cubical Quad Antennas"* by W6SAI, £1.00. *"Guide to Astronomy"* by James Muirden, 40p. *"Astronomy"* by David Evans, £1.25. *"Atomic Radiation & Life"*, Pelican Books, 40p. Box No. G390

NEW QUALITY AMPLIFIERS! From £12-£45. 60W stereo output. AX60: Vinyl case, fascia, all sockets, controls, switching, L.E.D. display. I.C. Preamp. F.E.T. Drivers. Stabilised power supply. Screened transformer, 240V a.c. £35. inc. Klifco Electronics, 1 Regent Road, Ilkley, West Yorkshire. S.A.E. for leaflet.

THE RADIO AMATEUR INVALID & BEDFAST CLUB is a well established Society providing facilities for the physically handicapped to enjoy the hobby of Amateur Radio. Please become a supporter of this worthy cause. Details from the Hon. Secretary, Mrs. F. E. Woolley, 9 Rannoch Court, Adelaide Road, Surbiton, Surrey, KT6 4TE.

WANTED: Service Manual circuit of R1155A receiver. To buy or borrow copy. All expenses refunded. Box No. G.391.

ENTIRE SHACK CLEARANCE: Resistors, condensers, transistors, printed panels, variacs, transformers, valves etc. For details please telephone Surfleet (077-585) 517. Evenings only.

(Continued on page 575)

Use Strip-fix Plastic PANEL SIGNS

6 SHEETS IN EACH SET

★ **SET 3 - Wording - WHITE**

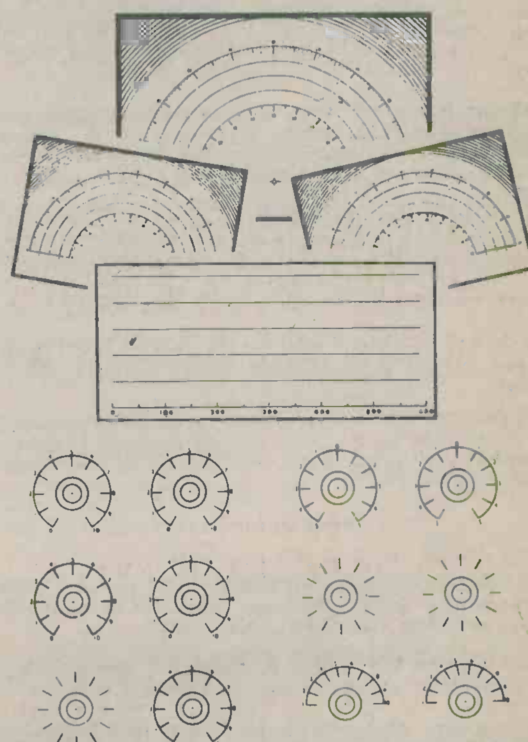
★ **SET 4 - Wording - BLACK**

Over 1,000 words and symbols, covering more than 300 terms, in each set

Illustration of actual size = RADIO

★ **SET 5 - DIALS**

6 sheets containing one Large and two Medium scales, Large Horizontal Tuning scale, Frequencies, 12 Control Panels



SET 3: £1.50
SET 4: £1.50
SET 5: £1.50

ALL PRICES INCLUDE V.A.T.

P. & P. 11p per set

- Easy to fix
- Stapled in booklet form
- Designed to hang above workbench
- Professional finish

To Data Publications Ltd., 57 Maida Vale, London, W.9 1SN

Please supply Panel Signs as follows: Set 3 ..... Set 4 ..... Set 5 .....

I enclose cheque / crossed postal order for .... (Tick which set is required)

NAME ....

ADDRESS ....

(BLOCK LETTERS PLEASE)

SMALL ADVERTISEMENTS

(Continued from page 573)

POSTAL ADVERTISING? This is the Holborn Service. Mailing lists, addressing, enclosing, wrapping, facsimile letters, automatic typing, copy service, campaign planning, design and artwork, printing and stationery. Please ask for price list. — The Holborn Direct Mail Company, Capacity House, 2-6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01-407 6444.

FOR SALE: Video Tape recorders, need attention. £25.00-£75.00. Also C.C.T.V. Cameras. Box No. G392.

200 MIXED COMPONENTS £3.50. Money refunded if not satisfied. Send S.A.E. for list of our other bargain packs. Servio Radio, Dept. RE1, 156-158 Merton Road, Wimbledon, London SW19 1EG.

WANTED: FAX equipment, manuals, service sheets, etc. G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk. NR32 3PJ.

SHACK CLEARANCE. Large selection of good components. Everything must go so selling cheaply. S.A.E. for details. Box No. G393.

INTERESTED IN RTTY? You should find the *"RTTY Journal"* of interest. Published in California, U.S.A., it gives a wide outlook on the current RTTY scene; RTTY-DX; DXCC Honour Roll; VHF RTTY news; and up to date technical articles are included. Specimen copies 35p from: The Subscription Manager, RTTY Journal, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk, NR32 3PJ.

CUSTOM ENGRAVED FASCIAS for your projects in brushed aluminium, bronze, brass and a wide range of colours. Send your requirements. We do the rest. Male, 159 Victoria Road, Swindon, Wilts., SN1 3DA.

CONSTRUCT METAL DETECTORS: 1. £120 pulse discriminator (£12 construction cost). 2. £60 model (£6 con-/cost). 3. £30 BFO (£3 con/cost). For all three together, written guaranteed d.i.y. plans, send £2. (Dept. RC), J. Lucas, 2 College Road, Grays, Essex. (Established 1973).

FOR SALE: Sinclair programmable calculator and cards £14.00. J. Fuilton, Derrynaseer, Dromore, Co. Tyrone, N. Ireland.

WANTED: Service manual, circuit of Hallicrafters SX28 receiver. Buy, borrow or copy. All expenses refunded. Maddocks, 70 Kings Road, Southsea, Hants. Telephone: Portsmouth 29129.

PERSONAL

JANE SCOTT FOR GENUINE FRIENDS. Introductions to opposite sex with sincerity and thoughtfulness. Details free. Stamp to: Jane Scott, 3/Con North St. Quadrant, Brighton, Sussex, BN1 3GJ.

IF YOU HAVE ENJOYED A HOLIDAY on the Norfolk Broads, why not help to preserve these beautiful waterways. Join the Broads Society and play your part in determining Broadlands future. Further details from: — The Hon. Membership Secretary, The Broads Society, "Icknield," Hilly Plantation, Thorpe St. Andrew, Norwich, NOR 85S.

SPONSORS required for exciting scientific project Norwich Astronomical Society are building a 30" telescope to be housed in a 20" dome of novel design. All labour being given by volunteers. Already supported by Industry and Commerce in Norfolk. Recreational. Educational. You can be involved. Write to: NAS Secretary, 195 White Woman Lane, Old Catton, Norwich, Norfolk.

BROADLANDS RESIDENTIAL CLUB for elderly people. Are you recently retired and looking for a home? We have a delightful top floor room overlooking Oulton Broad, facing south. Write to: The Warden, Broadlands Residential Club, Borrow Road, Oulton Broad, Lowestoft, Suffolk.