

An exciting hobby.... for everyone

everyday electronics

OCT. 73
15p

FREE INSIDE

DOUBLE-SIDED CHART

- Data Sheet
- Blueprint

for the **TUTOR BOARD**

*easy to
build*
Lamp Dimmer

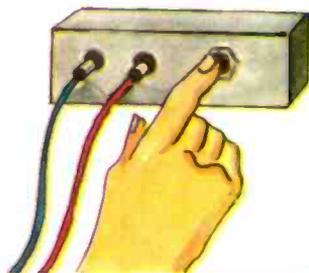


*easy to
build*

**Stereo
Headphone
Adaptor**



as used in the



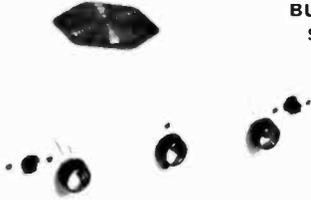
NEW
BEGINNERS
SERIES

Starting this month

NEW EDU-KIT MAJOR

COMPLETELY SOLDERLESS
ELECTRONIC CONSTRUCTION KIT.

BUILD THESE PROJECTS WITHOUT
SOLDERING IRON OR SOLDER.



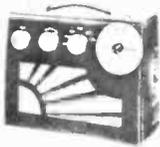
- ★ 4 Transistor Earpiece Radio
- ★ Signal Tracer
- ★ Signal Injector
- ★ Transistor Tester SPN-PN-P
- ★ 4 Transistor Push Pull Amplifier
- ★ 5 Transistor Push Pull Amplifier
- ★ 7 Transistor Loudspeaker Radio MW/LW
- ★ 5 Transistor Short Wave Radio
- ★ Electronic Metronome
- ★ Electronic Noise Generator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

Total Building Costs

£7.23 P & P Inc. 44p
(Overseas P & P £1.05p.)

ROAMER TEN

with VHF including aircraft. 10 Transistors, 8 Tunable Wavebands, MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Stations also Aircraft Band. Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600 mw Transistors, Car Aerial and Tape Recording Sockets, 10 Transistors plus 3 Diodes. Fine tone moving coil speaker. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off, Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts). Total building costs **£8.50** P & P (Overseas P & P £1.05) Inc. 52p



NEW EVERYDAY SERIES

Build this exciting New series of designs

E.V. 5 5 Transistors and 2 diodes. MW/LW. Powered by 4½ volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5½" x 2½" approx. Parts price list and Plans 15p. Free with parts.

Total Building Costs **£2.73** P & P (Overseas P & P 70p) Inc. 30p

E.V. 6 Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, loudspeaker, etc., MW/LW coverage. Push Pull output. Parts price list and Plans 15p. Free with parts.

Total Building Costs **£3.60** P & P (Overseas P & P 85p) Inc. 30p

E.V. 7 Case and looks as above. 7 Transistors and 3 diodes. 8½ wavebands. MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. Parts price list and easy build plans 20p. Free with parts.

Total Building Costs **£4.08** P & P (Overseas P & P £1.05) Inc. 31p

ROAMER EIGHT Mk I

NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mw transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9" x 4½" approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total Building Costs **£6.98** P & P (Overseas P & P £1.05) Inc. 47p

NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 8 Tunable wavebands as Roamer Ten, built in ferrite rod aerial for MW/LW. Retractable chrome plated telescopic aerial for VHF and SW. Push Pull output using 600 mw transistors, 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange. Attractive all white case with red grille and carrying strap. Size 9½" x 7" x 2½" approx. Parts Price list and Plans 30p (FREE with parts)

Total Building Costs **£6.95** P & P (Overseas P & P £1.05p) Inc. 44p

'EDU-KIT'

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



units including master unit to construct

Components include:

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

Total Building Costs **£5.50** P & P (Overseas P & P £1.05) Inc. 33p

ROAMER SIX

Case and looks as Trans-Elcht

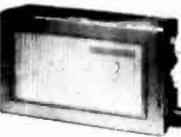
6 Tunable Wavebands: MW, LW, SW1, SW2, SW3, Trawler Band plus an Extra Medium waveband for extra tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9" x 5½" x 2½" approx. Plans and parts price list 25p (FREE with parts).

Total Building Costs **£3.98** P & P (Overseas P & P £1.05) Inc. 31p

POCKET FIVE

3 Tunable wavebands. MW, LW, and Trawler Band. 7 stages, 5 transistors and 2 diodes, super-sensitive ferrite rod aerial, moving coil loudspeaker, attractive Black and Gold Case. Size 3½" x 1½" x 3½" approx. Plans and parts price list 15p. (Free with parts).

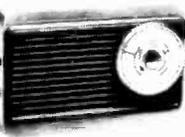
Total Building Costs **£2.28** P & P (Overseas P & P 65p) Inc. 24p



TRANSONA FIVE

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

Total Building Costs **£2.50** P & P (Overseas P & P 65p) Inc. 25p

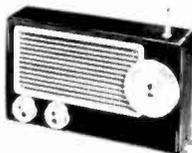


TRANS EIGHT

8 TRANSISTORS and 3 DIODES

8 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for MW, and LW. Telescopic aerial for Short Waves, 3in. Speaker. 8 Improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9" x 5½" x 2½" approx. Push pull output. Battery reconnection switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

Total Building Costs **£4.48** P & P (Overseas P & P £1.05) Inc. 33p



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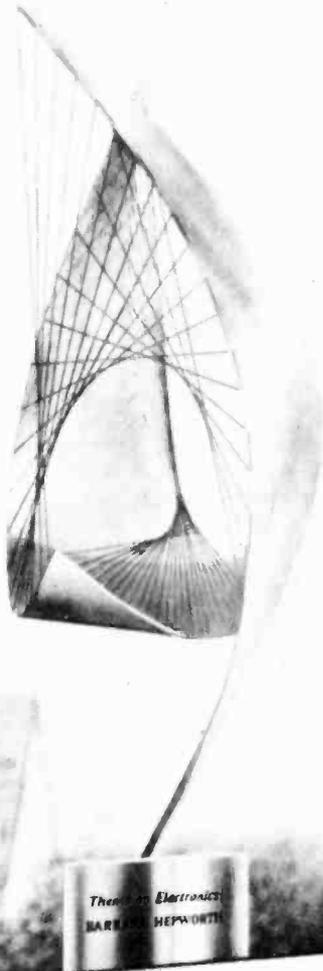
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5 Section
Extended Length 100cm
Length under Fender 40cm
Cable Length 120cm
complete with Fixing Bracket and Control Switch **£6.75** plus 25p P. & P.

STEREO / MONO HEADPHONE VOLUME CONTROL BOX

Plug Stereo phones into this control box and you then incorporate a right and left hand volume control and a stereo/mono switch. Complete with stereo jack plug and 2 m cable.
A Bargain at £1. Plus 10p P. & P.

LOW VOLTAGE AMPLIFIER

Few only at plus 13p P. & P. **£1.75**
5 transistor amplifier complete with volume control, is suitable for 9V d.c. and a.c. supplies. Will give about 1W at 8 ohm output.
With high IMP input this amplifier will work as a record player, baby alarm, etc. amplifier.



"CRESCENT" DIGITAL CLOCK KIT

24 Hour Nixie Digital Clock Kit We Supply:
★ A complete set of components
★ A complete set of easy to follow instructions
★ Printed circuits made to make construction as simple as possible
★ A cabinet and front panel to give a professional finish.
All for the price of the components. £22.50 + 50p. P. & P. Please send S.A.E. for more information.

MINIATURE RELAY

6 volt 70 ohm.
Single Pole Changeover.
Approx. size = 1 1/2" x 1" x 1".

40p plus 5p P. & P.

TWO WAY STEREO ADAPTOR

Stereo Jack plug to two stereo line sockets complete with 110 mm of cable. For plugging two stereo inputs into one. A Bargain at 65p plus 5p P. & P.

LOUDSPEAKER BARGAINS

E.M.I. 450 set 3.8. 15 ohm **£3.75** plus 38p. P. & P.
E.M.I. 350 set 8 ohm. **£2.00** plus 38p. P. & P.

MINI LOUSPEAKERS

2 1/2" (57mm) 40ohm — 50p each
2 1/2" (57mm) 80ohm — 50p each
Please include 5p. P. & P. up to 3 Mini-Loudspeakers

TRI-VOLT BATTERY ELIMINATOR

Enables you to work your transistor radio, amplifier, or cassette, etc. from A.C. mains through this compact eliminator. Just by moving a plug you can select the voltage you require — 6v, 7 1/2v or 9 volts. This means all your transistor power pack applications can be handled by this one unit.
Approx. size: 2 1/2" x 2 1/2" x 3 1/2". OUR PRICE — **£2.75p** + 10p. P. & P. Same model suitably wired for the Philips Cassette — **£3.00** + 10p. P. & P.

"CRESCENT" BUBBLE LIGHT SHOW PROJECTOR

150 watt.
Convection Cooled.
At 30ft the projected image — 16ft.
MOTOR
One Rev per Two Min.
LIQUID WHEEL
6" Diameter Multicolour
The motor is fitted to the projector and can only be purchased as a single unit. The Liquid Wheel however is our standard very popular model and may be purchased separately.
A BARGAIN AT—
Projector with Motor, ready for instant use **£15.00**
£5.00
£20.00
plus 30p P. & P.

200/250V MAINS RELAY

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

TRI-VOLT CAR CONVERTER

Enables you to work your Transistor Radio, Amplifier or Cassette etc. from the 12 volt car supply positive or negative earth. This converter supplies 6, 7 1/2 or 9 volts and is transistor regulated. Approx. size 2 1/2" x 3 1/2" x 2". Very easy to fit and a real money saving device for **£2.50** + 10p. P. & P.

V.A.T.

From 1st April, 1973, will you please include on your Total (Goods plus Postage and Packing) Value Added Tax at the Standard Stated Rate.

"CRESCENT BEAT BRITE" SINGLE CHANNEL SOUND TO LIGHT UNIT

This fantastic little box approx. 4" x 3" x 2 1/2" when connected to the output of a sound source from 1 to 100 watts produces a psychedelic light display of up to 1000 watts. Complete with a sensitive level control the unit is fused and can not harm your amplifier. A Bargain at **£7.50** plus 10p P. & P.

MAINS TRANSFORMER

Fused Primary 240V. Secondary 220V @ 50mA. 6.3V @ 1A. This transformer is made to a very high standard and is a small size: 2 1/2" x 2 1/2" x 2 1/2" plus 15p P. & P.

WAFER SWITCHES

1 pole 12 way
2 pole 2 way
2 pole 3 way
2 pole 4 way
2 pole 5 way
3 pole 4 way
4 pole 3 way
18p each. Please Inc. 5p P. & P. Up to 3 switches.

POTENTIOMETERS

All types 1 and less diameter. SINGLES DUAL
5K Log or 5K
10K Lin Less 10K
25K Switch 25K Less Switch
50K 120K 50K
100K 120K 100K
250K Double 250K 40p.
500K Pole 500K each
1M 1M
2M 2M
Up to 3 Pots. Please add 5p. P. & P.

MINIATURE RELAYS

Brand new range of British made Relays. Size—1 1/2" x 1" x 1"
All two changeovers with 250V. 1.5A contacts and suitable for fitting on 1mm Veroboard.
Type Volts Current Ohms.
27/A 12v 17mA 700 Ω
21/A 12v 23mA 430 Ω
12/A 6v 33mA 185 Ω
80p each.
Please include 5p P. & P. up to 3 Relays.

A DEXTER DIMMASWITCH

ALLOWS COMPLETE



LIGHTING CONTROL

The DEXTER DIMMASWITCH is an attractive Dimma unit which simply replaces the normal light switch. It is available as a complete "ready to install" unit or "simple to assemble" kit. Two models are available controlling up to 300W or 600W of all lights, except fluorescents, at mains 200-250V. 50Hz. All DEXTER DIMMASWITCH models have built-in radio interference suppression.
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SUPER "FUZZ" UNIT KIT. CONNECTS BETWEEN GUITAR & AMPLIFIER. OPERATES FROM 9v BATTERY (not supplied). ALL COMPONENTS AND PRINTED CIRCUIT BOARD WITH FULL INSTRUCTIONS. KIT PRICE: **£2.88** post paid.

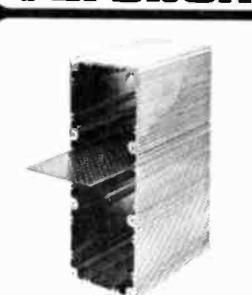
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 Plus ULTRA SHORT WAVES
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BATTERY MODEL: £18.50
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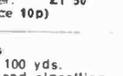
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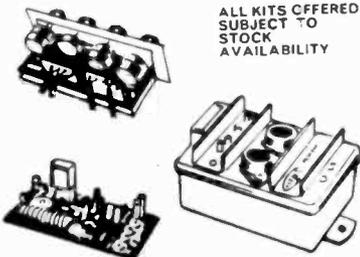


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780 Metal Detector (electronics only)	6.16	
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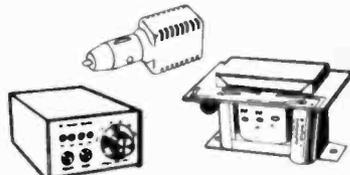
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EAGLE	TS1419	25.10	
	TS1451	34.85	
	AA2	30.80	
	AA4	42.45	
	AA6	52.95	
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HENELEC TEXAN	Built	35.00	
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	RA810	75.75	
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	2000	22.95	
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TELETON	SAQ206B	22.50	
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EAGLE	AA8	40.50	
	TST152	22.45	
HENELEC Stereo Kit		21.00	
HENELEC Stereo Built		24.95	
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PIONEER	TX500A	48.75	
ROTEL	RT320	36.95	
	ST620	51.95	
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	3000	26.95	
TELETON	GT202	30.50	

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DYNACO QUADRATOR		16.90	
EAGLE	AA10	12.00	
	AA26	16.35	

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TATE 4	15.75	
TATE 7	19.95	
	25.85	

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150	15 watt	23.50 pr.
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Acousta	2500 20 watt	28.50 pr.

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Trilon	25 watt	37.75 pr.

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250	18 watt	42.50 pr.

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(HL)	GL75 P/C G800E	37.50	
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	Pioneer PL120	31.75	
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(carr. etc. 15p)				
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M44.7	3.85	M75/6/11B	6.75	
M44E	4.25	M75 EDII	8.50	
		M75 EIII	7.85	
M55E	4.95	M75GII	7.25	
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G850	2.85	G800SE	10.00	
G800	3.75	G820	10.70	
G800H	3.50	G820E	6.00	
G800E	5.75	G820SE	13.35	
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Q36	10.70	Q30	5.90	
Q32	8.70			
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F3E	11.25	MZ	18.75	
EMPIRE				
909EX	7.25	999SEX	10.75	
999EX	8.25	999TEX	14.85	

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Complete with Speakers (carr./packing £1.25)			
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Sony	G2601KL	125.50	
Sony	G2815N	71.50	
Sony	GXT4520KL	103.50	
Sony	GXT4730KL	97.50	
Philips	GF908	99.85	
Philips	RH802	159.95	
Philips	RF836	57.20	
Philips	GF826	41.75	
Philips	RH813/RH142	129.50	
Philips	RH811/RH421	84.95	
Philips	RF839	95.95	
Philips	GF829	39.95	
Philips	GF815	47.75	
Philips	GF808	85.75	
Philips	RH814/RH411	93.50	
Philips	GF603	19.95	

8 TRACK STEREO HOME UNITS

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Elizabeth T9	9"	43.50	
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(carr. etc. 30p)			
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Wlen	ET1008	11.00	
Philips	EL3302	14.40	
	N2203	16.60	
	N2211	19.95	
Sony	M1101	13.90	
	M1102	12.95	

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(carr. etc. 35p)			
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Amerex	AC101	12.00	
Elizabethan	LZ315	12.25	
Amerex	AC104	16.00	
Philips	N2204	20.75	
	N2205	29.50	
PYE	9115	23.75	
	9118	21.20	
Hitachi	TRQ291	21.50	
Sony	M2000G	23.25	
	MR4010	28.95	
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(carr. etc. 30p)			
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	ACR201	30.00	
Elizabethan	LZ418	27.25	
	LZ416	28.10	
BASF	CC9301	28.75	
Philips	RR322	28.75	
	RR413	33.90	
	RR712	48.30	
Sony	M4141	39.50	
	M2400W	31.50	
	M2400FG	50.75	
	M4400FC	62.50	
Grundig	C250	47.95	
Hitachi	TRK1240E	29.50	
	TRS1181	35.00	
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(carr./packing 50p)			
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Pye	9145	44.50	
Tandberg	TCD300	112.00	
Akal	GXC40D	57.75	
	GXC45D	74.00	
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TEAC	A250/A350-A450	Stocked	

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Tandberg	3321X/3341X	102.80	
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ASE22	8.25		
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SH850GX	3.95		
SH1300VS	5.25		
AKG			
K60	9.25		
ROTEL			
RH630	4.85		
RH700	6.75		
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WHARFEDALE			
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ISODYN	14.35		
KOSS			
K6	9.95		
K8/LC	11.25		
K711	7.95		
KRD711	7.95		
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8 TRACK

Akal	CR81D	54.10
	CR80DSS	94.95

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Cassette			
Akal	GXC40	87.95	
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Philips	N2400/RH411	83.75	
	N2401/RH411	74.50	
	N2401S/RH411	79.95	
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Goodmans	Module 90	75.90	
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Pioneer	SX525	116.50	
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Rotel	RX150A	42.95	
	RX200A	53.95	
	RX400A	85.95	
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	RX800	116.50	
	RX154A	98.95	
Tandberg	TR200MPX	85.00	
	TR1000MPX	125.35	
	TR1010MPX	135.75	
Teleton	TSF55	57.20	

8 TRACK

Akal	CR81	66.20
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8 TRACK PLAYER DECKS

(carr./packing 35p)			
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McDonald/BSR	TD8S	12.75	
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CIS2000	15.25		
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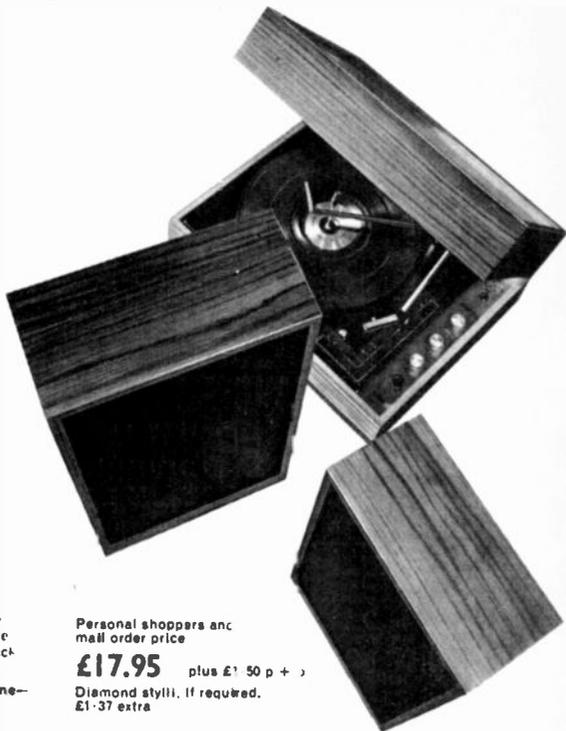
20301	0-15	2N3414	0-10	40316	0-02	BC125	0-15	BDY20	1-05	B8Y26	0-20
20302	0-15	2N3415	0-10	40360	0-02	BC126	0-20	BDY38	0-05	B8Y27	0-15
20303	0-25	2N3416	0-15	40362	0-43	BC134	0-30	BDY60	0-90	B8Y28	0-20
20306	0-30	2N3417	0-21	40363	0-45	BC135	0-11	BDY62	1-00	B8Y39	0-20
20309	0-30	2N3418	0-21	40363	0-61	BC136	0-15	BF115	0-23	B8Y61	0-25
20345B	0-30	2N3570	1-25	40389	0-46	BC137	0-15	BF117	0-43	B8Y62	0-25
20371	0-15	2N3571	1-12	40394	0-56	BC138	0-24	BF119	0-58	B8Y63	0-25
20374	0-15	2N3572	0-97	40395	0-55	BC140	0-84	BF121	0-25	B8Y64	0-20
20374	0-15	2N3702	0-11	40406	0-44	BC141	0-89	BF123	0-27	B8Y66	0-18
2N174	1-40	2N3703	0-10	40407	0-33	BC142	0-24	BF125	0-25	B8Y65	0-18
2N404	0-43	2N3704	0-14	40408	0-50	BC143	0-21	BF122	0-28	B8Y78	0-40
2N455	0-75	2N3705	0-10	40409	0-52	BC144	0-24	BF153	0-29	B8Y79	0-40
2N456A	0-75	2N3706	0-09	40410	0-53	BC145	0-21	BF154	0-19	B8Y93A	0-09
2N457A	0-30	2N3707	0-13	40411	2-25	BC147	0-12	BF158	0-23	C111	0-33
2N491	1-25	2N3708	0-07	40414	3-55	BC148	0-12	BF159	0-27	D40N3	0-55
2N696	1-25	2N3709	0-09	40467A	0-69	BC149	0-12	BF160	0-23	GE111	0-45
2N697	0-25	2N3710	0-12	40468A	0-46	BC152	0-18	BF161	0-42	GE114	0-20
2N698	0-25	2N3711	0-09	40469	0-46	BC154	0-15	BF163	0-20	GE115	0-40
2N699	0-52	2N3712	0-06	40469	0-67	BC157	0-15	BF166	0-35	GE119	0-35
2N706	0-52	2N3713	1-05	40602	0-46	BC158	0-18	BF167	0-21	GE153C	0-20
2N706A	0-30	2N3714	0-29	40603	0-56	BC159	0-14	BF173	0-24	GE153B	0-20
2N709	0-38	2N3715	1-23	40604	0-68	BC160	0-37	BF177	0-29	GE1780	0-30
2N710	0-30	2N3716	3-00	40638	1-10	BC167B	0-11	BF178	0-35	GE1783	0-20
2N718	0-20	2N3717	3-06	40673	0-70	BC168A	0-11	BF179	0-43	GE1787	0-20
2N718A	0-40	2N3719	3-15	AC107	0-35	BC168B	0-11	BF181	0-32	TP29A	0-58
2N720	0-50	2N3790	4-21	AC113	0-18	BC169B	0-18	BF182	0-40	TP30A	0-48
2N721	0-55	2N3794	2-06	AC117	0-20	BC170	0-11	BF183	0-40	TP31A	0-62
2N918	0-41	2N3791	2-06	AC121	0-13	BC171	0-18	BF184	0-17	TP32A	0-74
2N918	1-50	2N3792	2-20	AC126	0-25	BC172	0-11	BF185	0-17	TP33A	1-51
2N929	0-14	2N3794	0-10	AC127	0-20	BC182	0-10	BF194	0-14	TP35A	2-90
2N930	0-48	2N3819	0-32	AC128	0-20	BC182L	0-12	BF195	0-17	TP36A	3-70
2N1090	0-25	2N3823	0-47	AC141K	0-30	BC183L	0-09	BF196	0-15	TP41A	2-70
2N1091	0-24	2N3824	1-33	AC142K	0-25	BC183L	0-09	BF197	0-15	TP42A	0-90
2N1131	0-24	2N3825	1-42	AC143	0-16	BC184	0-11	BF198	0-18	TP43A	0-90
2N1132	0-25	2N3826	0-23	AC143V	0-14	BC184L	0-11	BF199	0-18	TP50.5	0-90
2N1302	0-16	2N3854	0-18	AC153	0-22	BC186	0-25	BF200	0-40	ME401	1-18
2N1303	0-16	2N3854A	0-19	AC153K	0-25	BC187	0-25	BF224J	0-14	ME402	0-20
2N1304	0-20	2N3855	0-19	AC154	0-20	BC190	0-12	BF225J	0-19	ME404	0-18
2N1305	0-20	2N3855A	0-20	AC178	0-18	BC190	0-12	BF227	0-22	ME411	0-17
2N1306	0-22	2N3856	0-19	AC187K	0-20	BC192L	0-18	BF244	0-16	ME412	0-16
2N1307	0-22	2N3857	0-19	AC187K	0-20	BC192L	0-18	BF245	0-33	ME1120	0-25
2N1308	0-25	2N3858	0-17	AC187K	0-20	BC194L	0-11	BF246	0-43	ME4001	0-09
2N1309	0-25	2N3858A	0-19	AC17	0-35	BC197	0-09	BF247	0-49	ME4002	0-11
2N1483	0-90	2N3859	0-16	AC118	0-24	BC198	0-09	BF254	0-16	ME4003	0-14
2N1507	0-24	2N3859A	0-19	AC119	0-27	BC199	0-09	BF255	0-17	ME4101	0-10
2N1613	0-33	2N3860	0-20	AC120	0-22	BC201	0-20	BF257	0-17	ME4102	0-11
2N1631	0-33	2N3866	1-69	AC121	0-26	BC203	0-23	BF258	0-53	ME4103	0-11
2N1637	0-33	2N3877	0-28	AC122	0-16	BC205	0-09	BF259	0-13	ME4104	0-14
2N1638	0-32	2N3877A	0-59	AC122	0-16	BC205	0-09	BF270	0-25	ME8101	0-14
2N1701	1-10	2N3900	0-00	AC129	0-42	BC208	0-13	BF272	0-53	ME8102	0-16
2N1702	2-15	2N3900A	0-21	AC129	0-42	BC208	0-13	BF273	0-25	ME8003	0-17
2N1711	0-45	2N3901	0-32	AC140	0-17	BC211	0-20	BF274	0-23	ME8003	0-16
2N1903	0-41	2N3903	0-24	AC141	0-17	BC213	0-22	BF437	0-53	MJ400	0-78
2N2102	0-30	2N3904	0-27	AC144	0-41	BC200	0-42	BF438	0-53	MJ401	0-66
2N2147	0-20	2N3905	0-24	AD135V	0-91	BC201	0-54	BF821A	0-30	MJ421	0-85
2N2192	0-20	2N3906	0-57	AD140	0-55	BC202	0-57	BF822	0-27	MJ440	0-75
2N2192A	1-41	2N3907	0-46	AD142	0-50	BC203	0-54	BF861	0-27	MJ440	0-71
2N2193	0-41	2N3908	0-57	AD143	0-55	BC203	0-54	BF898	0-28	MJ440	0-75
2N2193A	0-60	2N4058	0-16	AD149V	0-66	BC207	0-10	BF910	0-61	MJ481	0-85
2N2193A	0-60	2N4059	0-09	AD150	0-63	BC207A	0-10	BF911	0-61	MJ480	0-94
2N2194	0-73	2N4060	0-11	AD161	0-45	BC208	0-09	BF913	0-11	MJ481	1-10
2N2194A	0-73	2N4061	0-11	AD162	0-45	BC208A	0-09	BF929	0-30	MJ391	2-65
2N2195	0-37	2N4062	0-11	AD162	0-45	BC209	0-10	BF937	0-30	MJ1801	2-65
2N2195A	0-36	2N4062	0-11	AD161	1-05	BC209A	0-09	BF944	0-33	MJ1800	1-88
2N2218A	0-88	2N4303	0-47	AF109R	0-40	BC209B	0-10	BF963	0-48	MJ2509	2-92
2N2219	0-57	2N4916	0-20	AF114	0-26	BC232	0-24	BF968	0-24	MJ2501	3-25
2N2219A	0-86	2N4917	0-17	AF115	0-24	BC238	0-22	BF984	0-28	MJ2955	1-00
2N2220	0-45	2N4918	0-73	AF116	0-26	BC238	0-22	BF985	0-28	MJ2956	4-47
2N2221	0-41	2N4919	0-84	AF117	0-20	BC237	0-27	BF986	0-24	MJ3001	2-73
2N2222	0-60	2N4920	0-99	AF118	0-20	BC238	0-19	BF986	0-24	MJ3001	2-73
2N2222A	0-91	2N4921	0-78	AF121	0-22	BCY30	0-43	BF987	0-28	MJ3701	0-90
2N2268	0-31	2N4922	0-84	AF124	0-24	BCY31	0-51	BF988	0-25	MJ4502	4-44
2N2269	0-37	2N4923	0-83	AF125	0-20	BCY32	1-15	BF989	0-45	MJ4540	4-47
2N2369A	0-41	2N5172	0-12	AF126	0-19	BCY33	0-84	BFY10	0-35	MJ4570	0-78
2N2369A	0-41	2N5174	0-22	AF127	0-20	BCY34	0-84	BFY11	0-35	MJ4571	0-80
2N2446	0-77	2N5175	0-28	AF139	0-38	BCY35	0-58	BFY17	0-30	MJ4599	0-58
2N2471	1-20	2N5176	0-33	AF170	0-25	BCY39	1-05	BFY18	0-35	MJ4521	0-44
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2N2923	0-18	3N129	1-63	AF211	0-75	BCY90	0-85	BFY64	0-41	MPF111	0-32
2N2924	0-17	3N139	1-42	AL102	0-75	BCY91	0-85	BFY76	0-22	MPF12	0-25
2N2925	0-14	3N140	0-92	AL103	0-70	BD115	0-75	BFY77	0-22	MPF15	0-47
2N2926	0-13	3N141	0-81	ASX28	0-30	BD116	0-50	BFY78	0-62	MPF8A05	0-25
Green	0-10	3N142	0-58	ASX27	0-36	BD121	0-75	BFY90	0-60	MPF8A06	0-20
Yellow	0-15	3N143	0-75	ASX28	0-28	BD123	0-82	BFY99	0-38	MPF8A12	0-40
Orange	0-10	3N152	0-92	ASX29	0-28	BD124	0-67	BFY99	0-18	MPF8A14	0-24
2N3053	0-33	3N153	0-81	ASX50	0-20	BD125	0-71	BFY99	0-18	MPF8A35	0-28
2N3054	0-86	3N154	0-84	ASX55	0-55	BD131	0-40	BFY99	0-18	MPF8A36	0-28
2N3055	0-75	3N159	1-17	BC107	0-10	BD132	0-50	BFY99	0-18	MPF8A6	0-28
2N3390	0-28	3N167	1-55	BC108	0-10	BD135	0-43	BFY99	0-18	MPF801	0-44
2N3391	0-28	3N200	2-49	BC109	0-10	BD136	0-49	BFY99	0-18	MPF805	0-48
2N3391A	0-30	3N20									

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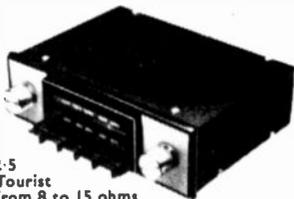
The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2.5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loud-speaker from 8 to 15 ohms.

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modularised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

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Truly pocket-sized

With all its calculating capability, the Cambridge still measures just $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$. That means you can carry the Cambridge wherever you go without inconvenience – it fits in your pocket with barely a bulge. It runs on ordinary U16-type batteries which give weeks of life before replacement.

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All parts are supplied – all you need provide is a soldering iron and a pair of cutters. Complete step-by-step instructions are provided, and our service department will back you throughout if you've any queries or problems.

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Features of the Sinclair Cambridge

- * Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{11}{16}''$, weight $3\frac{1}{2}$ oz.
- * Standard keyboard. All you need for complex calculations.
- * Clear-last-entry feature.
- * Fully-floating decimal point.
- * Algebraic logic.
- * Four operators (+, -, x, ÷), with constant on all four.
- * Constant acts as last entry in a calculation.
- * Constant and algebraic logic combine to act as a limited memory, allowing complex calculations on a calculator costing less than £30.
- * Calculates to 8 significant digits, with exponent range from 10^{-20} to 10^{79} .
- * Clear, bright 8-digit display.
- * Operates for weeks on four U16-type batteries. (MN 2400 recommended.)



A complete kit!

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

Contents:

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



This valuable book – free!

If you just use your Sinclair Cambridge for routine arithmetic – for shopping, conversions, percentages, accounting, tallying, and so on – then you'll get more than your money's worth.

But if you want to get even more out of it, you can go one step further and learn how to unlock the full potential of this piece of electronic technology.



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Price fully built: £29.95 + £3.00 VAT. (Total: £32.95)

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everyday electronics

PROJECTS...
THEORY.....

JOIN THE CLUB!

Welcome to the Club! Several ardent hobbyists have already suggested that "being a reader of EVERYDAY ELECTRONICS is just like belonging to a special kind of club."

We are flattered and highly delighted to hear such a view expressed. Also, we are mindful of our responsibilities, and will certainly do all in our power to preserve, and extend whenever possible, this spirit of *camaraderie* which undoubtedly exists between fellow electronic enthusiasts—be they readers or contributors, or members of the editorial team.

Well, a club must have a Constitution, so here goes.

1. The aims of the Everyday Electronics Club are:

(a) To encourage the use of electronic techniques by the ordinary person in order to solve everyday needs, through relatively simple and inexpensive designs.

(b) To take any stuffiness out of electronics, to dispel its mystique and to present this subject, in theory and practice, in the clearest and most objective fashion.

2. Membership shall be open to any individual who has a curiosity about electronics and wishes to participate in an interesting creative hobby.

3. No formal education or training in electronics is necessary since the Club undertakes to provide, at regular intervals, adequate instruction for beginners, in both theoretical and practical matters.

How about that, then?

A NEW SEASON STARTS

In the formal sense our "Club" may indeed be a mere figment of the imagination. But the above "constitution" is actually a restatement of this magazine's well established policy. And it is worth spelling it out again at this particular time, because we are now on the eve of another busy season for constructors.

Apart from many old stalwarts returning to their favourite hobby after an "ease up" during the summer, we anticipate a large influx of newcomers to electronics around this time.

To each and everyone of these beginners, a very special welcome. You couldn't have chosen a better month to "discover" electronics. The *Teach-In '74* series (commencing in this issue) has been prepared just for you. We hope you like the series. Follow each article carefully and carry out the simple experiments described. It's our guess that very soon you will become an enthusiastic "member of the Club", like many thousand others. Good Luck with your new-found hobby!



Our November issue will be published on Friday, October 19

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EASY TO CONSTRUCT SIMPLY EXPLAINED

VOL. 2 NO. 10

OCTOBER 1973

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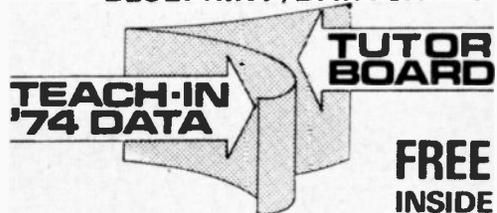
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Publisher's Annual Subscription Rate, including postage to any part of the world, £2.35. International Giro facilities Account No. 5122007. State reason for payment "message to payee". Address to Everyday Electronics, Subscription Department, Carlton House, Great Queen Street, London, WC2E 9PR. Binders for volumes 1 and 2 (state which) and indexes for volume 1 available for 97p and 11p respectively, including postage, from Binding Department, at the above address.

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PLUS....
BLUEPRINT/DATA CHART



LIGHT DIMMER

BY MIKE HUGHES

A basic circuit for electronically dimming a mains lamp

THE few components and novel construction of this Light Dimmer enable it to be made by virtually anyone and the result is a really smart contemporary style tablelamp that will grace any decor. Basically the unit is a dimmer circuit built into the base of a simple lamp stand; there is no reason why the dimmer circuit should not be used in isolation or in conjunction with other lighting circuits provided the maximum current drawn does not exceed 1 amp (i.e. the bulb should not require more than 250 watts when run off 250V mains).

The dimmer is only suitable for controlling non-inductive loads—tungsten filament bulbs—it should not be used in conjunction with fluorescent tubes.

DIAC AND TRIAC

The circuit is shown in Fig. 1 and as can be seen is in series with the main light circuit. This means that it can be simply wired into the lighting system in place of, or as well as, the existing

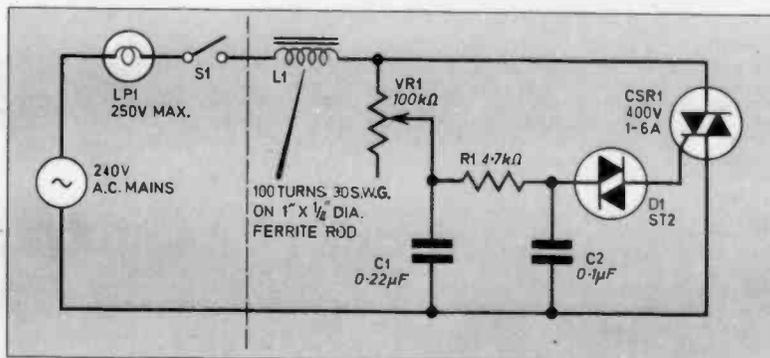


Approximate cost of components including V.A.T. £3.50 all parts listed

switch. The important components are D1 which is called a **diac** (sometimes a trigger diode) and CSR1 which is a **triac**.

The diac will not normally pass current in either direction unless the voltage across it exceeds a certain value (the trigger voltage). When this happens the device conducts completely and—like a thyristor—will continue to pass current until the current falls below a certain level. A diac will operate with either polarity and

Fig. 1. The complete circuit diagram of the Light Dimmer. Only the circuitry to the right of the dotted line is assembled on the tag board.



therefore it does not matter which way round it is connected in the circuit.

The triac works rather like a thyristor except that it can also operate with either polarity across it. Normally it does not conduct but if the gate is made positive or negative with respect to MT1 (main terminal one) and gate current of about 30mA is allowed to flow the device goes into conduction and stays in conduction until the current flowing through it falls below the holding current level. When operating from a.c. mains this occurs every half cycle.

CIRCUIT OPERATION

Dimming is effected by triggering the gate of the triac at different points on the mains half cycle waveforms (Fig. 2). If triggered early in the half cycle almost full power is obtained and this can be reduced to almost zero power as the triggering point is progressively moved later within the cycle. We use the combination of VR1, C1, R1 and C2 to delay the voltage rise across the diac—relative to the timing of the mains waveform.

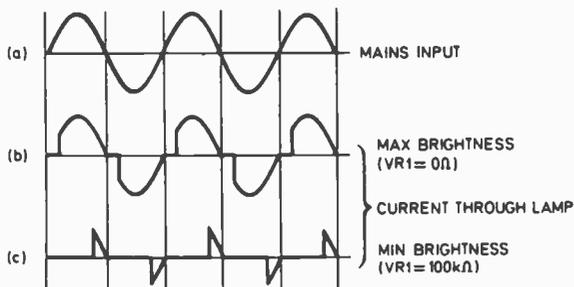


Fig. 2. Waveforms of current through the lamp for triggering (b) early in the half cycle (c) late in the half cycle.

In this circuit the delay can be from virtually zero to 10 milliseconds, which corresponds to the time for a half cycle of 50Hz mains. Thus we can say we obtain a phase shift of nearly 180 degrees.

The diac needs about 20V across it for it to trigger—and hence pass current into the gate of the triac. If VR1 is set to a low value the potential across C1 builds up rapidly and in almost exact step with the mains; likewise across C2 although there will be a slight fixed delay caused by R1. As soon as the mains rises to plus or minus 20V the diac will trigger and the triac conducts. The voltage between the top end of VR1 and the bottom end of C1 will fall to almost zero and both C1 and C2 discharge into the gate of the triac.

By increasing the value of VR1 to 100 kilohm C2 will not reach 20V until much later in the cycle. The former setting gives near maximum light output while the latter gives minimum. As stated previously it does not matter whether the mains is on a positive or negative half cycle, the triac will still function in this way.

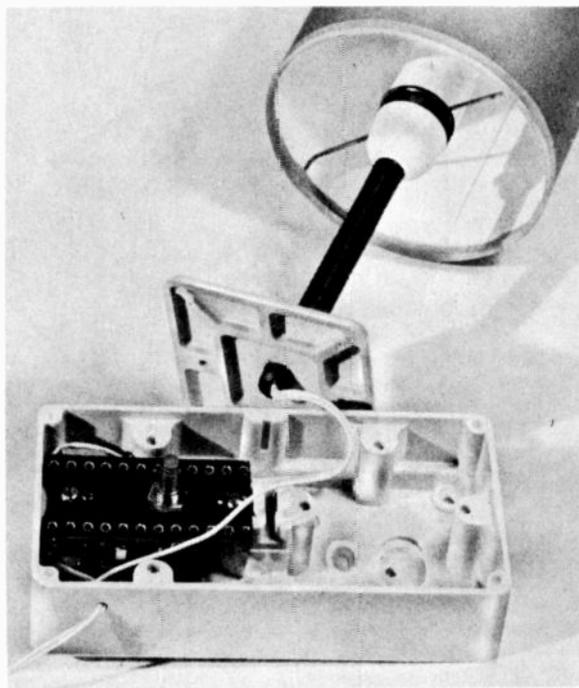
COMPONENTS

The values of VR1, C1, R1 and C2 are fairly important to maintain the correct range of control. For example C1 is specified as 0.22 μ F; if you make this 0.33 μ F the circuit will still work but minimum light intensity will be obtained well before you have turned VR1 to maximum resistance—this means the control movement of the knob becomes cramped.

It is suggested that VR1 is a wirewound potentiometer—not so much because of power dissipation but because of better reliability. The capacitors should be of 250V working and the Mullard C240 range of polyester devices are ideal. You might have a bit of trouble locating diacs and triacs—particularly when it comes to their specifications. Most of them are sold “unbranded” which means that you must state the voltage and currents you require when ordering.

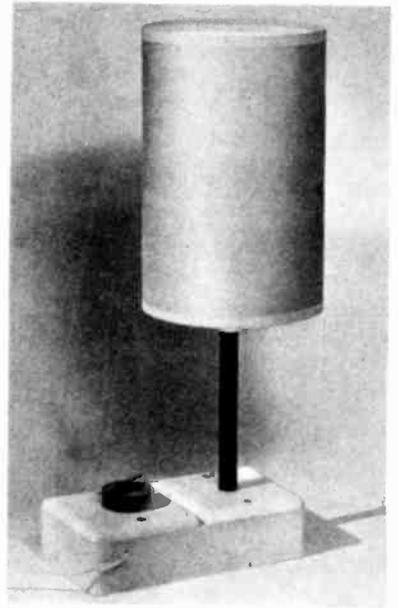
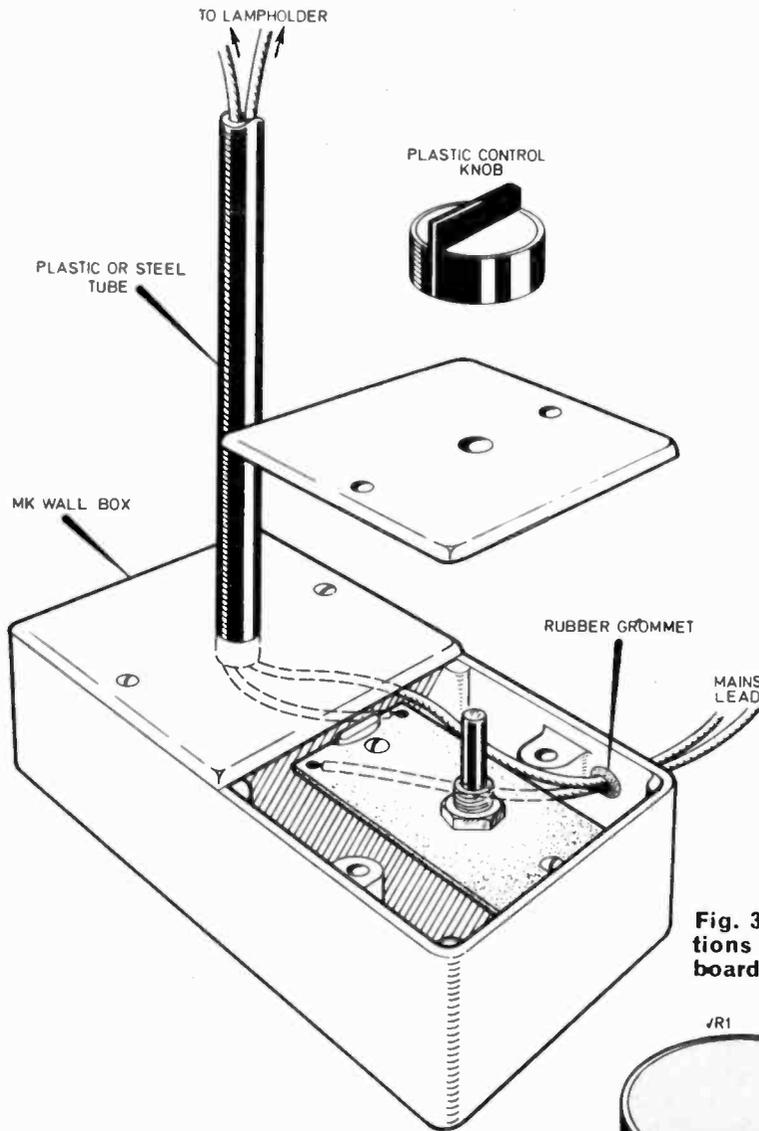
In this circuit almost any diac will do but you must make sure the triac is at least a 400V device with a current rating of at least 1 amp. A triac in a TO-5 transistor encapsulation will do but these are not as readily available as the “stud” mounting variety. We have therefore designed the mechanical construction around the latter.

The inductor L1 is there purely to act as an interference suppressor and is a “home wound” job. About 100 turns (a few more will not hurt, but don't cut down on the 100) of 30 s.w.g. enamelled copper wire are wound on a 25mm (one inch) length of 1/4 inch diameter ferrite aerial rod and Araldited into position.



Photograph of the Lamp Dimmer in final stages of assembly.

LIGHT DIMMER



Photograph of completed unit.

Fig. 3 (below). The component positions and wiring details on the tag board.

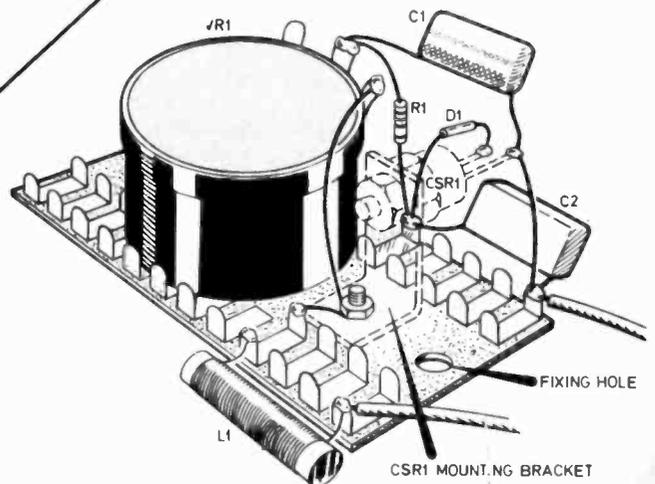


Fig. 4 (above). Fixing the component board in its case. Also shown is stem for holding lamp holder and shade.

Components

Resistors

R1 4.7k Ω $\frac{1}{4}$ W $\pm 10\%$ carbon
VR1 100k Ω wirewound potentiometer

Capacitors

C1 0.22 μ F 250V polyester
C2 0.1 μ F 250V polyester

Semiconductors

D1 ST2 or similar diac

CSR1 400V 1 to 6 amp triac

Miscellaneous

L1 Interference suppressor—see text
LP1 240V lamp (up to 250W)
S1 On/off switch incorporated in lamp-holder

Piece of 12-way twin tagboard 76mm long, MK double plastic wall box, 2MK plastic cover plates, 130mm length of $\frac{1}{2}$ inch diameter gas pipe, insulated knob, bayonet lamp holder (incorporating S1), lamp shade (Woolworths), aluminium for CSR1 mounting, length of twin mains flex.

SEE
**SHOP
TALK**

CONSTRUCTION

All the electronic components are mounted on a piece of tag board as shown in Fig. 3 which is then fixed within one half of a double MK wall box (the white plastic type). A hole is drilled in a blank white cover plate to allow the spindle of the potentiometer to pass through and this will ultimately be positioned over the circuit half of the box (Fig. 4).

The lamp holder is made from a 130mm length of $\frac{1}{2}$ inch diameter steel gas pipe—screwed or stuck into a second blank cover plate with a switched bayonet lamp holder fixed, likewise, to the top end. The mains input wires are brought into the side of the box; one lead goes straight to the lamp holder, the other is broken and goes via the circuitry. To finish the unit off give the steel pipe a touch of paint and select a fully insulated knob to match the general appearance of the unit.

The advantage of using a plastic case is that you do not have to worry too much about insulation problems. If you use a metal case such as a standard "sunk" metal wall box ensure that none of the circuitry touches the metalwork. If in doubt you can cover the inside of the box with two layers of good quality insulating tape. \square



...Counter Intelligence

BY PAUL YOUNG

A retailer discusses component supply matters.

Component consumers are our "bread and butter." As an electronic component retailer I say this advisedly, because you constructors are indeed just this.

Specialisation

Now the variations in electronic circuit components are proliferating so fast that the first thing you are going to have to face up to, is that you are highly unlikely to get *all* your requirements from one source. I know a large component firm in South East London who do not stock any "radio-frequency" goods at all. This may sound as though it's against your interests, but is it? It means in practice they can carry a bigger range and bigger stocks of "audio frequency" components.

I think this trend may go on for quite a while, and each dealer will have to specialise in a smaller section of the field. The disadvantage is that it will make it essential for you to deal with several firms, an obvious complication. On the credit side: if

each dealer is doing his job well, he should be able to offer you a large range, (within his limits) and be able to buy bigger stocks, which will help to keep down prices.

To anyone embarking on this hobby I therefore suggest that their first purchase should be *catalogues*. Buy several of the electronic magazines and read all the advertisements. In this way you will come to know supplier's strengths and weaknesses.

Mail Order

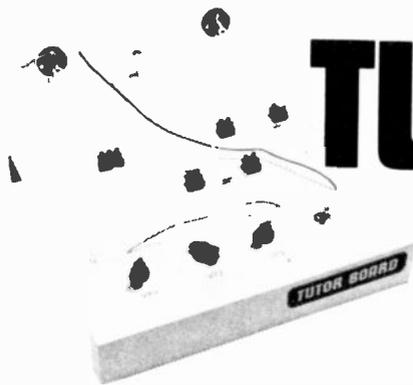
Now since all these suppliers will be spread out over a fair size area, most of your orders will have to be through the mail. A few points relating to ordering by mail order are in order. Use the firm's own order form (if they have one). Write your name and address clearly (preferably print in BLOCK CAPITALS) and clearly state your wants. If you are using a firm's catalogue, I would emphasise particularly, do not put down something they do not list, because if you do, your order

will have to be specially dealt with, and my guess is that it will be the very last to be tackled. Above all don't write queries on your order form.

Queries

It might be an appropriate moment to consider exactly what kind of queries you can expect your supplier to deal with. Every supplier will of course have his own ideas on this subject. However, I would suggest that they must be confined to information about that particular dealer's own stock; and even then, if they concern data that is not readily available, I would not condemn a supplier if he limited his help to giving you the name and address of the manufacturer concerned.

It is not in the province of the dealer to answer technical queries about articles appearing in the electronics magazines. In any case it is always far more satisfactory to contact the magazine concerned. As my partner so rightly remarked, "Extra good service for the one, means poorer service for the many." Translated into practical terms, it means that while we are struggling with your one query, twenty other customers' orders are held up!



TUTOR BOARD

How to Construct

By PHIL ALLCOCK*

Designed specifically for use in the Teach-In '74 series for beginners.

THE Tutor Board to be described here and on the blueprint presented free with this issue of *EVERYDAY ELECTRONICS*, is an essential piece of apparatus for use in the *Teach-In '74* series for beginners in electronics.

The Tutor Board will be used extensively throughout the series its primary function being to carry out experiments to illustrate the theory.

It is not essential to adhere exactly to the given dimensions for the Tutor Board and some readers may wish to modify the construction to suit materials at hand. If major changes are contemplated it is necessary first to ensure that adequate space and clearances are available, especially for the potentiometers, meter and batteries.

BUILDING

Cut the plywood base and rear panel (pieces A and B) to the dimensions shown on the blueprint and drill all the holes with reference to the heading **DRILLING**.

The large hole for the meter can be cut out by a fret saw, an expandable wood bit or by drilling a series of closely spaced holes round the inside of a marked circle. In the latter case the centre disc of wood can be removed by cutting along the holes with a sharp knife on both sides of the plywood. Finally the hole edge must be smoothed with sandpaper.

Next cut the front and rear supports (pieces C) to the sizes indicated and then fix, with glue and panel pins, to the baseboard as shown.

Now cut to size the battery support, piece D, and glue and pin to the back panel as indicated on the blueprint. When the glue has completely set, the base and rear panel can be sanded down before finishing with two coats of emulsion paint.

The rear panel is held to the base by three screws so that the Tutor Board can be taken apart if necessary for storage, in say a shallow drawer, or repainting.

As the Tutor Board will be used throughout the series it is worth making as good a job of this as possible. A high standard should always

be the aim and this applies especially to electronics because most problems arise from poor workmanship or untidy work. Good workmanship from the start will repay itself as the series develops and will give more pleasure and satisfaction in the long run.

TERMINAL BLOCKS

While the paintwork is drying the electrical components can be studied. The Data Chart illustrates the various components, to aid identification, and it is worth spending a little time examining the chart and the actual components until they can all be readily identified.

An important part of the Tutor Board system is the terminal blocks. These are supplied in strips of twelve connectors and must be cut with a sharp knife to give smaller blocks. Using the first strip carefully cut along the grooves to give two blocks each having three connectors, two blocks each having two connectors and two blocks each having one connector. The remaining two strips of twelve should be cut to give twelve blocks, each having two connectors.

The two three-connector blocks are for the BC107 transistors (see Fig. 1a), which have three leads each, but as these are not required straight away they can be stored with the other components until needed.

The two-connector blocks will have a single fixing hole, Fig. 1b, and at this stage it is advisable to check that the wire nails are a good fit when pushed into the fixing hole so that the barbs on the nail enter the plastic block. If all is well the nails can be cut to length to suit the thickness of the plywood used for the baseboard. In the prototype, which uses 4mm plywood, a cut nail length of 10mm was found ideal see Fig. 1c. The cut ends should be rounded slightly with a file to remove any sharp edges or burrs. A total of about 15 or 20 cut nails will ensure some spares to replace any that are lost during the series.

Two of the pointed nail off-cuts are required to make up a pair of test prods and after filing away any burrs these can be clamped firmly in

each of the two single-connector blocks using one of the screws; this is shown in Fig. 1d. The unused screw in each single connector is for the connection of a flexible lead later on.

It is worth noting at this stage that the test prod point can be used to push out the fixing nails of the other terminal blocks when they have to be removed or repositioned on the base-board.

CONNECTING LEADS

The next requirement is preparation of the connecting leads. Five different colours are used and leads of different lengths will be required, see Table 1.

Table 1: Coloured Wire Lengths

Colour	Length (mm)	Quantity	Use
Red	45	1	positive test prod
	40	2	positive battery connectors
Black	30	2	general
	45	1	negative test prod
	40	2	negative battery connectors
	30	2	general
Blue	10	6	general
	30	4	general
Green	10	6	general
	30	4	general
Yellow	15	4	general
	20	6	general

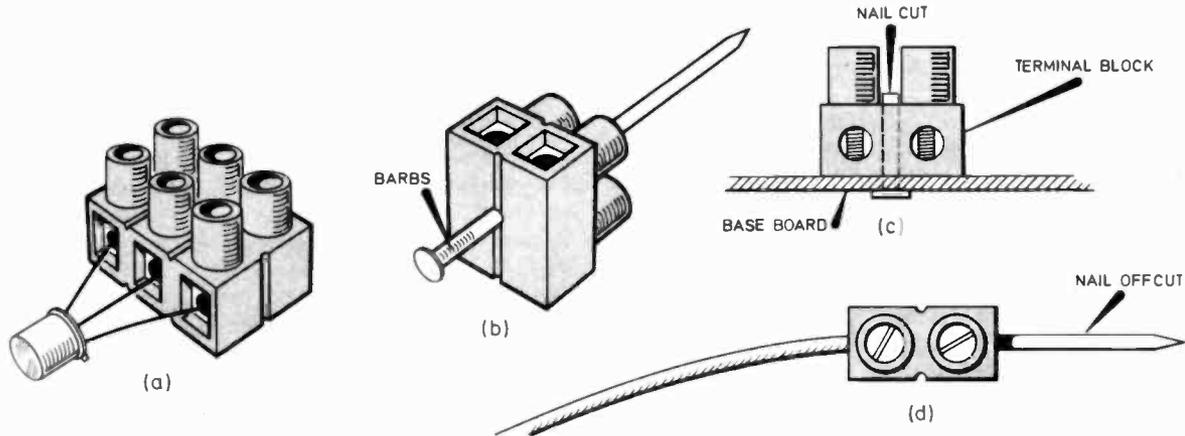


Fig. 1 (a). Shows the three-connector block for mounting transistors **(b)** checking that the nail fits snugly in the terminal block **(c)** method of fixing the terminal blocks to the Tudor Board baseboard **(d)** a made up test prod.

Components

Resistors

100Ω	1W ± 5% carbon	(1 off)
1kΩ		(2 off)
4.7kΩ		(2 off)
10kΩ	½W ± 5% carbon	(2 off)
47kΩ		(2 off)
100kΩ		(2 off)
100kΩ	½W ± 2% thick film	(1 off)

Potentiometers

100Ω	1W wirewound semi-precision
5kΩ	1W wirewound semi-precision
100kΩ	carbon linear

Capacitors

1000μF	elect. 9 to 25V	(1 off)
250μF	elect. 9 to 25V	(2 off)

Semiconductors

BC107	silicon npn	(2 off)
IN4001	silicon diode	(1 off)
BZY88	4.7V 400mW Zener diode	(1 off)

SEE
**SHOP
TALK**

Miscellaneous

Meter 0-100μA d.c. moving coil—SEW MR45P or similar; 12-way 2A terminal blocks (3 off); M.E.S. batten mounting lampholders (2 off); M.E.S. 6V 60mA bulbs (2 off); S.P.D.T. toggle switch; pointer knobs (3 off); miniature crocodile clips (24 off); coloured 7/0.2mm wire—one of each colour Red, Black, Blue, Green, Yellow—each 2 metres long.

The components listed above are those required for the first six months of *Teach-In '74*, see page 535. Approximate cost including V.A.T. £7.00.

Hardware

4mm Plywood 300 x 300mm
6mm Plywood 150 x 300mm
Deal or similar soft wood 48 x 22 x 300mm (2 off)
Deal or similar soft wood 18 x 22 x 300mm
Wood glue; half inch panel pins; No. 10 round headed screws (3 off); screw hooks (4 off); screws for lampholders (4 off); stout rubber bands (2 off). **Drill bits:** 10mm dia.; 13mm dia.; 4mm dia.; No. 42.

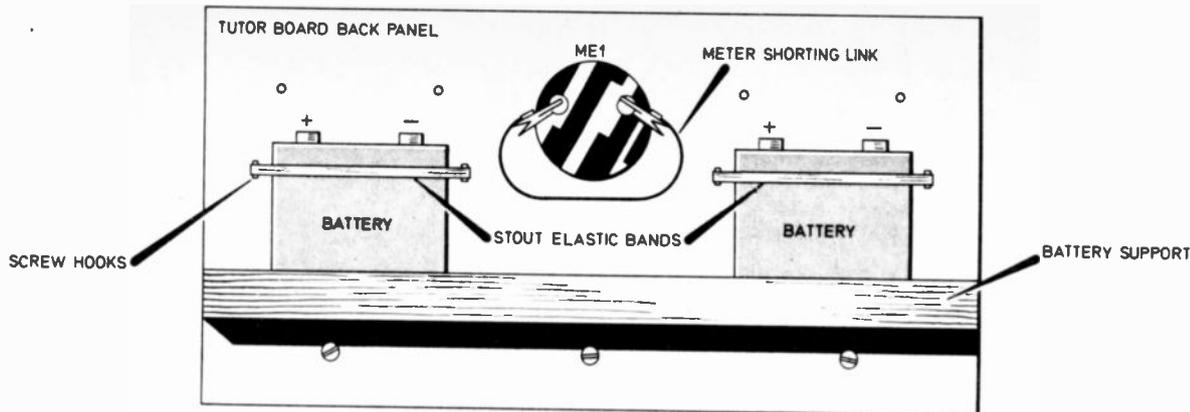


Fig. 2. Details of the battery mountings and meter short-circuit lead.

Using your wire strippers, carefully set so as not to cut or nick the wire strands, about 10mm of the outer plastic insulation should be removed from each end of all the above wires. This process may take a little practice and for short wire lengths it is sometimes convenient to grip the wire with pliers near the end to be stripped whilst levering the strippers outwards, away from the pliers.

With the strippers set at the correct gap excessive force is not necessary—too small a gap causes damage to the strands of wire. After stripping, the bare wire strands should be twisted tightly together.

CROCODILE CLIPS

Half of the 20, 30 and 40mm leads of each colour can now be fitted with a miniature crocodile clip at *one* end only, as shown on the Data Chart. Other leads can be similarly prepared if needed. The tubular end of the clip should be gently squeezed until it grips the plastic lead firmly as this provides added strength and the leads will be more durable.

One of the 10mm leads should be fitted with clips at both ends and reserved for use as a short circuit link across the meter terminals when this is not in use. The thin wire across the terminals of the meter serves the same function during transit and the need for this will be covered later. At this stage it is sufficient to say that a shorting lead helps to protect the

delicate moving coil and needle from damage during handling. When the meter is used in an experiment the lead is always removed.

When the paint on the Tutor Board is completely dry, the final stages of fitting out can be performed. The meter should be fixed in the rear panel cut out—do not overtighten the fixing nuts as this may cause the plastic case to crack.

When this stage is complete the thin wire across the meter terminals may be removed and replaced by the 10mm lead with crocodile clips at each end, Fig. 2. Attach one clip to the tag on each meter terminal.

Next the batteries should be attached using four small screw hooks and rubber bands as shown, see Fig. 2. The two batten lamp holders for the 6V bulbs should be screwed into position, and the toggle switch mounted in position, see blueprint and Fig. 3.

The rotary carbon and wire wound potentiometers should now be fitted as detailed on the blueprint and in Fig. 3. The carbon potentiometer has a spindle which must be shortened to the same length as the other potentiometers. The free end of the spindle should be held firmly in a vice and then cut through with a hacksaw—at no time must any stress be applied to the body of the component as this could cause damage. Any burrs on the cut end should be removed with a file. The Tutor Board is now complete and ready for use. □

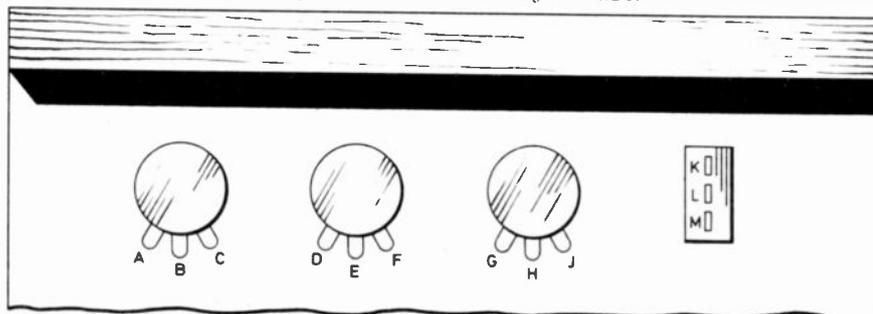


Fig. 3. Underside view of the Tutor Board showing potentiometer and switch labels to be referred to in the Teach-In '74 series.

TEACH-IN '74

FOR BEGINNERS IN ELECTRONICS ...
THEORY AND EXPERIMENTS

TUTOR: PHIL ALLCOCK*

LESSON 1 Current Flow and Resistance

THIS completely new series has been designed to run for approximately twelve months and provides an introduction to the basic practical and theoretical aspects of electronics. No previous knowledge or skill is required and the series is in fact ideally suited to anyone who is interested in learning the basics of electronics. Basic experiments will be described for each part and these can be performed without the need for soldering.

TUTOR BOARD

The series has been devised around a low-cost Tutor Board designed to obviate soldering. As a consequence the initial expenditure is kept to a minimum and the risk of damage to any of the components, by excess heat, is avoided. The construction of the Tutor Board is very simple and the Blueprint, enclosed with this issue of E.E. gives the constructional details for the board, this, together with the article on page 532 provides full construction information.

All the electrical components specified are readily available from advertisers in this issue and can be purchased through some of our advertisers in the form of a kit, providing all the components for approximately the first six parts. To assist those who wish to purchase all the electrical components for the first half of the series a components list is included in the Tutor Board article.

The Blueprint/Data Chart enclosed in this issue also contains basic information for use with this series and electronics in general.

TOOLS

As with most constructional hobbies a few tools are necessary from the outset and the basic requirements are: a small screwdriver, wire strippers and wire cutters (side cutters). A pair of long nosed pliers might also prove useful

for wire bending. Note that the screwdriver should have a narrow blade and must be small enough to fit the screws in the terminal blocks. (A kit containing all these tools except the wire strippers will be available next month).

Good quality tools are an investment in the long run as they are more durable and often easier to handle. It is assumed that the few tools required to cut and assemble the wooden parts of the Tutor Board are already to hand.

Before any experiments can be undertaken it is necessary to look at some basic ideas regarding electricity and to introduce the ideas of a circuit, current flow, resistance and voltage.

ELECTRICAL CIRCUITS

Perhaps much of the apparent mystique surrounding electronics stems from the fact that electricity itself cannot be seen. In some ways this may seem a real stumbling block but need not be so because the presence of electricity can easily be demonstrated. The "switching-on" of a room light or a torch is a simple example in which electricity makes its presence known by the light (and heat) that it produces when the switch is operated.

All materials are made of atoms in each of which there is a central core or nucleus and outside this one or more electrons. For our purposes the electron can be considered to be a minute package of electricity (or more correctly electrical charge). In some materials, like glass, these electrons are prevented from moving away from their parent atom by strong forces of attraction. As a result electrons cannot flow in these materials and they are called insulators.

Materials like copper and aluminium on the other hand do not possess these same restrictions and many of the electrons are free to move within the material. It is this movement which gives us the idea of electrical current or flow of electrons and we can in fact think of current flow in metal wires in the same way that we think of water flow in pipes of a central heating system. Metals are good conductors of electricity.

*North Staffordshire Polytechnic (Any communications arising from the Teach-In '74 series must be addressed to Everyday Electronics, Fleetway House, Farringdon Street, London E.C.4)

In a heating system the flow of water may be due to the pressure produced by a small pump where in an electrical circuit the pressure may arise from chemical effects inside a battery. The water is guided by ensuring that it always flows in a system of pipes or closed vessels and in the electrical circuit the current is made to flow where we want it to by using insulation round the wires and other components.

A common insulation is the plastic covering on the wires used for the Tutor Board. Fortunately air, when dry, is also a good insulator which is just as well as otherwise electricity might never have been found.

RESISTANCE

The amount of current that can flow in a circuit for a given pressure or battery depends on the ease with which the electrons can pass along the various parts of the circuit. The amount of opposition to current flow is determined by what is known as the electrical resistance of the material.

The resistance of a wire, say, depends on the material from which the wire is made, the length of the wire and wire diameter. Increasing the wire length increases the resistance whilst increasing the diameter reduces the resistance.

The connecting wires used with the Tutor Board are stranded and consist of seven wires side by side. Because the material is copper, a very good electrical conductor, the resistance of the wire is very low and when we require appreciable resistance we must add it to our circuit by connecting a resistor into the system.

The resistor is simply a component that has been manufactured to have a certain amount of resistance and this is often marked on the body of the component by a special colour code which is covered in more detail later on.

OHM'S LAW

So far we have introduced three terms which are very important, namely current flow, resistance and pressure. Each of the quantities can be measured and for this we must specify the units used. Pressure is measured by referring to the electromotive force (e.m.f.) of the battery and the unit used is the volt.

Current flow round the circuit is measured in amperes, often abbreviated simply to amps, whilst resistance is measured in terms of a unit called the ohm. The Data Chart gives the symbols that are normally used for these and several other quantities that will be introduced later.

These three quantities are related to each other by a well known law called Ohm's law. This simply states that current is proportional to the voltage and consequently inversely proportional to the resistance. As an equation this can be written as:

$$\text{current in amps} = \frac{\text{e.m.f. in volts}}{\text{resistance in ohms}}$$

CURRENT MEASUREMENT

Strictly speaking the ampere is a measure of the number of electrons that flow past a given point in one second. Each electron carries the same fixed amount of electrical charge (measured in coulombs) and a current of one ampere represents the movement of approximately six million million electrons per second! Do not let this large number worry you—it is impossible for most people to visualise such a large number anyway.

On the Tutor Board current flow can be measured by using the moving coil meter. The current is allowed to flow through a coil of very fine wire which has the pointer attached to it. The current reacts with a magnet system placed near the coil and the coil rotates on its pivot. The deflection of the pointer across a calibrated scale is used to measure the amount of current.

The meter specified for this series is very sensitive and could easily be damaged by misuse. A full scale deflection, shown as 100 on the scale, occurs for a current of only 100 millionths of an ampere. Just as we can divide the inch unit into thousandths of an inch or the metre into centimetres so we can divide our electrical units. As shown on the Data Chart our new current unit can be written as

$$1 \text{ millionth of an ampere} = 1 \text{ microamp} = 1 \mu\text{A}$$

VOLTAGE MEASUREMENT

Thus the meter requires 100 microamps for full deflection. The meter can be transformed into a device for measuring e.m.f. or voltage by adding a resistance in series with the meter. The combination is then known as a moving coil voltmeter. To determine the resistance required we must use Ohm's law.

Let us change the full scale current of 100 microamps into say a reading of 10 volts i.e.: 100 on the scale will represent a voltage of 10 volts applied to the meter and resistor taken together. Thus:

$$\text{resistance required} = \frac{10 \text{ (volts)}}{0.0001 \text{ (amps)}} = 100,000\Omega$$

From the Data Chart we see that this value can be written as 100k Ω (100 kilohms). To make the total resistance of the voltmeter equal to 100 kilohms we must allow for the resistance of the coil of wire in the meter. For the meter chosen this is about 800 ohms which is much smaller than the total resistance required and can be ignored, so we can make our voltmeter simply by adding a 100 kilohm resistor in series with the meter. The arrangement can be illustrated by what is known as a schematic circuit in which the various components are represented by the circuit symbols shown on the Data Chart. Our voltmeter representation is therefore as shown in Fig. 1.1.

The small circles in the schematic representation are included to indicate connector points

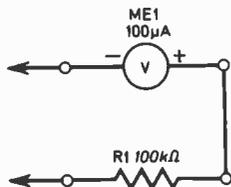


Fig. 1.1. Schematic circuit of the voltmeter.

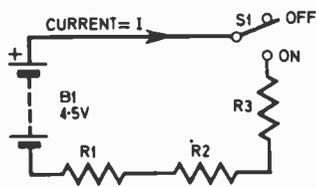


Fig. 1.2. A switch and three resistors in series with the battery.

but would not normally be shown in such a diagram. Wire connections are simply shown as solid lines joining the components (represented by their particular symbols) together.

RESISTORS IN SERIES

To illustrate this principle further, consider Fig. 1.2. This schematic diagram shows a series arrangement of a switch S_1 , three resistors (R_1 , R_2 , R_3) and a 4.5 volt battery B_1 . The circuit is said to be a series arrangement because the current flow (when S_1 is closed) is through all the components, one after another. In other words the same current flows in all components. This is not always the case and it is possible to have components in parallel so that they all experience the same voltage. This will be covered in more detail later.

As already mentioned the resistance value of each resistor is indicated by a series of coloured bands on the body of the component. Using the information given on the Data Chart study this method of colour coding and hence locate the 100 kilohm ± 2 per cent resistor. The shopping list shows three 100 kilohm resistors but the ± 2 per cent tolerance component should be specially reserved for making up the 0 to 10V voltmeter by the method already outlined, whenever it is needed.

This close tolerance resistor can be permanently mounted on one of the two-connector blocks as shown in Fig. 1.3. It is inadvisable to bend the resistor wires too close to the case, it is better to leave the wires long to avoid any stress in the component. Flexible leads can be connected to the other ends of each metallic connector as required.

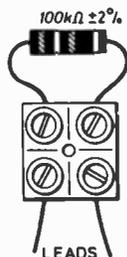


Fig. 1.3. The method of mounting a resistor in one of the connecting blocks. The resistor should be identified with reference to the Data Chart.

If we return for a moment to Fig. 1.2 and consider the effect of the current flow when switch S_1 closes, we can see that the total

circuit resistance (i.e. opposition to current flow) is due to the combined effect of R_1 , R_2 and R_3 taken together. If we call the total resistance R_T ohms then $R_T = (R_1 + R_2 + R_3)$, the sum of all the individual resistance values. This is a necessary consequence of the series circuit connection and the fact that the current is common to all components. The circuit current, I , can be found by applying Ohm's law:—

$$I = \text{current in amps} = \frac{\text{battery e.m.f. in volts}}{\text{total circuit resistance in ohms}} \quad (\text{switch closed})$$

$$\text{Hence } I = \frac{4.5}{R_T} \text{ amps.}$$

KIRCHOFF'S VOLTAGE LAW

The current, in flowing through each resistor gives rise to a voltage difference (sometimes called a potential difference or p.d.) across each component's terminals. These voltage differences can also be found by using Ohm's law and if we work out the values for each resistor we get:

$$\begin{aligned} \text{Voltage difference across } R_1 &= I \times R_1 = \frac{4.5}{R_T} \times R_1 \\ \text{" " " } R_2 &= I \times R_2 = \frac{4.5}{R_T} \times R_2 \\ \text{" " " } R_3 &= I \times R_3 = \frac{4.5}{R_T} \times R_3 \end{aligned}$$

If we add these voltage differences together to determine the total voltage difference for the three resistors we find, since $\frac{4.5}{R_T}$ is common to all terms, that:—

$$\text{Total voltage difference} = \frac{4.5}{R_T} \times (R_1 + R_2 + R_3) = 4.5 \text{ volts since } R_T = (R_1 + R_2 + R_3).$$

This might well have been expected and simply shows that the total voltage drop across all components in a series circuit is the same as the battery e.m.f. (This is known as Kirchoff's voltage law.)

Well, that is enough basic theory for the time being. Study the circuit and ideas carefully before proceeding to the experimental section of this part. The experimental work will give greater benefit if the basic theory is clearly understood beforehand.

TESTS

The tests should be done in the order indicated. Do not miss out any test as this may give difficulty in later tests.

The tests for this month start on the next page and should only be attempted when the theory has been fully studied. A number of tests will be given each month and will be based on the Tutor Board.

Next month: We shall examine the behaviour of parallel circuit. Some new experiments will be given and the basic theory will be taken a step further. A summary of the results of this month's experiments will also be given.

TUTOR BOARD EXPERIMENTS

Test No. 1

The purpose of this test is to build a series circuit using the 100 ohm potentiometer (VR1) as a variable resistor, together with a 6 volt 60 mA bulb, one 4.5 volt battery and a switch. The layout is shown in Fig. 1.4a and the corresponding schematic in Fig. 1.4b. Note that only two of the three tags on the 100 ohm potentiometer and the switch are actually used. The remaining tag on each component is not connected to any other point. In each case the centre tag and one of the two outer tags is used.

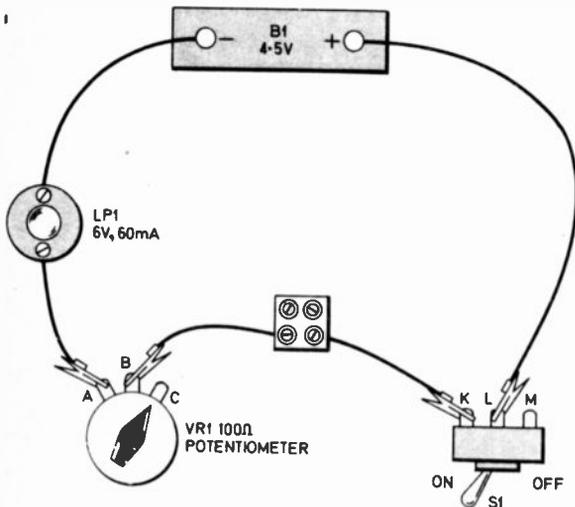


Fig. 1.4a (above). Basic layout on the Tutor Board for the first test.

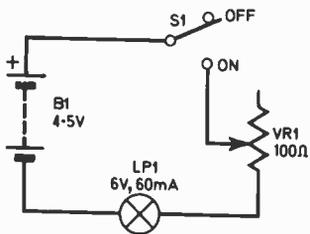


Fig. 1.4b. Schematic diagram of Fig. 1.4a.

The relative position of the switch toggle for ON and OFF is dependent on which outer tag is used. Similarly for the potentiometer, the relative position of the spindle or knob for maximum and minimum resistance will depend on the choice of outer tag as before.

Observe the operation of these two components very carefully so that their action is fully understood. For example, the switch is ON when the toggle points towards the end tag actually in use. When the toggle points towards the unused end tag the switch is off. Work out a similar rule for the resistance of the 100 ohm potentiometer.

It is always desirable to check any circuit before connecting the battery or other power source and this habit is worth cultivating. If the bulb does not light it is most likely that a poor

connection has been made.

The strands of wire should be twisted together and can be folded back to double the thickness when only one wire per hole is required in the terminal block. Do not overtighten the screws as this will fracture the strands very quickly. The terminal blocks can be used to join two or more wires, or wires and component leads, together. A few minutes practice will soon indicate the amount of screw pressure required.

When this first test has been completed, dismantle the Tutor Board wiring and proceed to Test No. 2. Never leave a battery connected to any circuit for longer than is necessary. Always move the switch to the OFF position when a circuit is not in use as this will ensure long life from the batteries.

Test No. 2

Set up the voltmeter circuit with the series 100 kilohm ± 2 per cent resistor and two test prods. Use a black lead for the meter negative terminal (marked -) and a red lead for the connection to the 100 kilohm resistor (refer to Fig. 1.5). Check the voltage of each battery, paying special attention to the correct polarity of the leads (red lead to battery positive terminal, black lead to battery negative terminal).

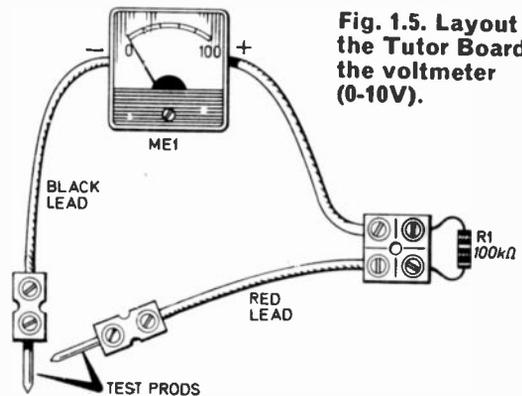


Fig. 1.5. Layout on the Tutor Board for the voltmeter (0-10V).

Mark each battery with the measured voltage. (Nominal voltage is 4.5V, but will be higher when the battery is first purchased.) Subsequent checks of battery voltage will show lower voltage readings as the battery becomes exhausted. Leave the voltmeter set up and proceed to next test.

Test No. 3

Devise your own Tutor Board layout and then set up the circuit shown schematically in Fig. 1.6. Operate the switch to the on position and set the 5 kilohm potentiometer (VR2) for maximum resistance using the principles covered in Test No. 1. Check for current flow by measuring the voltage across the 1 kilohm resistor. (Red

lead to switch end of resistor. A zero reading indicates faulty circuit wiring or switch in wrong position).

Measure the voltage between the potentiometer end of the 1 kilohm resistor, furthest away from the switch, and the junction of the two batteries. (Black lead to the batteries.) A reading of about 3 volts should be obtained (30 on the meter scale). Whilst observing the meter adjust the 5 kilohm potentiometer until the meter reads zero. For equal battery voltages this occurs when the variable potentiometer resistance is equal to 1 kilohm.

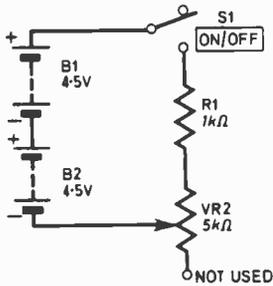


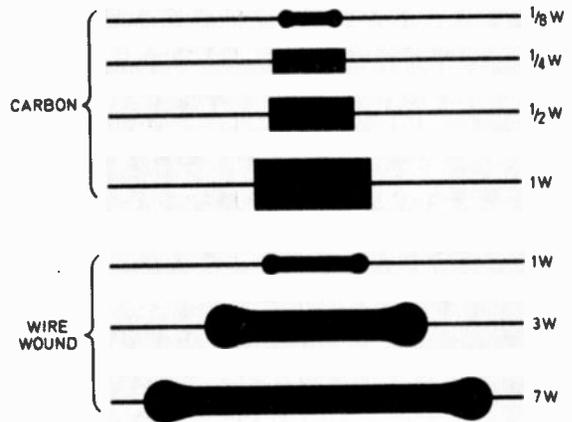
Fig. 1.6. Schematic diagram of the circuit used in test 2.

Without disturbing the potentiometer setting measure the voltage difference across the variable potentiometer and across the 1 kilohm resistor. These should be about equal if the battery voltages are similar. Switch off and dismantle all wiring. Replace the shorting lead across the meter terminals for protection.

Study the results of all tests and try to explain to your own satisfaction what is happening in each test, particularly Test No. 3. If you feel it will help you, try making a few notes about each test in a notebook. In particular try to work out what each test has taught you!

DATA CHART

The following information on resistor wattages was unfortunately omitted from the Data Chart enclosed in this issue.



Ruminations

By Sensor

Weather or Not

The holiday season will be almost over by the time this piece is published. But before we all take up our work again it is worth while recalling the part played by electronics in improving weather forecasting. Accurate forecasting depends upon the collection of an enormous amount of data from a very wide area, and the rapid processing of this data, together with a few facts and maybe some inspired guesses.

Electronics is involved in almost every aspect of weather forecasting but its greatest contribution has been the electronic

computer. A prodigious quantity of data can be processed by the computer in a very short time and thus an up-to-date and accurate forecast can be made available, via radio or telephone, to all who may have need of it.

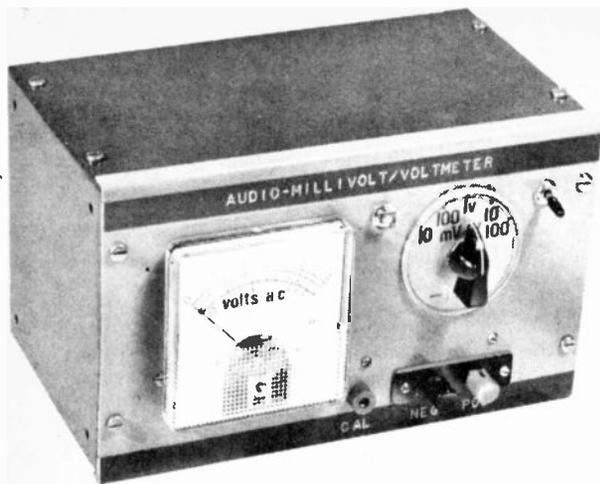
Unfortunately, little progress has been made in controlling the weather; gales, typhoons and hurricanes have no beneficial effects, and while it is very useful to know where and when they are likely to occur, we would be far better off without them! One can foresee that our cities may, in the future, have a controlled environment in a manner rather like that described by H. G. Wells in his book "The Sleeper Awakes." I suppose that it would only rain at night (only people up to no good, and policemen, are out at night!) and storms would be unknown.

Theoretically, there would seem to be no great problem in covering an entire city with a

transparent dome and equipping the area with the necessary air conditioning plant, but the practical problems would be enormous. Modern electronics would find no difficulty in providing the sensing and control equipment for such a project, apart from the sheer size of such an undertaking.

Perhaps the inhabitants of such a city would read with wonder of the great freeze-up of 1963 or the floods of 1973. But there is some cosy satisfaction to be felt when indoors with the rain beating against the windows and the wind howling round the house. And what of the free firework display (son et lumiere) provided by a good thunderstorm?

I think that I prefer to take the weather as it comes; always provided that the weather forecasters can give me some idea of what to expect. If the weather were controlled what on earth would we talk about?



AUDIO Voltmeter

BY F.C. JUDD

Measures a.c. voltages over a large frequency range—useful instrument for the audio enthusiast.

ONE of the most valuable test instruments for audio work is the Audio Voltmeter, so called because it will read alternating voltages over a wide range of frequencies and is sensitive enough to read very small audio signals of down to one millivolt or less. It is basically a bridge rectifier system, the rectifier being used to convert alternating voltage to d.c. in order to drive the meter movement.

To be able to read very small voltages, the bridge rectifier and meter is preceded by an amplifier. Wide frequency response is achieved by careful design of the amplifier section and by the use of negative feedback.

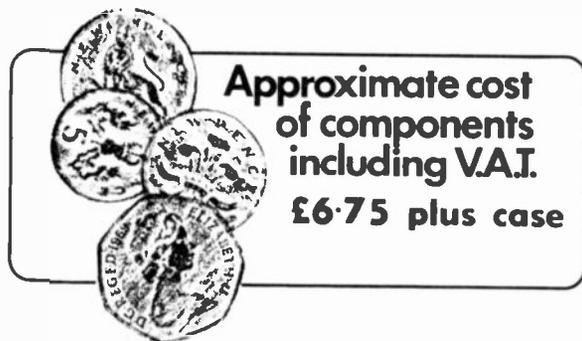
RANGES

The meter described in this article operates over five ranges as follows:

- Range 1 0 to 10 millivolts (mV)
- Range 2 0 to 100 millivolts
- Range 3 0 to 1 volt
- Range 4 0 to 10 volts
- Range 5 0 to 100 volts

It has a high input impedance of approximately one megohm, which is essential to prevent the meter "loading" the circuit to which it is connected and so produce errors in reading. The meter has a wide, flat frequency response from 10Hz to over 100,000Hz (± 1 dB).

Some ways of using the meter will be explained later but before describing the circuit and construction, readers should note that although the circuit may not look too complicated, this project is not one for absolute beginners to tackle. Those who feel capable of building the instrument however, will, providing con-



struction, specified components and wiring etc., are strictly adhered to, find it a worthwhile item of test gear and moreover one with reasonable accuracy.

It can be used for measuring the signal level going into and out of a pre-amplifier, the gain of an amplifier, the output power from amplifiers designed to deliver power and of course for generally checking newly built audio equipment. One other instrument is required to do all this and that is an audio signal generator, which is also not difficult to construct and a possible subject for an E.E. project.

THE CIRCUIT

The Audio Voltmeter circuit is shown in Fig. 1 and reading as is usual in circuitry, from left to right, begins with the input, followed by the attenuator network which consists of S1a and S1b (ganged 5 way wafer switches) and resistors R1 to R8. The "impedance" of the network which is also the input impedance of the meter, is about one megohm and more or less determined by the main leg of the attenuator network R8.

In the 10mV, or most sensitive range, R8 is switched direct to earth so no attenuation occurs. For the 100mV range an attenuator factor of 10 is provided by R8 in series with R1 and R2. The 1V, 10V and 100V ranges are achieved in the same way but by attenuation factors of 100, 1,000, 10,000 and 100,000. The values of the network are not precise but do allow the use of standard value resistors and a readout accuracy from the meter of ± 5 per cent which is about average for a low cost audio voltmeter.

The output from the attenuator is fed to TR1

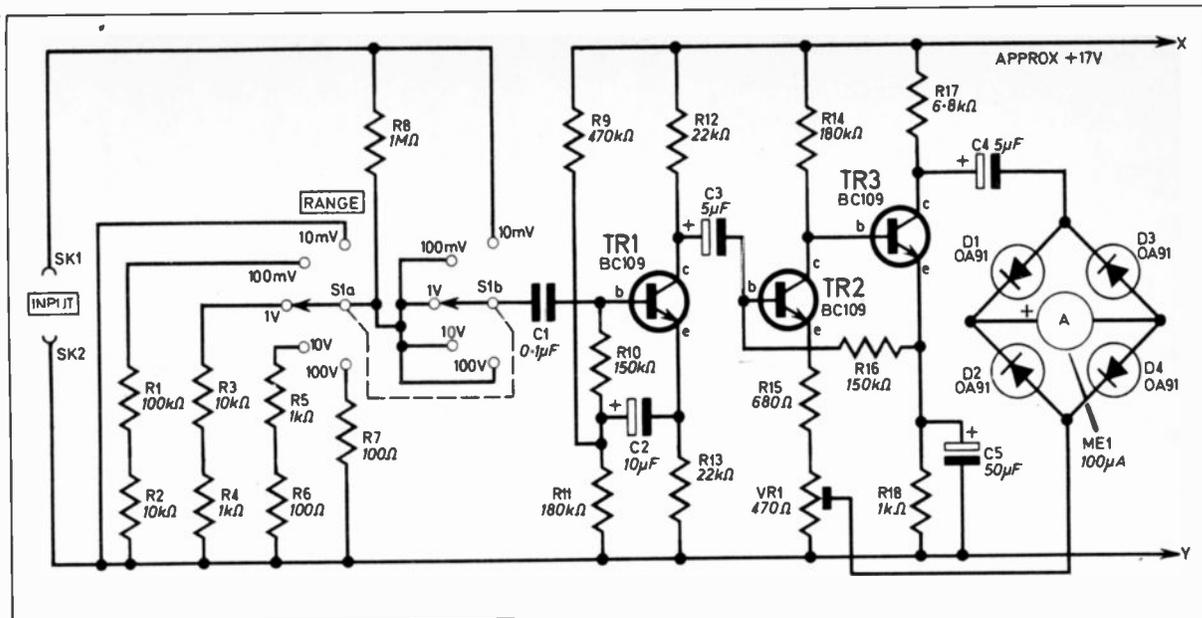


Fig. 1. The complete circuit diagram of the Audio Voltmeter with built in power supply.

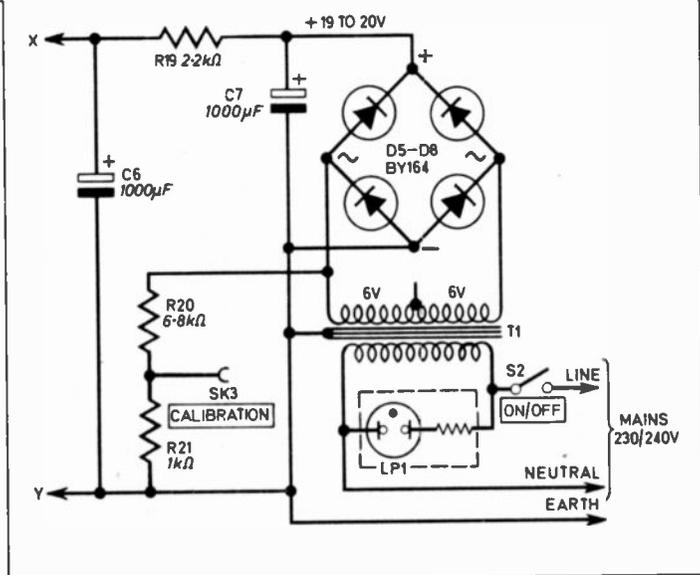
which is a special amplifier stage with a high impedance input so as not to shunt the high impedance of the attenuator itself. Transistors TR2 and TR3 are a conventional signal amplifier to further boost the signal so that it will drive the meter via the bridge rectifier network consisting of D1, D2, D3 and D4.

In order to achieve a wide frequency response one arm of the bridge is coupled back to the emitter of TR2 via the preset potentiometer VR1. This not only provides negative feedback, and an aid to wide frequency response but also the means of "self-calibrating" the finished meter. This is why a portion of the 50Hz voltage from the secondary of the mains transformer T1 is tapped off from R20 and R21. This voltage is brought out to a socket on the front panel and is used in conjunction with VR1 to set the meter calibration. The amplitude of the 50Hz signal at the calibration socket (SK3) is 1V, give or take a few millivolts, but more of this later.

The remainder of the circuit is the power supply consisting of T1 which supplies 12V a.c. to the bridge rectifier (D5-D8) which, in turn feeds pulsating d.c. to the smoothing components C7, R19 and C6. The supply rail to the amplifier at the junction of C6/R19 should be about 17 volts.

CONSTRUCTION

The prototype shown in the photographs was built into a case measuring approximately 222 ×



130 × 125 mm made from Lektrokit parts, however any similar sized metal case could be used but a metal case it must be.

The circuitry is assembled on plain Veroboard as in Fig. 2 and this is attached, when wired, to the front panel by means of small angle brackets (Fig. 3). The meter may be any good quality 100 micro-amp, moving coil type with the usual 90 degree scale calibrated in 10 divisions each subdivided by 10 or 5.

The front panel layout is shown in Fig. 4, note that the input terminals (one red and one black) and calibration socket, are insulated from the panel. The black terminal (earth) is only earthed at the circuit board common negative/earth line; the metal case is also earthed to the common negative supply rail.

When the circuit wiring is completed check if

possible the supply rail voltage at the junction of C6/R19. This should be approximately 17 volts. Short circuit the input terminals and switch to the 10mV range to ensure that the meter is reading zero.

Note: Immediately after switching on the meter will read for a moment or two and then drop back to zero. Allow a few seconds for it to settle before using.

If the range switch is left in the 10 or 100mV position and the short circuit from the input terminals removed, the meter will usually read because of 50Hz hum pickup. Remember at low millivolt ranges it is effectively a high gain amplifier with a response down to 10Hz.

For calibration the meter and circuit must be out of the case so as to get at the pre-set VR1. Couple the calibration socket to the red or live input terminal and switch to the 1 volt range. Adjust VR1 until the pointer of the meter reads exactly full scale—10 on the meter or 1 volt. The meter is now calibrated and can be fitted into its case.

DECIBEL MEASUREMENT

Voltage (and current and power) can be expressed in decibels and it is usual to include a scale for decibels on audio voltmeters. This is useful when checking gain and/or plotting the frequency response of an amplifier. A full decibel scale, as normally found on audio voltmeters, is shown beneath the regular voltage scale in Fig. 4a.

With very large meter scales the full scale can usually be included but on small meters, such as the one specified for this project, it is better to use the part scale as in Fig. 4b otherwise the divisions are too cramped together at the higher or minus dB readings i.e., between -5 and -10dB. For practical purposes the +2dB down to -5dB scale with divisions of 1dB, is sufficient anyway.

The point of 0dB is based on 0.755 volts, the reference of which is a power of 1 milliwatt into 600 ohms. Normally the power level holds for any impedance but the voltage only for 600

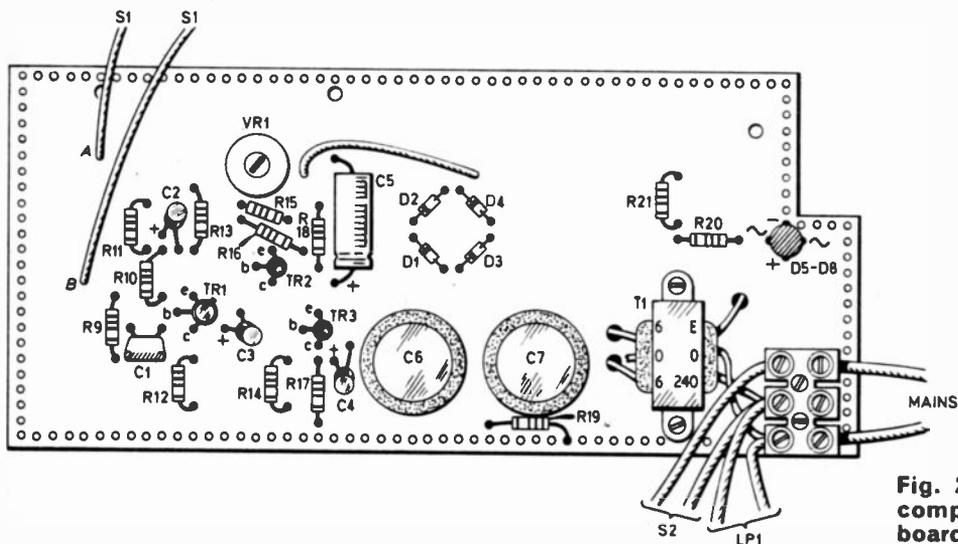
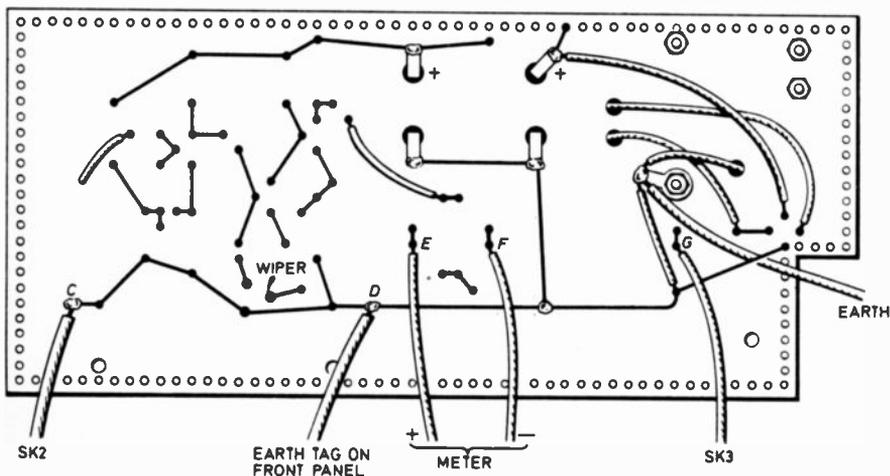


Fig. 2. The layout of the components on the Veroboard topside and the interconnection details below the board.



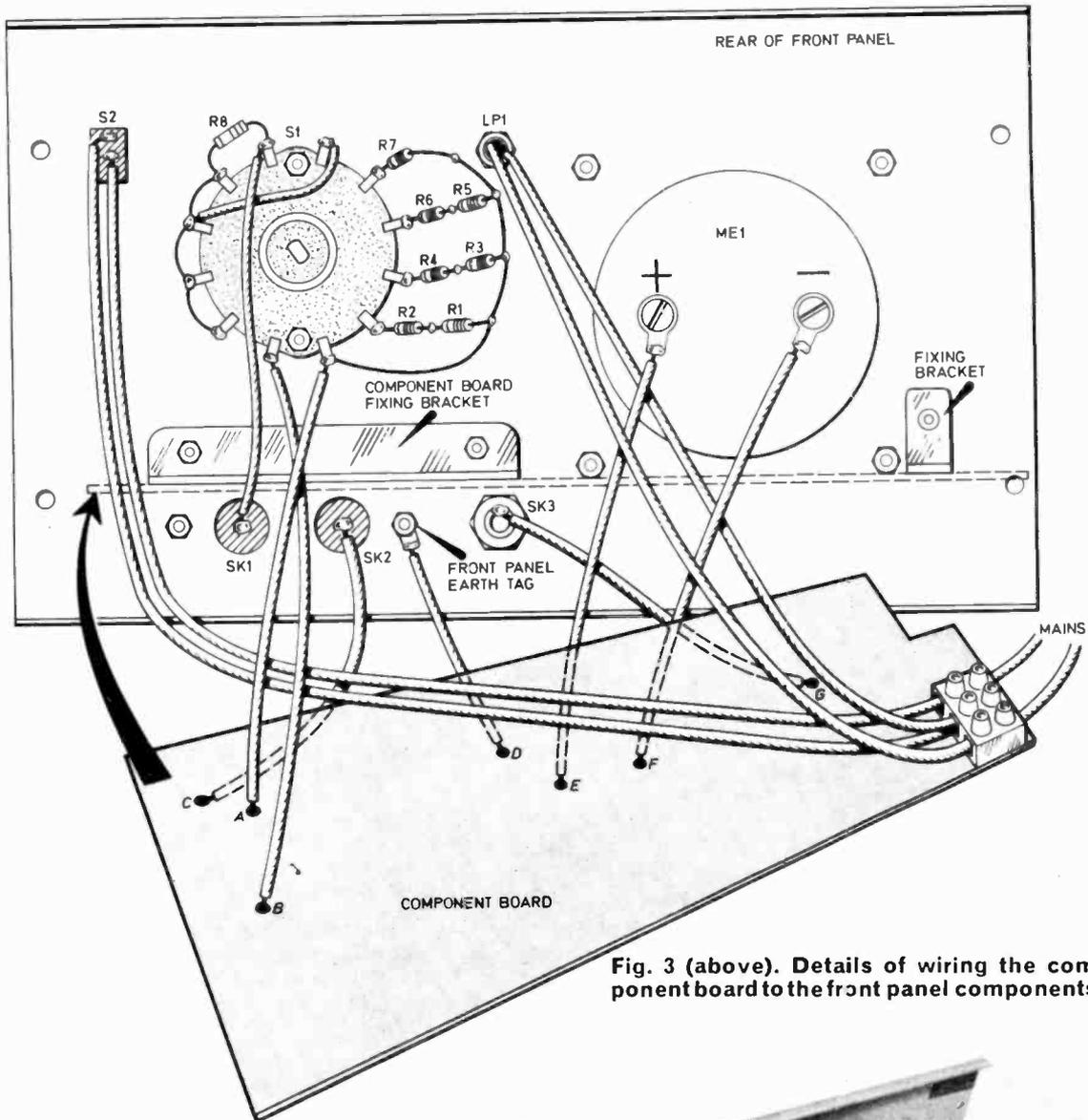


Fig. 3 (above). Details of wiring the component board to the front panel components.

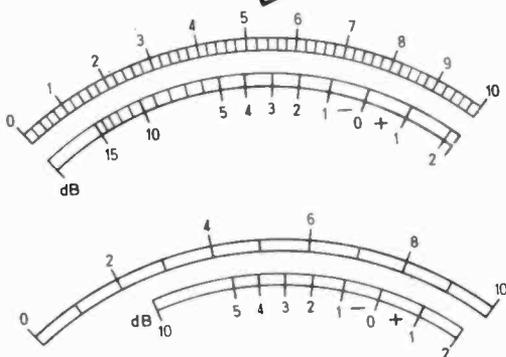
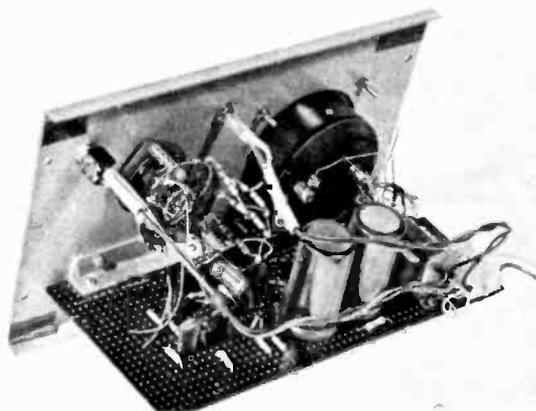
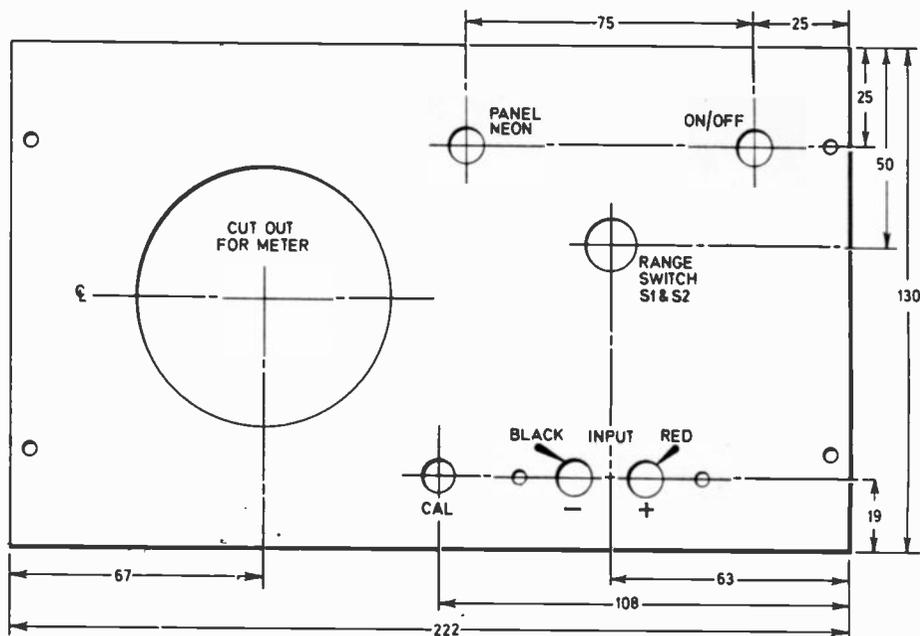


Fig. 4. Voltage and decibel scales for the unit, see text.



Photograph of coupled board and front panel.

Fig. 4. Drilling and meter cut-out details for the front panel. The meter cut-out should be made to suit meter used.



Components

Resistors

R1 100k Ω	R8 1M Ω	R15 680 Ω
R2 10k Ω	R9 470k Ω	R16 150k Ω
R3 10k Ω	R10 150k Ω	R17 6.8k Ω
R4 1k Ω	R11 180k Ω	R18 1k Ω
R5 1k Ω	R12 22k Ω	R19 2.2k Ω
R6 100 Ω	R13 22k Ω	R20 6.8k Ω
R7 100 Ω	R14 180k Ω	R21 1k Ω

All $\frac{1}{2}$ W +5% carbon

Capacitors

C1 0.1 μ F	C5 50 μ F elect. 15V
C2 10 μ Fd elect. 15V	C6 1000 μ F elect. 25V
C3 5 μ F elect. 15V	C7 1000 μ F elect. 25V
C4 5 μ F elect. 15V	

Semiconductors

TR1, 2, 3 BC109 silicon *n*p*n* (3 off)

SEE
**SHOP
TALK**

D1, 2, 3, 4 OA91 or similar (4 off)
D5-D8 BY164 or any 50 p.i.v. 500mA bridge rectifier

Miscellaneous

SK1, 2 Single spring loaded terminals (one red one black) or terminal block (2 way)
SK3 Insulated panel socket
S1 Double pole 5 way wafer switch
S2 S.p.s.t. toggle switch
VR1 470 Ω skeleton preset
ME1 100 μ A moving coil meter approx 3in square
T1 240V primary, 6-0-6V 100mA secondary (Eagle MT6 type)
LP1 Panel neon indicator incorporating dropper resistor.
Metal case approximately 222 x 130 x 125mm, knob for S1, plain perforated Veroboard 203 x 95mm x 0.15inch matrix, mains lead and 3 pin plug.

ohms. However, for practical use the dB scale can be used directly for determining gain or loss when dealing with voltage only and providing the impedance of the circuit at which the measurement is being made is not changed during the measurement.

For example, a signal amplifier may be delivering 0.775 volts, as read on the meter (which is 0dB). If the gain of the amplifier was increased by 2dB then the output voltage would be increased to 0.975.

In plotting the frequency response of an amplifier the signal level out is adjusted (by the volume control or input signal level) to read 0dB on the audio voltmeter. If the amplifier has a flat response from say 20 to 10,000Hz the meter will read 0dB over that frequency range. As the

response falls away at either end of the flat part of the frequency range, so the meter readings fall accordingly and the amount in decibels by which it falls can be noted.

DECIBEL SCALE

Those who wish to put a decibel scale directly on the meter will have to remove the meter cover and then very carefully remove the scale plate itself. The scale can now be drawn with Indian ink (a compass and fine nib pen will be required) and the dB figures marked as shown in Fig. 4b.

The prototype was checked against a high grade laboratory audio voltmeter and accuracy was found to be within ± 5 per cent on any range. \square

SEMICONDUCTORS

FIVE

THE TRANSISTOR

J.B. DANCE M.Sc.

THIS month's article in the Semiconductor series continues with transistor types and explains the manufacture of planar devices; also discussed are types of encapsulation.

ALLOY JUNCTION GERMANIUM POWER TRANSISTORS

Power transistors must be able to dissipate the heat generated in their collector, so the small types of construction discussed previously are unsuitable. The collector must be in good thermal contact with the external metal base of the device.

This external base must be designed so that it can be bolted onto a piece of metal which serves to dissipate the heat. The transistor is kept cooler if the metal is blackened, since black surfaces radiate more heat than bright surfaces for the same temperature difference.

A thin mica washer may be placed between the transistor and the heat sink, although this washer will inevitably result in a slight increase in the working temperature of the transistor.

It is best to coat the mounting base of the transistor (and the mica washer, if used) with silicon grease so that good thermal contact is established. Special silicon compounds which conduct heat better than ordinary silicon grease are available and can be used with advantage.

The construction of a typical germanium alloy junction transistor is shown in Fig. 5.1.

The OC35 is a typical general purpose transistor of this type. It can dissipate 30W if the

mounting base of the transistor is kept at a temperature of not more than 45°C.

The V_{ce0} rating is 48V at collector currents of up to 0.5A and 32V at collector currents up to 6A. The value of h_{fe} is in the range 25 to 75 at 1A.

The OC36 is a high voltage version of the

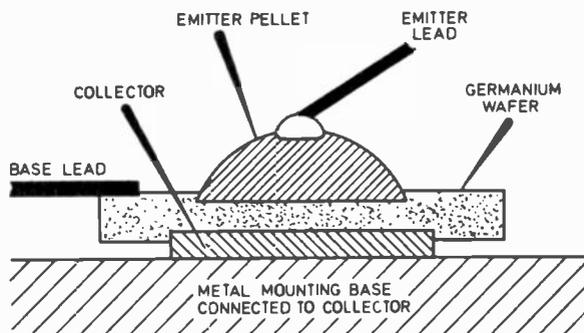


Fig. 5.1. The construction of a typical germanium alloy junction power transistor.

OC35, whilst the OC29 is a higher gain type (with an h_{fe} of 45 to 130 at 1A). All of these transistors have a cut off frequency of around 250kHz.

The OC22 to OC24 range has a higher cut off frequency (2.0 to 2.5MHz), but the power dissipation must be limited to 15W.

All of these transistors have a diamond shaped base of the TO-3 type shown in Fig. 5.2.

No similar npn germanium power transistors are generally available.

Table 5.1: Germanium PNP Power Transistors

Device	V_{cbo} (V)	V_{ceo} (V)	$I_{c\ max}$ (A)	$P_{t\ max}$ (W)	h_{fc}	f_T (MHz)	Application
OC20	-100	-75	8.0	30	25-75	0.25	High Voltage
OC22	-47	-24	1.0	15	150	2.0	General purpose, high frequency
OC23	-55	-24	1.0	15	150	2.5	Power Switch
OC24	-40	-24	1.0	15	150	2.5	Power Switch
OC25	-40	-40	4.0	22.5	15-80	0.25	General purpose power transistor
OC28	-80	-60	8.0	30	20-55	0.25	High voltage, especially suitable for d.c. converter
OC29	-60	-32	8.0	30	45-130	0.25	High gain power transistor
OC35	-60	-32	8.0	30	25-75	0.25	General purpose power transistor
OC36	-80	-32	8.0	30	30-110	0.25	High voltage power transistor

Table 5.2: PNP Silicon Alloy Junction Transistors

Device	V_{cbo} (V)	V_{ebo} (V)	$P_{t\ max}$ (MW)	h_{fe}	f_T (MHz)	Remarks
OC200	-25	-25	100	20	1.0	Low gain
OC201	-25	-25	100	30	4.0	
OC202	-15	-15	100	70	4.0	Medium gain
OC203	-60	-60	100	15	1.0	High voltage
OC204	-32	-32	125	24	1.5	Medium voltage
OC205	-60	-60	125	24	1.5	High voltage
OC206	-32	-24	125	40	2.0	
BCZ11	-30	-25	100	25-60	1.5	

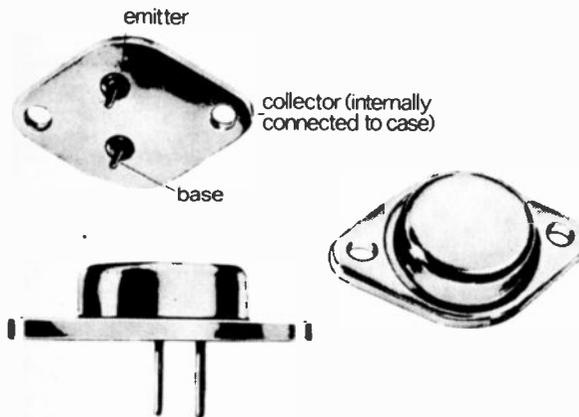


Fig. 5.2. The TO-3 encapsulation showing lead-out details.

SILICON ALLOY JUNCTION TYPES

The early silicon transistors were made by an alloy junction technique similar to that used for manufacturing germanium transistors.

These techniques resulted in the production of transistors such as the OC200 to OC206 which are a *pn*p series with cut off frequencies in the range 1 to 4MHz and values of h_{fe} in the range 20 (for the OC200) to 70 (for the OC202).

The V_{ceo} rating varies from -15V for the OC202 to -60V for the OC203 and OC206. The BCZ11 is another transistor of this type.

This range of transistors is encapsulated in the small metal envelope of Fig. 4.7 (last month) with a red spot near the collector.

SILICON PLANAR DEVICES

The silicon planar process has made possible the mass production of the very high performance transistors which are available today.

The present trend is for silicon planar devices to displace most of the earlier germanium devices in almost all applications.

The planar process cannot be used to produce germanium devices, although it can be employed to manufacture other silicon devices, such as diodes.

The diagrams of Fig. 5.3 show some of the processes involved in the manufacture of a silicon planar *n*p*n* transistor.

An *n*-type slice of silicon of about 2.5 cm diameter is heated in oxygen so that a layer of silicon oxide is formed all over it. A drop of photosensitive material is placed on top of the slice and the latter is spun so that the photosensitive material forms an even layer of the desired thickness.

The slice is then covered by a "base mask", which is a photographic negative containing a pattern, the opaque parts of which are in the positions of the bases of the hundreds or thousands of transistors which are to be made from the silicon slice.

The slice is then put under an ultra-violet light. The parts of the photosensitive material which receive the radiation are hardened and become fixed in position, but the other parts are easily washed away.

The slices are treated with acid which removes the oxide layer at the points where the photosensitive layer has been washed away.

Each of the positions in the silicon slice where a transistor is to be formed now has the type of cross section shown in Fig. 5.3b.

After cleaning, the slice is treated with a *p*-type material and heated so that the latter diffuses to the required depth. An oxide layer is then formed over the whole surface. The cross section of a single part of the disc is now as in Fig. 5.3c.

A photosensitive material is then used with a new mask (the emitter mask) and holes in the oxide layer are formed in positions which are to be treated with an *n*-type impurity (Fig. 5.3d).

Afterwards an *n*-type material is allowed to diffuse in to form the emitter and an oxide layer is formed over the whole surface (Fig. 5.3e).

CONTACTS

A further photosensitive layer is applied and a mask used to produce gaps in the oxide layer over the small parts of the base and emitter where the contacts can be fitted (Fig. 5.3f). A thin layer of aluminium is then deposited over the whole surface and, by means of a fourth mask, the aluminium is removed from all parts except where it is required to form the base

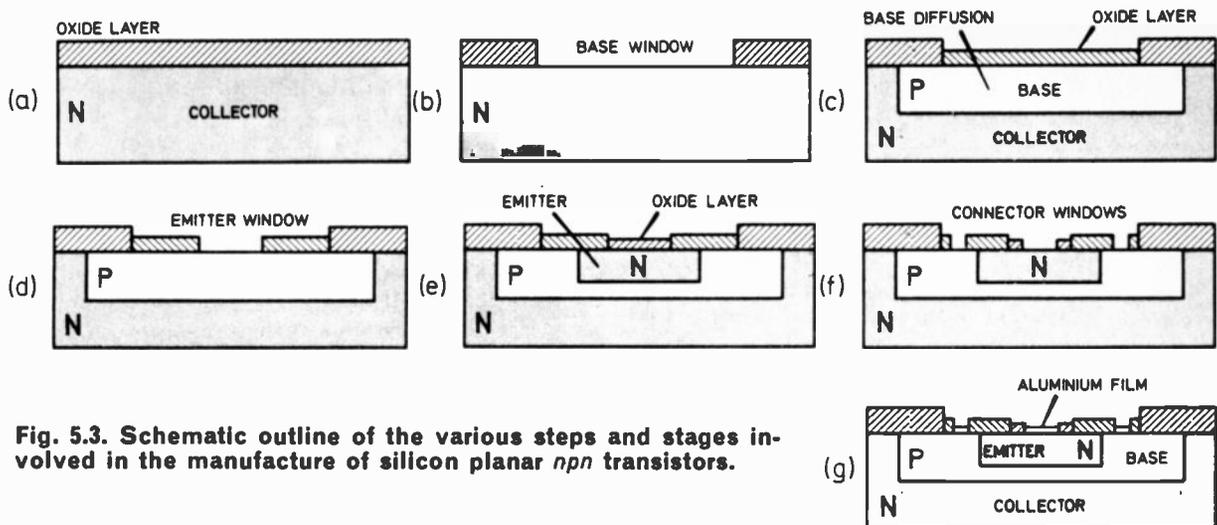


Fig. 5.3. Schematic outline of the various steps and stages involved in the manufacture of silicon planar *npn* transistors.

and emitter contacts.

Each transistor now has the general form shown in Fig. 5.3g.

The transistors on each slice are now briefly tested, separated, and the good ones encapsulated. Finally each device is thoroughly tested.

The manufacture of silicon planar *pnp* transistors is very similar. In epitaxial planar transistor manufacture, a lightly doped thin layer of silicon is used on a more heavily doped substrate. The transistor is formed within the thin layer.

LOW CURRENT PLANAR TYPES

Low current transistors operating with collector currents (I_c) of 1mA or less, are used in

low level circuits where one may require a low noise transistor.

Typical *npn* transistors of this type are the BC107 ($V_{ce0}=45V$), the BC108 ($V_{ce0}=20V$) and the low noise BC109.

Electrically equivalent types in an epoxy encapsulation are the BC147, BC148 and BC149.

The 2N929 and the higher gain, low noise 2N930 are similar *npn* types ($V_{ce0}=45V$). Another similar type is the 2N2483 and the higher gain 2N2484 (minimum value of $h_{fe}=250$ at $I_c=1mA$) which have V_{ce0} equal to 60V and which may be used at values of I_c as low as $1\mu A$.

In the S.G.S. range, one may mention the epoxy encapsulated C450 and the BFX76 and BFX77. Other *npn* types are the 2S501 to 2S503

Table 5.3: Low Level Silicon Planar Transistors

Device	V_{cbo} (V)	V_{ebo} (V)	$I_{c\ max}$ (mA)	$P_{T\ max}$ (mW)	h_{fe}	f_T (MHz)	Remarks
<i>npn</i>							
BC107	50	45	100	300	125-500	300	TO-18
BC108	30	20	100	300	125-500	300	TO-18
BC109	30	20	100	300	240-900	300	Low noise, TO-18
BC147	50	45	100	220	125-500	300	Lockfit
BC148	30	20	100	220	125-500	300	Lockfit
BC149	30	20	100	220	125-500	300	Low noise, Lockfit
2N929	45	45	30	300	100-350	50	TO-18
2N930	45	45	30	300	200-600	50	Low noise, TO-18
2N2483	60	60	—	360	>175	60	High voltage, TO-18
2N2484	60	60	—	360	>250	60	Low noise, high voltage, TO-18
BC184L	45	30	200	300	>250	150	Sillect
<i>pnp</i>							
BC157	-50	-45	100	220	75-260	130	Lockfit
BC158	-30	-25	100	220	75-260	130	Lockfit
BC159	-25	-20	100	220	125-500	130	Low noise, Lockfit
BFX37	-60	-60	50	360	70-300	40	High voltage, Low noise, TO-18
2N2604	-60	-45	30	400	40-120	30	High voltage, TO-46
2N2605	-60	-45	30	400	100-130	30	High voltage, Low noise, TO-46

(Texas) and the ZTX114 "E line" Ferranti type.

Similar types of low current high gain *npn* transistors are available. For example, the Texas 2N2605, the Mullard BC157 to BC159 series and the BFX37.

MEDIUM CURRENT PLANAR TYPES

The number of planar transistors for use in the 10 - 200mA range is very numerous and most designers choose from a few types with which they are especially familiar.

Common examples of such transistors are the economical types 2N2926 (International General Electric) and the ZTX300 (Ferranti) in epoxy encapsulation, whilst amongst the metal cased types there are C111E (S.G.S.), the 2N696, 2N697, 2N1613, 2N1711, 2N3053, etc.

Most of these have f_T values around 50MHz, but one may select one of the 2N2217 to 2N2219 series if one requires a 250MHz f_T . The BFY50 to BFY53 series offer a higher value of I_c (1A) than most of the other small types.

In the *npn* medium current types, one may use the 2N1131 or 2N1132 which have an f_T around 50MHz.

The common 2N2904 to 2N2907A series offer an f_T value of 200MHz and are rather similar in performance to the 2N2217 *npn* series.

Of the epoxy encapsulated *npn* types, one may mention the 2N3702/2N3703 with an f_T of 100MHz.

HIGH FREQUENCY TYPES

Various silicon planar transistors are available for the u.h.f. region. One of the best known is the BFY90 (minimum $f_T=1000$ MHz). Other *npn* types are the 2N3570 (minimum $f_T=1500$ MHz) and the S.G.S. BFY78.

The 2N3662/2N3663 (Int. Gen. Electric) are examples of transistors designed for u.h.f. tuners, whilst the Mullard BF200 ($f_T=270$ MHz) is intended for use in v.h.f. tuners.

Various *npn* high frequency amplifiers are available, but their operating frequency is not normally quite so high as some of the *npn* types. An example is the BFX48 (S.G.S.).

HIGH VOLTAGE

In some applications a transistor capable of controlling a high voltage is required; for example, in the control of neon filled numerical indicator tubes.

The S.G.S. *npn* type C407 is one of the best known (with a V_{ce} rating of 120V). The ZTX341 and ZTX342 (Ferranti) have V_{ce} ratings of 100 and 120V respectively and are also intended for driving numerical indicator tubes.

The S.G.S. V765 is a *npn* type with a 120V V_{ce} rating.

SWITCHING

Many of the transistors already mentioned (both silicon and germanium types) are also used for switching applications. In particular, the *npn* 2N2217 series and the *npn* 2N2904 series are widely used for medium current switching.

However, many silicon transistors especially designed for switching applications are now available. Some of the best known are the *npn* 2N706 and 2N708 for moderate speeds and the 2N709 for very fast switching.

The TIS45 (Texas) is similar to the 2N708, but is in a plastic encapsulation. Another fast general purpose switch is the S.G.S. type P346A.

Special types of ultra fast switch, such as the Motorola 2N3960 with $f_T=1800$ MHz, are available, but lie outside the scope of this article.

Table 5.4: Medium Current Silicon Planar Transistors

Device	V_{cbo} (V)	V_{ceo} (V)	I_{cmax} (mA)	$P_{t max}$ (mW)	h_{fe}	f_T (MHz)	Encapsulation
<i>npn</i>							
BFY50	80	35	1000	800	>30	60	TO-5
BFY51	60	30	1000	800	>40	50	TO-5
BFY52	40	20	1000	800	>60	50	TO-5
2N696	60	40	—	600	20-60	40	TO-5
2N697	60	40	—	600	120-150	40	TO-5
2N1613	75	30	—	800	40-120	60	TO-5
2N1711	75	30	—	800	100-300	70	TO-5
2N2217	60	30	800	800	20-60	250	TO-5
2N2218	60	30	800	800	40-120	250	TO-5
2N2219	60	30	800	800	100-300	250	TO-5
2N2219A	75	40	800	800	100-300	300	TO-5
2N3053	60	40	700	5000	50-250	100	TO-5
<i>npn</i>							
2N1131	-50	-35	600	600	20-45	50	TO-5
2N1132	-50	-35	600	600	90-150	60	TO-5
2N2904	-60	-40	600	600	40-120	200	TO-5
2N2905	-60	-40	600	600	100-300	200	TO-5
2N2905A	-60	-60	600	600	100-300	200	TO-5

ENCAPSULATION

Silicon planar transistors are available in quite a number of types of encapsulation.

A very common encapsulation for both silicon and germanium transistors is the TO-5 type shown in Fig. 5.4. The diameter of the main part of the metal body of the device is about 8.15 mm. One of the electrodes (normally the collector) is often internally connected to the metal body.

Another very common form of encapsulation for small transistors is known as the TO-18 type.

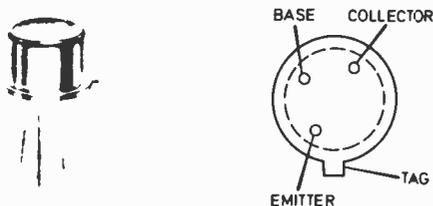


Fig. 5.4. Details of the TO-5 type encapsulation.

This is a metal encapsulation of the same form as the TO-5, but considerably smaller, the diameter of the main part of the body being about 4.8 mm.

The connections are almost invariably as shown in Fig. 5.4, but other devices (such as field effect transistors) are produced in the same types of encapsulation. Some types of electrically similar transistors are available in both the TO-5 and TO-18 types of encapsulation, but the maximum permissible dissipation of the TO-5 type is usually about double that of the TO-18 type.

A further variation of the TO-18 type is the TO-72 encapsulation in which a fourth lead (often connected to the metal case of the device) is present so that the four leads of the base are at the corners of a square. The TO-46 is even smaller than the TO-18, but has the same general type of base connections.

PLASTIC TYPES

A number of the manufacturers have developed their own type of epoxy (black plastic) encapsulation.

The S.G.S. and Fairchild companies employ epoxy forms which are somewhat similar to the TO-18 and TO-5 types, but the top is rounded off. The base connections are similar to the metal types.

Texas Instruments employ a form called "Silect" in many economical devices. This form, shown in Fig. 5.5a, is also used for field effect transistors.

The Ferranti 'E-line' is shown in Fig. 5.5c, whilst the International General Electric epoxy encapsulation is shown in Fig. 5.5b.

HIGH POWER SILICON TYPES

The most commonly used high power silicon transistor is almost certainly the *npn* 2N3055. This can dissipate up to 115W, has a minimum f_T of 1MHz and a current gain of 20 to 70 at $I_C = 4A$.

In general its ratings are well above those of germanium power transistors, since the silicon material can operate at a much higher temperature. The encapsulation is as shown in Fig. 5.2.

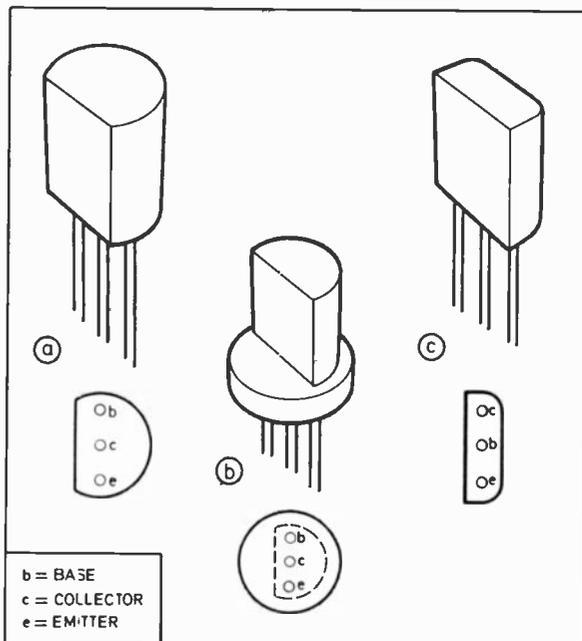


Fig. 5.5. Various common found types of encapsulation.

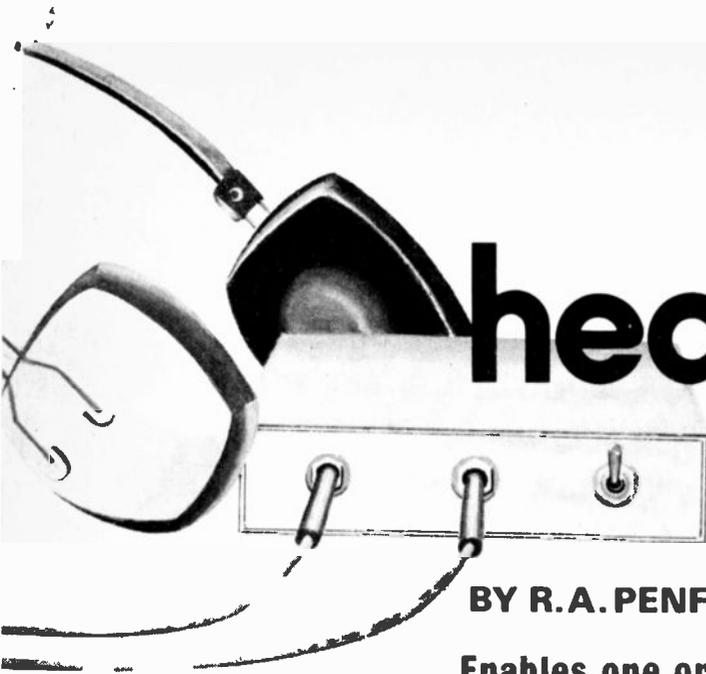
For some purposes the *npn* RCA type 40250 is suitable. This is in a smaller case (known as TO-66) which also has a "diamond" shape. The maximum dissipation is 29W and it is cheaper than the 2N3055. Another *npn* type is the 2N3054 which has a 25W maximum dissipation.

Various *npn* planar high power transistors are available, such as the Mullard BD121 (45W, $f_T = 95MHz$) and the BD123 (45W, $f_T = 85MHz$, $V_{C_{EO}} = 60V$) and the S.G.S. BD117 which is intended for high power audio amplifiers.

The number of *pnp* high power transistors is more limited than that of the *npn* types, but they find application in power amplifiers in conjunction with *npn* types.

Special power transistors are available for use at radio frequencies.

Next Month: Testing transistors.



Stereo headphone adaptor

BY R.A. PENFOLD

Enables one or two sets of stereo headphones to be used with an amplifier.

DESPITE the popularity of stereo headphones, a large number of stereo amplifiers, and record players, have no provision for using headphones. It is, however, a simple matter to construct an adaptor to enable the use of headphones.

SENSITIVITY

It is not really practical to connect the phones straight across the speaker terminals, as the sensitivity of a pair of headphones is of course much greater than that of a pair of speakers. It would therefore be necessary to have the volume control set almost at minimum.

This results in excessive hum, and noise, as the general noise level of an amplifier is usually expressed as *minus* a certain number of dB compared with the maximum output of the amplifier. This could be for example, -60dB, which means that the noise level is one thousandth of the level of the full output of the amplifier.

When using speakers the amplifier would be used at something approaching full output, and a noise level as low as this would be virtually inaudible. If headphones were in use, the output from the amplifier would, in all probability, never be more than say, one hundredth of the maximum output of the amplifier. This means that the required signal at its peak would only be ten times stronger than the noise level, and this would obviously be very unsatisfactory.

Also, due to crossover distortion, some amplifiers have a lower output quality at low output levels, than they do at higher output levels. This would be the result when headphones were in use.

ATTENUATOR

In order to enable headphones to be used with the volume control set higher, an attenuator is required. The circuit of a simple attenuator is shown in Fig. 1.

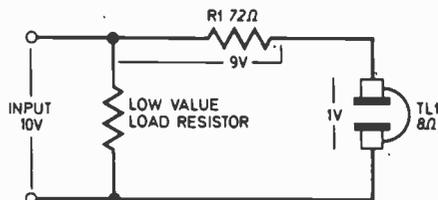


Fig. 1. The circuit of a simple attenuator to explain the theory used in the prototype.

The load resistor is *not* part of the attenuator, but forms a suitable low impedance load for the amplifier. The 72 ohm resistor, R1, and the headphone itself form the attenuator.

The input voltage from the amplifier (10 volts in this example) will be shared across the resistor and the headphone in proportion to their resistance. In this case they have a total resistance of 80 ohms (72 ohms + 8 ohms in series).

The headphone constitutes one tenth of this resistance, and will have one tenth of the input



**Approximate cost
of components
including V.A.T.
£1.85 plus case**

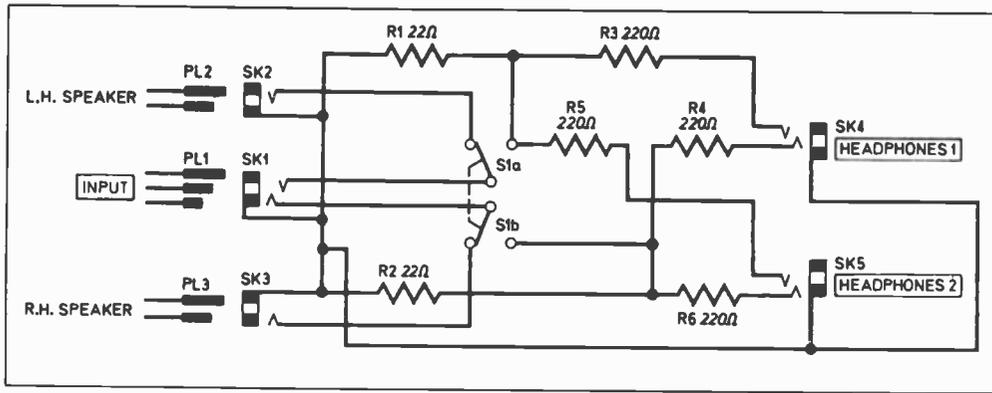


Fig. 2. The complete circuit diagram of the Stereo Headphone Adaptor.

voltage across it, the other nine tenths appearing across the 72 ohm resistor. The simple formula for calculating the attenuation factor of a circuit such as this is $(R1 + R_{TL1})/R_{TL1}$. Thus in the circuit of Fig. 1 we have an attenuation factor = $(72 + 8)/8 = 10$.

Using this circuit, the headphone has only one tenth of the sensitivity it would have without it, and would therefore require ten times the output voltage from the amplifier. This would result in the noise level being reduced by a factor of ten.

PRACTICAL CIRCUIT

The complete circuit diagram of the Stereo Headphone Adaptor is shown in Fig. 2. The input to the adaptor (from the speaker outlets of the amplifier) is through SK1, a stereo jack socket, which is connected to the double-pole two-way switch S1. The latter enables the headphones to be used (via the attenuator) in one position, and the loudspeakers in the other via SK2 and SK3, the output sockets to the loudspeakers.

The unit can therefore drive one, or two pairs of headphones, or can be switched for ordinary loudspeaker use.

Resistors R3, R4, R5, and R6 are the attenuator resistors, two for each pair of headphones (one for each earphone). If only one pair of headphones are likely to be used, SK5, R5, and R6 can be omitted; resistors R1, and R2 are the load resistors.

As the circuit stands it is suitable for use with almost any modern *transformerless* amplifier, as these work well with a wide variety of output impedances, and the value of the load resistors is therefore not too critical. With the values shown two to four watts will be developed across R1, and R2 at normal listening levels. With the majority of amplifiers, distortion is at its lowest at around this output level, and a good low noise level is obtained.

CONSTRUCTION

The prototype unit was constructed in an aluminium case, see Fig. 3, and straightforward

point to point wiring as employed as shown in Fig. 4.

First of all make the metal case as shown in Fig. 3 and make the cut-outs for the various sockets and switch. With this done fit the latter in position on the lid as indicated.

The wiring up of the components should be somewhat easier if it is carried out in the following order:

- (1) Connect and solder the leads from the speaker sockets SK1 and SK2 using sleeved wire.
- (2) Using stout tinned copper wire connect and solder together all the earth terminals on the sockets.
- (3) With sleeved wire connect and solder the two leads from SK1 to S1.
- (4) Wire in R1 and R2 followed by R3, R4, R5, and R6.

Thoroughly check out the wiring, and when satisfied that it is correct the case may be fixed together and the sockets and switch positions marked, with Letraset for example, so they may be identified.

A double length of twin cable is required to connect the unit to the amplifier or record player with which it is to be used; the length of the wire will depend on the relative positions of the unit and amplifier.

This lead should have, at one end, two suitable plugs which connect into the amplifier loudspeaker sockets, and a stereo jack plug at the other end, Fig. 5.

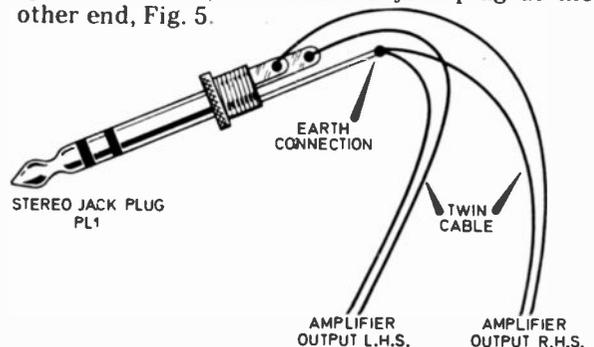
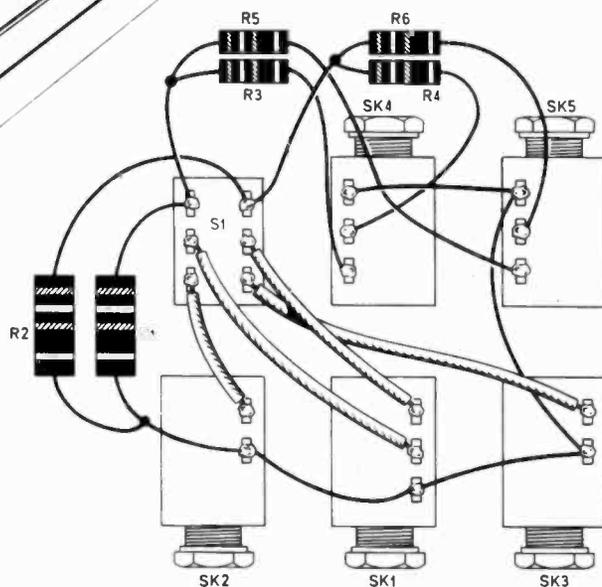
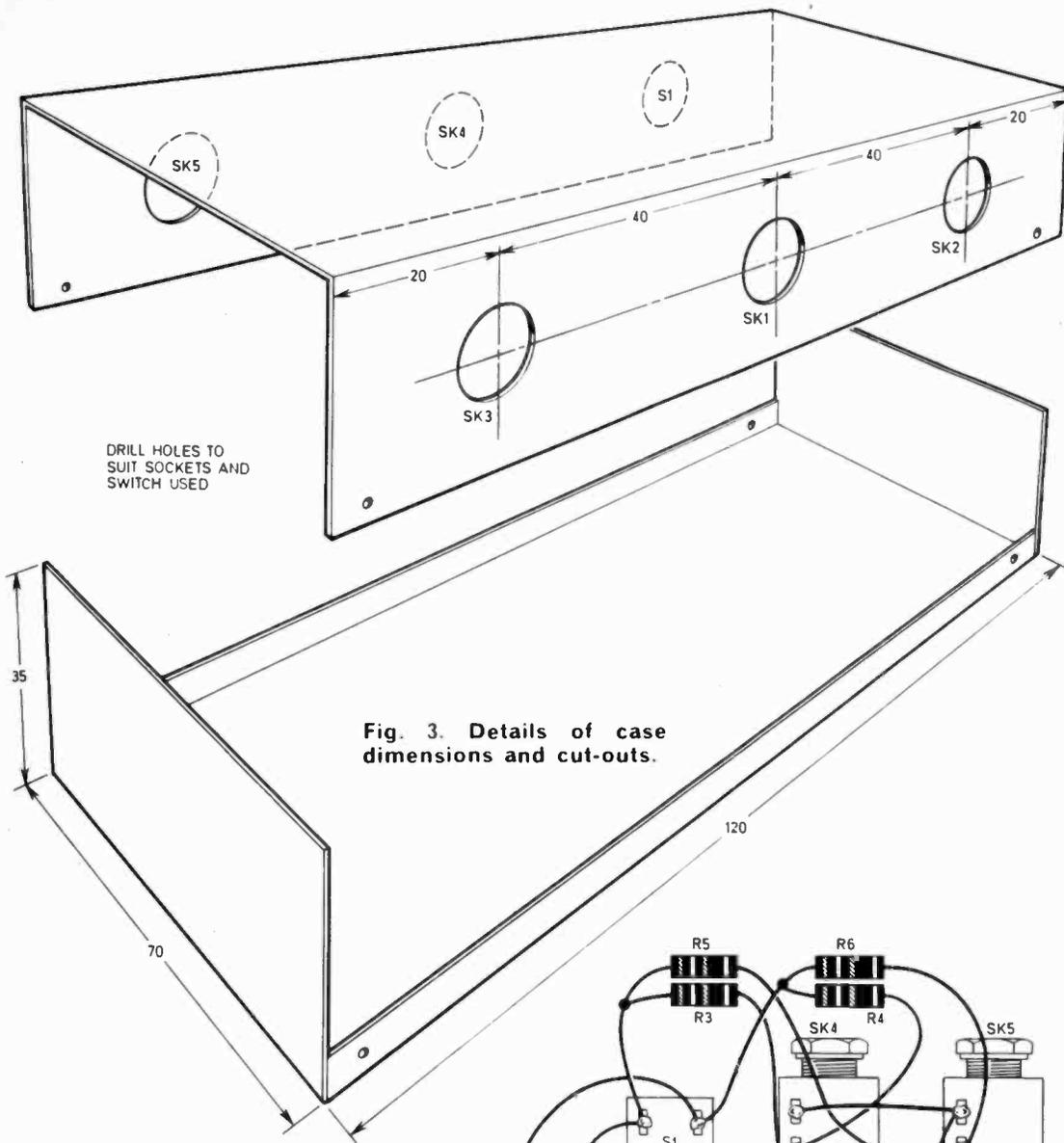


Fig. 5. Wiring details of the input jack plug, PL1.

Stereo headphone adaptor



Components

Resistors

R1	22Ω	5W
R2	22Ω	5W
R3	220Ω	
R4	220Ω	} ½ watt carbon +10%
R5	220Ω	
R6	220Ω	

SEE
**SHOP
TALK**

Sockets

SK1	stereo jack socket
SK2	standard jack socket
SK3	standard jack socket
SK4	stereo jack socket
SK5	stereo jack socket

Miscellaneous

PL1	stereo jack plug
PL2	standard jack plug
PL3	standard jack plug
S1	Double-pole double-throw toggle; Small metal case (see text); stout copper wire; insulated wire; length of twin cable.

MODIFICATIONS

Sensitivities of different makes, and models of headphones do tend to vary slightly. If when the unit is in use it is found to be impossible to obtain sufficient volume, or R1, and R2 are found to be overheating (these are intended to operate at quite high temperatures, but should not seriously discolour, or smoke), R3, R4, R5, and R6 should be reduced in value, to about 82 ohms.

If the unit is to be used with an amplifier which uses an output transformer, it will be

Table 1: Component changes necessary when using an amplifier with transformer output.

Speaker Impedance (ohms)	R1, R2 (ohms)	R3 to R6 (ohms)	R3 to R6 (ohms)
3	3.3 5W	68	33
8	10 5W	100	47
15	18 5W	150	68

Note: the final column with values for R3 to R6 is for use with low sensitivity headphones.

necessary to alter the values of all the resistors. Table 1 gives suitable resistor values for use with this type of amplifier, for the usual output impedances quoted by manufacturers.

As in the standard circuit, it is possible that R1 and R2 may overheat, or there will be a lack of volume. Thus in the table, suitable values for R3-R6 are shown in the last column for this eventuality.

Should there be any doubt as to whether or not the amplifier is a transformerless type or not, this can be ascertained by tracing back the speaker leads from the output sockets to see if these emanate from a transformer. If the amplifier is a valve type, it will certainly use an output transformer.

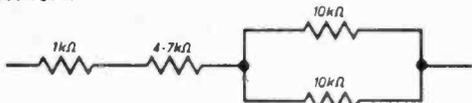
IN USE

The Stereo Headphone Adaptor has been designed to be situated by the listeners armchair so that a set of headphones (or two sets) may be conveniently switched in without the listener needing to stir from his armchair whilst transferring from speakers to headphones. □

What do you know?

RESISTORS

- (1) There are two well known formulae for calculating the total resistance of a number of resistors in (a) parallel (b) series, can you write these down? (2) Calculate the total resistance of the following network.



- (3) (a) State Ohm's law and write down the equation relating voltage, current and resistance. (b) What current will flow in a 100 ohm resistor connected across a 6V battery? (c) the power in watts (P) is related to voltage (V) and current (I) by the equation $P = VI$. Calculate the power dissipated in the resistor in (b). What wattage resistor would you use?

ANSWERS

- (1) (a) Ohm's law states that the current (I) flowing in a circuit is directly proportional to the voltage (V) across the circuit; $V = I \times R$, where R is the circuit resistance.
(b) Using Ohm's law, $I = \frac{V}{R} = \frac{6}{100} = 0.06A = 60mA$.
(c) $P = (6 \times 0.06) \text{ watts} = 0.36 \text{ watts}$. You would use the nearest standard value above this, i.e. ½ watt.
- (2) The two resistors in parallel yield a total resistance of 5 kilohms; this is in series with the other two giving a total resistance of $(1 + 4.7 + 5)$ kilohms which equals 10.7 kilohms.
- (3) (a) Ohm's law states that the current (I) flowing in a circuit is directly proportional to the voltage (V) across the circuit; $V = I \times R$, where R is the circuit resistance.
(b) $R_T = \frac{R_1}{1} + \frac{R_2}{1} + \frac{R_3}{1} + \dots$
(c) $R_T = \frac{R_1}{1} + \frac{R_2}{1} + \frac{R_3}{1} + \dots$

DOWN TO EARTH

By GEORGE HYLTON

"My amplifier has an input resistance of 20 kilohms and is fully loaded by an input of 5 millivolts r.m.s. I wish to use a crystal pickup with it. The manufacturers' data for the pickup says that it is correctly matched and equalised when it is loaded with 100 kilohms. The output is given as 100 millivolts peak. How can I adapt the pickup to the amplifier?"

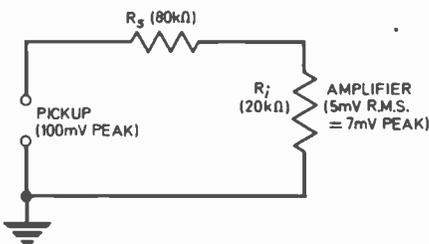
This problem really has two parts. First, the amplifier's input-signal requirement is given in r.m.s. (root mean square) millivolts, while the pickup output is in peak millivolts. These are not directly comparable. Secondly, there is the real problem of whether the pickup can be matched to the amplifier.

The required amplifier input voltage (for full output) is 5 millivolts r.m.s., and it can be taken that this specification refers to sine-wave signals. In this case, the peak voltage is about 1.4 times the r.m.s. voltage, so 5 millivolts r.m.s. corresponds to 7 millivolts peak. From now on we'll work in peak voltages and forget the r.m.s. ones.

THE MATCHING PROBLEM

We have to make sure that whatever matching arrangement we make doesn't reduce the voltage at the amplifier input terminals to less than the 7 millivolts needed for full output. At the same time the pickup must "see" a load of 100 kilohms.

The simplest possible arrangement is shown in Fig. 1. Here a resistance R_s is put in series with the input impedance R_i of the amplifier. To match the pickup, ($R_s + R_i$) must total 100 kilohms.



Since R_i is 20 kilohms, it follows that R_s must be 80 kilohms. (In practice it would be all right to use the nearest standard value, 82 kilohms, since the matching isn't very critical in this sort of circuit.)

The question is, will adding 80 kilohm, which must absorb some of the output of the pickup, leave at least the required 7 millivolts at the amplifier input?

In Fig. 1, R_s and R_i form a potential divider. Since R_s is four times R_i , it must absorb four times as much voltage as R_i . In other words, four-fifths of the pickup voltage is wasted in R_s and the remaining one-fifth appears at the amplifier input. So the amplifier gets one-fifth of 100 millivolts, or 20 millivolts, which is comfortably greater than the required 7 millivolts but not so enormous as to overload the input stage of the amplifier (most amplifier inputs are designed to accept a 20dB overload, and in the present case the overload is roughly 10dB, which is the decibel equivalent of a threefold increase in voltage).

In this case, then, the simple matching arrangement works well. Unfortunately, it is not possible to match any pickup (or other signal source) to any amplifier in this way. For example, if the pickup in question

Fig. 1. A very simple form of attenuator/matching circuit.

had had an output of only 20 millivolts, then the amplifier would have received only 4 millivolts, which is not enough to give full power output. In such a case, extra amplification is needed, or a high input impedance buffer stage before the amplifier. If the pickup had an output of 500 millivolts the amplifier would be in danger of being overloaded and some extra attenuation would have to be put between it and the pickup.

MATCHING CRITERION

To check whether a particular combination of pickup and amplifier will work with this simple matching arrangement, calculate this *Matching Criterion*:

$$\left(\frac{\text{Pickup output (mV)}}{\text{Amplifier input (mV)}} \right) \times \left(\frac{\text{Amplifier input resistance}}{\text{Required pickup load resistance}} \right)$$

If this comes to more than unity, the system will work. If it comes to more than 10, there may be a danger of overloading the input stage (this doesn't apply if there is a volume control before the input stage). If less than unity, either more amplification or more input impedance with the same amplification is needed.

In calculating the *Matching Criterion*, both voltages must be in millivolts and both resistances (or impedances) in kilohms. The criterion also applies to matching signal sources other than pickups.

Occasionally, a pickup or some other signal-source may produce far too much output and be in danger of overloading the amplifier which it drives. To avoid overloading the preamplifier it is necessary to attenuate the signal while at the same time presenting the pickup with the correct load.

Taking the figure of 500 millivolts for the pickup output, but keeping the load at 100 kilohm as before, how can we reduce the input to the amplifier without at the same time presenting the wrong load to the pickup? The simplest answer is to connect a resistance in parallel with R_i , thus bringing down the effective input impedance of the amplifier. To preserve the required 100 kilohm, R_s must be increased, and this, together with the reduced input impedance, causes the desired attenuation of the signal.

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3 1/2 x 3 1/2in 28p	28p		
2 1/2 x 1in 7p	7p		
2 1/2 x 5in (plain) 14p	14p		
2 1/2 x 3 1/2in (plain) 12p	12p		
5 x 3 1/2in (plain) 22p	22p		
Insertion tool	59p		
Track cutter	44p	44p	
Pins, pkt. 25	10p	10p	
2 pin DIN Plug, 12p; Skt., 10p.			
3 pin DIN Plug, 13p; Skt., 10p.			
5 pin DIN Plug, 18p; Skt., 12p.			
Transistor Equip. Book, 40p.			
Carbon pots 5K-2M log. & lin. single 161p, single with switch 26p, dual 46p.			

IN4001	61p	QUANTITY DISCOUNT
IN4002	71p	SPECIAL BULK BUY PRICES
IN4003	81p	ARE AVAILABLE BY
IN4004	91p	QUOTATION FOR LARGE
IN914	7p	PROJECTS AND TRADE.
µL914	35p	
OC71	13p	S.C.R.
OC75	17p	50V 1A 29p 3A 33p
OC83	20p	100V 1A 33p 3A 40p
		400V 1A 50p 3A 60p
Screened wire, m.		51p
Twin screened wire, m.		10p
Stereo s.c. wire, m.		10p
Connecting Wire, all colours, m.		21p
Neon bulb 90V wire ended		5 for 24p
Preset skeleton pots 1K-1M		6p

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KEMPSTON HARDWICK,
BEDFORD.

C.W.O. PLEASE. POST AND PACKING
PLEASE ADD 10p TO ORDERS UNDER £2.

Catalogue which contains data sheets for most of the
components listed will be sent free on request.
10p stamp appreciated.

OPEN ALL DAY SATURDAYS
PLEASE ADD 10% VAT

RESISTORS

1/2W Iskra high stability carbon film—very low noise—capless construction.
1/2W Mullard CR25 carbon film—very small body size 7.5 x 2.5 mm.
1/2W 2% ELECTROSIL TRS.

Power watts	Tolerance	Range	Values available	Price
1/2	5%	4.7Ω-2.2MΩ	E24	1p
1/2	10%	3.3MΩ-10MΩ	E12	1p
1/2	2%	10Ω-1MΩ	E24	3-sp
1/2	10%	1Ω-3.9Ω	E12	1p
1/2	5%	4.7Ω-1MΩ	E12	1p
4	10%	1Ω-10Ω	E12	6p

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

DEVELOPMENT PACK

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

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log 1/2W, lin 1/2W).
Single, 12p. Dual gang (stereo), 40p. Single D.P. switch, 24p.

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C.
mounting (0.1 matrix).
Sub-miniature 0.1W, 3p each. Miniature 0.25W, 7p each.

TRANSISTORS

AC107	15p	AF126	20p	BF115	25p	OC42	12p	SN3707	12p
AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC46	12p	2N3710	11p
AD131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	21p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BFY50	20p	2N3055	58p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF14	20p	BC159	14p	BFY52	20p	2N3702	13p	2TX108	15p
AF115	20p	BC187	22p	BUY105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ETX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	EXT503	20p

ZENER DIODES

400mW 5% 3.3V to 30V, 12p. | WIRE WOUND POTS. 3W, 10, 25,
50Ω and decades to 100kΩ, 35p.

DIODES

RECTIFIER	1250V	1A	12p	SIGNAL
BY127	800V	6A	25p	OA85
BZY10	200V	6A	20p	OA90
IN4001	50V	1A	7p	OA91
IN4004	400V	1A	8p	OA202
IN4007	1000V	1A	10p	IN4148
				BA114

BRUSHED ALUMINIUM PANELS

12in x 6in, 25p; 12in x 2 1/2in, 10p; 9in x 2in, 7p

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log, or lin, 40p.
DUAL GANG, 10K + 10K etc. log, or lin, 60p.
KNOB FOR ABOVE, 12p.
FRONT PANEL, 65p.
18 Gauge panel 12in x 4in with slots cut for use
with slider pots. Grey or matt black finish complete
with fixings for 4 pots.

THERMISTORS

VA10555 15p
VA10665 15p
VA1077 15p
R53 £1.35

THYRISTORS

2N5060 50V 0.8A 30p
2N5064 200V 0.8A 47p
106F 50V 4A 40p
106D 400V 4A 55p

MULLARD POLYESTER CAPACITORS C296 SERIES

400V: 0.001μF, 0.0015μF, 0.0022μF, 0.0033μF, 0.0047μF, 21p, 0.0068μF, 0.01μF,
0.015μF, 0.022μF, 0.033μF, 3p, 0.047μF, 0.068μF, 0.1μF, 4p, 0.15μF, 6p, 0.22μF,
74p, 0.33μF, 11p, 0.47μF, 13p,
160V: 0.01μF, 0.015μF, 0.022μF, 0.033μF, 0.047μF, 0.068μF, 3p, 0.1μF, 3p, 0.15μF,
44p, 0.22μF, 5p, 0.33μF, 6p, 0.47μF, 7p, 0.68μF, 11p, 1.0μF, 13p.

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0.01μF, 0.015μF, 0.022μF, 3p, 0.033μF, 0.047μF, 0.068μF,
34p, 0.1μF, 4p, 0.15μF, 0.22μF, 5p, 0.33μF, 64p, 0.47μF, 84p, 0.68μF, 11p, 1.0μF,
13p, 1.5μF, 20p, 2.2μF, 24p.

MYLAR FILM CAPACITORS 100V

0.001μF, 0.002μF, 0.005μF, 0.01μF, 0.02μF,
24p, 0.04μF, 0.05μF, 0.068μF, 0.1μF, 34p.

CERAMIC DISC CAPACITORS

100pF to 10,000pF, 2p each.

ELECTROLYTIC CAPACITORS

(KFV) 1/63, 1.5/63, 2.2/63, 3.3/63, 4.7/63, 6.8/40, 6.8/63, 10/25, 10/63, 15/16, 15/40,
15/63, 22/10, 22/25, 22/63, 33/6, 33/16, 33/40, 47/4, 47/25, 47/40, 68/6, 3,
68/16, 100/4, 100/10, 100/25, 150/6, 3, 150/10, 220/4, 220/6, 3, 220/16, 330/4, 6p, 47/63,
100/40, 150/25, 220/25, 330/10, 470/6, 3, 7p, 68/63, 150/40, 220/40, 330/16, 1000/4, 10p,
470/10, 680/6, 3, 11p, 100/63, 150/63, 220/63, 1000/10, 12p, 470/25, 680/16, 1500/6, 3, 13p
470/40, 680/25, 1000/16, 1500/10, 2200/6, 3, 18p, 330/63, 680/40, 1000/25, 1500/16,
2200/10, 3300/6, 3, 4700/4, 21p.

SOLID TANTALUM BEAD CAPACITORS

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

VEROBOARD

2 1/2 x 3 1/2	0.1	1.15
2 1/2 x 5	22p	16p
3 1/2 x 5	24p	24p
3 1/2 x 5	24p	24p
3 1/2 x 5	27p	27p
17 x 2 1/2	75p	57p
17 x 3 1/2	100p	78p
17 x 5 (plain)	—	82p
17 x 3 1/2 (plain)	—	60p
17 x 2 1/2 (plain)	—	42p
2 1/2 x 5 (plain)	—	12p
2 1/2 x 3 (plain)	—	11p
Pin insertion tool	52p	52p
Spot face cutter	42p	42p
Pkt. 50 pins	20p	20p

JACK PLUGS AND SOCKETS

Standard screened	18p	2.5mm insulated	8p
Standard insulated	12p	3.5mm insulated	8p
Stereo screened	35p	3.5mm screened	13p
Standard socket	15p	2.5mm socket	8p
Stereo socket	18p	3.5mm socket	8p

D.I.N. PLUGS AND SOCKETS

2 pin, 3 pin, 5 pin 180°, 5 pin 240°, 6 pin
Plug 12p, Socket 8p.
4 way screened cable, 15p/metre.
6 way screened cable, 22p/metre.

BATTERY ELIMINATOR

£1.50
9V mains power supply. Same size as PP9 battery.

LARGE (CAN) ELECTROLYTICS

1600μF 64V 74p	2500μF 64V 80p	4500μF 16V 50p
2500μF 40V 74p	2800μF 100V £2.60	4500μF 25V £1.68
2500μF 50V 58p	3200μF 16V 50p	5000μF 50V £1.10

HIGH VOLTAGE TUBULAR CAPACITORS—1,000 VOLT

0.01μF 10p	0.047μF 13p	0.22μF 20p
0.022μF 12p	0.1μF 12p	0.47μF 22p

POLYSTYRENE CAPACITORS 160V 2 1/2%

10pF to 1,000pF E12 Series Values, 4p each.

SMOKE AND COMBUSTIBLE GAS DETECTOR—GDI

The GDI is the world's first semiconductor that can convert a concentration of gas
or smoke into an electrical signal. The sensor decreases its electrical resistance when
it absorbs deoxidizing or combustible gases such as hydrogen, carbon monoxide,
methane, propane, alcohol, North Sea gas, as well as carbon-dust containing air or
smoke. This decrease is usually large enough to be utilized without amplification.
Full details and circuits are supplied with each detector.
Detector GDI, £2. Kit of parts for detectors including GDI and P.C. board but
excluding case. Mains operated detector £5.20, 12 or 24V battery operated audible
alarm £7.30. As above for PP9 battery, £6.40.

PRINTED BOARD MARKER

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

LARGE RANGE ITT/TEXAS IC's NOW IN STOCK

PRICES ARE CALCULATED ON TOTAL NUMBER ORDERED REGARDLESS OF MIX

1-11	12-24	25-99	100+	7448	185	175	170	165	74118	100	82	73	64
7400	18	16	14	13	7450	18	16	14	74121	43	40	38	36
7401	18	16	14	13	7451	18	16	14	74141	100	95	90	85
7402	18	16	14	13	7453	18	16	14	74145	150	140	130	120
7403	18	16	14	13	7454	18	16	14	74150	330	280	250	220
7404	20	18	16	14	7460	18	16	14	74151	110	100	95	89
7405	20	18	16	14	7470	30	28	25	74153	120	110	105	95
7406	50	45	40	35	7472	30	28	27	74154	200	180	170	160
7407	56	50	44	38	7473	40	38	36	74155	150	120	100	86
7408	36	30	27	23	7474	40	36	32	74156	130	120	100	96
7409	36	30	27	23	7475	55	52	50	74180	155	136	112	105
7410	36	30	27	23	7476	40	36	32	74190	195	190	185	180
7411	33	21	20	18	7480	100	95	90	74191	195	190	185	180
7412	36	30	27	23	7481	125	115	110	74192	200	190	180	164
7413	34	28	26	22	7482	100	96	90	74193	200	180	170	150
7416	45	43	39	34	7483	100	97	95	74196	200	190	180	170
7420	18	16	14	13	7484	120	115	110	74197	200	195	180	170
7421	36	30	27	23	7485	250	245	240					
7426	32	29	23	20	7486	45	42	37					
7430	20	18	16	14	7490	75	67	60					
7432	40	36	32	28	7491A	100	92	85	709				
7440	20	18	16	14	7492	75	70	65	741				
7441	80	75	70	65	7493	75	68	60	741				
7442	80	75	70	65	7494	95	90	85	723				
7443	125	120	115	110	7495	105	100	95	747				
7447	175	165	150	120	7496	90	85	80	748				
					74100	250	240	235	230				

LINEAR IC's		

in



NEXT MONTH

THE 4 BAND T.R.F. RECEIVER

A radio capable of receiving short wave amateur and shipping transmissions as well as the normal medium wave band



GAS alarm

A simple alarm for the detection of combustible gases and vapours and smoke

THREE BY THREE GAME

An addition to any game using a dice, or a novel game for two players

**ALL IN THE
NOVEMBER
ISSUE OF**
**everyday
electronics**

On Sale Friday, September 21

Everyday Electronics, October 1973

EXTRA INSIDE
8 PAGE
SUPPLEMENT
**ON CONSTRUCTIONAL
METHODS**

WE appear to have overlooked the supply problem concerning one major component used last month. The CA3046 integrated circuit, used in the *Train Controller*, is not particularly easy to get hold of, but one large supplier of semiconductors does list it—A. Marshal and Son, their address can be found on their advertisement elsewhere in this issue.

Lamp Dimmer

To get to the supply problems likely to occur when buying for this month's projects we will first look at the *Lamp Dimmer*. Most components for this project will cause few problems, but it might be as well to shop around before buying the diac and triac as prices vary widely.

Some firms sell these items in pairs and this is probably a good way of buying them. The case and other mechanical parts should be available from most electrical shops.

Audio Millivoltmeter

The case used on the prototype *Audio Millivoltmeter* is a good case for this piece of test gear but is rather expensive (about £2.50). This case is made from Lektrokit parts available from Home Radio.



The meter used can be any type of the approximate size quoted (provided the range is correct) and there are a number of reasonably priced types available from advertisers. The transformer specified should preferably be used since the calibration voltage is likely to be more accurate with one particular type.

Headphone Adaptor

The only component likely to be

difficult to get for the *Stereo Headphone Adaptor* is the case. A design for a home model case is shown in the article but any small metal or plastic case could be used.

All the other components are readily available.

Tutor Board

We hope that some of our advertisers will be supplying a full kit of parts for the *Tutor Board* and the first six parts of *Teach-In '74*. We have taken the unusual step of informing advertisers of the necessary components so that they can help you by selling them all in one kit.

Just one point, the last *Teach-In* series also used a small moving coil meter and the demand was so heavy that all the stocks were exhausted; we hope this will not happen this time as the suppliers have been warned.

If the meter does become unavailable similar types should be sought. The size is not that critical but we suggest you do not use one very much smaller than the original.

Another point if you are buying the parts individually make sure you get R.S. Components connector blocks—this is because of the method of fixing them used.

CONSTRUCTORS TAKE YOUR PICK . . .

Build one of four special simple projects, described in an 8-page supplement, on the **FREE VERSATILE PRINTED WIRING BOARD** included in the **NOVEMBER** issue of **PRACTICAL ELECTRONICS**

- WAA WAA EFFECTS UNIT
- SIMPLE TOUCH SWITCH
- DIODE THERMOMETER
- LIGHT OPERATED SWITCH

. . . THE CHOICE IS YOURS!

THE GOOD COMPANIONS



Two magazines designed to complement each other in every way—together satisfying the needs of everyone involved in electronics.

PE

PRACTICAL ELECTRONICS

November Issue on sale Friday, October 12

BRIGHT IDEAS

Readers' Bright Ideas; any idea that is published will be awarded payment according to its merit. The ideas have not been proved by us.

I have often spent many hours sorting through a box of resistors to find the values I need, so I have come up with the following idea. Obtain a polystyrene ceiling tile and divide it into many parts using a felt-tipped pen and number these sections with resistor values, preferably in ascending order. The resistors can then be placed in their respective sections by inserting one wire end into the tile. It is then an easy matter to find the required value resistor.

P. D. Turner,
Woodbridge, Suffolk.

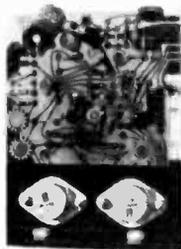
SAXON ENTERTAINMENTS LTD.

STANDARD & CUSTOM-BUILT AUDIO & ELECTRONIC EQUIPMENT
NEW & SECONDHAND MUSICAL INSTRUMENTS.
DISTRIBUTORS FOR A.K.G. HIGH QUALITY MICROPHONES.

Announcing our improved range of constructor modules

FOR DOMESTIC & COMMERCIAL USE

New Versions using 3A 'Plastic Power' Driver Transistors Now Available. To meet demand, we have included a more powerful module in our well-established and proven range. These power amplifiers are carefully assembled, tested and guaranteed. They offer superb value for reliability and versatility.



SA35 35 watts RMS. Uses 7 transistors and 7 diodes Carr. paid. **£4.45**

A NEW ADDITION IS THE SA50 at £5.65

Carr. paid. A rugged, well built unit, capable of 50 watts R.M.S. out, with all the advantages of Saxon Amplifier design and quality. Ready now.

SA100 makes an ideal unit in disco assemblies. A real glutton for work. **£10.90**

Reliable, tough and compact. 11 transistors, 6 diodes. Carr. paid.

BRIEF SPEC. FOR ALL THREE MODULES

All modules incorporate OPEN and SHORT CIRCUIT PROTECTION, plus proof against over-dissipation and faulty inductive loads in the SA.100.

Freq. response 15-40,000 Hz ± 1 dB
Distortion 0.2% at 1 kHz
Loads 4 to 16 ohms
Quiescent current 15 mA
Noise Better than -75 dB
Supply voltage SA35 25-45 volts
SA50/SA100 40-70 volts
Size 4 1/2" x 4" x 1" (SA100)
4" x 3" x 1" (SA35/SA50)

Circuits, connecting instruction and application data are supplied free with all modules.

POWER SUPPLIES FOR THE SA25/35 & SA100 AUDIO MODULES

PU45 Unstabilized supply for 2 SA25/35 £4.90
PU70 Unstabilized supply for one or two SA100 £7.75 carr. 40p
PS45 Stabilized module for 2 SA25's or two SA35's £3.50 carr. free
MT45 Transformer for above, heavy duty £2.85 carr. 20p
MT30 Transformer for unstabilized supply complete with rectifier diodes mounted £3.50 carr. 20p
PS70 Stabilized supply module for one or two SA100's £4.90 carr. free
MT70 Transformer for PS70 £4.90 carr. 40p

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Telephone 01-684 6385

Hours 9.30 a.m.-5.30 p.m.

TRADE & EXPORT ENQUIRIES INVITED

TWO NEW PA/MIXER CONTROL UNITS

Using grouped pairs of inputs and outputs (high Z and low Z inputs) with individual bass, treble and volume controls on each pair, plus master control. These low-noise units will feed all makes of amplifiers, making them ideal for clubs, discos etc. Standard jack sockets. Compact design. In strong metal cases. All units guaranteed for 3 years.

●M.4H

4 high Z, 4 low Z inputs, 4 sets of controls. Case 14" x 8" x 2 1/2" Carr. pd.

£18.50 + V.A.T.

●M.6HL

Case 18" x 8" x 2 1/2"

12 inputs (6 high Z, 6 low Z). Carr. pd.

£27.50 + V.A.T.

● Channel section modules, for building your own mixer. Gain—16 x (24dB). Tone controls—18dB swing. Carr. pd. £3.50 + V.A.T.

SAXON CONTROL UNITS

Mono (as shown)

Carr. 20p. **£6.50**

Stereo. Carr. 30p.

£15.80



Two decks, and full headphone monitoring. The unit is mains operated and measures 17 1/2" x 3" x 4" deep and is finished with a smart white on black face. The controls are: Left/Right deck fader, volume, bass, treble, Headphone Selector and volume, Microphone volume, bass, treble, mains on/off.

COMPARABLE TO UNITS AT OVER TWICE THE PRICE. (N.B.—Stereo only has mic input.)



120 WATT HEAVY DUTY MODULE

Rugged class A driver stage, this module will run from all our mixers, etc., and most other makes. Delivers 120 watts into an eight ohm load and employs 4 T03 can (115 watt) output transistors. These are the modules where extra power is demanded.

Power output 120 watts into 8 ohms
Freq. response 20-20,000 HZ ± 2 dB
Input sensitivity 200 mV into 10K
Construction Fibreglass board
Size 8" x 4" x 4" (5" with supply)

Module only **£13.90**
(Carr. 20p)

160 watt version with power supply (Carr. 50p) **£27.50**

Low distortion parallel push-pull output stage.

Module & power supply (Carr. 40p) **£18.95**

SOUND AND LIGHT UNITS



3 CHANNEL UNIT

Includes bass, middle and treble as well as master controls. 2 amplifier sockets eliminate need for split leads. Up to 3KW lighting load. Smartly finished steel case. Carr. 30p.

£19.75

SINGLE CHANNEL UNIT

Operates from 5 to 100 watt amplifiers. Supplied for bass note operation, is easily adapted for treble or mid-range at a cost of about 5p.

Carr. pd. **£8.90**

COMPLETE AMPLIFIERS

CSE 100. £34.90 carr. free

This versatile unit is now available in a black vinyl case and so represents even better value than ever delivering speech and music powers of up to 100 watts RMS and continuous signal outputs of 70 watts. Two individually controlled inputs with wide range bass and treble controls.



SAXON 100 £48.50 carr. free



With an RMS output of 120 watts speech and music, 100 watts continuous power, four individually controlled FET input stages and wide range bass and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

500 Watt 3 colour Light Boxes Smart Rextone finish £15 carr. free.

LOUDSPEAKERS British made bargains!!

12" 25 watt 8/15 ohms £5.95 carr. 30p. 15" 50 watt 8/15 ohm £14.50 carr. 50p.
12" 40 watt 15,000 gauss magnet system 8/15 ohm £11.50 carr. 40p.

A.K.G. MICROPHONES

D11 DHL IDEAL DISCO MIKE ONLY £9.45 (rrp £11.00).

Prices quoted do NOT include V.A.T. 10% must be added on to total value of order for V.A.T. S.A.E. for special price list.

TERMS OF BUSINESS

Cash with order (C.W.O.) For C.O.D. please add 35p extra, cash by regd. letter, please

ZN414 £1.25 POST FREE
 The I.C. Radio in a TO18 can. Supplied complete with data sheet No. 10 which contains specification, circuit and details and prices of components such as ferrite rods, compression trimmers etc.

I.C. Sockets
 Dug-in-line or Zip-Zag (Quil), 14 and 16 pin
 Our Price 1p per pin

VDR's & Thermistors

A15B 75p	GL23 £1 00	VA1005 15p
CZ1 15p	R53 £1 32	VA1026 13p
CZ4 13p	R54 £1 46	VA1033 13p
CZ13A 13p		VA1040 10p
E298 ED/A258 10p		VA1053 10p
E298 ZZ/06 10p		VA1055S 10p
GL16 £1		VA1034 10p

Potentiometers



5KΩ	50KΩ	500KΩ	
10KΩ	100KΩ	1MΩ	
25KΩ	250KΩ	2MΩ	

log or lin less switch (& 1KΩ lin) 12p
 log or lin with switch 24p
 dual less switch 40p
 dual with switch 10K, 100K & 1M log only 52p
 10K log 10K antilog less switch 40p

Capacitors

disc ceramic		low voltage	
0.1μF 18V	5p	0.1μF 30V	5p
0.22μF 18V	5p	0.22μF 6V	5p
0.47μF 12V	5p	0.47μF 3V	5p
ceramic plate		30V	
1000pf	10p	4700pf	10p
2200pf	10p	10,000pf	10p

Slider Pots

Single	Dual	log
10K	10 + 10K	or
25K	25 + 25K	lin
50K	50 + 50K	
100K	100 + 100K	knobs
30p	50p	10p.

Resistors

1/2 watt 5% Carbon Film - low noise Hi-Stabs

All E24 values 1p each plus p. & p. 7p for up to 50 Resistors and a further 2p for each additional 50. Deduct 33 1/3% for 100 of one type or 25% for mixed orders over £1 in value.

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 2W 10% Carbon Composition 6p each
 2W 5% Wire wound 9p each
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EA1000



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5 Watt Audio Amplifier
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Presets



Vertical or Horizontal	0.25 watt 7p
100 1KΩ	10KΩ 100KΩ 1MΩ
250 2.5KΩ	25KΩ 250KΩ 2.5MΩ
500 5KΩ	50KΩ 500KΩ 5MΩ

Ceramic - plate 63V (C333)

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

all 5p. each

mvlar film 100V

1000pf 2p	0.1μF 3p	0.68μF 4p
2000pf 2p	0.2μF 3p	1μF 4p
5000pf 2p	0.4μF 3p	2μF 5p
	0.5μF 3p	

polystyrene 160V
 10pf to 10,000pf in multiples of 10, 15, 22, 33, 47 & 68 3p each

metallised polyester 250V (C280)

0.1μF 3p	0.68μF 3p	47μF 8p
0.15μF 3p	1μF 4p	68μF 11p
0.22μF 3p	1.5μF 4p	1μF 13p
0.33μF 3p	2.2μF 5p	1.5μF 20p
0.47μF 3p	3.3μF 6p	2.2μF 24p

metallised polyester 400V (C281)

0.1μF 4 1/2p	0.47μF 6p	22μF 10p
0.15μF 4 1/2p	0.68μF 6p	33μF 14p
0.22μF 4 1/2p	1μF 7p	47μF 15p
0.33μF 5 1/2p	1.5μF 8p	

silvred mica 1% (>50pF) 500V

2.2pf-820pf	7p	4.7nF-5600pf	19p
1nF-2.2nF	9p	6800pf-0.1μF	29p
2.7nF-3.6nF	18p		

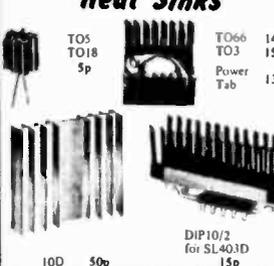
mixed dielectric 600V

0.1μF 7p	0.47μF 7p	22μF 16p
0.22μF 7p	0.68μF 8p	47μF 23p
0.33μF 7p	1μF 8p	1μF 34p

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BC107 10p		OC45 15p	ZTX305 21p	2N3905 21p	μA723C £1.86
BC108 10p		OC71 11p	ZTX306 12p	2N3906 12p	μA747C 50p
BC109 10p		OC72 11p	ZTX307 15p	2N3906 12p	

mixed dielectric 1000V

1000pf 6p	6800pf 9p	1μF 12p
2200pf 6p	0.1μF 9p	2.2μF 22p
3300pf 6p	0.22μF 9p	47μF 30p
4700pf 6p	0.47μF 12p	

Ceramic 8KV d.c. HI-K 750V

12KV d.c.	8KV d.c.	HI-K 750V
10pF 9p	200pF 9p	1000pF 5p
15pF 9p	220pF 9p	2000pF 5p
22pF 9p	250pF 9p	3000pF 5p
68pF 9p	270pF 9p	5000pF 5p
82pF 9p	300pF 9p	10,000pF 5p
100pF 9p	750V DISC	10,000pF 5p
120pF 9p	470pF 5p	faed.
140pF 9p	1000pF 5p	through
150pF 9p	5000pF 5p	
180pF 9p	10,000pF 5p	1000pF 5p

Veroboard

Copperclad	Plain
0.1"	0.15"
0.15"	0.15"

2 1/2" x 1"	6p	6p	-
2 1/2" x 3 1/2"	20p	16p (9)	10p
2 1/2" x 5"	24p	21p (7)	12p
3 1/2" x 3 1/2"	24p	21p (8)	12p
3 1/2" x 5"	27p	27p (10)	17p
17" x 2 1/2"	67p	50p	37p
17" x 3 1/2"	90p	70p	52p
17" x 5"	-	-	75p

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Mullard B Siemens Electrolytics

CAP μF	VOLTAGE							
	4	6.3	10	16	25	40	63	
1	-	-	-	-	-	-	6p	
1.5	-	-	-	-	-	-	6p	
2.2	-	-	-	-	-	-	6p	
3.3	-	-	-	-	-	-	6p	
4.7	-	-	-	-	-	-	6p	
6.8	-	-	-	-	-	-	6p	
10	-	-	-	-	-	-	6p	
15	-	-	-	-	6p	-	6p	
22	-	-	-	-	6p	-	6p	
33	-	-	-	-	6p	-	6p	
47	6p	-	-	-	6p	-	6p	
100	-	-	-	-	6p	-	10p	
150	6p	-	-	-	6p	-	12p	
220	6p	-	-	-	6p	-	12p	
330	6p	-	-	-	6p	-	12p	
470	-	-	-	-	10p	-	12p	
680	-	-	-	-	10p	-	12p	
1000	-	-	-	-	12p	-	12p	
1500	-	-	-	-	12p	-	12p	
2200	-	-	-	-	12p	-	12p	
3300	8p	-	-	-	12p	-	12p	
4700	8p	-	-	-	12p	-	12p	

Quantity Prices on application.

Aluminium Boxes

including baseplate and screws

No.	L.	W.	D.	Price	p. & p.
(7)	2 1/2"	3 1/2"	1 1/2"	35p	8p
(8)	4"	4"	1 1/2"	35p	8p
(9)	4"	2 1/2"	1 1/2"	35p	8p
(10)	4"	3 1/2"	1 1/2"	40p	8p
(11)	4"	2 1/2"	2"	35p	8p
(12)	3"	2 1/2"	1 1/2"	32p	9p
(13)	6"	4"	2"	50p	10p
(14)	7"	5"	2 1/2"	58p	12p
(15)	8"	6"	3"	75p	18p
(16)	10"	7"	3"	85p	20p

Hi-Volt Electrolytics

1, 2, 4, 8μF	450V	14p	32p	450V 20p
16μF	450V	15p	50p	350V 20p
8 μF;	450 V.W.	18p	32 pF;	350 V.W. 25p
8 16μF;	450 V.W.	20p	32 pF;	450 V.W. 43p
16 16μF;	450 V.W.	25p	50 pF;	350 V.W. 35p



Smoothing Capacitors

When designing a mains power supply for transistor circuits you use a large value electrolytic capacitor. How do you arrive at the value for this and is it very critical?

The general rule is to make the capacitor as large as possible (or as one can afford) however there is a slightly more scientific answer. If you assume full wave rectification the capacitor has to smooth out what is, effectively, a 100Hz waveform. This pulsating waveform is constantly trying to fill the capacitor with charge (if you consider it like a bucket) and in the absence of any current being drawn from the capacitor this happens quite quickly and once it is fully charged there is no further ripple across its terminals.

As soon as you connect to an external circuit, charge will be drawn from the capacitor—hopefully at a lower rate than it is being fed in. The crux of the problem is to make sure that the rectifying circuit can keep the capacitor filled with charge more easily than the external circuit can draw it.

If you consider the external circuit to be a box having impedance (forget what the function of the circuit actually is) we must make sure that the impedance of the charge circuit is very much less than the impedance of the external circuit. This means that

the reactance of the smoothing capacitor must be very low at a frequency of 100Hz. If the external circuit has a high impedance (e.g. it draws only a milliamp or two) we can afford to use a low value capacitor for smoothing (a few hundred micro-farad which does not have an exceptionally low reactance) but if we need to supply several hundred milliamps we must reduce the reactance of the capacitor proportionally (to perhaps several thousand micro-farads). The values are not very critical provided you are in the right order of magnitude but there is a hidden snag—if the capacitor is too large there might be a big current surge at switch on as it charges up for the first time and this surge—in badly designed circuits—can sometimes destroy the rectifiers!

Impedance

I thought that impedance was dependent on frequency and yet you often talk about input impedances without mentioning the frequency you are considering. My amplifier specification even says "Input impedance: 1 megohm" but it does not mention frequency. This does not seem to make sense!

When dealing with audio amplifiers there is a standard frequency that is used as the basis for calculating impedances; this has been chosen to be approximately in the peak of the human ear's frequency response—1kHz. Whenever we talk about input impedance or impedance matching in amplifiers we are assuming that a frequency of 1kHz is being used. Once you know this you can calculate impedances for other frequencies.

There is an exception (to prove the rule?) loudspeakers' impedances are usually quoted for a frequency of 400Hz.

Impedance Variation

I assume that it is possible to increase or reduce the impedance of a loudspeaker merely by connecting a resistor in series or in parallel with it but is this permissible and what effects would be evident?

It is perfectly permissible to do this—provided you carry out your series (or parallel) calculation

correctly. For example you can increase the impedance of a 3 ohm loudspeaker to about 8 ohms by putting a 5 ohm resistor in series with it. This would make it safe to connect to an amplifier with a restriction of 8 ohms "output impedance" but you will sacrifice a lot of power—over half the power would be dissipated by the resistor and the volume will be considerably reduced.

It is a handy "stop gap" technique for initially checking a circuit before you buy the correct loudspeaker but is not to be recommended as good practice!

Reversed Transistors

Why must you not connect transistors the wrong way round—by that I mean swop collectors for emitters. In an *npn* transistor both collector and emitter are made of *n* type material and the structure is a sort of sandwich so why on earth can't you reverse the connections without "dire" results.

Your description of the structure of an *npn* transistor is correct and we agree that it does seem strange that the device is not reversible. The reason lies behind the fact that although you have the sandwich structure there are differences in the doping levels of the silicon forming the collector and emitter regions respectively. Emitter doping is very much greater than that in the collector—this is necessary to improve the "emitter efficiency" which controls the gain and frequency characteristics of the device. A side effect of this high level doping is to reduce the reverse emitter base breakdown voltage (to typically 5 or 6 volts).

In normal circuits we take great care to ensure that for an *npn* transistor the base can never go more than about 5V negative with respect to the emitter for this very reason. When a transistor is in a correctly operating circuit the base is usually at a much more negative voltage than the collector—often there can be 7 or 8 volts difference and the collector base junction is always in a reverse biased condition. If you connect your transistor the wrong way round you will be applying these 7 or 8 volts across the emitter base junction which has a reverse limit

of 5 volts and this is why the device might be destroyed.

A point of interest is that provided the breakdown current is limited you can sometimes get away with it! If the supply voltage is less than the emitter base reverse breakdown voltage there will be no danger of damaging the transistor but your circuit will still not work as you do not get the true emitter efficiency that is required and the effective gain of the device—when operating the wrong way round—is in the order of 1:1.

Mono to Stereo

I have a mono cassette tape recorder which I want to modify to give me stereo playback. Is there any simple way to do this.

Theoretically it is possible to convert your device for stereo replay but if you are a beginner we feel that this might prove to be a very difficult operation. Not only is it difficult but you might have considerable difficulty getting the right parts and obtaining a reasonable balance between the two channels.

Your recorder will be fitted with a mono head which imprints the recorded signal as a magnetic pattern on a $\frac{1}{16}$ inch wide track of the cassette tape. To operate in stereo two tracks—containing left hand and right hand information—have to be recorded within this $\frac{1}{16}$ inch width, so firstly you have to change the head to one which has two electromagnetic cores. Problem number one is to locate a head that will mechanically fit your deck—because of the miniature nature of modern recorders getting one to exactly fit will be difficult! You then have to mechanically line up the head so that it exactly corresponds to the two tracks we have mentioned.

Assuming you are able to do this you then have to make a high gain audio amplifier which will operate from the very low signals that are derived from the tape when playing back. There are many amplifiers which are capable of doing this and you would have no problem in that respect unless you tried to get the signal from the extra channel to exactly match the quality from the existing one. The only satisfactory way to do this is to start from scratch and build two identical playback amplifiers and feed these from the

signals from the double track heads.

The answer would thus seem to be “don't modify but start from scratch” and to do that you need to be reasonably experienced—circuits for stereo tape recorders appear from time to time in our sister magazine *Practical Electronics* to which we hope you will progress as you get more confident in handling complex circuits.

Using Veroboard

I have read—somewhere—that Veroboard is not recommended for use in radio circuits why is this?

In some radios it is true that Veroboard can give problems. Because of the very close proximity of the conducting strips you can get parasitic capacitive coupling between stages and this can affect tuning and in some instances cause the circuit to be unstable and oscillate. In our designs we are very much aware of this problem and will only specify Veroboard in non critical applications.

Transformer Addition

Can I step up the output of my 1 watt transistor amplifier by putting a transformer between it and the loudspeaker.

No! The output of the amplifier is designed to match the impedance of a loudspeaker to give optimum power coupling. By putting in a transformer you will upset this coupling and at best will get slightly less power output. At worst you might damage the output transistors of your amplifier. Remember a transformer does not give power transformation—only voltages and currents are changed and always at the expense of each other.

Thyristor Check

Is there any “quick and easy” way of checking if a thyristor is working?

The following method will check if a thyristor is working but it will not check whether it is capable of withstanding higher voltages or for that matter will not

show any leakage current problems which might be encountered when operating at normal mains voltages.

Use a 9V battery and a 6V 150mA bulb in series with the anode/cathode circuit of the thyristor under test. The bulb should be between the anode and the positive terminal of the battery; the cathode goes straight to the negative terminal. The bulb should not light up. Now, with an extra lead and a 100 ohm resistor in series, connect from the positive battery terminal to the gate connection of the thyristor momentarily. The bulb should light up and stay alight even though you remove the connection to the gate.

Momentarily disconnect the main circuit and reconnect and the bulb should go out and stay out. This test should work for most thyristors available but one ought to say that there are a few devices around which need more gate current than this simple circuit can provide.

Dissipation

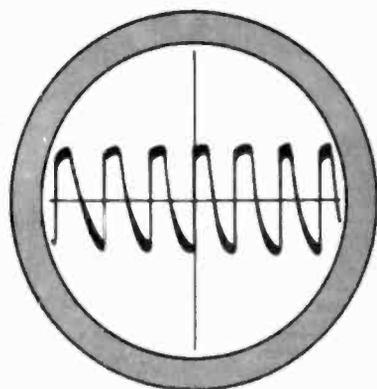
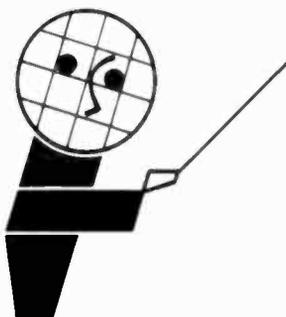
When I made your *Cassette Power Supply* (car version) it worked fine for about ten minutes and then TR2 blew. Admittedly I was not using the Philips unit as specified but as it worked for a bit and the current drawn was within the transistor's rating why should it “go” after a period of time.

The problem is that too much power is being dissipated in TR2. In this case the current rating is not the most important parameter of the transistor. Although the specification for it says it will pass up to 1 amp without damage you have to remember that the power dissipated within it is given by the voltage drop across it multiplied by the current going through it at the time and the product of these must not exceed 0.8 watts. It is likely you are exceeding this maximum power and the effect would be for the transistor to get hotter and hotter until something “goes” inside. The solution is to get the heat out faster than it is being generated and to do this might be necessary to go to a higher power dissipation transistor. A common device which is more than adequate would be a 2N3055.

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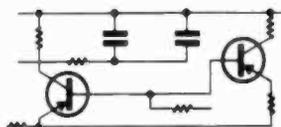
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Sinclair Project 60

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Such are the results of using a PZ8 Mk.3 to drive two Z.50 Mk.2 power amplifiers. Developed from the original Z.50, the Mk.2 has improved thermal stability, better regulated D.C. limiting to ensure more symmetrical output voltage swing with still less distortion at lower outputs and automatic transient overload protection. The PZ.8 Mk.3 is the most advanced power supply unit ever to be made at a reasonable price. It cannot be damaged by direct shorting, nor will it fail through overloading, because of an ingenious re-entrant current limiting principle used usually only in expensive laboratory equipment. Because output voltage is variable, the PZ8 Mk.3 makes a worthwhile alternative where PZ.5 and PZ.6 are recommended for Project 60 applications, particularly since this most powerful of all Sinclair supply units can be operated from a smaller mains transformer. Together, the Z.50 Mk.2 and PZ8 Mk.3 provide new standards of performance and reliability and these modules are compatible with earlier types in the Project 60 range.

Z.50 Mk.2 SPECIFICATIONS

Input impedance 100 K Ω
 Input (for 30W into 8 Ω) 400mV
 Signal to noise ratio, referred to full o/p at 30v HT 80dB or better
 Distortion 0.02% up to 20W at 8 Ω .
 See published curve
 Frequency response 10Hz to more than 200 KHz \pm 1dB
 Max. supply voltage 45v (4 Ω to 8 Ω speakers) (50v 15 Ω speakers only)

Min. supply voltage 9v

Load impedance - minimum: 4 Ω at 45v HT

Load impedance - maximum: safe on open circuit

£5.48 - V.A.T.
54p

PZ.8 Mk.3 SPECIFICATIONS

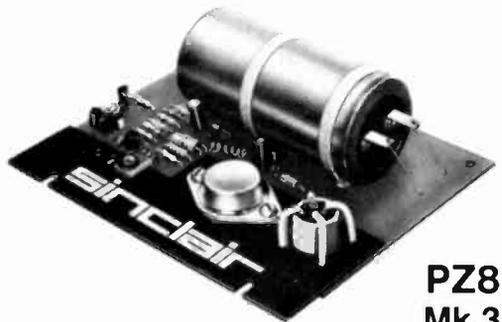
Nominal working output 45V.
 Adjustable between 20 & 50V

£7.98 - V.A.T.
79p

Mains Transformer: £5.98 - V.A.T. 59p



Z.50
Mk 2



PZ8
Mk 3

Other power supplies

In addition to the remarkable Sinclair PZ.8 Mk.III as described, there are two other power units available, which should be chosen according to their types in order to buy to best advantage. All are for operation from A.C. mains 240V.

PZ.5 30 volt, unstabilised £4.98
+ V.A.T. 49p

PZ.6 35 volt, stabilised (Not suitable for Super IC.12). £7.98
+ V.A.T. 79p

Guarantee

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd., you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

Each Project 60 module is tested before leaving our factory and guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you. A small charge may be made in those cases where damage arises through miss-use. No charge is made for postage by surface mail. Air Mail charged at cost.

Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	Z.50	Crystal P.U., 12V battery volume control, etc.	£5.48 + V.A.T. 54p
Mains powered record player	Z.50, PZ.5	Crystal or ceramic P.U. volume control, etc.	£10.46 + V.A.T. £1.04
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.50. Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	£25.92 + V.A.T. £2.59
25W. RMS continuous sine wave stereo amp. using low efficiency (high performance) speakers	2 x Z.50. Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	£28.92 + V.A.T. £2.89
80W. (3 ohms) RMS continuous sine wave deluxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50 Mk.2. Stereo 60; PZ.8 Mk.3 transformer	As above	£34.90 + V.A.T. £3.49
Indoor P.A.	Z.50 Mk.2. PZ.8 Mk.3 transformer	Mic., guitar, speakers, etc., controls	£19.44 + V.A.T. £1.94

A.F.U. (£5.98 + V.A.T. 59p) may be added as required.

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SINCLAIR RADIONICS LTD., LONDON RD., ST. IVES, HUNTINGDONSHIRE PE17 4HJ Telephone: St. Ives (0480) 64311 Telex: 32250 Reg. No. 699483 England

the world's most advanced high fidelity modules

Q.16 high fidelity loudspeaker

The Q 16 employs original and by now well proven acoustic principles in which a special driver assembly is meticulously matched to a uniquely designed cabinet. In performance it comfortably stands comparison with very much more expensive loudspeakers. A solid teak surround is used with a special all-over cellular black foam front chosen both for its appearance and ability to pass all audio frequencies without masking.

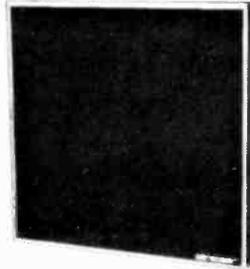
Specifications

Construction: A sealed seamless sound or pressure chamber is used with internal baffle, and special high flux driver

Loading: Up to 14 watts RMS, into 8 ohms

Frequency response: From 60 to 16,000 Hz

Size and styling: 248 mm square x 120 mm deep (9 7/8" x 4 3/4") with neat pedestal base.



£7.70 + V.A.T. 77p

Project 605



the simple way to build a Project 60 system without soldering

For the many audio enthusiasts anxious to build to high standards without too many involvements, there could be nothing better or simpler than Project 605. It offers the advantages of Project 60 and is absolutely complete down to the last piece of wire cut to length. Whilst not as powerful as assemblies using Z.50 power amplifiers, we know from experience that there are many for whom the specifications of Project 605 are ideal, particularly in relation to the environment in which it is required to be used. In Project 605 you have everything necessary to build a versatile Project 60 thirty watt high fidelity amplifier system suitable for all domestic requirements. The convenient pack includes two Z.30 power amplifiers, a Stereo 60 pre-amp control unit and the special Masterlink unit to and from which all input and output connections are made. For power a PZ.5 is provided. Building is particularly easy since all necessary leads are supplied colour coded, cut to length and terminated by contact clips which connect firmly to the modules. There is absolutely no soldering to be done. Complete with comprehensive, easy to follow instructions manual.

£29.95 + V.A.T. £2.99 Post free

Send coupon for leaflet

Please send leaflet and name and address of my nearest Sinclair stockist

Name _____

Address _____

SINCLAIR RADIONICS LTD., LONDON ROAD, ST. IVES, HUNTINGDON PE17 4HJ

EE2

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Stereo 60 pre-amp/control unit

Designed specifically for Project 60 systems, the Stereo 60 is equally suitable with any high quality power amplifier. Silicon epitaxial planar transistors used throughout ensure high signal-to-noise ratio and excellent tracking between channels. Input selection is by press buttons, with accurate equalisation on all input channels. The unit is easy to mount.

SPECIFICATIONS—Input sensitivities: Radio—up to 3mV, Mag. p.u. 3mV; correct to R.I.A.A. curve ± 1 dB. 20 to 25,000Hz. Ceramic p.u.—up to 3mV. Aux.—up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE: 12 to -12 dB at 10KHz. BASS: $+12$ to -12 dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

Built, tested and guaranteed.

£9.98 + V.A.T. 99p



AFU filter unit

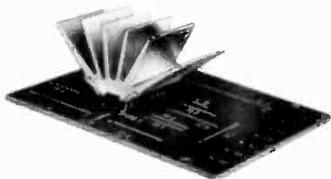
For use between Stereo 60 and two Z.30's or Z.50's in stereo formation. Cut off frequencies are continuously variable, with 12dB/octave cut in the rejection band. Two stages of filtering—rumble (high pass) and scratch (low pass). Amplitude and phase distortion are negligible. Supply voltage needed—15–35V. H.F. cut-off (-3 dB) 28KHz to 5KHz. L.F. (-3 dB) 25Hz to 100Hz. For Project 60 or any good stereo system.

Built, tested and guaranteed

£5.98 + V.A.T. 59p



Super IC.12 Integrated circuit high fidelity amplifier



Having introduced Integrated Circuits to hi-fi constructors with the IC.10, which was the first time an IC had ever been made available for such purposes, we followed it with an even more efficient version, the Super IC.12. This needs very few external resistors and capacitors to make an exceedingly efficient high fidelity amplifier for pick-up, F.M. radio or small P.A. set up etc. The free 40 page manual supplied details many other applications which this remarkable IC make possible. The Super IC.12 is the equivalent of a 22 transistor circuit

contained within a 16 lead DIL package, and the finned heat sink is sufficient for all likely requirements. The Super IC.12 is also compatible with those Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak) into 6–8 Ω . **Frequency Response:** 5Hz to 100KHz ± 1 dB. **Total Harmonic Distortion:** less than 1%. (Typical 0.1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 x 45 x 28mm including pins and heat sink.

Manual available separately 15p post free

With FREE printed circuit board and 40 page manual.

£2.98 + V.A.T. 29p Post free

ALL PRICES QUOTED IN THIS ADVERTISEMENT ARE THE RECOMMENDED RETAIL PRICES.

KITS FOR PREVIOUS PROJECTS

Unless otherwise stated, kits contain electronic parts only. The case and special items can be obtained locally. Also batteries are not included. Kits may be returned for refund if construction has not been started. We reserve the right to substitute components should deliveries be protracted so as to avoid undue delay.

If reprint of data is required add 10p

HOME SENTINEL. "Ward off the unwanted intruder"—An elaborate setting up or wiring required. Kit of parts £4-25.

"SNAP" INDICATOR. Press your button first and your opponent is blocked also suitable for Quiz games and reaction testing. Kit of parts £1-10.

RECORD PLAYER. Good quality at a reasonable price—good enough for classical records and pop. Kit of parts £2-10.

WINDSCREEN WIPER CONTROL. Wet dirty road—Drizzle—Fog—Smear screen—Scraping wipers—combat these with add-on wiper control. Kit of parts £2-50.

FUZZ BOX. Add weird and interesting effects to guitar playing with this solid state Fuzz box. Kit of parts £2-10.

PHOTOGRAPHIC COLOUR TEMPERATURE METER. Must for colour photographer get the colours right gives quick indication of filters necessary for correction in any light. Can be used with natural or Studio lighting. Kit of parts £2-50.

ASTON M.W. RADIO. A simple M.W. reflex circuit receiver easy to build £2-30.

REMOTE TEMPERATURE COMPARATOR. Measures small temperature changes in liquids or gases—fish tank, photographic solution—thermostatically controlled rooms etc. Kit £2-25.

RAIN WARNING ALARM. Keep your washing dry with this automatic alarm device. Kit £2-20.

WAA WAA PEDAL. Add excitement and sound vibration to your music. Kit £2-50.

ELECTRO LAUGH. Laughter simulator also useful electronic alarm. Kit of parts £2-20.

SOIL MOISTURE METER. Many plants are killed through over-watering—this meter measures soil moisture at root depth—probes can be left permanently beside the plant—indicator remotely housed could monitor several plants. Kit £2-20.

SIGNAL INJECTOR. A useful pocket instrument for fault finding in radio and amplifiers. Kit £1-10.

BABY ALARM. Keep a check on the kids—this device will give you peace of mind as you watch T.V. Kit £2-40.

SIMPLE CALCULATOR. Teaching aid for multiplication—can be used for quick checks. Kit £2-10.

POWER SUPPLY UNIT. Just right for testing low voltage circuits—a simple stabilised supply providing 0-16 volts D.C. continuously variable. Kit £2-20.

METAL LOCATOR. A simple easy to construct self-contained metal locator giving a meter indication of buried metal. Kit £2-50.

AUDIO TONE GENERATOR. Makes electronic music—covers range from 50—2000 Hz. Specifically designed for use with tape recorder. Kit £2-25.

LIGHT TO SOUND CONVERTER. Produces an audio tone—the frequency of which is dependent on the light level. Kit £2-15.

SHAYER INVERTER. Provides 240v 50Hz from 12 volt car battery—gives approx. 10 watts which is enough for most shavers. Kit £4-25.

ELECTRONOME. Electronic Metronome with pulse frequency continuously variable from 40—225 beats per minute. Kit £2-15.

THROUGH LENS LIGHT METER. A simple light meter for use with single lens reflex camera. Kit £2-25.

MEDIUM AND LONG WAVE RADIO TUNER. A simple radio tuner for use with almost any amplifier. Kit £2-25.

INFRARED BURGLAR ALARM. Uses an invisible reflected beam to detect intruders when beam is interrupted—a power output is switched on for up to one minute. Kit £4-25.

CASSETTE TAPE POWER SUPPLIES. Two units to power a cassette tape player or recorder one from the mains. Price £2-50. Two from the car battery—price £1-40.

REACTOMATIC. A reaction testing game that can also be a quiz answering indicator. Kit £2-20.

ELECTRONIC MOUSE TRAP. A humane mouse trap—catches them alive so that you can release them in the park. Kit £2-25.

TRANSISTOR TESTER. A rapid tester for checking most transistors—tests transistors in an oscillator circuit and gives audible indication of goodness. Kit £2-15.

BIT SAVER. Prolongs life of soldering iron bit—prevents pitting. Kit £1-25.

ICE WARNING DEVICE. A device that can be set to indicate 'ice' conditions or similar temperature levels. Kit £1-25.

AUDIO COLOUR UNIT. Add a colour dimension to your audio equipment. This unit will modulate three lamps in accord with Bass—middle and treble notes of any music. Kit of parts £7-20.

U.H.F. T.V. AERIAL. A simple aerial for U.H.F. reception on your band could improve your reception immensely. Kit £1-25.

DAMP LOCATOR. Easily carried in your pocket this little unit gives visible indication of damp. Kit £1-25.

ENLARGER & EXPOSURE METER. For D.I.Y. photographer £2-00.

EGG TIMER. Simple timer with audible warning. £2-15.

TERMS—10% discount if ten of an item ordered, and postage where quoted—other items, post free if order for these over £4-00 otherwise add 20p.

MULLARD UNILEX

This D.I.Y. Stereo Amplifier is still available complete at £7-00 for the four Mullard Modules, or Modules can be bought separately as follows:—4 watt amplifier module (2 required) Mullard Ref. No. E.P.9000—£1-60 each.
750m amp module Mullard Ref. No. E.P.9001—£1-90 each.
Power module—Mullard Ref. No. E.P.9002—£2-25 each.
Central panel parts with scotchcote and ally faced knobs—£2-25

SPECIAL OFFER the complete Unilex with control panel and 2 matching speakers. **£14**

THYRISTOR LIGHT DIMMER

Domestic model for any lamp up to 250 watt. Mounted on switch plate to fit in place of standard switch. Virtually no radio interference. Price £2-25. Industrial model 5 amp module with control knob £2-20.



DISTRIBUTION TABLES

Just what you need for work bench or lab

4 x 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2-50 plus 25p P. & I

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quiet running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4" x 4" x 4". When mounted by flange, air is blown into the equipment but to suck air out, mount it from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, flem drying cabinet or for removing fux smoke when soldering etc. A real bargain at £2-05.

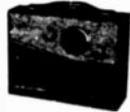


TEACH-IN '74 SOLID STATE DIMMER STEREO HEADPHONE ADAPTOR

To receive parts for these and other feature projects send the quoted approximate amounts and any cash adjustment can be made later.

GOOD COMPANION

We can now offer these again in i.c. version using Ferranti ZN414 and Mullard AF Modules 1172. Excellent tone wood cabinet. Cabinet size approx. 11in wide x 8in. high x 3in. deep. Complete assembly instructions £2-75 plus 25p post and ins.



MIGHTY MIDGET

Probably the tiniest portable radio, as described in 'Practical Wireless', January '73. All electronic parts £2-20 post paid.

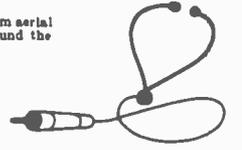


DRILL CONTROLLER NEW IKW MODEL

Electrically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1-60 plus 15p post and insurance. Made up model also available. £2-50 plus 15p post a p.

RADIO STETHOSCOPE

Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV amplifier, anything a complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2-20—twin stethoscope instead of earpiece £2-25 extra—post and ins. 20p.



MULLARD AUDIO AMPLIFIERS

All in module form, each ready built complete with heat sinks and connection tags, data supplied.

Model 1153 500m watt power output 25p.

Model 1172 750m watt power output 24p.

Model EP9000 4 watt power output £1-60.

EP9001 Stereo preamp £2.

10% discount if 10 per type or more ordered.

HORTSMAN 24 HOUR TIME SWITCH

With 6 position programmer. When fitted to hot water systems this could programme as follows:—

Programme	Hot Water	Central Heating
0	ON	ON
1	Twice daily	ON
2	All day	ON
2	Twice daily	Twice daily
4	All day	All day
5	Continuously	Continuously

Suitable of course, to programme other than central heating and hot water, for instance, programme upstairs and downstairs electric heating or heating and cooling or taped music and radio. In fact there is no limit to the versatility of this Programmer. Mains operated—Size 3" x 3" x 2" deep as illustrated but less case. Price £2-50 each.



KITS FOR PREVIOUS PROJECTS CONT. FROM LEFT HAND COL.

NEON NOVELTY. Interesting modern ornaments! device £1-25.

INDICATOR AUDIBLE WARNING. Add this audible warning device to car indicators or dashboard warning lights and your attention will be instantly drawn to the warning lamp kit. £1-20.

NIGHT LIGHT SWITCH. A simple control to dim a lamp. Kit £1-10.

GENERAL PURPOSE AMPLIFIER. An audiophile amplifier of reasonable quality for use with radiograms—audio oscillators, record decks—electric guitars, etc. Kit £4-00.

SOME INTERCOM. Keep in touch with this simple, easily connected good quality two way intercom. Kit £2-00.

FLASHING LIGHT METRONOME. For use in the musical field and the laboratory—where an audible not on click could get lost or become annoying. Kit £1-40.

MINI ORGAN. A three octave, stylus operated organ—neatly and simply constructed on a printed circuit board. Kit £2-75.

RAIN ALARM II. Bountiful an audible alarm as soon as the first rain drops fall. Kit £2-00.

CASSETTE AMPLIFIER. Boosts the output from cassette tape recorders and transistor radio. Kit £2-50.

AUDIO SIGNAL MIXER. Where you want to mix speech and music, and to fade them in and out—no tape enthusiast should be without this. Kit £2-20.

AUTO FAN. A thermostatic control for car engine fan, gives quicker warming up time, etc. Kit £2-25.

SLAVE FLASH. Photos taken with a single flash have a "flat" appearance a second flash correctly positioned overcomes this. This unit enables a second (or third) flash to be automatically triggered. Kit £1-25.

ELECTRONIC DOORBELL. Not in fact a bell but an electronic circuit that produces an unusual sound when the button is pressed. Kit £2-00.

WAA WAA. Add another sound dimension to your guitar or organ. Kit £1-60.

I.C. RADIO. A fantastic personal radio uses a special I.C., is small, easy to build, yet gives excellent results. Kit £2-10.

AQUARIUM THERMOSTAT. A very sensitive electronic thermostat. Can also be used for other applications requiring fine control of temperature. Kit £2-25.

TRAIN CONTROLLER. With most control there is considerable loss of power on low speeds—this unit overcomes this problem and makes slow speed realistic. Kit £2-15.

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:—
2 track record playback heads 50p each.
4 track record playback heads 75p each.
3 track heads are also available separately—
2 track 25p—4 track 50p

AC CONDENSERS

In addition to the normal uses as motor starters, power factor correction etc. These make very good voltage droppers for working low voltage appliances from mains. The voltage working quoted is AC and condensers are usually suitable for working on DC at 2 1/2 times the quoted AC voltage.

1-5 mfd 400v 25p 5 mfd 570v 66p 8 mfd 400v 85p
2 mfd 440v 25p 6-25 mfd 250v 12 mfd 250v 77p
3-4 mfd 440v 44p 55p 15 mfd 250v 88p
3-8 mfd 250v 25p 8 mfd 250v 65p 20 mfd 275v 99p

TINIEST AUDIO UNIT

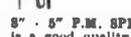
Although only the same size as an Oxo cube these are completely self contained and comprise microphone, 3 transistor amplifier with volume control and battery compartment and finally a dynamic earpiece. All in a plastic case. Made by Ardent (Solid, we believe at over £20 each). These are really hearing aids complete except for the ear tube but we are not selling these as hearing aids only for the micro midsize parts they contain. Believed to be in perfect working order but not tested. Price £2-50 each.

MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. 50hp at 60p. Postage 20p for first one then 10p for each one ordered.
1" stackmotor 24p.
1 1/2" stackmotor £1-10.

NEED A SPECIAL SWITCH

Double Leaf Contact. Very slight pressure closes both contacts. 5p each 10 for 80p. Plastic pushrod suitable for operating. 5p each. 10 for 64p.



5" x 5" P.M. SPEAKER. 15 ohm—£1-60. This is a good quality speaker by famous maker High flux ideal for use with our Mullard 4 watt amplifier.

3 GANG TUNING CONDENSERS. 500pF each section ideal for transmitter or communications receiver. 51p.

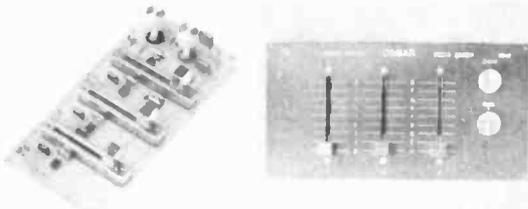
1 1/2" TRACE TAPE HEAD for 1" or 1 1/4" tape. This is a brass encased tape head and measures approx 1 1/2" x 1 1/2" x 1 1/2". Resistance is approx. 20-20 ohms. These heads are beautifully made but we have no technical data, also have only a limited quantity. Price £2-50 each or 10 for £25.

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 7 Park Street, Croydon CRO 1YD

Callers to: 102/3 Tamworth Road, CROYDON.

DABAR MN3 MIXER KIT



INTRODUCING THE NEW DABAR MINI THREE CHANNEL MIXER KIT WITH THE FOLLOWING FEATURES:

- ★ Three inputs easily adjustable to suit users input requirements. e.g., Mic., Tape, Disc., etc.
- ★ Uses advanced design with five integrated circuits.
- ★ Slider fader volume controls mount directly on P.C. board.
- ★ Full range bass and treble controls.
- ★ Guaranteed top grade components with fibreglass printed circuit board, ready-drilled and tinned.
- ★ Battery operated (2 x PP3) not supplied with kit.
- ★ Easy to follow assembly instructions (available separately 25p).
- ★ Attractive ready punched facia plate, available at extra cost, gives that professional finish to the unit.
- ★ Size: 9.5" x 4.8" x 2".

PRICE: KIT ONLY £11.00
 FACIA PLATE £1.50
 MANUAL AND ASSEMBLY INSTRUCTIONS 25p
 AVAILABLE READY BUILT WITH FACIA £15.00

ALL PRICES INCLUDE V.A.T. & POSTAGE IN U.K.

S.A.E. ALL ENQUIRIES.

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WE GUARANTEE THAT WITHIN 7 DAYS OF PURCHASE IF ANY ITEM OF GOODS IS FOUND TO BE DEFECTIVE WE WILL REPLACE THE SAID GOODS WITHOUT QUESTION. AFTER 7 DAYS GOODS ARE COVERED BY MANUFACTURERS 12 MONTHS GUARANTEE.

ALL PRICES ARE INCLUSIVE OF V.A.T.

FANTASTIC OFFER
GARRARD SP25 Mk III
 Goldring G800. Teak finish, plinth and tinted cover with mains lead and DIN plug and screened lead. All fully wired.
 Please add £1.75 for P. & P. & Ins. **£15.20**

TURNTABLES

Please add 95p P. & P. & Ins.
 BSR MP60 £9.15
 Garrard SP25 Mk III £9.50
 Garrard SL65B £13.25
 Garrard AP76 £17.95
 Garrard 401 £24.85
 Garrard Zero 100 sgl. £33.55
 Garrard Zero 100 auto. £36.50
 Goldring G185/P&C £59.35
 Goldring G101P P&C £19.40
 Goldring GL72 £21.95
 Goldring GL72/P £28.55
 Goldring GL75 £27.40
 Goldring GL75P £33.90
 Goldring GL75 Lid £3.85
 Leak Delta £44.20
 Pioneer PL12D £35.10
 Thorens TD125 £58.55
 Thorens TD125 AB Mk II £89.50
 Thorens TD160 AB&C £49.30
 Wharfedale Linton with cart. £25.00

TUNERS

Please add 93p P. & P. & Ins.
 Alpha Highgate FT 150 £33.30
 Amstrad Multiplex 3000 £24.90
 Leak Delta FM (Cased) £47.45
 Leak Delta AM/FM £55.90
 Metrosound FMS 20 Mk II £38.35
 Rogers R/brook FET4 (Cha.) £29.50
 Rogers R/brook FET4 (Cased) £31.90
 Rogers R/bourne FET4 (Cased) £41.25
 Sinclair PRO60 Mod. £14.90
 Sinclair cased tuner £26.15

TUNER/AMPLIFIERS

Please add £1.10 P. & P. & Ins.
 Alpha FR 3000 £61.35
 Goodmans Module 80 £59.90
 Goodmans Mod 80 Com £100.00
 Goodmans Mod 90 £74.65
 Goodmans One-Ten £86.65
 Leak Delta 75 £107.75
 Rogers R/brook cha. £62.30
 Rotel 150A £45.90
 Rotel 203A £58.95

AMPLIFIERS

Please add 95p P. & P. & Ins.
 Amstrad 8000 Mk II £16.45
 Amstrad IC2000 £28.15
 Amstrad Integra 4000 £23.45
 Alpha Highgate FA400 £39.05
 Global 10+10 £19.75
 Global 20+20 £25.20

All prices correct at time of press E. & O. E. and are subject to alterations.

Leak Delta 30 £49.40
 Leak Delta 70 £63.10
 Metrosound ST20E Mk II £32.50
 Metrosound ST60 £35.50
 Rogers R/brook Ch. £41.15
 Rogers R/brook Ca. Mk III £42.25
 Rogers R/bourne Ch. £54.25
 Rogers R/bourne Ca. £54.95
 Sinclair 2000 £24.00
 Sinclair 3000 £30.50
 Sinclair 605 £21.45
 Sinclair PRO 60 2 x Z30/PZ5 £16.40
 Sinclair PRO 60 2 x Z30/PZ6 £19.45
 Sinclair PRO 60 2 x Z50/PZ8 Trans. £25.25
 Sinclair AFU (Filter Unit) £4.95
 Sinclair Stereo 60 Pre-amp £7.35
 Sinclair IC 12 (Int. Circ.) £2.20
 Sinclair Z3 Amp. £3.85
 Sinclair Z50 Amp. £4.50
 Sinclair PZ5 Power Supp. £4.20
 Sinclair PZ6 Power Supp. £6.15
 Sinclair PZ8 Mains Trans. £4.95
 Sinclair PZ8 Power Supp. £6.15

SPEAKERS

£1.65 for P. & P. (per pair)
 Amstrad Acoustra 1500 £27.95
 Amstrad Acoustra 2500 £31.95
 Apollo 138 £14.05
 B&W DMX.5 £41.65
 Celestion Ditton 15 £45.50
 Celestion Ditton 44 £74.90
 Goodmans D/Maxim £39.70
 Goodmans Mavox 3 £49.70
 Goodmans Havant £34.45
 Kelatron L5 100 £18.95
 Leak 150 £32.75
 Sinclair O16 £10.95
 Sinclair O30 £30.60
 Wharfedale Denton II £26.65

SPEAKER UNITS

Wharfedale Unit 3 £15.60
 Wharfedale Unit 4 £27.25
 Wharfedale Unit 5 £39.60

PLINTH & COVERS

£3.02*

For Garrard SP 25, 2025 TC, 3000, BSR McDonald MP60 £3.08, P. & P. 71p. For AP76, SL72B, SL95B, etc. £4.51, + 71p P. & P.

CARTRIDGES

Please add 11p P. & P. & Ins.
 Goldring G850 £2.85
 Goldring G800 £3.70
 Goldring G800E £6.45
 Goldring G800SE £12.15
 Shure M3D £3.10
 Shure M4E £4.40
 Shure MS5E £5.00
 Shure 75EO Type 2 £9.35
 Shure V15 £25.95
 Shure M75EJ Type 2 £8.10

GLOBAL AUDIO DISCOUNT WAREHOUSES

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H1012 £1.87

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SELECTED RESISTORS

R1. Our mix. 1/2 watt carbon—50 for 55p

CAR STEREO SPEAKERS

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BI-PAK

CATALOGUE AND LISTS
Send S.A.E. and 10p.

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BA4	5 1/2"	4"	1 1/2"	47p
BA5	4"	2 1/2"	2"	41p
BA6	3"	3"	1"	34p
BA7	7"	5"	2 1/2"	66p
BA8	8"	6"	3"	84p
BA9	6"	4"	2"	54p

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De Luxe Groov-Kleen

Model 42 £1.84

Chrome Finish Model 60 £1.50



Ref. 36A. Record/Stylus Cleaning Kit 28p
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Ref. 31. Cassette Head Cleaner 64p
Ref. 32. Tape editing Kit £1.54
Model 9. Wire Stripper/Cutter 83p

Ref. P. Hi-Fi Cleaner 31p
Ref. 32A. Stylus Balance £1.36
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Ref. 34. Cassette Case £1.27
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SOLDER: 188WG Multicore 7oz 82p
228WG 7oz 82p. 188WG 22ft 28p
228WG Tube 22p

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102 For model CN240 3/16" 28p
1100 For model CCN240 3/32" 28p
1101 For model CCN240 3/8" 28p
1102 For model CCN240 1" 28p
1020 For model G240 3/32" 28p
1021 For model G240 1/8" 28p
1022 For model G240 3/16" 28p
50 For model X25 3/32" 37p
51 For model X25 1/8" 37p
52 For model X25 3/16" 37p

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ECN 240 £1.16 ECCN 240 £1.16
EG 240 £1.16 EX 25 £1.16

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NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C1	250	Resistors mixed values approx. count by weight	0.55
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C3	50	Precision Resistors .1%, mixed values	0.55
C4	75	1/4 W Resistors mixed preferred values	0.55
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PS 36 DIN 3 Pin 0-10
PS 37 DIN 5 Pin 180° 0-10
PS 38 DIN 5 Pin 240° 0-10
PS 39 Jack 2.5mm Switched 0-09
PS 40 Jack 3.5mm Switched 0-10
PS 41 Jack 1" Switched 0-17
PS 42 Jack Stereo Switched 0-26
PS 43 Phono Single 0-06
PS 44 Phono Double 0-10
PS 45 Car Aerial 0-09
PS 46 Co-Axial Surface 0-08
PS 47 Co-Axial Flush 0-14

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PS 21 D.I.N. 2 Pin (Speaker) 0-13
PS 22 D.I.N. 3 Pin 0-17
OS 23 D.I.N. 5 Pin 180° 0-17
PS 24 D.I.N. 5 Pin 240° 0-17
PS 25 Jack 2.5mm Plastic 0-10
PS 26 Jack 3.5mm Plastic 0-12
PS 27 Jack 1" Plastic 0-24
PS 28 Jack 1" Screened 0-28
PS 29 Jack Stereo Plastic 0-22
PS 30 Jack Stereo Screened 0-32
PS 31 Phono Screened 0-14
PS 32 Car Aerial 0-15
PS 33 Co-Axial 0-17

PLUGS

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PS 2 D.I.N. 3 Pin 0-12
PS 3 D.I.N. 4 Pin 0-15
PS 4 D.I.N. 5 Pin 180° 0-14
PS 5 D.I.N. 5 Pin 240° 0-15
PS 6 D.I.N. 6 Pin 0-15
PS 7 S.I.N. 7 Pin 0-15
PS 8 Jack 2.5mm Screened 0-10
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PS 10 Jack 3.5mm Screened 0-12
PS 11 Jack 1" Plastic 0-13
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PS 15 Car Aerial 0-15
PS 16 Co-Axial 0-10

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CP 1 Single Lapped Screen 0-08
CP 2 Twin Common Screen 0-08
CP 3 Stereo Screened 0-08
CP 4 Four Core Common Screen 0-22
CP 5 Four Core Individually Screened 0-30
CP 6 Microphone Fully Braided Cable 0-10
CP 7 Three Core Mains Cable 0-07
CP 8 Twin Oval Mains Cable 0-08
CP 9 Speaker Cable 0-04
CP 10 Low Loss Co-Axial 0-10

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Log and Lin
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VC 2 Single D.P. Switch 0-26
VC 3 Tandem Less Switch 0-44
VC 4 1K Lin Less Switch 0-14
VC 5 100K Log anti-Log 0-14

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0-1 watt 0-06 each
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Resistor Colour Code Disc Calculator 10p

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AC08 GP91-19C. 200mV at 1-2cm/sec £1.18

AC08 GP93-1. 280mV at 1cm/sec £1.65

AC08 GP96-1. 100mV at 1cm/sec £2.65

TTC J-2005. Crystal/Hi Output 85p

TTC J-20 10C Crystal/Hi Output Compatible £1.10

TTC J-200 C8 Stereo/Hi Output £1.60

TTC J-2105 Ceramic/Med. Output £1.94

CARBON FILM RESISTORS

The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—
R1 50 Mixed 100 ohms–820 ohms 40p
R2 50 Mixed 1K ohms–8-2K ohms 40p
R3 50 Mixed 10K ohms–82K ohms 40p
R4 50 Mixed 100K ohms–1 Meg. ohms 40p
THESE ARE UNBEATABLE PRICES—LESS THAN 1p EACH INCL. V.A.T.

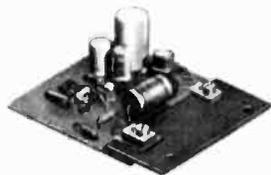
BI-PAK SUPERIOR QUALITY LOW-NOISE CASSETTES

C80, 32p C90, 41p C120, 52p

-the lowest prices!

BI-PAK QUALITY COMES TO AUDIO!

AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



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

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

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

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

AUDIO AMPLIFIER MODULES

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

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £2-25
FRONT PANELS PA 12 with Knobs £1-00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4-95
PA 100. (Use with AL30 & AL50) £13-15

TRANSFORMERS

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

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with ceramic cartridges while the auxiliary input will suit most magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm x 84mm x 35mm.

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

EA1000 AUDIO AMP MODULE 5 WATTS R.M.S.

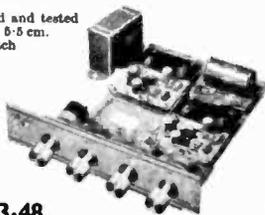


Module Tested and Guaranteed. Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

SPECIAL OFFER £2 each while stores last

The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 6.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls, Transformer, Power supply and Power amp. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 20Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion ±12dB at 1W. Harmonic distortion typically 0.25% at 1 watt. Treble con. ±14dB at 14kHz. **£13.48**

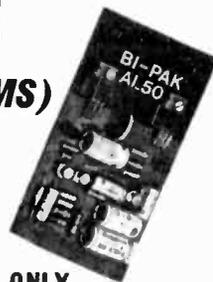


50W pk 25w (RMS)

0.1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

- ★ Frequency Response 15Hz to 100,000-1dB.
- ★ Load—3, 4, 8 or 16 ohms.
- ★ Distortion—better than .1% at 1 KHz.
- ★ Signal to noise ratio 80dB

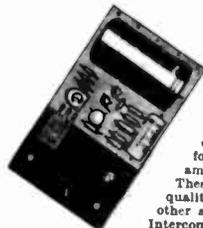


ONLY
£3.58 each

- ★ Supply voltage 10-35 Volts.
- ★ Overall size 63mm 105mm x 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
FULLY BUILT—TESTED—GUARANTEED.

STABILISED POWER MODULE SPM80



AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm x 105mm x 30mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including—Disc Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3.25**

TRANSFORMER. BMT80 £2-15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

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



SPECIFICATION

Frequency Response 20Hz - 20KHz ± 1dB
Harmonic Distortion better than 0.1%
Inputs: 1. Tape Head 1.25 mV into 50K Ω
2. Radio, Tuner 35 mV into 50K Ω
3. Magnetic P.U. 1.5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.
Bass Control ± 15dB at 20Hz
Treble Control ± 15dB at 20 KHz
Filters: Rumble (Elgh Pass) 100Hz
Scratch (Low Pass) 8KHz
Signal/Noise Ratio better than -65dB
Input overload + 26dB
Supply + 35 volts at 20mA
Dimensions 292mm x 82mm x 35mm

ONLY £13.15
SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 & 1 PA100 ONLY £25.30 FREE p. & p.

Giro No. 388-7006

Please send all orders direct to warehouse and despatch department

BI-PAK

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Postage and packing add 11p. Overseas add extra for airmail.
Minimum order 55p. Cash with order please.
Guaranteed Satisfaction or Money Back

G.W. SMITH & CO (RADIO) LTD

AUDIOTRONIC MODEL ATM.1

Top value 1000 o.p.v. pocket multimeter. Ranges: 0/10/50/250/1000v. A.C. and D.C. DC Current 0-1mA/100mA. Resistance 0/180k ohms. Decibels -10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads. £8.50. Post 15p.



LT601 MULTIMETER

New style 20,000 o.p.v. pocket multimeter. 8/25/50/250/500/2500 V. D.C. 10/50/100/500/1000V. A.C. 50µA/250mA. 6K/6 meg ohms. -20 to +22 dB. £8.75. Post 20p.



MODEL TH-12

90,000 o.p.v. Overload protection. Slide switch selector 0/25/2.5/10/50/250/1000V. D.C. 0/10/50/250/1000V. A.C. 0/50µA/25/250mA. D.C. 0/1K/30K/300K/3 meg. -20 to +50dB. £8.97. Post 15p.



RUSSIAN 22 RANGE MULTIMETER

Model U487, 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2.5/10/50/250/500/1000V. D.C. 2.5/10/50/250/500/1000V. A.C. DC Current 10µA/110/100mA/1A. Resistance 800 ohms/330/300K/3mΩ. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE £4.95. P. & P. 25p



MODEL PL436

80kΩ/Volt D.C. 8kΩ/Volt A.C. Mirror scale. -6/3/12/30/120/600 V D.C. 3/30/120/600 V A.C. 50/600µA/500/800 mA. 10/100K/1 Meg/10 Meg Ω -20 to +48dB. £8.97. P. & P. 12p.



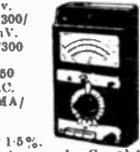
MODEL 500

90,000 O.P.V. with overload protection mirror scale 0/5/2.5/10/25/100/250/500/1000V. D.C. 0/2.5/10/25/100/250/500/1000V. A.C. 0/50µA/5/50/500mA. 12 amp. D.C. 0/60K/6 Meg/60 Meg Ω. Post paid. Leather Case £1.75



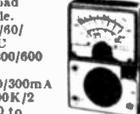
U4312 MULTIMETER

Extremely sturdy instrument for general electrical use. 607 o.p.v. 0/3/1.5/7.5/30/60/150/300/600/900 V AC and 75mV. 0/3/1.5/7.5/30/60/150/300/600/900 V A.C. 0/300µA/1.5/15/60/150/300µA/1.5/6 AMP. D.C. 0/200/2/2K/20K Ω. Accuracy DC 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions. £9.75. P. & P. 25p.



HIKOKI MODEL 700X

100,000 O.P.V. Overload protection. Mirror scale. 3/6/12/2.5/15/30/60/120/300/600/1200V DC 1.5/3/6/12/30/60/150/300/600 1200 V. A.C. 15/30µA/3/30/60/150/300mA 6/12 AMP. DC. 2K/200K/2 Meg/20 Meg ohm -20 to +63dB. £13.50. P. & P. 20p



MODEL C-7080 EN

Giant 6" mirror scale. 20,000 o.p.v. 0/25/1/2.5/10/50/250/1000/5000V. A.C. 0/2.5/10/50/250/1000/5000V. A.C. 0/50µA/1/10/100/500mA/10 amp. D.C. 0/2K/200K/20 meg -20 to +50 dB. £13.95. Post 35p.



370 WTR MULTI-METER

Features A.C. current ranges. 20,000 o.p.v. 0/3/2.5/10/50/250/500 1500 V. D.C. 0/2.5/10/50/250/500/1000V AC 5/50µA/1/10/100mA/10 Amp D.C. 0/100mA/1/10 Amp AC 0/5K/50K/500K/5 MEG/50 MEG. -20 +62db. £13. P. & P. 35p.



KAMODEN HM. 7200 MULTITESTER

High sensitivity tester. 200,000 o.p.v. Overload protection. Mirror scale. Ranges: 0/1/0.1/1/3/30/150/300/1200V. D.C. 0/3/12/60/300/11,200V. A.C. 0/6µA/1/2mA/120mA/600mA/12A. D.C. 0/12A. A.C. -20 to +63dB. 0/2K/200K/2 meg/200 meg ohms. £18.95. Post 30p.



TMK LAB TESTER.

100,000 O.P.V. 61in. Scale Buzzer Short Circuit Check. Sensitivity: 100,000 O.P.V. D.C. 5K/Volt A.C. D.C. Volts: 5, 2.5, 10, 50, 250, 1,000 V. A.C. Volts: 3, 10, 25, 50, 250, 500, 1,000V. D.C. Current: 10, 100µA, 10, 100, 500mA, 2.5, 10 amp. Resistance: 1K, 10K, 100K, 10MEG, 100MEG Ω. Decibels: -10 to +49 db. Plastic Case with Carrying Handle. Size: 7 1/2 in. x 6 1/2 in. x 3 1/2 in. £18.95. P. & P. 25p.



Model S-100TR MULTIMETER/ TRANSISTOR TESTER

100,000 o.p.v. mirror scale/overload protection. 0/12/6/3/12/30/120/600 V DC. 0/6/30/120/600. V AC. 0/12/600µA/12/300mA/12 AMP DC. 0/10 K/1 MEG/100MEG. -20 to +50db. 0-01-2 MPD. Transistor tester. Measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13.50. P/P 25p.



KAMODEN HM.350 TRANSISTOR TESTER

High quality instrument to test Reverse Leak current and DC current. Amplification factor of NPN, PNP, transistors, diodes, SCR's etc. 4" x 4 1/2" clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle. £12.50. Post 30p.



MODEL 449A IN CIRCUIT TRANSISTOR TESTER

Checks true A.C. beta in / out. Checks Icho. Checks diodes in / out. Checks SCR, etc. Beta HI 10 - 500. LO 2 - 50. Icho 0-5000µA. 220/240 V A.C. operation £17.50. Post 25p.



LB3 TRANSISTOR TESTER

Tests Ico and B. PNP / NPN. Operates from 9v battery. Complete with all instructions, etc. £9.95. P. & P. 20p.



LB4 TRANSISTOR TESTER

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10 meg. input. 10 ranges: 01/003/1/3/1/3/10/30/100/300V. R.M.S. 4cps.-1.2 Mc/s. Decibels -40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. £17.50 Carr. 25p.



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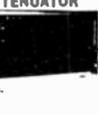
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500µA	£3.70
1mA	£3.60
20V. D.C.	£3.60
50V. D.C.	£3.60
300V. D.C.	£3.60
1 amp. D.C.	£3.60

Type MR.85P. 4 1/2 in. x 4 1/2 in. fronts

50µA	£3.90
100µA	£3.90
500µA	£3.90
1 amp.	£3.90
5 amp.	£3.90
15 amp.	£3.95
30 amp.	£3.95
20V. D.C.	£3.90
50V. D.C.	£3.90
150V. D.C.	£3.90
300V. D.C.	£3.90
18V. A.C.	£3.95
300V. A.C.	£3.95
5 Meter 1mA	£3.95
VU Meter	£4.45

Type MR.38P. 1 1/2 3 1/2 in. square fronts

200µA	£2.55
300µA	£2.55
500µA	£2.55
750µA	£2.55
1 amp.	£2.55
2 amp.	£2.55
5 amp.	£2.55
10 amp.	£2.55
15V. D.C.	£2.55
10V. D.C.	£2.55
15V. D.C.	£2.55
20V. D.C.	£2.55
50V. D.C.	£2.55
100V. D.C.	£2.55
300V. D.C.	£2.55
100V. A.C.	£2.55
300V. A.C.	£2.55
5 Meter 1mA	£2.55
VU Meter	£2.55

Type SD.830 82.5mm x 110mm Fronts

10mA	£3.10
100mA	£3.10
500mA	£3.10
1mA	£3.10
1 amp.	£3.10
5 amp.	£3.10
10 amp.	£3.10
5V. D.C.	£3.10
10V. D.C.	£3.10
20V. D.C.	£3.10
50V. D.C.	£3.10
300V. D.C.	£3.10
18V. A.C.	£3.10
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1mA	£3.10
VU Meter	£3.60

Type MR.52P. 2 1/2 in. square fronts

50µA	£3.50
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£2.95
500µA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95
50µA	£3.50
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£2.95
500µA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95
50µA	£3.50
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£2.95
500µA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95
50µA	£3.50
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£2.95
500µA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95
50µA	£3.50
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£2.95
500µA	£2.95
1mA	£2.95
5mA	£2.95
10mA	£2.95

Type MR.45P. 2 in. square fronts

50µA	£2.70
50-0-50µA	£2.65
100µA	£2.65
100-0-100µA	£2.60
500µA	£2.65
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.70
50-0-50µA	£2.65
100µA	£2.65
100-0-100µA	£2.60
500µA	£2.65
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.70
50-0-50µA	£2.65
100µA	£2.65
100-0-100µA	£2.60
500µA	£2.65
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.70
50-0-50µA	£2.65
100µA	£2.65
100-0-100µA	£2.60
500µA	£2.65
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
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Type SD.640 63.5mm x 85mm Fronts

50µA	£3.05
50-0-50µA	£3.05
100µA	£3.00
100-0-100µA	£3.00
500µA	£3.00
1mA	£3.00
50µA	£3.05
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£3.00
500µA	£3.00
1mA	£3.00
50µA	£3.05
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£3.00
500µA	£3.00
1mA	£3.00
50µA	£3.05
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£3.00
500µA	£3.00
1mA	£3.00
50µA	£3.05
50-0-50µA	£3.05
100µA	£3.05
100-0-100µA	£3.00
500µA	£3.00
1mA	£3.00

Type MR.65P. 3 1/2 in. x 3 1/2 in. fronts

50µA	£3.70
50-0-50µA	£3.15
100µA	£3.15
100-0-100µA	£3.10
500µA	£3.15
500µA	£3.15
500-0-500µA	£3.10
1mA	£3.10
5mA	£3.10
10mA	£3.10
50µA	£3.70
50-0-50µA	£3.15
100µA	£3.15
100-0-100µA	£3.10
500µA	£3.15
500µA	£3.15
500-0-500µA	£3.10
1mA	£3.10
5mA	£3.10
10mA	£3.10
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100µA	£3.15
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500µA	£3.15
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Type MR.65. 3 1/2 in. square fronts

50µA	£2.60
50-0-50µA	£2.60
100µA	£2.60
100-0-100µA	£2.60
500µA	£2.60
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.60
50-0-50µA	£2.60
100µA	£2.60
100-0-100µA	£2.60
500µA	£2.60
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.60
50-0-50µA	£2.60
100µA	£2.60
100-0-100µA	£2.60
500µA	£2.60
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60

Type SD.460 46mm x 59.5mm Fronts

50µA	£2.80
50-0-50µA	£2.80
100µA	£2.75
100-0-100µA	£2.75
500µA	£2.75
1mA	£2.75
50µA	£2.80
50-0-50µA	£2.80
100µA	£2.80
100-0-100µA	£2.75
500µA	£2.75
1mA	£2.75
50µA	£2.80
50-0-50µA	£2.80
100µA	£2.80
100-0-100µA	£2.75
500µA	£2.75
1mA	£2.75
50µA	£2.80
50-0-50µA	£2.80
100µA	£2.80
100-0-100µA	£2.75
500µA	£2.75
1mA	£2.75

Type MR.65P. 3 1/2 in. x 3 1/2 in. fronts

50µA	£3.70
50-0-50µA	£3.15
100µA	£3.15
100-0-100µA	£3.10
500µA	£3.15
500µA	£3.15
500-0-500µA	£3.10
1mA	£3.10
5mA	£3.10
10mA	£3.10
50µA	£3.70
50-0-50µA	£3.15
100µA	£3.15
100-0-100µA	£3.10
500µA	£3.15
500µA	£3.15
500-0-500µA	£3.10
1mA	£3.10
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50V. D.C.	£2.60
100V. D.C.	£2.60
300V. D.C.	£2.60
150V. D.C.	£2.60
300V. D.C.	£2.60
50mV. D.C.	£2.60
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30V. A.C.	£2.60
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50-0-50µA	£3.60
100µA	£3.60
100-0-100µA	£3.50
500µA	£3.50
200µA	£3.40
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50
500µA	£3.50
1mA	£3.50

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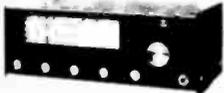
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General coverage 150-400 kc/s, 550 kc/s-30 mc/s, FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, 8 Meter Bandspread, RF Gain, 15in. x 9 1/2in. x 8 1/2in. 18 lb. 220/240 v. A.C. or 12 v. D.C. Brand new with instructions.

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4 bands covering 550 kc/s to 30 mc/s continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. 8SB-CW, ANL, Variable BFO. 8 meter. Sep. bandspread dial. 1F frequency 445 kc/s, audio output 1.5w. Variable RF and AF gain controls. 115/250 v. A.C. Size: 7in. x 13in. x 10in. with instruction manual.

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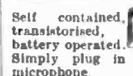
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Can be used with most hi fi amplifiers. Push button track selector and illuminated indicators. Attractive cabinet with black and silver trim. Output level 750mV. AC 220/240v.

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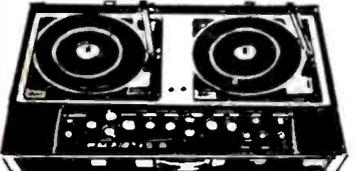
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